

Feb. 25, 1958

A. P. STROM
CIRCUIT INTERRUPTERS

2,824,937

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2 Sheets-Sheet 1

Fig. 3.

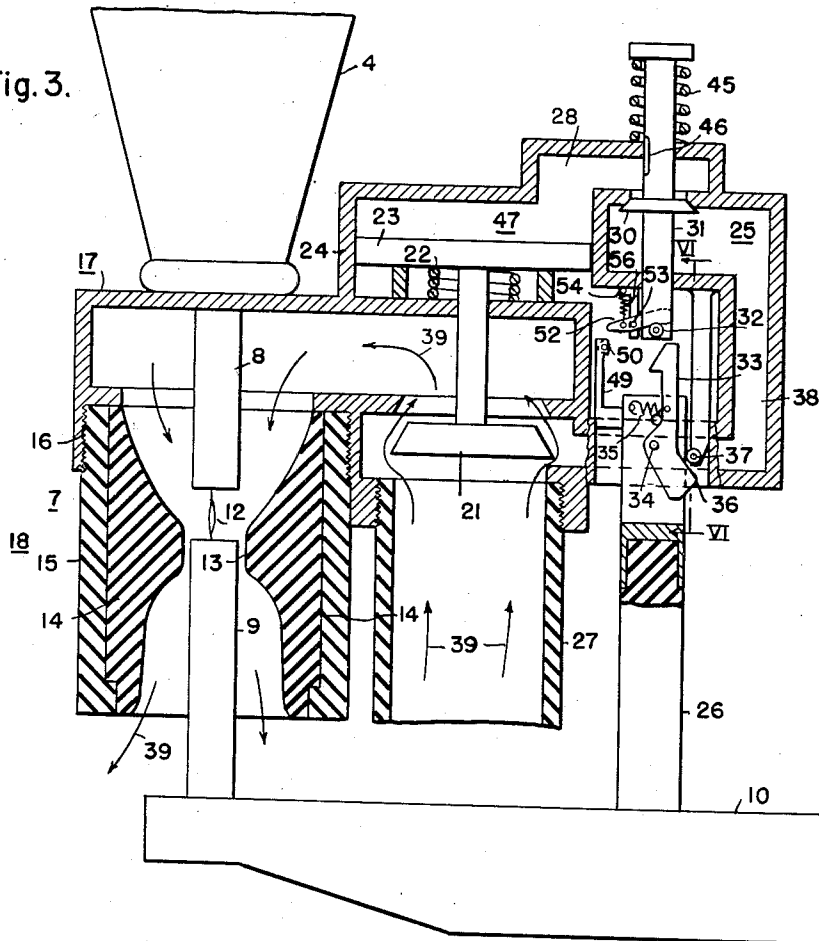


Fig. 1.

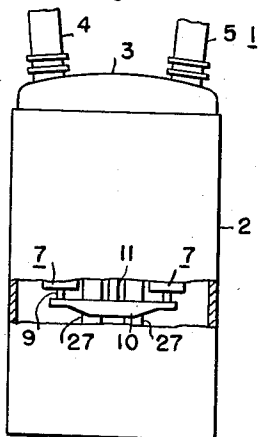
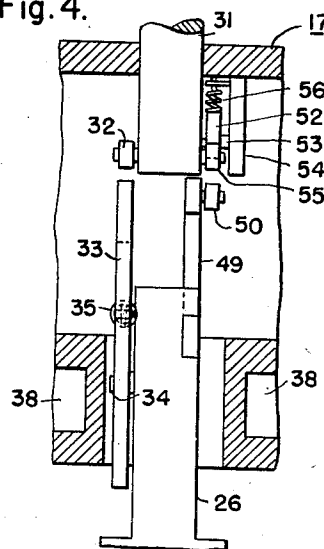


Fig. 4.



