Nov. 14, 1961 J. E. SCHRAMECK ET AL 3,009,042

CIRCUIT INTERRUPTERS

Filed April 18, 1958 3 Sheets-Sheet 1

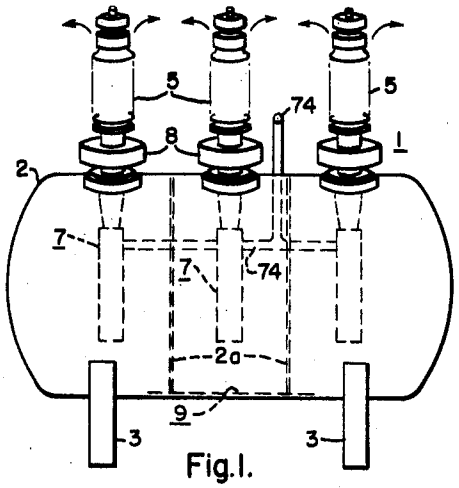


Fig.1.

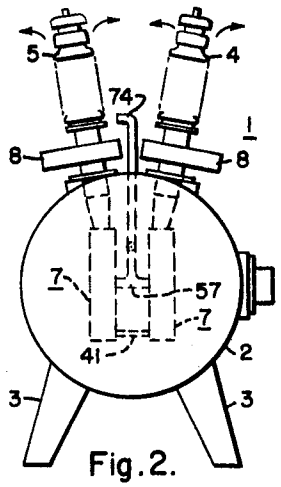


Fig.2.

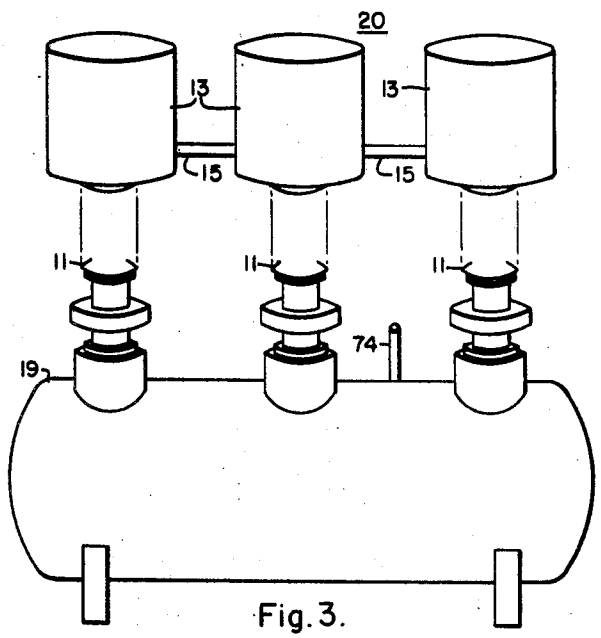


Fig.3.

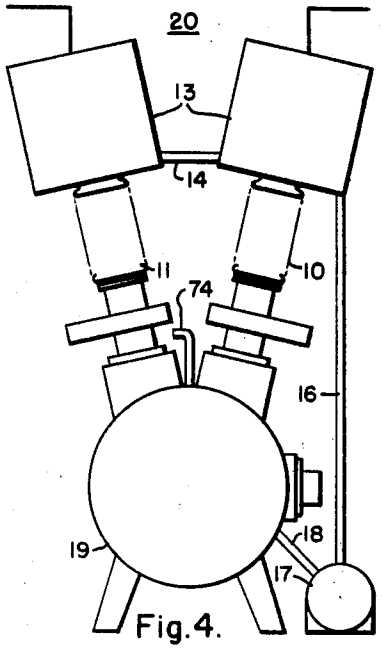


Fig.4.

WITNESSES:

Barnard R. Giegue

Wm. B. Sellers.

INVENTORS

Jack E. Schrameck and

Richard E. Kane

BY

Willard R. Crout

ATTORNEY

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CIRCUIT INTERRUPTERS

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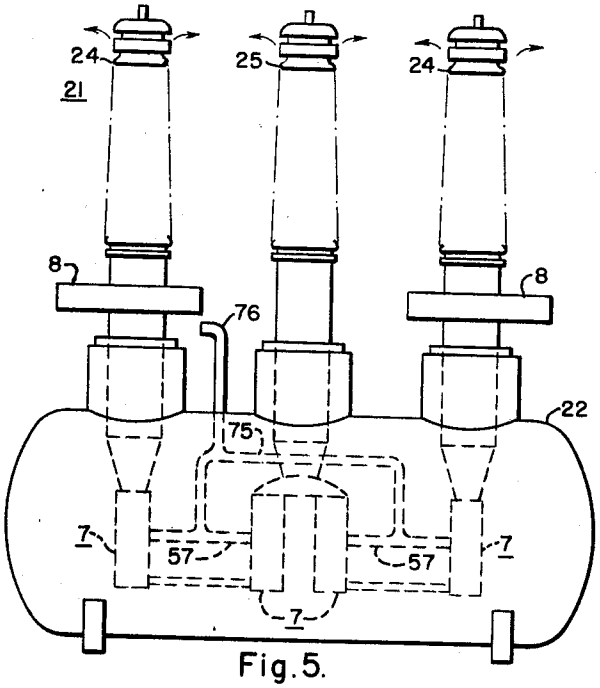


Fig. 5.

