July 17, 1962 W. M. LEEDS ETAL 3,045,086

CIRCUIT INTERRUPTERS

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Fig. 1.

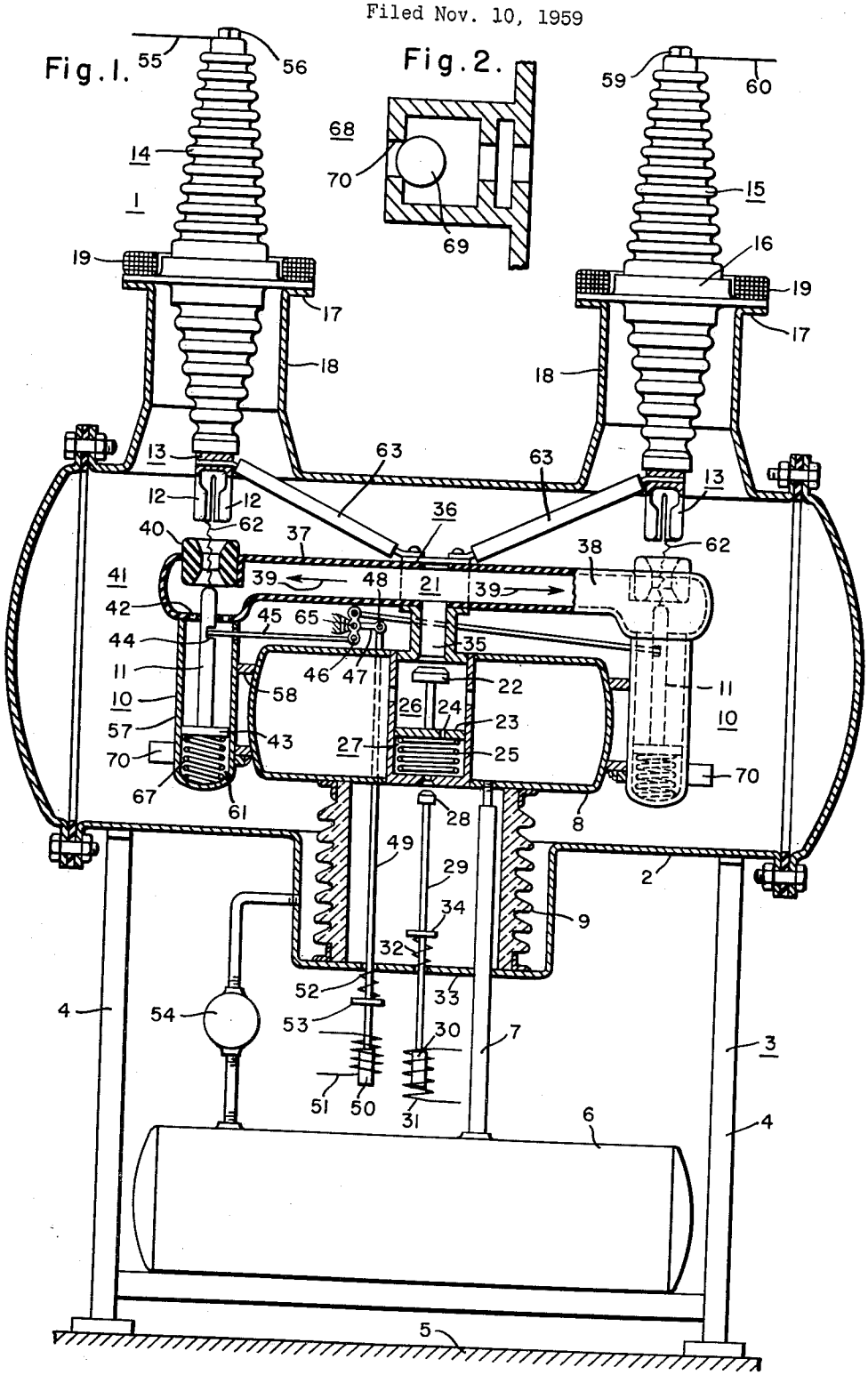


Fig. 2.

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CIRCUIT INTERRUPTERS

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This invention relates to circuit interrupters in general, and, more particularly, to compressed-gas circuit interrupters.