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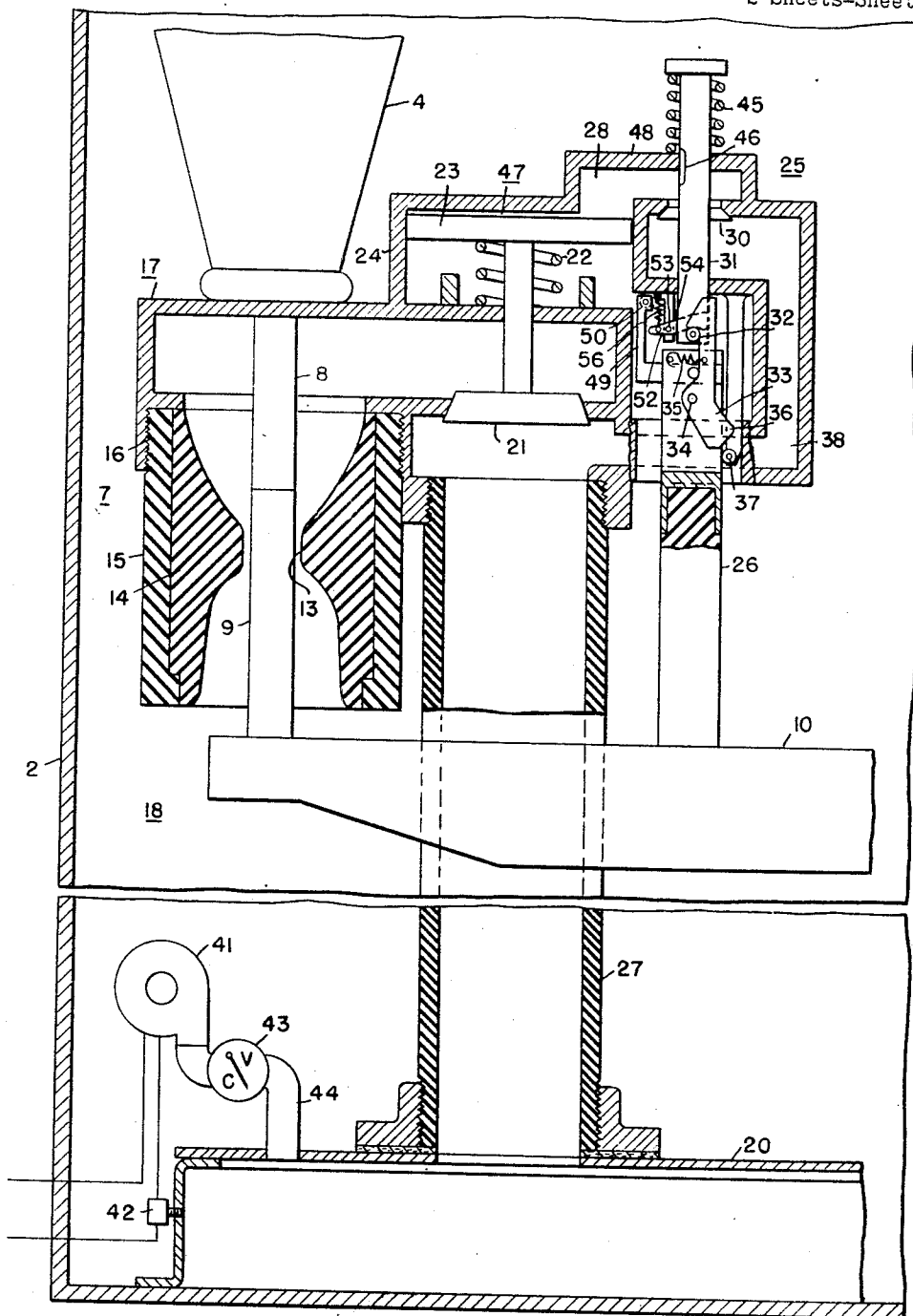
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2 Sheets-Sheet 2



WITNESSES:

E. A. M. M. M. M.
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Fig. 2.

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2,824,937

CIRCUIT INTERRUPTERS

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Application December 30, 1954, Serial No. 478,636

17 Claims. (Cl. 200—148)

This invention relates to circuit interrupters in general, and, more particularly, to improved arc-extinguishing structures therefor.

A general object of my invention is to provide an improved compressed-gas type of circuit interrupter, in which more effective operation is obtained than has been obtained in constructions hitherto used.

A more specific object of my invention is to provide an improved compressed-gas type of circuit interrupter utilizing a grounded metallic exhaust tank as an enclosing chamber filled with gas at a relatively low pressure, and associating therewith a high-pressure gas reservoir, so that during the opening operation gas from the high pressure reservoir may be blown against the established arc and exhausted into the lower pressure region within the exhaust tank.

Another object is to provide an improved compressed-gas circuit interrupter, which has all of the advantages of a dead-tank oil circuit interrupter, yet has the high-speed characteristics of a compressed-gas circuit interrupter.