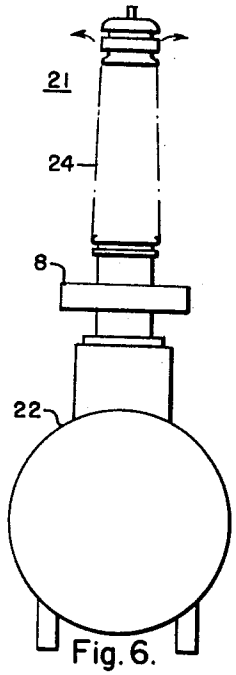


Fig. 6.

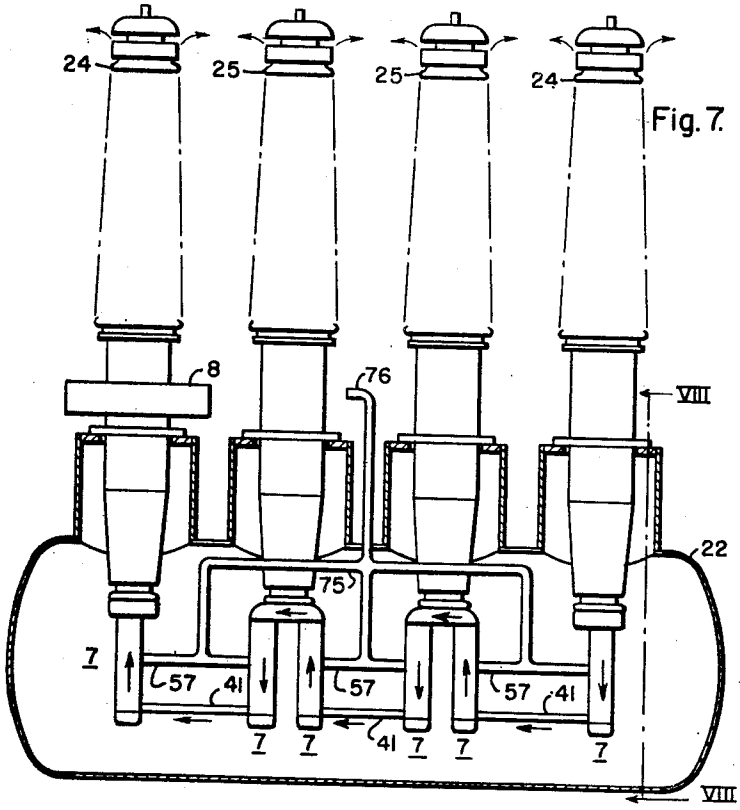
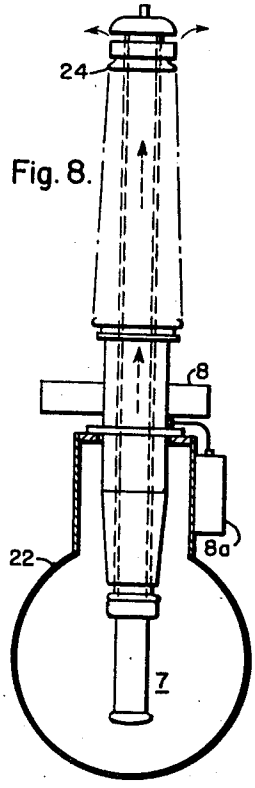


Fig. 7.

Fig. 8.



