June 28, 1966 R. E. FRINK 3,258,569

TRUCK-MOUNTED COMPRESSED-GAS CIRCUIT INTERRUPTER WITH TANK-ENCLOSED INTERRUPTING UNITS AND BLAST TUBES IN SPACED VERTICAL PLANES

Filed Feb. 15, 1961 6 Sheets-Sheet 1

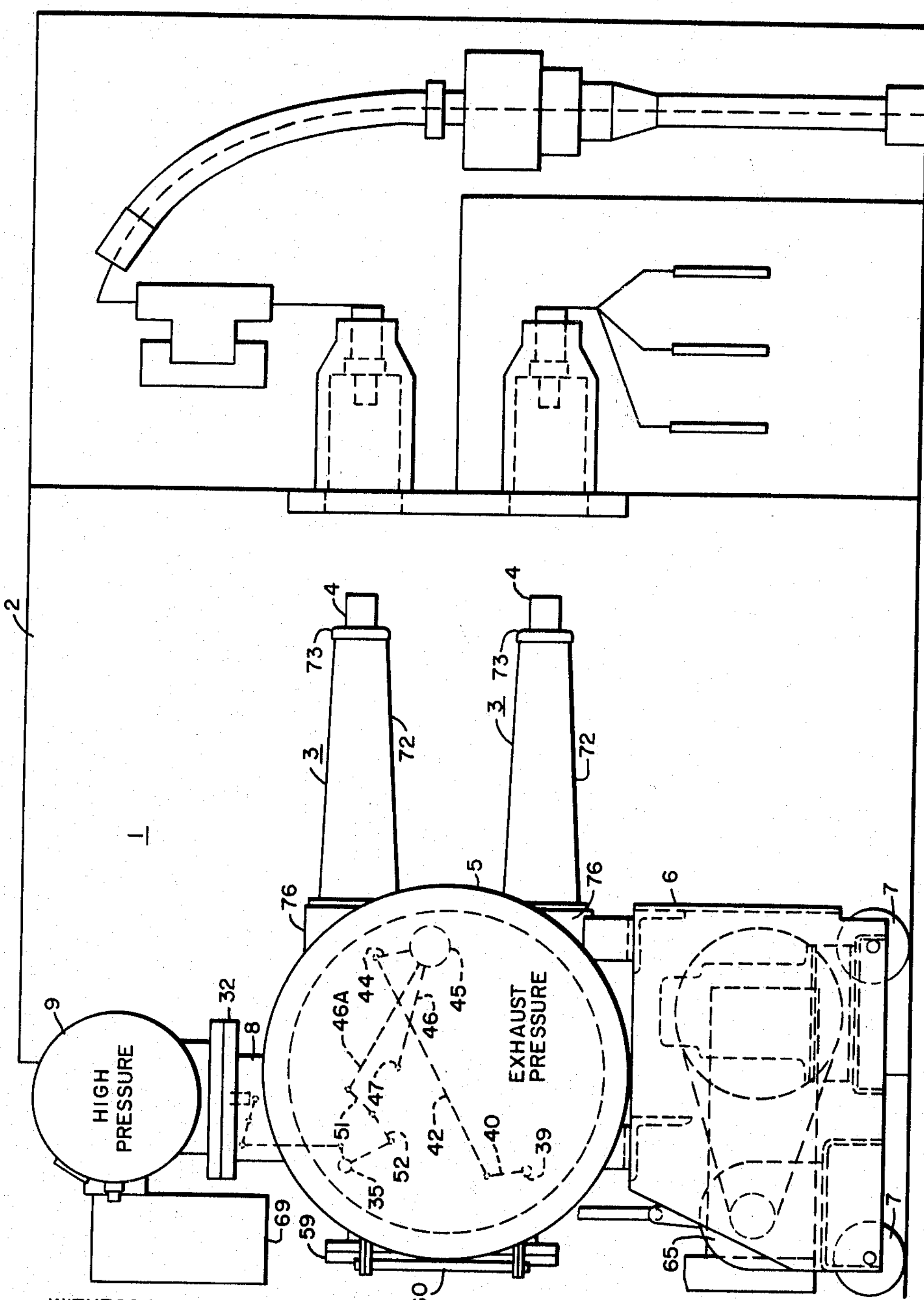

Fig.1.

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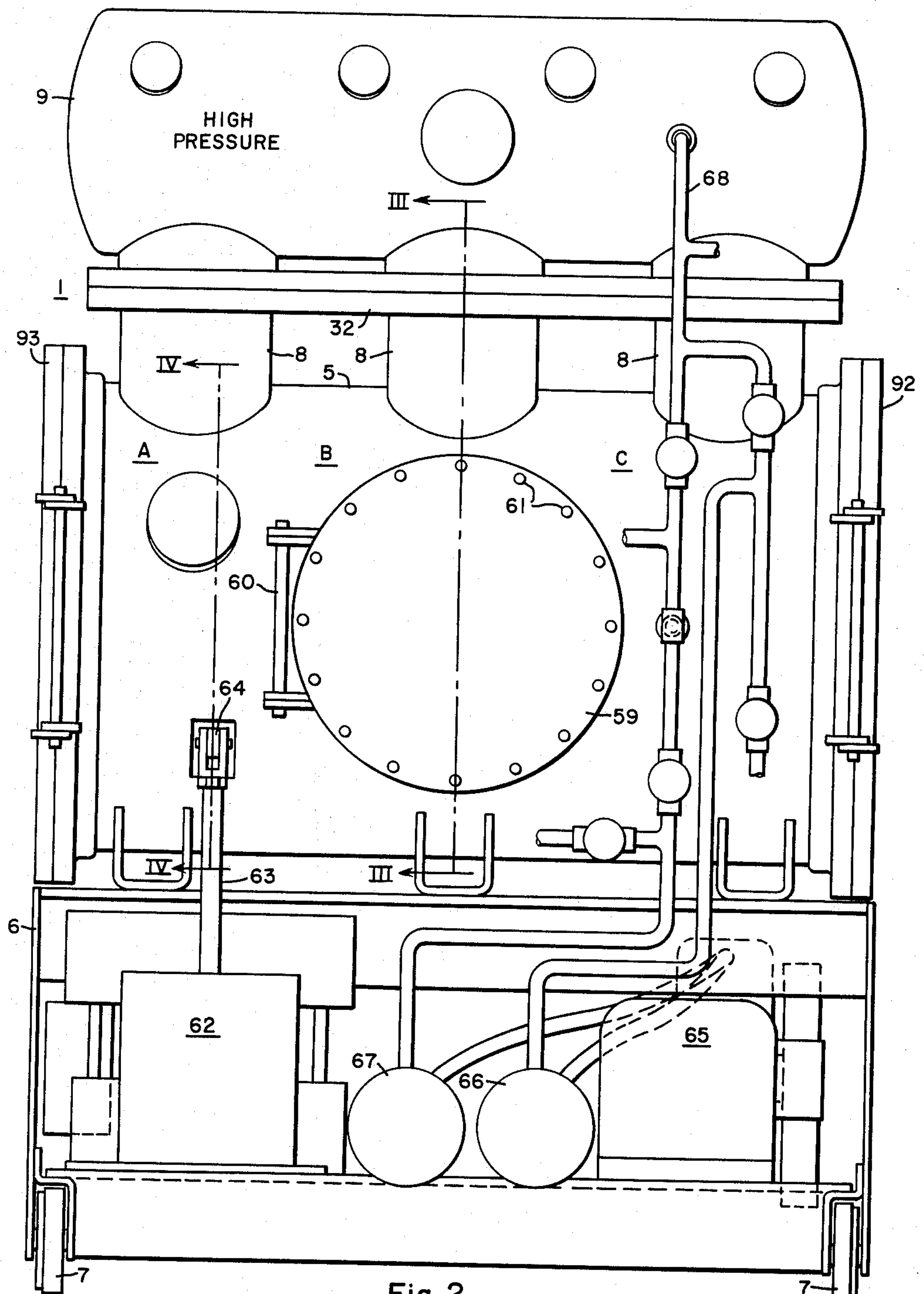
9
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Fig. 2.