Still a further object of my invention is to provide an improved compressed-gas circuit interrupter of the type specified in the immediately preceding paragraph, which is particularly adaptable for employment with a relatively expensive gas, which it is desired to use over and over again, during repeated operations, without loss.

Another object of my invention is to provide an improved compressed-gas valve operating arrangement for a compressed-gas type of circuit interrupter.

Still a further object of my invention is to provide an improved circuit interrupter of substantially enclosed construction, in which a portion of the gas is maintained at high pressure, and another portion of the gas is maintained at a somewhat lower pressure, in which the advantages of a dead-tank type of construction may be taken.

Yet a further object is to provide an improved circuit interrupter of the foregoing type, in which improved means are utilized to provide a blast of gas during the closing operation as well as during the opening operation.

An additional object of my invention is to provide a circuit interrupter particularly adapted for use with sulfur hexafluoride gas, the remarkable extinguishing properties of which are set out and claimed in U. S. patent application, filed July 19, 1951, Serial No. 237,502, now United States Patent 2,757,261, issued July 31, 1956, to Harry J. Lingal, Thomas E. Browne, Jr., and Albert P. Strom, entitled "Circuit Interrupters" and assigned to the assignee of the instant application.

Another object is to provide a circuit interrupter particularly adapted for use with selenium hexafluoride gas, the extinguishing properties of which are described and claimed in United States patent application filed September 14, 1954, S. N. 455,976, now United States Patent 2,733,316, issued January 31, 1956, to Thomas E. Browne, Jr., Albert P. Strom and Harvey E. Spindle, and assigned to the assignee of the instant application.

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Thus, the circuit interrupters of my invention are particularly adapted to use at least one gas selected from the group consisting of sulfur hexafluoride and selenium hexafluoride, or admixed with at least one of the group consisting of helium, carbon dioxide, air, nitrogen and argon.

In a circuit interrupter utilizing a relatively expensive gas like SF_6 or SeF_6 , it is desirable to conserve such gas, and to use it repeatedly for subsequent operations; and my present invention has, as one of its aspects, the provision of a dead-tank type of circuit interrupter particularly suitable for utilization with such a gas.

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 circuit interrupter employing the principles of my invention, with the contacts being illustrated as being in the closed-circuit position;

Fig. 2 is an enlarged view of a portion of the interior of the circuit interrupter of Fig. 1, with the contacts likewise being illustrated in the closed-circuit position;

Fig. 3 is a fragmentary view, similar to that shown in Fig. 2, but illustrating the contact positions during a portion of the opening operation; and

Fig. 4 is an enlarged fragmentary vertical sectional view taken substantially along the line IV—IV of Fig. 3.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 generally designates a compressed-gas type of circuit interrupter, in this particular instance comprising a grounded metallic exhaust tank 2, of the type usually employed in dead-tank oil circuit breakers.

As well known by those skilled in the art, such a tank construction involves a cover 3 and a pair of terminal bushings 4, 5, which insulate the conductors leading out of the enclosed apparatus from the metallic cover 3 of the exhaust tank 2.

Referring more particularly to Fig. 2, which more clearly illustrates, in enlarged fashion, a portion of the internal construction of the exhaust tank 2 of Fig. 1, it will be observed that at the lower interior end of the terminal bushing 4 is secured an arc-extinguishing unit, generally designated by the reference numeral 7, and comprising a relatively stationary rod-shaped contact 8, and a cooperable movable rod-shaped contact 9, the latter being secured to and movable with an extremity of the conducting bridging member 10, which is actuated by the usual lift rod 11, as more fully disclosed in Fig. 1. Any suitable mechanism, either pneumatic, electrical or hydraulic, may be utilized to effect upward or closing motion of the lift rod 11 and conducting crossbar 10, or downward opening motion of said lift rod 11 and attached conducting crossbar 10.

The contacts 8, 9 separate to establish an arc 12 (Fig. 3) within an orifice 13, defined by an orifice sleeve member 14 enclosed in an insulating tube 15, the upper end of which is threadedly secured at 16 to a suitably configured support casting, generally designated by the reference numeral 17, and secured in any desired manner to the lower interior end of the terminal bushing 4.

The gas disposed within the interior 18 of the exhaust tank 2 may be under any desired pressure, it merely being desirable to have this pressure, which may be above or below atmospheric pressure, at a value substantially half that of the gas disposed within a high-pressure container, or reservoir, 20 disposed interiorly within the tank 2, adjacent the lower end thereof, as shown in Fig. 2 of the drawings.