In United States patent application filed September 24, 1959, Serial No. 842,069, by Winthrop M. Leeds, and assigned to the assignee of the instant application, there is disclosed and claimed a novel compressed-gas circuit-interrupting structure, in which a metallic storage tank at high potential and containing gas at a relatively low pressure is supported in an upstanding manner by an insulating pedestal. A pair of terminal bushings extend downwardly into the high-potential, relatively low-pressure storage tank and carry relatively stationary contact structures at their interior ends. Disposed within the high-potential storage tank is a pair of serially related arc-extinguishing units, each of which has a movable contact, which is cooperable with one of the aforesaid relatively stationary contact structures.

Disposed interiorly within the outer high-potential exhaust tank of the structure is an interiorly disposed high-pressure storage tank, which conductively interrelates a pair of arc-extinguishing units. It is a general object of the present invention to improve upon the interrupting structure described in the aforesaid Leeds patent application, rendering it more adaptable for the use of ring-type current transformers on both terminals of the breaker, which may be used to provide overlapping differential relay protection.

The interrupting structure according to the present invention is in many respects similar to that of the aforesaid Leeds structure, but contains the advantage that a grounded, outer, metallic exhaust tank is provided, which, as mentioned, affords the distinct advantage of permitting the use of relatively inexpensive through-type current transformers on both terminals of the breaker for obtaining the desired differential relay protection of the interrupter. Another advantage of the present interrupting structure is that by the use of a suitable insulating support, the high-pressure storage tank, at high potential, is disposed interiorly within the outer grounded, metallic exhaust tank, resulting in the advantage that a readily available supply of high-pressure gas is immediately adjacent to the separable contact structures to result in an extremely high-speed circuit interrupter.

In United States patent application filed April 29, 1958, Serial No. 731,706, now United States Patent 3,033,962, issued May 8, 1962, to Robert E. Friedrich and Harry J. Lingal, and assigned to the assignee of the instant application, there is disclosed a horizontally-extended, grounded, metallic tank, into which extend a pair of terminal bushings. The terminal bushings support, in bridging manner, an arc-extinguishing assemblage involving a plurality of serially related arc-extinguishing units. A disadvantage of the Friedrich and Lingal interrupting structure is that in the open-circuit position, there are provided creepage breakdown paths between the lower interior ends of the terminal bushings by the presence of the arc-extinguishing assemblage. It is another object of the present invention to provide clear, free gaps between the separated contact structure in the open-circuit position to minimize adjacently disposed leakage paths, which may possibly be broken down, due to contamination, over long periods of operating time.

Another object of the present invention is the provision of an improved circuit interrupter, involving a high-pressure tank at high potential disposed interiorly within an outer, grounded, metallic exhaust tank, the high-pressure tank supporting a pair of serially related arc-extinguishing units, in which by the use of suitable balancing capacitor tubes, the voltage between the two arc-extinguishing units may be equally divided.

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

FIGURE 1 illustrates a side elevational view, partially in vertical section, taken through a compressed-gas circuit interrupter embodying the principles of the present invention, the contact structure and the blast-valve mechanism being illustrated in the fully open-circuit position; and,

FIG. 2 illustrates a detailed view of a ball-valve assembly, which may be associated with each arc-extinguishing unit to provide rapid reclosing of the contact structure.

Referring to the drawing, and more particularly to FIG. 1 thereof, the reference numeral **1** generally designates a circuit-interrupting structure generally including a grounded, metallic exhaust tank **2** filled with gas at a relatively low pressure. The exhaust tank **2** is supported in an upstanding manner, as illustrated in FIG. 1, by an upwardly extending, angle-iron framework, generally designated by the reference numeral **3**, and including upstanding supports **4** mounted upon a suitable base **5**.

A high-pressure storage tank **6** contains gas at a relatively high pressure, which is fed upwardly through a supply conduit **7**, which is preferably of insulating material, into a high-potential, interiorly disposed, high-pressure storage tank **8**. As shown, the high-pressure storage tank **8** is supported in insulating relationship with respect to the outer grounded tank **2** by an insulating column **9**.

Associated with the opposite ends of the conducting, high-potential, high-pressure storage tank **8** is a pair of of serially related arc-extinguishing units, generally designated by the reference numeral **10**.