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TRUCK-MOUNTED COMPRESSED-GAS CIRCUIT INTERRUPTER WITH TANK-ENCLOSED INTERRUPTING UNITS AND BLAST TUBES IN SPACED VERTICAL PLANES

Filed Feb. 15, 1961

6 Sheets-Sheet 3

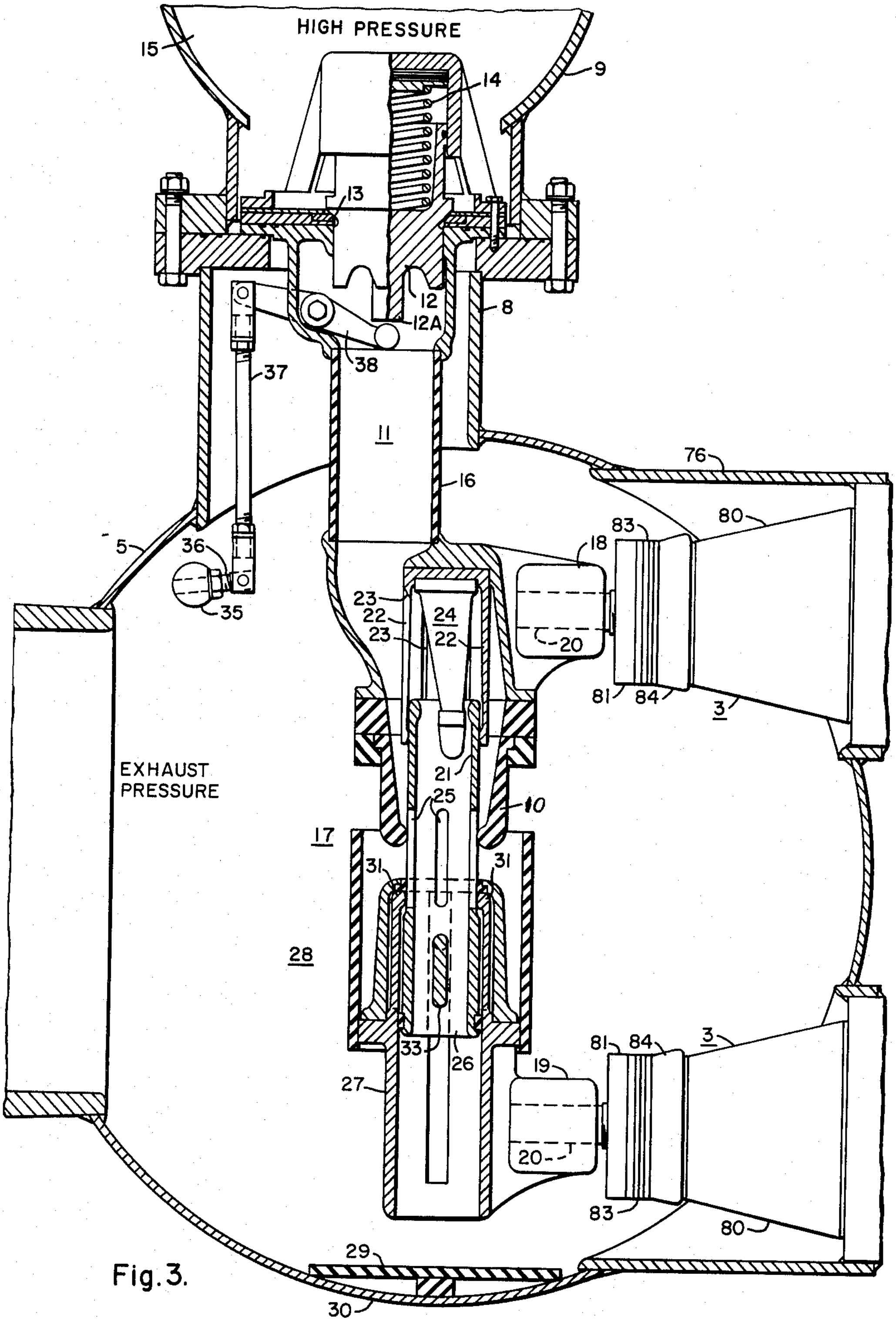


Fig. 3.