CIRCUIT INTERRUPTERS

Filed April 18, 1958 3 Sheets-Sheet 3

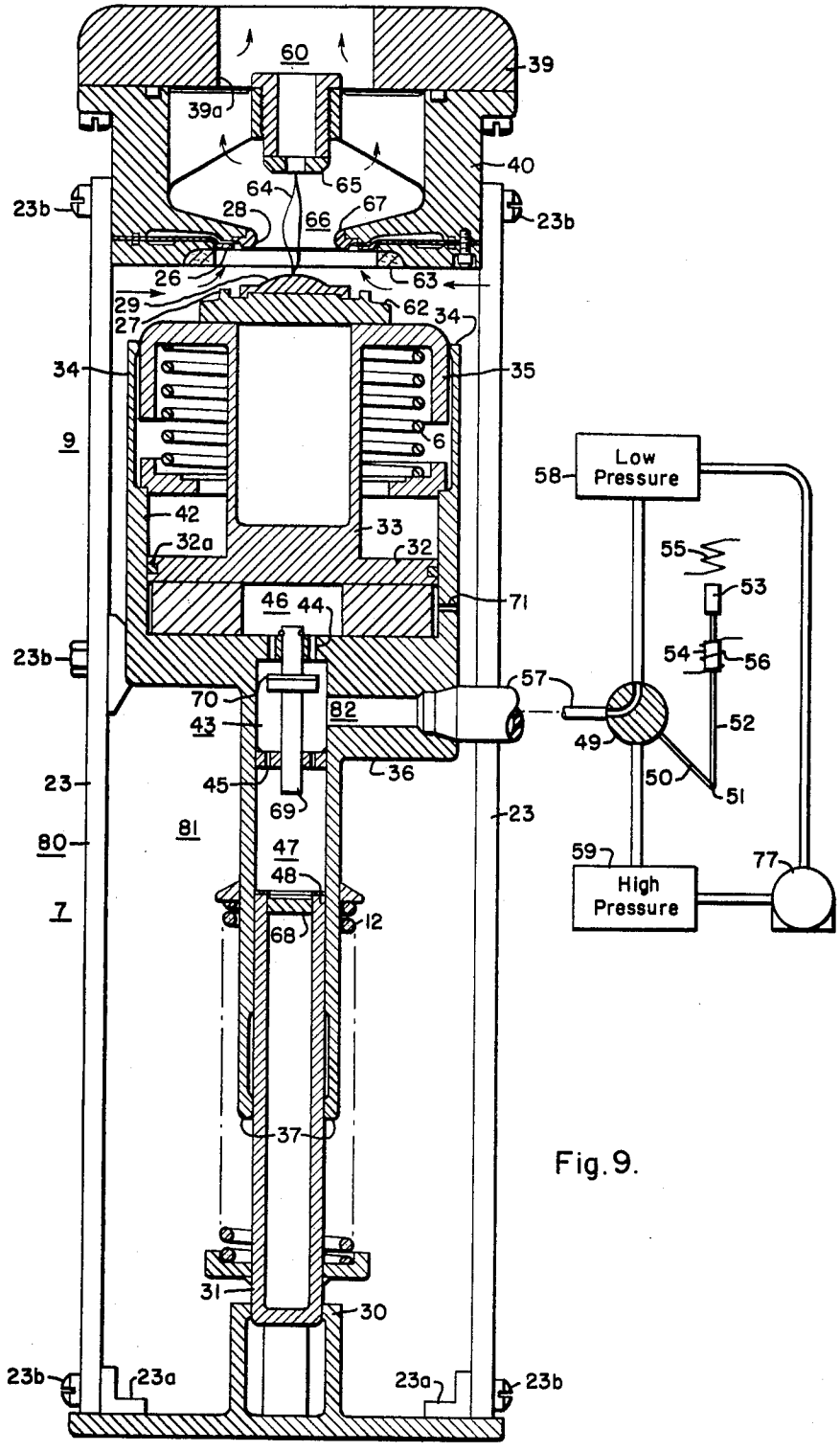


Fig. 9.

United States Patent Office 3,009,042 Patented Nov. 14, 1961

3,009,042

CIRCUIT INTERRUPTERS

Jack E. Schrameck, Pittsburgh, and Richard E. Kane, Monroeville, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Apr. 18, 1958, Ser. No. 729,368
15 Claims. (Cl. 200—145)

This invention relates to circuit interrupters in general, and more particularly, to compressed-gas arc-extinguishing structures and mounting arrangements therefor.

A general object of the present invention is to provide an improved circuit interrupter which will more effectively interrupt a wider range of current and voltage ratings than have interrupters heretofore employed in the industry.

A more specific object of the invention is to provide an improved compressed-gas circuit interrupter, which will be highly effective and yet will have compact dimensions.

A further object is to provide an improved circuit interrupter which will be extremely rugged, and will have a grounded dead-tank construction to insure safety for the operating personnel.

Another object of the present invention is to provide an improved arc-extinguishing unit, which will be readily adaptable for a serially-arranged, multiple unit, arc-extinguishing assemblage arrangement for accommodating the higher voltage and current applications.

Another object of the present invention is to provide a complete line of circuit interrupters adaptable over a wider range of voltage and current ratings, in which the same arc-extinguishing unit may be employed in all of the ranges, and merely duplicated in a serially-arranged assemblage for the higher voltage and current applications.

Another object is to provide an improved dead-tank construction for compressed-gas circuit interrupters.

Yet a further object of the present invention is to provide an improved circuit interrupter mounting arrangement having a plurality of serially-arranged arc-extinguishing units, in which one or more hollow support bushings are utilized, extending within a tank structure to not only assist in supporting a part of the foregoing arc-extinguishing assemblage, but also to provide an exhaust path to the region exteriorly of the enclosing tank for the exhaust of arc products from one or more adjacently disposed arc-extinguishing units.

Yet a further object of the invention is to provide an improved elemental, arc-extinguishing unit in which isolating contacts are serially arranged with respect to the arcing contacts within the same elemental unit, and novel interlocking means are provided to insure the correct sequence of operation of the two pairs of serially-arranged contacts within the same elemental, arc-extinguishing unit.