By having SeF_6 or SF_6 within the interior of the tank 2 advantage may be taken of the high dielectric strength of these gases. Also because of the high dielectric

strength, the spacing between live parts may correspondingly be reduced with smaller external dimensions, as compared with a filling of air.

More accurately, to obtain acoustic gas flow through the interrupting unit 7, using SF_6 gas, it is necessary to have a 66% higher pressure in the high pressure container 20 than in the low pressure exhaust region 18 within the tank 2.

The flow of gas at high pressure out of the high-pressure reservoir 20 is controlled by a blast valve 21, spring-biased to the closed position by a coil compression spring 22, and operated by a piston 23, which moves within a piston chamber 24. The operation of the blast valve 21 is brought about by the actuation of a pilot-valve assembly 25, which is actuated, in turn, by a valve operating rod 26, secured to and movable with the conducting crossbar 10. An insulating blast tube 27 leads from the high-pressure container 20 to the blast valve 21, which, it will be noted, is disposed immediately adjacent to the arc-extinguishing unit 7, so that there will be a minimum time delay, upon actuation of the blast valve 21, for the gas to reach the orifice 13, and to quickly effect extinction of the established arc 12.

The pilot-valve assembly 25 will now be described. A passage 28 leads from the upper side of the operating piston 23 of blast valve 21 to the pilot valve 30, which is secured to, and movable with, a valve stem 31. At the lower end of the valve stem 31 is a roller 32, over which is latched a pivotally mounted latch 33, pivoted, as at 34, to the upper end of the valve operating rod 26, as shown in Fig. 2 of the drawings. Preferably a tension spring 35 biases the latch 33 about the roller 32. It will be noted that at the lower end of the latch 33 is disposed a cam portion 36, which makes engagement with a relatively stationary cam roller 37 for effecting release of the actuating roller 32 at an intermediate point in the opening operation.

From the foregoing description, it will be apparent that downward opening movement of the conducting crossbar 10 and valve operating rod 26 with the latch 33 pivotally supported on the latter, will correspondingly effect downward opening movement of the valve stem 31, and hence opening of the pilot valve 30. This will permit high-pressure gas, which is present within the blast tube 27 and passage 38, to pass about the pilot valve 30, enter passage 28 and act upon the upper side of operating piston 23. This will effect opening of the blast valve 21, against the closing biasing action exerted by the differential pressure on this valve and the compression spring 22, to permit the gas to flow in the direction indicated by the arrows 39 of Fig. 3 and to exhaust through the orifice member 14 into the relatively lower pressure exhaust region within the interior 18 of the exhaust tank 2.

It will be apparent that the pressure within the high-pressure reservoir 20 will be lowered to some extent by such an operation, and to maintain the pressure at a high value within the high-pressure container 20, preferably at a value substantially twice that of the pressure within the exhaust region 18, a suitable compressor 41 is provided, which is electrically connected through a pressure responsive switch 42 to maintain the pressure within the high-pressure tank 20 at the desired value.

As shown in Fig. 2, the compressor 41 forces high-pressure gas through a one-way valve 43 and through a conduit 44 to be stored within the high-pressure container 20.

It will be obvious from an inspection of Figs. 2 and 3 that upon a predetermined downward opening motion of the latch 33, the cam portion 36 thereof will engage the stationary roller 37 to effect release of the actuating roller 32. At this point the spring 45 will cause reclosure of the pilot valve 30. A leak 46 is provided by a groove within the upper end of the valve stem 31 to permit a slow release of pressure out of the region

47 above the piston 23, to permit a gradual reclosure of the blast valve 21 following previous closure of the pilot valve 30.

From the foregoing description it will be readily apparent as to the sequence of events which transpire during the opening operation. However, to recapitulate, in the closed-circuit position of the interrupter 1, the circuit extends therethrough by way of terminal bushing 4, contacts 8 and 9, through the conducting bridging member 10, and through the other extinguishing unit 7 (Fig. 1) to the other terminal bushing 5. During the opening operation, which may be effected either automatically in response to overload currents, or manually in accordance with the wishes of a station attendant, suitable mechanism, which may be of any conventional type, effects downward opening travel of the crossbar 10, movable contacts 9 and both valve operating rods 26.