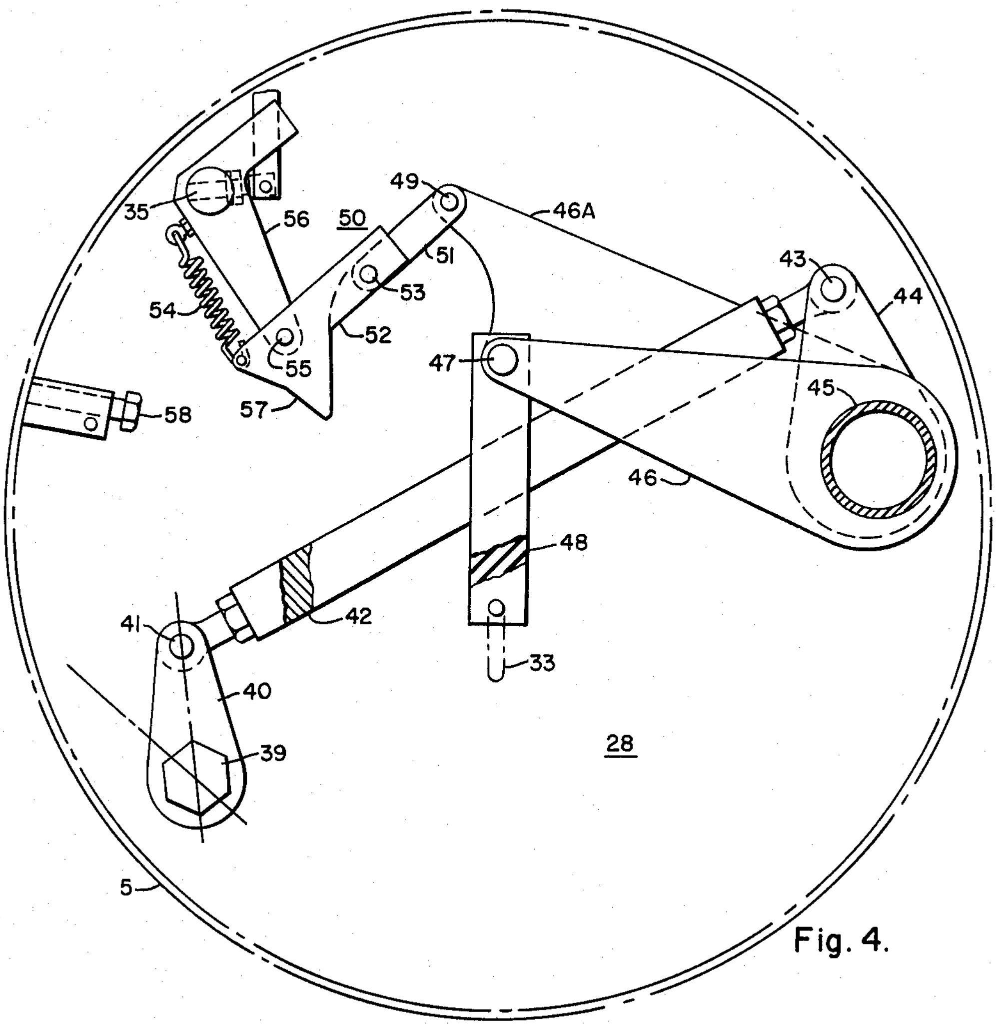
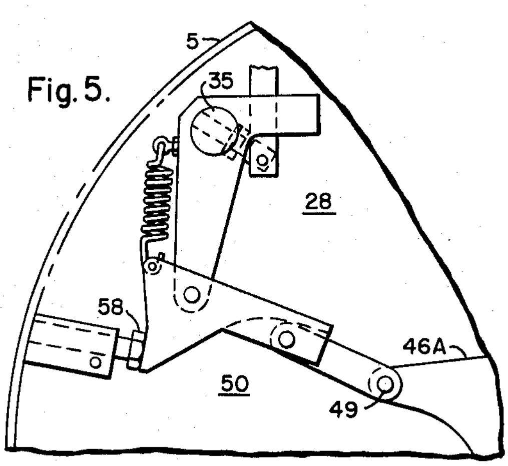


Fig. 4.

Fig. 5.



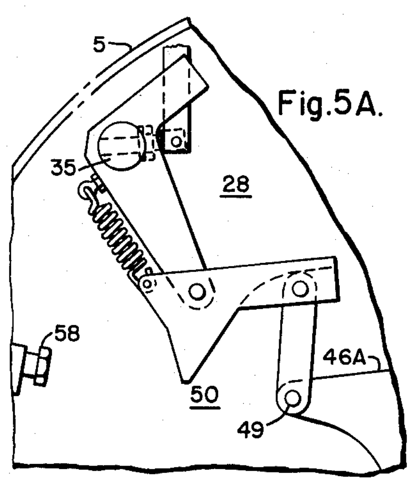


Fig. 5A.

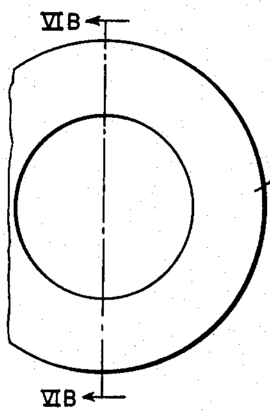


Fig. 6A.