Another object is to provide an improved compressed-gas circuit interrupter, which may be readily adapted for the use of other arc-extinguishing gases than compressed air, but which is so designed that such changes from compressed air to the arc-extinguishing gases, such as sulfur hexafluoride (SF_6) or selenium hexafluoride (SeF_6) or mixtures of one or more of the foregoing gases with carbon dioxide, air, helium, argon and nitrogen may be made with a minimum of changes in the interrupting structure.

An ancillary object of the invention is to provide an extremely rigid, rugged and compact circuit interrupting construction adapted to withstand earthquake shocks

and other disturbances, and possessing a maximum of safety features for operating personnel, while at the same time using the economical bushing-type current transformers and potential devices, which have heretofore been customary in oil-tank, circuit-interrupter arrangements.

In United States patent application filed February 18, 1957, Serial No. 640,861, now United States Patent 2,970,198, issued January 31, 1961, to Jack E. Schrameck, and assigned to the assignee of the instant application, there is illustrated and described a compressed-gas circuit interrupter including a grounded metallic tank, containing compressed gas and having terminal bushings extending through the opposite ends thereof. It is another object of the present invention to improve upon the compressed-gas circuit interrupting construction of the aforesaid patent, rendering it adaptable for a line of high-voltage, compressed-gas circuit interrupters and generally improving its construction.

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

FIG. 1 is a somewhat diagrammatic, side elevational view of a three-phase compressed-gas circuit interrupter employing the principles of the present invention;

FIG. 2 is a similar diagrammatic, end elevational view of the compressed-gas circuit interrupter of FIG. 1;

FIG. 3 is a side elevational view of a modified type compressed-gas, three-phase circuit interrupter similar to that illustrated in FIG. 1, but embodying certain changes to adapt it for use with relatively expensive arc-extinguishing gases, such as SF_6 or SeF_6;

FIG. 4 is a somewhat diagrammatic, end elevational view of the circuit interrupter of FIG. 3;

FIG. 5 is a somewhat diagrammatic, side elevational view of a single-pole construction for one phase of a three-phase circuit interrupter, embodying the principles of the present invention;

FIG. 6 is an end elevational view of the circuit interrupter of FIG. 5;

FIG. 7 is another modified type of compressed-gas circuit interrupter, illustrating a single pole unit for a single phase of a three-phase circuit interrupter installation, the arc-extinguishing units being diagrammatically illustrated;

FIG. 8 is a sectional end view of the single-phase circuit interrupter of FIG. 7 taken along line VIII—VIII of FIG. 7; and,

FIG. 9 is a considerably enlarged view taken in vertical cross-section through one of the elemental, arc-extinguishing units, which may be employed either singly, or in multiple-unit construction, for the foregoing circuit interrupters, the contact structures being illustrated in the partially open-circuit position, and a somewhat diagrammatic operating arrangement being pictured to show the operation of said unit.

It is characteristic of compressed-air circuit breakers employing orifice-type interrupters, that economical sizes of the interrupters are limited by the amount of current that can be interrupted at a limiting value of recovery voltage rate appearing across the interrupter during the interrupting process. Both of these limitations can be improved by connecting two or more interrupters in series electrically, preferably with parallel air flow. By this means, more current per interrupter can be interrupted for a given voltage recovery rate, or without an increase in current, a higher recovery rate can be interrupted. Or, increases in both the current and the recovery rate can be obtained within the capabilities of the interrupter design.

The foregoing is well established in the art of circuit

interruption and has been used for extending the voltage application range of compressed-air circuit breakers. However, developments in this respect have been toward the use of porcelain structures for support and insulation. This has resulted in the loss of ability to use conventional current transformers and potential operating devices, and the requirement of larger mounting areas. Limited applications to steel, dead-tank constructions have been made, but the arrangements used have limited the circuit breakers in their range of voltage applications.

The present invention is, in part, concerned with a line of metallic dead-tank, gas-filled circuit breakers operating over a range of voltages from 69 kv. to 330 kv., although it should be understood that the 330 kv. design is not limiting, and that the arrangement can be extended to even higher voltages. It will be noted that the arrangement, according to the present invention, provides for the mounting of conventional and less expensive, bushing-type current transformers. It also provides bushing taps for the operation of potential devices. In addition, it uses identical interrupting units for all voltage ratings. As more fully brought out hereinafter, the invention provides for suitable orientation of the metallic dead-tank for mounting all three poles of a three-phase breaker, with phase isolation, in a single dead tank, where practical and economical. Where this is not feasible, all interrupters for a single pole are enclosed in a single tank.

With reference to FIG. 1 of the drawings, the reference numeral **1** generally designates a circuit interrupter of the compressed-gas type. Generally, the circuit interrupter **1** includes a generally horizontally extending, cylindrical, steel, dead-tank **2**, supported upon support legs **3**.