With particular reference to Fig. 2, the downward movement of the latch 33 will effect opening of the pilot valve 30 to permit high-pressure gas to pass through the passages 38, 28 to the region 47 above the operating piston 23. This will move the piston 23 downwardly within the operating cylinder 24 to effect thereby opening of the blast valve 21. This will permit gas at high pressure within the high-pressure reservoir 20 to pass upwardly through the blast tube 27 and into the arc-extinguishing unit 7, in a manner indicated by the arrows 39 of Fig. 3, to effect rapid extinction of the two arcs 12 associated with the two serially related arc-extinguishing units 7.

Shortly thereafter the cam portion 36 engages the cam release roller 37 to effect release of the pilot valve stem 31 to permit the compression spring 45 to effect reclosure of the pilot valve assembly 25, this preferably being accomplished approximately at the time the movable contacts 9 reach their fully open position. Upon a decrease in pressure within the high-pressure reservoir 20 the compressor 41, energized by operation of the pressure responsive switch 42, will take gas at the relatively low pressure present within the exhaust region 18, and compress this gas to a value suitable for admission into the high-pressure reservoir 20. The interrupter is now in the open position.

To effect reclosure of the interrupter, it is merely necessary for the operating mechanism to raise the lift rod 11, causing upward closing motion of the crossbar 10 and movable contacts 9. At the end of the closing stroke the latches 33 will be forced laterally about the sides of the rollers 32, this action being permitted by extension of the tension springs 35. In the completely closed position of the interrupter 1, the latches 33 will again latch over the rollers 32 associated with the lower end of the valve stems 31 of the pilot-valve assemblies 25.

For certain applications it may be desirable to provide a gas flow through the interrupter upon reclosing of the breaker. In such an event, there is provided auxiliary apparatus which may be attached to the other side of the top of the valve operating rod 26 to effect such a momentary reopening of the pilot-valve assembly 25 during the closing operation. As well known by those skilled in the art, such a blast of gas during the closing operation helps to prevent prestriking of an arc across the approaching contacts 9, 8.

The particular construction which I utilize comprises an upwardly projecting arm 49, having an actuating roller 50 at the upper end thereof, as more clearly shown in Figs. 2, 3 and 4 of the drawings. An operating lever 52, pivotally mounted at a stationary pivot 53 to a downwardly extending bracket portion 54 of the support casting 17, is biased against a roller 55 disposed at the opposite side of the lower end of the valve stem 31 from the roller 32, as shown in Fig. 4. A tension spring 56 maintains the operating lever 52 against the upper side of the roller 55 of pilot-valve stem 31. Thus upon upward closing motion of the valve operating rod 26,

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the roller 50 will forcibly effect clockwise rotation of the operating lever 52, as viewed in Fig. 2, to effect momentary opening of the pilot-valve assembly 25, in the manner previously described. Upon rotation of the operating lever 52, the roller 50 will slip by to permit the compression spring 45 to effect reclosure of the pilot valve 30. This will permit compression spring 22 to effect reclosure of the blast valve 21 in the manner previously described. Consequently a momentary blast of gas is obtained near the end of the closing operation.

It will be apparent that during the opening operation the operating lever 52 is rendered ineffective since it rotates in a counterclockwise direction about the pivot 53, as viewed in Fig. 2, having no effect upon the pilot-valve stem 31.

From the foregoing description it will be apparent that I have provided an improved compressed-gas type of circuit interrupter utilizing a tank essentially similar to the closed steel tank, provided with bushings, that is utilized in dead-tank oil breaker constructions. The contacts 9 may be operated by the conventional cross-arm mechanism. The exhaust tank 2 contains gas at relatively low pressure having the high pressure maintained within a suitable high-pressure reservoir associated with a portion of the tank structure. Although the high-pressure reservoir 20 is shown at the bottom of the tank 2, it could be placed in a different position, such as at the top of the tank 2. Although an orifice-type interrupter 7 has been illustrated, it will be obvious to those skilled in the art that other types of interrupters, such as cross-blast interrupters, may be employed.