Each of the arc-extinguishing units **10** includes a movable rod-shaped contact **11**, which is cooperable with a plurality of flexible relatively stationary finger contacts **12**, constituting collectively a relatively stationary contact structure **13**, carried at the lower extremity of each terminal bushing **14**, **15**. As shown, the terminal bushings **14** and **15** extend downwardly into the interior of the grounded exhaust tank **2**, and are supported, at the mid-flange portions **16** thereof, upon outwardly extending flange portions **17** of upstanding cylindrical portions **18** of the tank structure **2**.

Since the exhaust tank **2** and the supporting extensions **18** thereof are grounded, ordinary, inexpensive, through-type current transformers **19** may be employed on both terminals to result in the attainment of differential overlapping relay protection, as well known by those skilled in the art.

A blast-valve mechanism, generally designated by the reference numeral **21**, is provided, including a balanced-pressure blast valve **22**, operated by a valve piston **23** having an aperture **24** therethrough. A closing valve spring **25** is provided to effect reclosure of the blast valve **22** upon an equalization of the pressure within the regions **26**, **27** on opposite sides of the operating piston **23**.

A pilot valve **28** is operated by an insulating trip rod **29**, the latter being actuated in a vertical direction by an armature **30** and an associated energizing winding **31**. A compression spring **32**, disposed between a lower plate portion **33** of the tank **2** and a washer **34** fixed to the rod

29, biases the trip rod 29 in an upward direction to close the pilot valve 28.

From the foregoing description, it will be apparent that upon energization of the winding 31, the armature 30 will be moved downwardly against the biasing action exerted by the closing spring 32, and will effect opening of the pilot valve 28. The opening of the pilot valve 28 will lower the pressure within the region 27, below the operating valve piston 23, and will permit the high-pressure gas present within the region 26 to move the main blast valve 22 downwardly against the action exerted by the closing valve spring 25. The opening of the main blast valve 22 will permit the release of the high-pressure blast of gas out of the high-pressure tank 8 and through an opening 35 in a manifold structure 36, and through a pair of oppositely extending blast tubes 37, 38 in the manner indicated by the arrows 39.

Each of the arc-extinguishing units 10 has associated therewith an orifice structure 40, through which the blast of gas issues into the interior region 41 within the exhaust tank 2.

The blast of gas passing outwardly through the blast tubes 37, 38 will also pass through apertures 42 and act upon operating pistons 43 fixed to the lower ends of the movable contacts rods 11.

Preferably the movable contact rods 11 are latched in their fully open-circuit position following cessation of the gas blast. To effect this end, notches 44 are provided in the sides of the movable contact rods 11. The notches 44 cooperate with latching rods 45, which are pivotally connected, as at 46, to a doubled-arm-bell-crank lever 47, which is pivotally connected, as at 48, to a downwardly extending insulating closing rod 49. As was the case with the trip rod 29, the closing rod 49 has secured thereto an armature 50, and an associated energizing winding 51. A latching spring 52 is provided to bias the latching rods 45 in their latching direction. The latching spring 52 is disposed between a washer 53, fixed to and movable with the closing rod 49, and the lower side of the plate portion 33 of the tank 2.

A pump 54 is utilized to withdraw gas from the tank 2 and to recompress it to the high pressure employed within the high-pressure tank 6. The high-pressure tank pressure may attain the value of say 150 to 200 p.s.i., for example. The low pressure disposed within the region 41 of the exhaust tank 2 may, for example, be at a value of 30 to 45 pounds per square inch.

In the closed-circuit position of the interrupter 1, the electrical circuit passing therethrough includes transmission line 55, terminal stud 56, relatively stationary contact structure 13, movable contact rod 11, conducting operating piston 43, through the walls of the operating cylinder 57 and through conducting supports 58, through conducting high-pressure tank 8, to the right-hand arc-extinguishing unit 10, whence the circuit passes, in a similar manner, to the outer terminal stud 59 of the terminal bushing 15 and to the transmission line 60.

To effect the opening of the circuit interrupter 1, the tripping solenoid 31 is energized. Through the downward movement of the insulating trip bar 29, the pilot valve 28 is opened, to dump the pressure below the blast-valve operating piston 23. The blast valve 22 moves downwardly, against the biasing action exerted by the compression spring 25, to permit the blast of gas to exhaust outwardly, in the direction indicated by the arrows 39, toward the orifice structures 40.