Extending downwardly, interiorly into the tank **2** are three pairs of terminal bushings **4, 5**, one pair of bushings **4, 5** being employed for each pole of the three-phase circuit interrupter. The particular voltage rating for the circuit interrupter illustrated in FIGS. 1 and 2 is 69 kv., but it is to be clearly understood, as more fully brought out hereinafter, that this rating is merely given for illustrative purposes, and constitutes no limitation upon the features of the present invention.

Depending from the interior, lower ends of the downwardly extending terminal bushings **4, 5** is a pair of serially-related, elemental, arc-extinguishing units, generally designated by the reference numeral **7**. As more fully brought out hereinafter, the serially-arranged, elemental, arc-extinguishing units **7** are adapted for simultaneous operation by the actuation of an external, two-way valve connected to a proper pneumatic source. It will be noted, with reference to FIGS. 1 and 2, that conventional bushing-type current transformers **8** are employed encircling the terminal bushings **4** and **5** to provide differential relay protection, where desired. Also, it is obvious that the steel, dead-tank **2** is rugged and well capable of withstanding high internal pressure, it being remembered that the interior **9** of the horizontally extending dead-tank **2** is filled with compressed gas, such as compressed air, at a suitable pressure say from 250 p.s.i. to 500 p.s.i.

In the interrupter of FIGS. 1 and 2 all three poles are mounted in a common tank with the entrance bushings perpendicular to the long axis of the tank. Tank sizes may be determined by the amount of free air required per interrupter and by electrical clearances to the grounded dead-tank. These clearances will be determined in part by the operating pressure within the tank **2**. Metallic inter-phase barriers **2***a* may be employed, if desired.

With reference to FIGS. 3 and 4 of the drawings, it will be noted that for the voltage rating considered, say, for example, 138 kv., that, as compared with the 69 kv. circuit interrupter of FIG. 1, that clearance spacings have been increased, and the length of the bushings **10, 11** have also correspondingly been increased.

Since, as will be more fully brought out hereinafter,

compressed gas is exhausted upwardly through the terminal bushings **10, 11** during the interrupting operation, where a relatively expensive, arc-extinguishing gas is employed, such as SF_6 or SeF_6, it is desirable to conserve the supply of such expensive gas, and for this reason, collecting chambers **13** are employed over the outer ends of the terminal bushings **10, 11** to collect the exhausted arc-extinguishing gas used during the interrupting operation. Suitable insulating connecting conduits **14, 15** are employed to pneumatically interconnect the insulating collecting chambers **13**. Also, an insulating pipe **16** is used to interconnect the collecting chambers **13** with a compressor **17**, so that, when the exhaust pressure within the collecting chambers **13** reaches a certain predetermined value, the compressor **17** will be set into operation to recompress the gas from collecting chambers **13**, and force this recompressed gas through a conduit **18** back into the tank **19** of the modified circuit interrupter **20**.

FIGS. 5 and 6 illustrate an application of the invention to a modified type of circuit interrupter, generally designated by the reference numeral **21**, and adapted for a higher voltage rating, say, for example, 230 kv. In this circumstance, it is not advisable to enclose the three poles of a three-phase circuit interrupter all within a single tank, and for this reason, three tanks **22** are employed, one tank for each pole unit, or each phase of the three-phase circuit interrupter. In other words, for this voltage rating, say 230 kv., four serially-arranged, elemental, arc-extinguishing units **7** are required to interrupt the voltage and current rating for this application, and all of those arc-extinguishing units **7** are arranged within a single tank **22**, collectively constituting one pole, or one phase, of a three-phase circuit interrupter. FIGS. 5 and 6 only show one pole, or the interrupting structure for only a single phase.

With reference to FIG. 5, it will be observed that a pair of end terminal bushings **24** are used to bring the electrical circuit into and out of the tank structure **22**. In addition, as fully brought out hereinafter, the end terminal bushings **24** not only serve to transmit current into and out of the tank **22**, but also they serve to exhaust compressed gas out of the tank **22** during an interrupting operation. As noted, current transformers **8** are employed, encircling the end terminal bushings **24**.

In addition to the end terminal bushings **24**, for the 230 kv. voltage rating, a third support bushing **25** is used, which serves only a support and exhausting function, and does not transmit any current therethrough. Thus, although three bushings **24, 25** are illustrated, the central bushing **25** merely serves a support function and also serves to exhaust gas from the two intermediate arc-extinguishing units **7**, which the bushing **25** supports at its lower interior end.

For extremely high-voltage ratings, such as 330 kv. and higher, it is desirable to utilize a plurality of such intermediate bushings **25**, instead of only a single bushing **25**, as was illustrated for the 230 kv. rating illustrated in FIGS. 5 and 6. Thus, FIGS. 7 and 8 illustrate the 330 kv. rating, again illustrating the use of a plurality of arc-extinguishing units **7** connected in series. It will be noted that the two intermediate bushings **25** again serve only a support and exhausting function, and do not carry any current flow therethrough. The end bushings **24**, of course, are employed, as was the case of the end bushings **24** in FIG. 5, to transmit current into and out of the steel tank **22**.