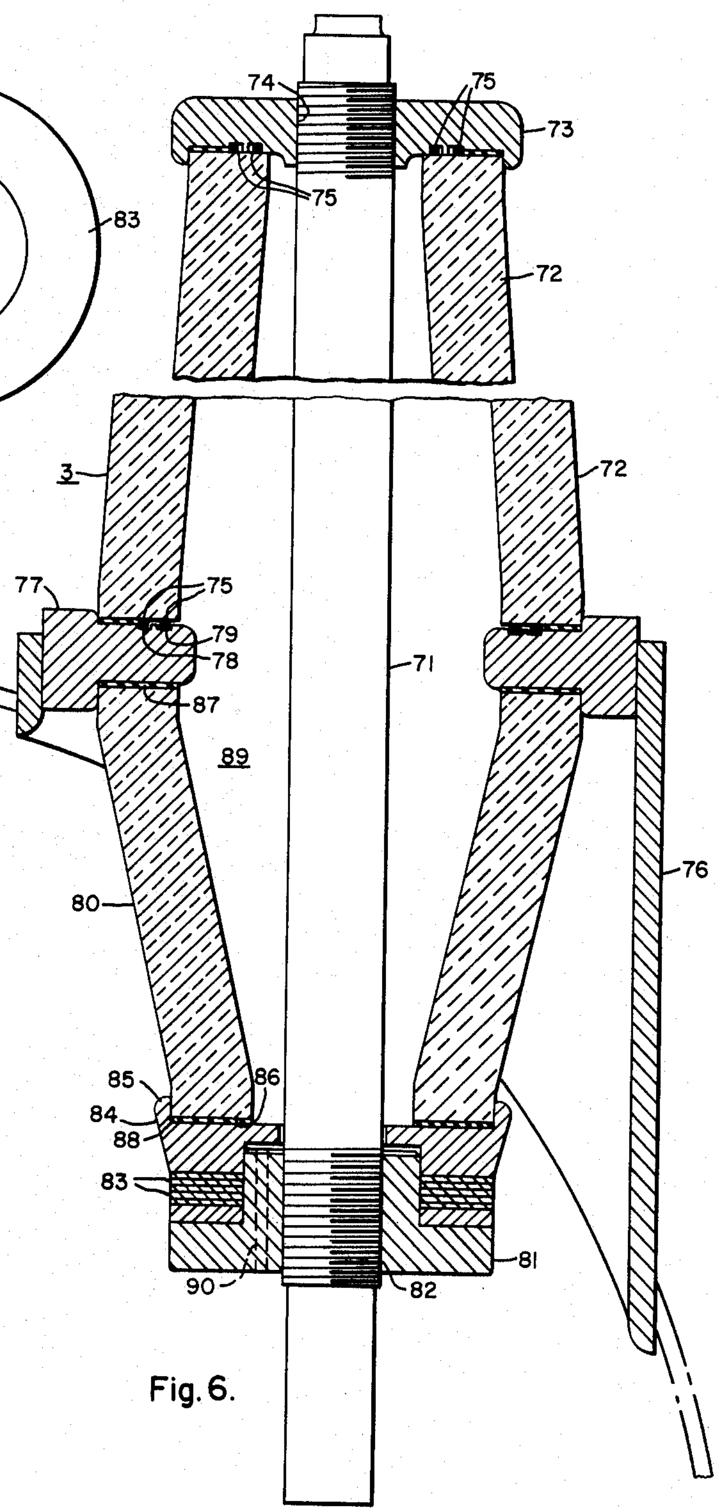


Fig. 6.

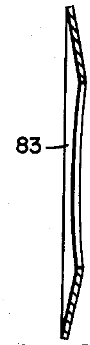


Fig. 6B.

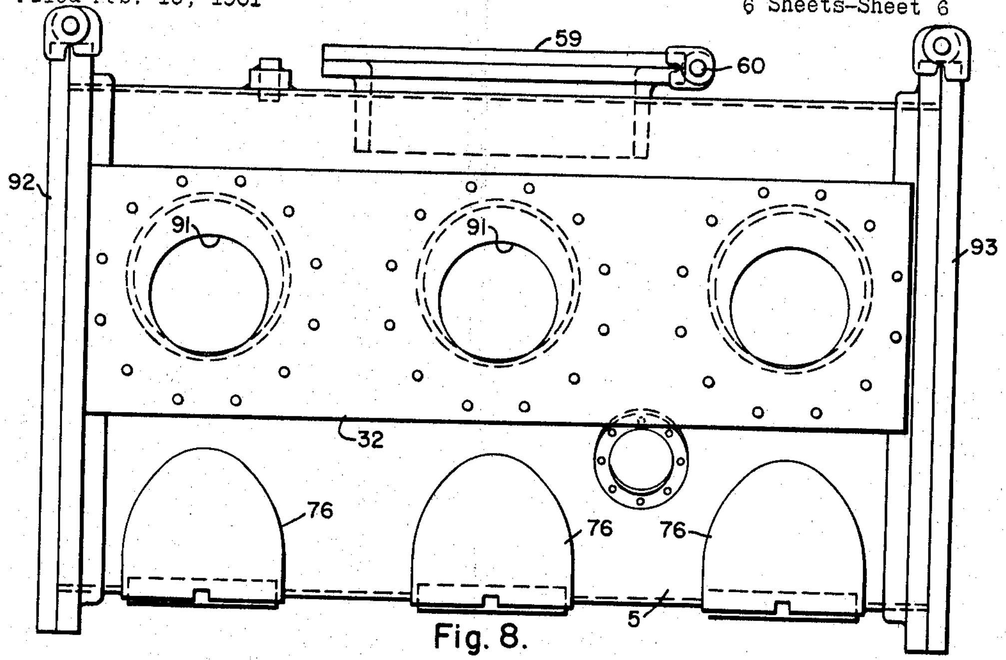


Fig. 8.