It will be noted that the leak 46 is rendered ineffective upon lowering of the pilot-valve stem 31 during the opening operation, and only becomes effective upon reclosure of the pilot valve 30. The compressor 41 may be located inside or outside of the breaker chamber, and senses a pressure drop within the high-pressure reservoir 20 as brought about by operation of the pressure responsive switch 42. In addition to the usual advantages of a dead-tank construction, such as a grounded case, bushing transformers, steel pressure enclosures, standard cross-arm mechanism, no external disconnect contacts etc., the construction described gives a high-pressure acoustic velocity flow without any discharge whatsoever to the outside of the tank. The blast valve is located very close to the interrupter, giving a minimum delay in starting the gas flow. Another advantage is the unrestricted discharge into the large low pressure exhaust volume 18. This is of particular benefit in SF_6 interrupters because the large thermal expansion of the gas in the arc requires very free discharge passages to prevent stoppage of flow during high-current interruption.

While a single interrupter is shown in Fig. 1, two or more interrupters in series per bushing can readily be used. In this case the series breaks are drawn simultaneously by the cross-arm movement, and gas for the units is supplied by a parallel connection to the inlet sides of the interrupters in an obvious manner.

Certain general aspects of the invention are set out and claimed in U. S. patent application, filed December 24, 1954, Serial No. 477,466, by Thomas E. Browne, Jr., and myself, and assigned to the assignee of the instant application.

Although I have shown and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration, and that changes and modifications may be readily 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 circuit interrupter of the compressed gas type including a main tank containing gas, a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically

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interconnecting the units, a pressure container containing gas at a higher pressure than the main tank, a blast tube pneumatically interconnecting the pressure container with each arc extinguishing unit, and blast valve means actuated by opening movement of the crossbar for permitting high pressure gas to flow from the pressure container through the blast tubes and into the two arc-extinguishing units to effect extinction of the arcs drawn therein.

2. A circuit interrupter of the compressed gas type including a main tank containing gas, a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the units, a pressure container containing gas at a higher pressure than the main tank and disposed inside of the main tank, a blast tube pneumatically interconnecting the pressure container with each arc-extinguishing unit, and blast valve means actuated by opening movement of the crossbar for permitting high pressure gas to flow from the pressure container through the blast tubes and into the two arc-extinguishing units to effect extinction of the arcs drawn therein.

3. A circuit interrupter of the compressed gas type including a main tank containing gas selected from at least one of the group consisting of SF_6 and SeF_6 , a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the units, a pressure container containing the aforesaid gas at a higher pressure than the main tank, a blast tube pneumatically interconnecting the pressure container with each arc-extinguishing unit, and blast valve means actuated by opening movement of the crossbar for permitting high pressure gas to flow from the pressure container through the blast tubes and into the two arc-extinguishing units to effect extinction of the arcs drawn therein.

4. The circuit interrupter of claim 3, wherein the gas is admixed with at least one of the group consisting of nitrogen, air, argon, helium and carbon dioxide.

5. A circuit interrupter of the compressed gas type including a main tank containing gas selected from at least one of the group consisting of SF_6 and SeF_6 , a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the units, a pressure container containing the aforesaid gas at a higher pressure than the main tank and disposed inside of the main tank, a blast tube pneumatically interconnecting the pressure container with each arc-extinguishing unit, and blast valve means actuated by opening movement of the crossbar for permitting high pressure gas to flow from the pressure container through the blast tubes and into the two arc-extinguishing units to effect extinction of the arcs drawn therein.

6. The circuit interrupter of claim 5, wherein the gas is admixed with at least one of the group consisting of nitrogen, air, argon, helium and carbon dioxide.

7. A circuit interrupter of the compressed gas type including a main tank containing gas, a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the units, a pressure container containing gas at a higher pressure than the main tank, a compressor for taking gas from the main tank and compressing it for maintaining the gas supply in the pressure container, blast tube means for pneumatically interconnecting the pressure container with the two arc-extinguishing units, and blast valve means actuated by opening movement of the crossbar for permitting the flow of high pressure gas from the pressure container

through the blast tube means and into the arc-extinguishing units.

8. A circuit interrupter of the compressed gas type including a tank containing gas at a relatively low pressure, a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the units, a high pressure container containing gas at a relatively high pressure, a compressor for taking gas at the relatively low pressure in the low pressure tank and compressing it for maintaining the gas supply in the high pressure container, blast tube means for pneumatically interconnecting the high pressure container with the two arc-extinguishing units, blast valve means actuated by opening movement of the crossbar for permitting the flow of high pressure gas from the high pressure container through the blast tube means and into the arc-extinguishing units, and the blast valve means being disposed immediately adjacent to the arc-extinguishing units to eliminate any delay in starting the blast of gas into the units.