FIG. 8 shows a potential device **8***a* employed in conjunction with the end terminal bushing **24**, in a manner well known to those skilled in the art.

The foregoing tank structures have been described to illustrate how the circuit interrupter of the present invention may be employed to interrupt a wide range of voltage ratings, extending all the way from 69 kv. through 138 kv., through 230 kv. and up to 330 kv., the latter construction being shown in FIG. 7. It is obvious, however,

that additional intermediate bushings 25 may be used to extend the voltage rating up to 500 kv. or more, employing the foregoing principles.

Attention is now directed to the elemental arc-extinguishing unit 7, which may be used in multiple throughout the foregoing interrupting structures.

With reference to FIG. 9, it will be observed that the elemental, arc-extinguishing unit 7 includes a pair of contacts 26, 27, a second parallel pair of arcing contacts 28, 29, and a pair of serially-arranged isolating contacts 30, 31. Means are provided to insure a proper sequence of separation between the contacts 26, 27 and the isolating contacts 30, 31, as will be brought out hereinafter.

A compression closing spring 6 biases the movable contacts 27, 29, to the closed position. A closing compression spring 12 also biases the movable isolating contact 31 to its closed, engaged position with relatively stationary isolating contact 30.

The movable contacts 27, 29 are secured to a movable piston 32 by a piston rod 33. The movable piston 32 is provided with a piston ring 32*a* and reciprocally moves within a stationary operating cylinder 42. Flexible fingers 34 maintain sliding contact with a downwardly extending skirt portion 35 of the movable contacts 27, 29, so that current may be transmitted from the movable contacts 27, 29 through finger contacts 34, through a conducting intermediate support portion 36 to lower contact fingers 37, which bear upon the side of the movable isolating contact 31. Thus, generally, the current flows from a conducting, apertured contact foot 39, which is secured to the lower end of the bushings 4, 5, 10, 11, 24 or 25, through an annular contact support 40 to relatively stationary contacts 26, 28, through movable contacts 27, 29, conducting skirt portion 35, flexible fingers 34, operating cylinder 42, intermediate conducting support portion 36, flexible fingers 37, movable isolating contact 31, relatively stationary isolating contact 30 and through conducting strips 41 (FIG. 2) to the adjacently disposed, serially arranged arc-extinguishing unit 7.

Insulating rod supporting means 80, including a pair of insulating support straps 23, fixedly support the operating cylinder 42 and intermediate support portion 36, together with relatively stationary isolating contact 30 from the annular contact support 40. Suitable lugs 23*a* and bolts 23b may be employed for this purpose. It will be observed that the insulating supporting means 80 supports a movable contact assemblage 81 including the movable main contacts 27, 29 and the movable isolating contact 31.

The interlocking means, generally designated by the reference numeral 43, to insure opening of the main contacts 26, 27, 28, 29 prior to the opening of the isolating contacts 30, 31 during the opening operation, includes relatively enlarged apertures 44 and relatively small apertures 45, so that, during the opening operation, the region 46 below the contact piston 32 is exhausted prior to the exhaustion of the region 47 above the movable isolating contact piston 48. Regions 46, 47 thus constitute a common gas-dumping chamber rearwardly of both piston-actuated movable contacts 29, 31. More specifically, initially there exists high pressure within the region 9 exteriorly of the elemental arc-extinguishing unit 7, as well as within the spaces 46, 47. To effect an opening operation, the two-way valve 49 is actuated by a lever 50, linked, as at 51, to an operating rod 52 having a pair of armatures 53, 54. A closing solenoid 55 and an opening solenoid 56 are provided to attract the armatures 53, 54, respectively, depending upon the wishes of the station attendant, to effect closing or opening of the circuit interrupter. Energization of the opening and closing solenoids 55, 56 will effect operation of the two-way valve 49 to either connect conduit 57 to a low-pressure source 58 or to a high-pressure source 59.

Connecting the conduit 57 through the valve 49 to a low-pressure source 58, as illustrated in FIG. 9, will rapidly dump the pressure within region 46 back of contact piston 32 more rapidly than the exhausting of the region 47 behind the movable isolating contact piston 48 by virtue of the enlarged apertures 44. Consequently, the main contacts 26, 27, 28, 29 will always separate prior to the separation of the isolating contacts 30, 31.