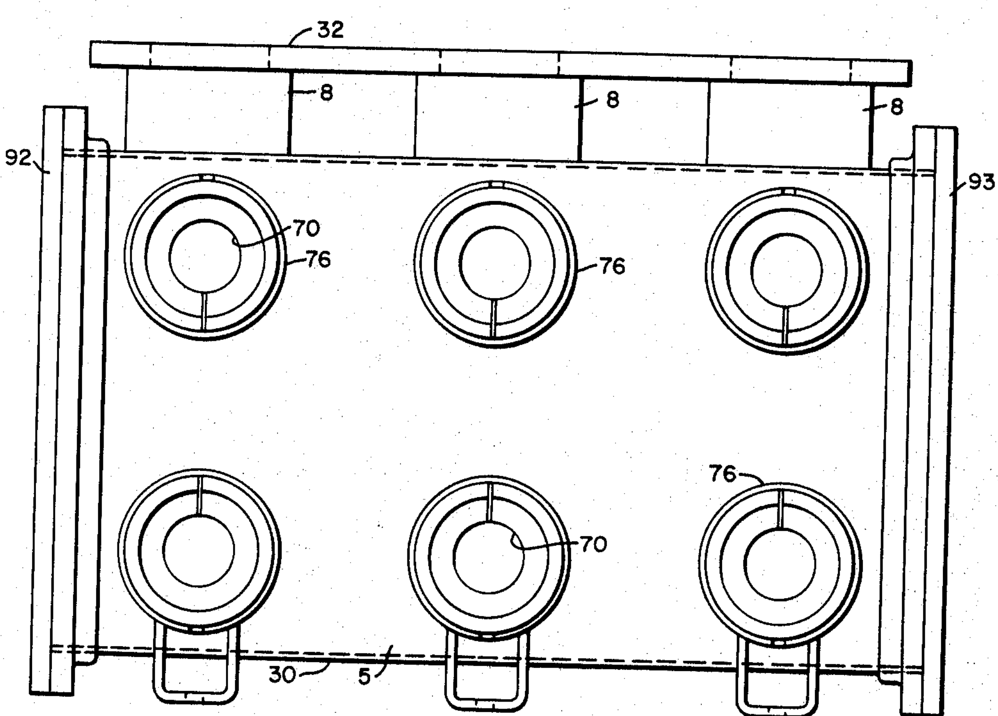


Fig. 7.

3,258,569

TRUCK-MOUNTED COMPRESSED-GAS CIRCUIT INTERRUPTER WITH TANK-ENCLOSED INTERRUPTING UNITS AND BLAST TUBES IN SPACED VERTICAL PLANES

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Filed Feb. 15, 1961, Ser. No. 89,496
10 Claims. (Cl. 200—148)

This invention relates to circuit interrupters in general, and, more particularly, to circuit interrupters of the gas-blast type.

A general object of the invention is to provide an improved compressed-gas circuit interrupter of compact dimensions and of highly efficient operation.

Another object of the invention is to provide an improved compressed-gas circuit interrupter adaptable for moving into and out of metal-clad switchgear.

Still a further object of the present invention is to provide an improved compressed-gas circuit interrupter having a closed gaseous system in which compressed-gas is utilized for arc-extinguishing purposes and is subsequently recompressed and stored for further operations in the same interrupter. In other words, the closed gaseous system conserves gas and enables its more efficient use.

A further object of the present invention is to provide a three-pole compressed-gas circuit interrupter utilizing a single grounded tank arrangement, in which the interrupter is particularly suitable for lateral rolling motion into metal-clad switchgear.

Another object of the invention is to provide an improved operating mechanism for a compressed-gas circuit interrupter.

An ancillary object of the present invention is to provide an improved blast-valve operating mechanism for ensuring simultaneous blast-valve action for a plurality of pole-units.

Still a further object of the present invention is to provide an improved operating mechanism for a compressed-gas circuit interrupter involving improved toggle-linkage means for actuating the blast valves at a desired point in the opening operation.

Still a further object of the present invention is the provision of an improved compressed-gas circuit interrupter of the type set forth in the immediately preceding paragraph in which improved means are provided to effect collapse of the toggle linkage at a predetermined point in the opening operation of the interrupter.

Another object of the present invention is to provide an improved terminal-bushing construction suitable for tank mounting, in which a highly efficient dielectric gas is employed as the arc-extinguishing and dielectric medium within the tank structure.

In United States patent application filed October 7, 1960, Serial No. 61,284, by Robert G. Colclaser, Jr., and Russell N. Yeckley, there is disclosed and claimed a novel type of interrupting unit, which is highly efficient in operation. The improved interrupting structure described in the aforesaid patent application was particularly devised for operation in a high-power circuit interrupter utilizing a plurality of such units in a grounded metallic tank structure. It is a further object of the present invention to utilize the advantageous features of such an arc-interrupting unit, employing only a single unit, and adapting the same for a three-pole operation with metal-clad switchgear.

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

FIGURE 1 is a side elevational view of a three-pole

compressed-gas circuit interrupter embodying features of the present invention, and diagrammatically illustrated in the closed-circuit position;

FIG. 2 is a front elevational view of the compressed-gas circuit interrupter of FIG. 1;

FIG. 3 is a vertical sectional view taken substantially along the line III—III of FIG. 2 illustrating the interrupting features with the contacts and blast valve being illustrated in the closed position;

FIG. 4 is a sectional view taken substantially along the line IV—IV of FIG. 2, and illustrating the operating linkage in the closed-circuit position;

FIG. 5 is a fragmentary view, somewhat similar to FIG. 4, but illustrating the position of the several linkage parts at a predetermined point in the opening operation, effecting blast-valve closure;

FIG. 6 is a longitudinal sectional view taken through the improved terminal bushing construction of the present invention;

FIG. 7 is a rear view of the main exhaust tank structure; and

FIG. 8 is a top plan view of the tank structure of FIG. 7.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral **1** generally designates a compressed-gas circuit interrupter adapted for lateral movement into an enclosed switchgear cell, such as represented by the reference numeral **2**. Preferably the compressed-gas circuit interrupter **1** is of three-pole construction, such as illustrated in FIG. 2, involving thereby three pairs of terminal bushings **3** having disconnect fingers **4** at their extremities. The terminal bushings **3** extend interiorly within a grounded cylindrically-shaped tank structure **5**, which is mounted upon a mechanism housing **6**.

As illustrated in FIG. 1, the interrupting assemblage is mounted upon wheels **7**, and adapted for lateral movement into the cubicle **2** for operatively controlling the connected circuit.

As more clearly illustrated in FIG. 2, the horizontally-extending cylindrically-shaped tank structure **5** has a plurality of neck portions **8**, which communicate with a high-pressure reservoir tank **9**. Preferably a suitable highly-effective arc-extinguishing gas, such as sulfur-hexafluoride (SF_6) gas, is stored within the high-pressure tank, say at a pressure of 150 p.s.i.

With reference to FIG. 3 of the drawings, it will be noted that disposed within the neck portion **8** of the tank structure **5** is a blast-valve mechanism, generally designated by the reference numeral **11**. The blast-valve mechanism **11** generally comprises a blast valve **12** making a seating engagement at a blast valve seat **13**, and biased downwardly, in the closed direction, by a biasing spring **14**. It will be obvious that upward opening motion of the blast valve **12** will permit a blast of compressed gas **15**, such as sulfur-hexafluoride (SF_6) gas to flow downwardly through the blast valve **12**, and downwardly through an insulating blast tube **16** into an interrupting unit, generally designated by the reference numeral **17**.