9. A circuit interrupter of the compressed gas type including a tank containing gas at a relatively low pressure, a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the units, a high pressure container containing gas at a relatively high pressure, a blast tube pneumatically interconnecting the high pressure container with each arc-extinguishing unit, a blast valve associated with each unit, a piston for actuating each blast valve, and a two-way pilot valve for each unit actuated by opening movement of the crossbar.

10. A circuit interrupter of the compressed gas type including a tank containing gas at a relatively low pressure, a pair of terminal bushings extending within the tank, a pair of arc-extinguishing units disposed adjacent the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the units, a high pressure container containing gas at a relatively high pressure, a blast tube pneumatically interconnecting the high pressure container with each arc-extinguishing unit, a blast valve associated with each unit, a piston for actuating each blast valve, a two-way pilot valve for each unit actuated by opening movement of the crossbar, and means for momentarily actuating the pilot valve during the closing operation to provide a blast of gas at the units during the closing operation.

11. The combination with a pair of arc-extinguishing units disposed in a main exhaust tank of a conducting crossbar, a pressure container, conduit means interconnecting the pressure container with the pair of arc-extinguishing units, a blast valve for permitting high pressure gas to flow from said pressure container into at least one unit and thence to exhaust into the main exhaust tank, said storage tank containing gas at a relatively low pressure, and pilot valve means latched to the crossbar at least during a portion of the opening operation to effect opening of the blast valve.

12. The combination with a pair of arc-extinguishing units disposed in a low pressure exhaust tank of a conducting crossbar, a high pressure container, conduit means interconnecting the high pressure container with the pair of arc-extinguishing units, a blast valve for permitting high pressure gas to flow from said high pressure container into at least one unit and thence into said exhaust tank, a piston for opening the blast valve, and a two-way pilot valve latched to the crossbar during at least a part of the opening operation.

13. The combination with a pair of arc-extinguishing

units disposed in a low pressure tank of a conducting crossbar, a high pressure container, conduit means interconnecting the high pressure container with the pair of arc-extinguishing units, a blast valve for permitting high pressure gas to flow into at least one unit, a piston for opening the blast valve, a two-way pilot valve latched to the crossbar during at least a part of the opening operation, and means connected to the crossbar for operating the two way pilot valve momentarily during the closing operation to obtain a closing blast of gas.

14. A compressed gas circuit interrupter including a grounded metallic main tank filled with gas and having a pair of terminal bushings extending therein, a pair of arc-extinguishing units of the gas-blast type secured to the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the two arc-extinguishing units in series in the closed position of the interrupter, a pressure container disposed within the tank and containing gas at higher pressure than the main tank, conduit means pneumatically interconnecting the pressure container with the two units, a blast valve associated with the conduit means, a piston connected to the blast valve and biased to the blast valve closed position, and means responsive to movement of the crossbar for selectively applying high pressure or lower pressure gas to the piston to effect its operation.

15. A compressed gas circuit interrupter including a grounded metallic tank filled with low pressure gas and having a pair of terminal bushings extending therein, a pair of arc-extinguishing units of the gas-blast type secured to the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the two arc-extinguishing units in series in the closed position of the interrupter, a high pressure container disposed within the tank and containing gas at relatively high pressure, conduit means pneumatically interconnecting the high pressure container with the two units, a blast valve associated with the conduit means, a piston connected to the blast valve and biased to the blast valve closed position, a pilot valve for applying low or high pressure to said piston, and latching means movable with the crossbar for momentarily latching onto the pilot valve during the opening operation to effect its operation.

16. A compressed gas circuit interrupter including a grounded metallic tank filled with low pressure gas selected from at least one of the group consisting of SF_6 and SeF_6 and having a pair of terminal bushings extending therein, a pair of arc-extinguishing units of the gas-blast type secured to the interior ends of the terminal bushings, a conducting crossbar electrically interconnecting the two arc-extinguishing units in series in the closed position of the interrupter, a high pressure container disposed within the tank and containing the aforesaid gas at relatively high pressure, conduit means pneumatically interconnecting the high pressure container with the two units, a blast valve associated with the conduit means, a piston connected to the blast valve and biased to the blast valve closed position, and means responsive to movement of the crossbar for selectively applying high pressure or low pressure gas to the piston to effect its operation.

17. The circuit interrupter of claim 16, wherein the gas is admixed with at least one of the group consisting of nitrogen, air, argon, helium and carbon dioxide.

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