During the opening operation, arcing contacts 28, 29 separate first, followed by separation of contacts 26, 27. Since the contact foot 39 is apertured, as at 39*a*, having a vent passage 60 therethrough leading into the hollow supporting terminal bushing 4, 5, a blast of compressed gas will flow radially inwardly between the main contacts 26, 27, 28, 29, following unseating of the movable blast valve 62 away from the resilient blast-valve seat 63. This radially inwardly extending blast of compressed gas from the region 9 will carry the arc, initially established between the contact fingers 26, 27 inwardly to contacts 28, 29. The radial inwardly extending blast of gas will then carry the upper terminal of the arc 64 to the arc catcher 65, where it will be disposed substantially centrally within the blast passage 66 within orifice 67, as defined by annular arcing contact 28. The blast of gas passing through blast passage 66, and exhausting through passage 60, and out through the hollow terminal bushing 4, 5 will quickly effect extinction of the main arc 64.

The dimensioning of the relatively restricted apertures 45 is such that the region 47 is never exhausted to low pressure until the arc 64 is extinguished. When arc 64 is extinguished, it is desirable to effect opening of the isolating contacts 30, 31 and to permit rapid reclosure of the main contacts 26, 27 and 28, 29 to permit quick reclosing of the movable blast valve 62. Rapid closing of blast valve 62 is, of course, desirable to conserve the compressed air.

It will be noted that the upward retracting, opening movement of the movable isolating contact piston 48 will be accompanied by abutment of plug 68 against the valve stem 69 of an interlocking control valve 70, so that the latter will be forced upwardly over the enlarged apertures 44. This closing of the enlarged apertures 44 will permit high-pressure gas from region 9 to pass through a bleeder opening 71, and through normal leakage channels, into the region 46 behind main contact piston 32 to equalize the pressure on both sides of the contact piston 32, to thereby permit the compression closing spring 6 to effect reclosing of the blast valve 62 and reclosure of the two pairs of contacts 26, 27 and 28, 29.

Thus, in the fully open-circuit position of the arc-extinguishing unit 7, high-pressure gas exists within the region 46, behind the main contact piston 32, and low-pressure gas exists within the region 47 behind the movable isolating contact piston 48, thereby maintaining the isolating contacts 30, 31 in their separated open-circuit position. The valve 49 is, of course, in its illustrated position, as shown in FIG. 9 during this time.

To effect a closing operation, the closing solenoid 55 is energized. This attracts armature 53 and rotates the two-way valve 49 so that the high-pressure source 59 is connected to the conduit 57. The high-pressure gas will pass through the restricted apertures 45 and into the region 47 behind the movable isolating contact piston 48 causing the latter to quickly move to the closed position into engagement with the stationary isolating contact 30, being assisted in this action by the closing compression spring 12. During this time, of course, the main contacts 26, 27 and 28, 29 are closed, having previously been reclosed at the end of the prior opening operation.

It will be noted that the region 82 between apertures 44, 45 is small so that it is quickly exhausted, or pressurized, depending upon the position of the two-way valve 49. Extremely fast operation of the arc-extinguishing unit 7 hence results.

With reference to FIG. 2, it will be observed that the conduits 57, leading to the six units 7 within tank 2, are

interconnected to a header conduit 74, the latter extending externally of the tank 2, and connected to the two-way valve 49, not shown. Also, with reference to FIG. 5, it will be observed that the conduits 57 are connected to a common conduit 75, the latter leading through another conduit 76 externally of the tank 22 to the valve 49, not shown. Thus, simultaneous actuation of all of the elemental, arc-extinguishing units 7 is assured.

When it is desired to use in place of compressed air, a more efficient arc-extinguishing gas, such as SF_6 or SeF_6, or mixtures of the foregoing gases, with each other or with one of the following gases, air, nitrogen, argon, helium, and carbon dioxide, it is desirable to collect such exhausted gas and to recompress it. This has been described above in connection with FIGS. 3 and 4 of the drawings, use of the collecting chambers 13 being described. In addition, when such gases are employed, the low-pressure source 58 (FIG. 9) may be maintained at the proper pressure by the use of a compressor 77 which is electrically actuated when the pressure within low-pressure source 58 raises to a predetermined value. In other words, during successive opening operations of arc-extinguishing unit 7, high-pressure gas will be fed into the low-pressure source 58, and this accumulation of gas will tend to raise the pressure therein. An uncontrolled raising of pressure within low-pressure source 58 would tend to slow down the opening operation of unit 7, and, consequently, the compressor 77 is arranged to withdraw gas out of the low-pressure container 58, recompress the same, and feed it back into the high-pressure source 59. This high-pressure source 59 may actually be one of the dead tanks 2, 19 or 22.

From the foregoing description, it will be apparent that there is provided a complete line of circuit interrupters, which may be adaptable over a wide range of voltage and current ratings. For the lower voltage ratings, all three poles may be contained within a single tank. For the higher voltage ratings, a single pole may be enclosed within a single tank. Either compressed air or more efficient arc-extinguishing gas may be employed. The hollow terminal bushings for exhausting of the high-pressure gas from the tanks may assume the form set out in United States Patent application filed June 7, 1956, Serial No. 590,066, now United States Patent 2,965,735 issued December 20, 1960 to Benjamin P. Baker, and assigned to the assignee of the instant application.