As illustrated in FIG. 3, the interrupting unit **17** is supported by clamps **18** and **19** to the inner extremities **20** of the terminal bushings **3**. A movable tubular contact **21** separates downwardly away from a plurality of segmental finger contacts **22** to draw an arc therebetween. The gas blast passing downwardly through the insulating blast tube **16** passes through openings **23** associated with the finger contacts **22**, and forces the established arc off of the finger contacts **22** and onto an arcing horn, designated by the reference numeral **24**. An insulating orifice structure **10** closely confines the movable tubular contact **21** to direct the gas blast therethrough.

Preferably slots 25 are provided in the movable tubular contact 21 to permit lateral exhausting of the arced gas therefrom during the interrupting operation. Also it will be noted that the lower extremity of the movable tubular contact 21 is open, as at 26, to permit the exhausting of gas out through a tubular guide 27, and into the general interior 28 of the tank structure 3.

To prevent the hot arc gases striking the walls of the tank 5, and possibly causing flashover therebetween, preferably an insulating barrier 29 is provided to cool the exhausted arc gases, and to provide insulation between these gases and the lower wall 30 of the tank 5.

As shown in FIG. 3, the movable tubular contact 21 makes sliding contacting engagement with a plurality of annularly-disposed finger contacts 31, which, in turn, are connected by suitable means to the lower support clamp 19. Generally, the circuit which passes through the circuit interrupter includes, for each pole thereof, the two terminal bushings 3, the clamps 18 and 19 and the separable contact structure 21, 22.

To effect the opening operation of each pole of the circuit interrupter suitable means, more particularly described hereinafter, is operable to effect downward movement of a driving pin or brace 33, which passes laterally through the side walls of the movable contact 21.

Simultaneously with downward opening movement of the drive pin 33 there occurs clockwise rotation of a blast-valve shaft 35. To a plurality of crank-arms 36 and links 37 a first crank 38, associated with each of the three blast valves 12 is operable to force the blast-valve stem 12A in an upward opening direction. The opening of the three blast valves 12 will cause the opening blast of arc-extinguishing gas to pass into the interrupting units in the manner previously described to effect arc extinction therein.

With reference to FIG. 4 of the drawings, it will be observed that there is provided a drive shaft 39 which extends externally of the tank structure 5, and is operated by a suitable mechanism, which, for example, may be of the solenoid type.

The opening and closing movement of the drive shaft 39 effects corresponding movement of a crank arm 40, which is fixed to and rotatable with the drive shaft 39.

Pivotally connected, as at 41, to the arm 40 is an insulating link 42, which is pivotally connected, as at 43, to a crank-arm 44. The crank-arm 44 causes the rotative opening and closing movement of an internal drive shaft 45 to which is fixed a plurality, for instance, six contact arms 46. Preferably a pair of contact arms 46 is associated with each of the pole-units A, B or C of the circuit interrupter 1.

Pivotally connected, as at 47, to the free extremities of the crank-arms 46 are insulating links 48, the lower extremities of which are pivotally connected to the drive pins 33 associated with the interrupting units 17.

From the foregoing description, it will be apparent that counterclockwise opening rotative movement of the drive shaft 39, as effected by the external driving mechanism, is effective to cause, through the link 42, corresponding counterclockwise rotative opening movement of the internal drive shaft 45. The counterclockwise opening rotative movement of the internal drive shaft 45, in turn, effects counterclockwise opening movement of the several crank-arms 46. Since each pair of crank arms 46 is connected by way of the insulating links 48 to a drive pin 33, the respective movable contact 21 will consequently be forced downwardly in an opening direction, drawing an arc, which is extinguished in the manner described hereinbefore.

One of the arms 46 is slightly longer than the other, and is herein designated by the reference numeral 46A. The crank arm 46A has pivotally connected thereto, at the outer free end thereof, as at 49, a collapsible toggle-linkage, generally designated by the reference numeral 50. Normally, the toggle linkage 50 is in a slightly overset position, as illustrated in FIG. 4 of the drawings.

More specifically, the thrust toggle linkage comprises a pair of toggle links 51, 52 pivotally connected by a knee pin 53, and biased by a tension spring 54 to an over-set position. The toggle link 52 is preferably connected, as at 55, to a crank-arm 56, which effects clockwise rotation of the blast-valve shaft 35.

To effect collapse of the thrust toggle linkage 50, the thrust link 52 has a projection 57, which strikes against an adjustable stop 58 at a predetermined point in the opening operation of the interrupter 1. When this occurs, the toggle linkage 50 will be broken against the force of tension spring 54, power being supplied by the opening mechanism. The several blast valves 12 will then close due to the biasing action exerted by the several closing springs 14.

The toggle linkage 50 remains in the collapsed position in the open-circuit position of the interrupter. During the closing operation, however, the thrust toggle linkage 50 is straightened by the biasing spring 54, and by the time the linkage 50 has reached its closed position, as illustrated in FIG. 4, the thrust toggle linkage 50 is again in its slightly overset position.

To facilitate maintenance work on the circuit interrupter 1, preferably an access door 59 is provided, as shown more clearly in FIG. 2 of the drawings. This door 59 is hinged by a vertical hinge pin 60, and is secured to its closed position by a plurality of bolts 61. FIGURE 2 also illustrates the solenoid mechanism 62, which actuates the operating rod 63 connected to the external crank-arm 64. As mentioned hereinbefore, the external crank-arm 64 is keyed to the main drive shaft 39.

The mechanism compartment 6 houses a compressor motor 65, a high-pressure filter 66, a low-pressure filter 67 and suitable piping for permitting relatively low-pressure gas from the interior of the tank structure 5 to be recompressed by the compressor motor 65, and forced under pressure, by way of the high-pressure intake 68, back into the upper high-pressure tank 9 for subsequent reuse.

Fixedly secured to the front of the high-pressure tank 9 is a pressure and temperature control panel 69 which encloses various control switches for the mechanism.