The gas blast passes through each orifice structure 40 and through apertures 42 into the operating cylinder 57 to act downwardly upon the contact operating piston 43. The operating piston 43 moves downwardly in opposition to the biasing action exerted by the closing spring 61, drawing an arc 62, the location of which is shown in FIG. 1 for clarity, even though said figure illustrates the parts in the fully open-circuit position.

At the end of the opening movement of the movable contact rods 11, the notches 44 are in alignment with the latching rods 45, and due to the latching spring 52 the latching rods 45 are moved into the notches to latch the movable contact rods 11 in their fully open-circuit position, as illustrated in FIG. 1.

The circuit arrangement, not shown, for energizing the tripping solenoid 31 is such as to become de-energized slightly prior, or substantially simultaneously with the time of arc extinction, so that the blast valve 22 will be closed at the time of circuit interruption.

The closure of the pilot valve 28, will, of course, permit high-pressure gas to leak through the aperture 24 and into the region 27 below the operating piston 23. Upon an equalization of the pressures within the regions 26, 27, the valve closing spring 25 will effect reclosure of the blast valve 22. This will cut off the blast of gas passing through the blast tubes 37, removable contacts 11 having previously been latched in the open-circuit position.

It will be noted that in the open-circuit position of the interrupter 1, an isolating gap exists between the separated contact structure 11, 13 and there are no insulating surfaces located between the contact structures 13, which would be subject to creepage break down following long operational life due to the accumulation of partially conducting surface deposits. When a high-dielectric strength gas, such as sulfur hexafluoride (SF_6) gas is used, a small free gap will withhold considerable voltage. It may, however, be necessary to employ voltage dividing capacitor tubes 63 to equally distribute the voltage between the arc-extinguishing units 10, so that both arc-extinguishing units interrupt their full share of the associated voltage.

The presence of the conducting structure associated with the arc-extinguishing units 10 and the high-pressure storage tanks 8 within the grounded, outer, exhaust tank 2, due to capacitive effects tends to result in an unequal distribution of voltage between the arc-extinguishing units 10, and the provision of the voltage-dividing capacitor tubes 63 will overshadow this slight unbalance. As a result, the voltage is divided susbtantially equally between the arc-extinguishing units 10.

To effect closing of the circuit through the circuit interrupter 1, it is merely necessary to energize the solenoid 51. The energization of the solenoid 51 will effect upward movement of the armature 50, and consequently upward movement of the insulating latch rod 49. The upward movement of the latch rod 49 will effect counter-clockwise rotation of the double-arm, bell-crank lever 48 about its center 65, to effect thereby withdrawing of the latch rods 45 from the notches 44. The closing spring 61 will then immediately effect reclosing of the contact structure. To prevent cavitation occurring within the region 67, within the operating cylinder 57 below the operating piston 43, ball-valve structures, generally designated by the reference numeral 68 and shown more clearly in FIG. 2 of the drawings, are employed.

With reference to FIG. 2, it will be noted that a ball valve 69 closes an opening 70, and opening of the valve structure 68 permits fast upward closing movement of the contact piston 43. As a result, there occurs no suction below the contact piston 43 in the region 67 within operating cylinder 57. Rapid contact closing motion is thereby achieved.

From the foregoing description, it will be apparent that we have provided an improved circuit-interrupting structure 1, in which an outer, grounded, metallic exhaust tank 2 is employed with which ordinary terminal bushinngs 14, 15 and inexpensive through-type current transformers 19 may be employed.

Clear breaks are provided in the open-circuit position of the interrupter, so that partially contaminated surfaces will not result in voltage breakdown in the open-circuit position of the interrupter.

The high-pressure reservoir 8 is provided at high potential, being fed from a reservoir 6 at ground potential, to give minimum interrupting time under fault conditions.

Tripping of the interrupter **1** is accomplished by energizing the trip coil **31**, which pulls open the pilot valve **28**, and dumps the pressure behind the main blast valve **22**. The main blast valve **22** consequently opens very quickly sending high-pressure arc-extinguishing gas, such as sulphur hexafluoride (SF_6) gas to the moving contact pistons **43** and through the orifice **40**, through which the arcs **62** are drawn and extinguished. The holding latches **45** are provided to keep the moving contacts **11** open when the blast valve **22** closes and pressure is removed. To close the interrupter **1**, the closing coil **51** is energized, which pulls down the insulating rod **49**, operating a linkage which releases the two contact-holding latches **45** simultaneously, allowing the contact springs **61** to close the contacts **11**. An important advantage of the present invention is the elimination of a separate mechanism to operate the contacts.