FIG. 7 illustrates the openings 70, which are provided at the rear of the tank structure 5 to support the laterally extending pairs of terminal bushings 3. Each of these terminal bushings 3 is of the construction illustrated in FIG. 6 of the drawings. As shown in FIG. 6, each terminal bushing 3 comprises a centrally-disposed longitudinally-extending conductor stud 71, enclosed by an external weatherproof shell 72 composed of a suitable weatherproof material, such as porcelain. A cap 73 is disposed at the outer free end of the terminal bushing 3, and preferably has a threaded and brazed connection with the outer extremity of the conductor stud 71, as shown at 74. Preferably "O" rings provide gasket seals, as at 75 to prevent any leakage of the sulfur-hexafluoride (SF_6) gas, which is present within the tank structure 5.

It is to be observed that the tank 5 is provided with supporting shells 76 having welded thereto a support ring 77. A pair of annular grooves 78, 79, machined in the support ring 77, is provided to retain additional O-rings 75 in proper position.

Disposed internally of the tank structure 5, and enclosing the lower end of the conductor stud 71 is an internal shell 80, which preferably is composed of a suitable insulating material, such as porcelain. A lower nut 81 is secured, as at 82, to the inner extremity of the conducting stud 71, and compresses a plurality of Bellville washers 83 against an annular cap 84. The upper surface of the cap 84, as viewed in FIG. 6, has a flange portion 85, which surrounds the lower extremity 86 of the internal porcelain shell 80 and assists in maintaining the same in a proper position. Preferably gaskets 87, 88 are provided at the opposite extremity of the interior porcelain shell 80 to cushion the percelain against shock.

It will be noted that with the construction illustrated, the seals at the gaskets **86**, **87** are not important since gas is permitted to leak into the interior **89** within the bushing **3**. If desired, a suitable opening **90** could be provided to permit a more rapid passage of gas into the interior **89** of the bushing **3** from the region within the tank structure **5**.

The bushing construction **3**, as illustrated in FIG. 6, has the advantage that only the seals **75**, externally of the supporting ring **78**, need to be gas-tight. The sealing condition of the gaskets **86**, **87** is not important, since it is desired to leak gas into the bushing **3** from the tank. As a result, only two sealed openings **75** (one at each end of the external shell **72**) are required, which need be gas-tight.

From the foregoing description of the invention, it will be apparent that there is provided an improved circuit interrupter adapted for cubicle mounting and of compact size. Upon removal of the upper high-pressure tank **9**, one may look through the openings **91** provided in the mounting plate **92** and view the interior blast-vale mechanism. Accessibility is additionally assisted by the several access doors **59**, **92** and **93** at the outer ends of the tank **5**. Simultaneous blast-valve operation is achieved by the linkage of all three blast-valves **12** with the blast-valve driving shaft **35**. The collapsible thrust toggle linkage **50** ensures that the blast-valves will open the desired length of time during the opening operation, and close at a predetermined point, which may be adjustable.

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

I claim as my invention:

1. A compressed-gas multi-pole circuit interrupter including a truck-mounted low-pressure grounded metallic elongated exhaust tank, a plurality of pairs of spaced terminal bushings extending laterally into the side wall of said metallic tank in spaced vertical planes and adapting the circuit interrupter to cubicle switchgear mounting, an elongated high-pressure tank disposed above said grounded elongated exhaust tank, an interrupting unit bridging the inner ends of each pair of terminal bushings, each interrupting unit including a relatively stationary contact structure and a movable contact separable to establish an arc, a plurality of separate spaced insulating blast tubes in said planes interconnecting said elongated high-pressure tank with the individual interrupting units, and a plurality of blast-valves at the upper ends of the blast tubes for controlling the blasting of gas from said high-pressure tank to each of the pole units.

2. A compressed-gas multi-pole circuit interrupter including a truck-mounted low-pressure grounded metallic elongated exhaust tank, a plurality of pairs of spaced terminal bushings extending laterally into the side wall of said metallic tank in spaced vertical planes and adapting the circuit interrupter to cubicle switchgear mounting, an elongated high-pressure tank disposed above said grounded exhaust tank, an interrupting unit bridging the inner ends of each pair of terminal bushings, each interrupting unit including a relatively stationary contact structure and a movable contact separable to establish an arc, a plurality of separate spaced insulating blast tubes in said planes interconnecting said elongated high-pressure tank with the individual interrupting units, a plurality of blast-valves at the upper ends of the blast tubes for controlling the blasting of gas from said high-pressure tank to each of the pole-units, a main drive shaft extending externally of said metallic exhaust tank, an internal drive shaft carrying a plurality of crank-arms therewith, linkage means connecting the main drive shaft with the internal drive shaft, and means interconnecting the movable contact of each pole-unit with at least one of said crank-arms.

3. A compressed-gas circuit interrupter including a truck-mounted relatively low-pressure metallic exhaust tank and a high-pressure reservoir tank disposed in close proximity, a plurality of spaced pairs of terminal bushings in spaced planes extending interiorly of said metallic exhaust tank and carrying bridging interrupting units adjacent their interior ends, a plurality of separate gas-blast passages in said spaced planes between the high-pressure reservoir tank and the exhaust tank, a blast-valve assembly disposed within each gas-blast passage, means including an axially extending blast-valve rod means for simultaneously opening and closing the blast-valve assemblies in unison, a main axially-extending drive shaft protruding externally of the exhaust tank, an axially-extending internal drive shaft, linkage means mechanically connecting the internal drive shaft with said main drive shaft, each interrupting unit having a movable contact, linkage means interconnecting the several movable contacts with said internal drive shaft, and a collapsible toggle linkage interconnecting said internal drive shaft with said blast-valve rod means.

4. A compressed-gas circuit interrupter including a truck-mounted relatively low-pressure metallic exhaust tank and a high-pressure reservoir tank disposed in close proximity, a plurality of spaced pairs of terminal bushings in spaced planes extending interiorly of said metallic exhaust tank and carrying bridging interrupting units adjacent their interior ends, a plurality of separate gas-blast passages in said spaced planes between the high-pressure reservoir tank and the exhaust tank, a blast-valve assembly disposed within each gas-blast passage, means including an axially extending blast-valve rod means for simultaneously opening and closing the blast-valve assemblies in unison, a main axially-extending drive shaft protruding externally of the exhaust tank, an axially-extending internal drive shaft, linkage means mechanically connecting the internal drive shaft with said main drive shaft, each interrupting unit having a movable tubular contact, each interrupting unit including an insulating orifice structure closely confining the movable tubular contact to direct a gas blast therethrough, linkage means interconnecting the several movable contacts with said internal drive shaft, and a collapsible toggle linkage interconnecting said internal drive shaft with said blast-valve rod means.

5. A compressed-gas circuit interrupter including a truck-mounted relatively low-pressure metallic exhaust tank and a high-pressure reservoir tank disposed in close proximity, a plurality of spaced pairs of terminal bushings in spaced planes extending interiorly of said metallic exhaust tank and carrying bridging interrupting units adjacent their interior ends, a plurality of separate gas-blast passages in said spaced planes between the high-pressure reservoir tank and the exhaust tank, a blast-valve assembly disposed within each gas-blast passage, means including an axially extending rotatable blast-valve rod means for simultaneously opening and closing the blast-valve assemblies in unison, a main rotatable axially-extending drive shaft protruding externally of the exhaust tank, an axially-extending rotatable internal drive shaft, linkage means mechanically connecting the rotatable internal drive shaft with said rotatable main drive shaft, each interrupting unit having a movable contact, linkage means interconnecting the several movable contacts with said rotatable internal drive shaft, and a collapsible toggle linkage interconnecting said internal drive shaft with said blast-valve rod means.

6. A compressed-gas circuit interrupter including a truck-mounted relatively low-pressure metallic exhaust tank and a high-pressure reservoir tank disposed in close proximity, a plurality of spaced pairs of terminal bushings in spaced planes extending interiorly of said metallic exhaust tank and carrying bridging interrupting units adjacent their interior ends, a plurality of separate gas-blast passages in said spaced planes between the high-pressure reservoir tank and the exhaust tank, a blast-valve assembly disposed within each gas-blast passage, means including an axially-extending blast-valve rod means for simultaneously opening and closing the blast-valve assemblies in unison, a main axially-extending drive shaft protruding externally of the exhaust tank, an axially-extending internal drive shaft, linkage means mechanically connecting the internal drive shaft with said main drive shaft, each interrupting unit having a movable contact, linkage means interconnecting the several movable contacts with said internal drive shaft, a collapsible toggle linkage interconnecting said internal drive shaft with said blast-valve rod means, said collapsible toggle linkage including a pair of overset toggle links biased to an overset position, and an adjustable stop for breaking said toggle linkage near the end of the opening operation to close the blast valves.

7. A compressed-gas multi-pole circuit interrupter including a truck-mounted low-pressure grounded metallic elongated exhaust tank, a plurality of pairs of spaced terminal bushings extending laterally into the side wall of said metallic tank in spaced vertical planes and adapting the circuit interrupter to cubicle switchgear mounting, an elongated high-pressure tank disposed above said grounded elongated exhaust tank, an interrupting unit bridging the inner ends of each pair of terminal bushings, each interrupting unit including a relatively stationary contact structure and a movable tubular contact separable to establish an arc, a plurality of separate spaced insulating blast tubes in said planes interconnecting said elongated high-pressure tank with the individual interrupting units, each interrupting unit including an insulating orifice structure closely confining the movable tubular contact to direct a gas blast therethrough, and a plurality of blast-valves at the upper ends of the blast tubes for controlling the blasting of gas from said high-pressure tank to each of the pole units.

8. A compressed-gas multi-pole circuit interrupter including a truck-mounted low-pressure grounded metallic elongated exhaust tank, a plurality of pairs of spaced terminal bushings extending laterally into the side wall of said metallic tank in spaced vertical planes and adapting the circuit interrupter to cubicle switchgear mounting, an elongated high-pressure tank disposed above said grounded elongated exhaust tank, an interrupting unit bridging the inner ends of each pair of terminal bushings, each interrupting unit including a relatively stationary contact structure and a movable contact separable to establish an arc, a plurality of separate spaced insulating blast tubes in said planes interconnecting said elongated high-pressure tank with the individual interrupting units, a plurality of blast-valves at the upper ends of the blast tubes for controlling the blasting of gas from said high-pressure tank to each of the pole units, and an axially-extending blast-valve rod means for effecting simultaneous operation of the blast-valves.

9. A compressed-gas multi-pole circuit interrupter including a truck-mounted low-pressure grounded metallic elongated exhaust tank, a plurality of pairs of spaced terminal bushings extending laterally into the side wall of said metallic tank in spaced vertical planes and adapting the circuit interrupter to cubicle switchgear mounting, an elongated high-pressure tank disposed above said grounded elongate exhaust tank, an interrupting unit bridging the inner ends of each pair of terminal bushings, each interrupting unit including a relatively stationary contact structure and a movable contact separable to establish an arc, a plurality of separate spaced insulating blast tubes in said planes interconnecting said elongated high-pressure tank with the indiviual interrupting units, a plurality of blast-valves at the upper ends of the blast tubes for controlling the blasting of gas from said high-pressure tank to each of the pole units, a rotatable main drive shaft extending externally of said exhaust tank, an internal drive shaft carrying a plurality of crank-arms therewith, means interconnecting the main drive shaft with the internal drive shaft, means interconnecting the movable contact of each pole-unit with at least one of the crank-arms, and a rotatable blast-valve rod means mechanically connected to the internal drive shaft for effecting simultaneous operation of the blast-valves.

10. A compressed-gas multi-pole circuit interrupter including a truck-mounted low-pressure grounded metallic elongated exhaust tank, a plurality of pairs of spaced terminal bushings extending laterally into the side wall of said metallic tank in spaced vertical planes and adapting the circuit interrupter to cubicle switchgear mounting, an elongated high-pressure tank disposed above said grounded elongated exhaust tank, an interrupting unit bridging the inner ends of each pair of terminal bushings, each interrupting unit including a relatively stationary contact structure and a movable tubular contact separable to establish an arc, said relatively stationary contact structure including a plurality of circumferentially-disposed finger contacts and a stationary arc horn which protrudes within said movable tubular contact in the closed-contact position, a plurality of separate spaced insulating blast tubes in said planes interconnecting said elongated high-pressure tank with the individual interrupting units, and a plurality of blast-valves at the upper ends of the blast tubes for controlling the blasting of gas from said high-pressure tank to each of the pole units.

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