Although there has been shown and described a particular form of a compressed-gas circuit interrupter embodying the principles of the present invention, 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 as our invention:

1. A compressed-gas circuit interrupter including a grounded metallic exhaust tank filled with gas at a relatively low pressure, a pair of terminal bushings extending into said grounded metallic tank and carrying relatively stationary contacts at their interior ends, a conducting high-pressure storage tank disposed within said grounded exhaust tank, insulating means for supporting said conducting high-pressure storage tank in insulating relationship with respect to said grounded exhaust tank, a pair of arc-extinguishing units disposed adjacent the ends of the high-pressure storage tank and at least partially supported thereby, each arc-extinguishing unit having a movable contact cooperable with one of the aforesaid relatively stationary contacts to establish an arc, and blast-valve means associated with the high-pressure storage tank to release a blast of gas from the high-pressure storage tank and toward the drawn arcs to effect their extinction.

2. A compressed-gas circuit interrupter including a grounded metallic exhaust tank filled with gas at a relatively low pressure, a pair of terminal bushings extending into said grounded metallic tank and carrying relatively stationary contacts at their interior ends, a conducting high-pressure storage tank disposed within said grounded exhaust tank, insulating means for supporting said conducting high-pressure storage tank in insulating relationship with respect to said grounded exhaust tank, a pair of arc-extinguishing units disposed adjacent the ends of the high-pressure storage tank, and at least partially supported thereby, each arc-extinguishing unit having a movable contact cooperable with one of the aforesaid relatively stationary contacts to establish an arc, blast-valve means associated with the high-pressure storage tank to release a blast of gas from the high-pressure storage tank and toward the drawn arcs to effect their extinction, the blast-valve means including a balanced-pressure blast valve and a pilot valve, and means extending through the wall of the grounded exhaust tank for operating the pilot valve at ground potential.

3. A compressed-gas circuit interrupter including a grounded metallic exhaust tank filled with gas at a relatively low pressure, a pair of terminal bushings extending into said grounded metallic tank and carrying relatively stationary contacts at their interior ends, a conducting high-pressure storage tank disposed within said grounded exhaust tank, insulating means for supporting said conducting high-pressure storage tank in insulating relationship with respect to said grounded exhaust tank, a pair of arc-extinguishing units disposed adjacent the ends of the high-pressure storage tank and at least partially supported

thereby, each arc-extinguishing unit having a movable contact cooperable with one of the aforesaid relatively stationary contacts to establish an arc, blast-valve means associated with the high-pressure storage tank to release a blast of gas from the high-pressure storage tank and toward the drawn arcs to effect their extinction, and means latching the movable contacts in the open-circuit position upon cessation of the gas blast.

4. A compressed-gas circuit interrupter including a grounded metallic exhaust tank filled with gas at a relatively low pressure, a pair of terminal bushings extending into said grounded metallic tank and carrying relatively stationary contacts at their interior ends, a conducting high-pressure storage tank disposed within said grounded exhaust tank, insulating means for supporting said conducting high-pressure storage tank in insulating relationship with respect to said grounded exhaust tank, a pair of arc-extinguishing units disposed adjacent the ends of the high-pressure storage tank and at least partially supported thereby, each arc-extinguishing unit having a movable contact cooperable with one of the aforesaid relatively stationary contacts to establish an arc, blast-valve means associated with the high-pressure storage tank to release a blast of gas from the high-pressure storage tank and toward the drawn arcs to effect their extinction, means latching the movable contacts in the open circuit position upon cessation of the gas blast, and a mechanical linkage operating through the wall of the grounded exhaust tank to effect release of the latching means to effect thereby reclosure of the separable contacts.

5. A compressed-gas circuit interrupter including a grounded metallic exhaust tank filled with gas at a relatively low pressure, a pair of terminal bushings extending into said grounded metallic tank and carrying relatively stationary contacts at their interior ends, a conducting high-pressure storage tank disposed within said grounded exhaust tank, insulating means for supporting said conducting high-pressure storage tank in insulating relationship with respect to said grounded exhaust tank, a pair of arc-extinguishing units disposed adjacent the ends of the high-pressure storage tank and at least partially supported thereby, each arc extinguishing unit disposed adjacent the ends of the high-pressure storage tank, each arc-extinguishing unit having a movable contact cooperable with one of the aforesaid relatively stationary contacts to establish an arc, an orifice structure associated with each arc-extinguishing unit through which the arc is drawn, and blast-valve means associated with the high-pressure storage tank to release a blast of gas from the high-pressure storage tank and toward the drawn arcs to effect their extinction.

6. The combination in a compressed-gas circuit interrupter of a grounded metallic exhaust tank, a pair of terminal bushings extending downwardly into said grounded metallic exhaust tank and carrying a pair of relatively stationary contacts at their interior ends, a pair of movable contacts cooperable with said pair of relatively stationary contacts, means including a metallic conducting high-pressure storage tank at high potential for electrically interconnecting the two movable contacts in series, insulating support means for supporting the high pressure, high-potential storage tank in insulating relationship with respect to the outer grounded metallic exhaust tank, and blast valve means for releasing a blast of gas from the interiorly disposed high-pressure storage tank toward the two established arcs drawn between the separable contacts to effect their extinction.

7. The combination in a compressed-gas circuit interrupter of a grounded metallic exhaust tank, a pair of terminal busings extending downwardly into said grounded metallic exhaust tank and carrying a pair of relatively stationary contacts at their interior ends, a pair of movable contacts cooperable with said pair of relatively stationary contacts, means including a metallic conducting high-

pressure storage tank at high potential for electrically interconnecting the two movable contacts in series, insulating support means for supporting the high-pressure high-potential storage tank in insulating relationship with respect to the outer grounded metallic exhaust tank, and blast valve means including a balanced-pressure blast valve and a dumping pilot valve for releasing a blast of gas from the interiorly disposed high-pressure storage tank toward the two established arcs drawn between the separable contacts to effect their extinction.

8. The combination in a compressed-gas circuit interrupter of a grounded metallic exhaust tank, a pair of terminal bushings extending downwardly into said grounded metallic exhaust tank and carrying a pair of relatively stationary contacts at their interior ends, a pair of movable contacts cooperable with said pair of relatively stationary contacts, means including a metallic conducting high-pressure storage tank at high potential for electrically interconnecting the two movable contacts in series, insulating support means for supporting the high-pressure, high-potential storage tank in insulating relationship with respect to the outer grounded metallic exhaust tank, blast valve means for releasing a blast of gas from the interiorly disposed, high-pressure storage tank toward the two established arcs drawn between the separable contacts to effect their extinction, and latching means for latching the movable contacts in the open-circuit position.

9. The combination in a compressed-gas circuit interrupter of a grounded metallic exhaust tank, a pair of terminal bushings extending downwardly into said grounded metallic exhaust tank and carrying a pair of relatively stationary contacts at their interior ends, a pair of movable contacts cooperable with said pair of relatively stationary contacts, means including a metallic conducting high-pressure storage tank at high potential for electrically interconnecting the two movable contacts

in series, insulating support means for supporting the high-pressure, high-potential storage tank in insulating relationship with respect to the outer grounded metallic exhaust tank, an orifice structure associated with each movable contact through which the arc is drawn, a blast tube leading to each orifice structure, and blast-valve means for releasing a blast of gas from the interiorly disposed high-pressure storage tank toward the two established arcs drawn between the separable contacts to effect their extinction.

10. The combination in a compressed-gas circuit interrupter of a grounded metallic exhaust tank, a pair of terminal bushings extending downwardly into said grounded metallic exhaust tank and carrying a pair of relatively stationary contacts at their interior ends, a pair of movable contacts cooperable with said pair of relatively stationary contacts, means including a metallic conducting high-pressure storage tank at high potential for electrically interconnecting the two movable contacts in series, insulating support means for supporting the high-pressure, high-potential storage tank in insulating relationship with respect to the outer grounded metallic exhaust tank, an orifice structure associated with each movable contact through which the arc is drawn, a blast tube leading to each orifice structure, and blast-valve means for releasing a blast of gas from the interiorly disposed high-pressure storage tank toward the two established arcs drawn between the separable contacts to effect their extinction, and latching means for latching the movable contacts in the open circuit position.

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