The described tank structures are rugged and well capable of withstanding earthquake shocks or other disturbances, and the resulting structures are exceedingly compact, partly due to the high dielectric strength of the high-pressure gas. The steel tanks are well capable of withstanding high internal gas pressures, and conventional bushing-type current transformers may be employed.

It is to be noted that the elemental, arc-extinguishing units 7 may be of one type and, therefore, economical to manufacture. The higher voltage ratings merely require a multiple of such units arranged in series fashion, as illustrated.

Although there have been illustrated and described specific arc-extinguishing structures for a wide range of voltage ratings, it is to be clearly understood that the same were 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. The combination in a compressed-gas circuit interrupter of a grounded metallic tank pressurized with a high-pressure gas which it is desired to conserve, one or more hollow terminal bushings extending interiorly into said grounded metallic tank, an arc-extinguishing unit disposed interiorly within said tank, means associated with said arc-extinguishing unit utilizing said high-pressure gas for arc extinction and for exhausting the utilized gas out through a hollow terminal bushing, and a collecting chamber at relatively low pressure surrounding the exterior end of at least one hollow terminal bushing to collect exhausted gas to prevent its dissipation to the atmosphere.

2. The combination in a compressed-gas circuit interrupter of a grounded metallic tank pressurized with a high-pressure gas which it is desired to conserve, one or more hollow terminal bushings extending interiorly into said grounded metallic tank, an arc-extinguishing unit disposed interiorly within said tank, means associated with said arc-extinguishing unit utilizing said high-pressure gas for arc extinction and for exhausting the utilized gas out through a hollow terminal bushing, a collecting chamber at relatively low pressure surrounding the exterior end of at least one hollow terminal bushing to collect exhausted gas to prevent its dissipation to the atmosphere, and means for recompressing the gas within said collecting chamber and forcing the recompressed gas back into the pressurized tank.

3. A compressed-gas circuit interrupter including a generally cylindrical metallic tank having its long central axis disposed substantially horizontally, means for filling said metallic tank with an arc-extinguishing gas under pressure, a pair of hollow terminal bushings for exhausting gas disposed at opposite ends of said tank extending radially outwardly substantially perpendicularly to the long central axis of said tank, an arc-extinguishing assemblage including a plurality of serially related arc-extinguishing units disposed within said tank and electrically connected between the interior ends of the hollow terminal bushings, and one or more hollow non-conducting support bushings adaptable for exhausting gas in substantial alignment with the aforesaid hollow terminal bushings for supporting at least a part of said arc-extinguishing assemblage.

4. The combination in a compressed-gas circuit interrupter of a grounded metallic tank, a plurality of serially related gas-blast arc-extinguishing units disposed interiorly within said tank, a pair of hollow terminal bushings extending into said tank and having said plurality of serially related arc-extinguishing units connected between the interior ends thereof, and one or more hollow, non-conducting support bushings in substantial alignment with the aforesaid hollow terminal bushings for supporting said gas-blast arc-extinguishing units, through which a blast of gas may be exhausted.

5. A compressed-gas circuit interrupter including a unitary gas-blast, arc-extinguishing unit the arc-extinguishing unit including a relatively stationary contact disposed adjacent one end thereof and a relatively stationary isolating contact disposed adjacent the other end thereof, means supporting the unitary, gas-blast arc-extinguishing unit solely from the relatively stationary contact thereof, insulating rod means for spacing the relatively stationary contact away from the relatively stationary isolating contact, an intermediately disposed movable contact assemblage including a movable main contact and a movable isolating contact movable toward each other during opening, said insulating rod means supporting said movable contact assemblage fixedly in position, and means for sequentially opening first the movable main contact to extinguish arcing and subsequently opening the movable isolating contact following arc extinction.

6. The combination in a compressed-gas circuit interrupter of a unitary gas-blast arc-extinguishing unit, means defining a pressurized enclosure, said arc-extinguishing unit being disposed within said pressurized enclosure, the gas-blast arc-extinguishing unit including a relatively stationary main contact disposed adjacent one end thereof, an intermediately disposed movable contact assemblage, a relatively stationary isolating contact disposed adjacent the other end thereof, means supporting the unitary gas-blast arc-extinguishing unit solely from the relatively stationary main contact thereof, insulating supporting rod means spacing the relatively stationary main contact and the relatively stationary isolating contact apart, said in-

sulating supporting rod means also supporting said intermediately disposed movable contact assemblage, the movable contact assemblage including a movable main contact cooperable with said relatively stationary contact to establish a main arc, the movable contact assemblage also including a movable isolating contact cooperable with said relatively stationary isolating contact to provide an isolating gap, the movable main contact and the movable isolating contact being movable toward each other during the opening operation, and means reclosing the main contacts following the establishment of the isolating gap in the fully open-circuit position of the interrupter.

7. The combination in a compressed-gas circuit interrupter of a unitary gas-blast arc-extinguishing unit, means defining a pressurized enclosure, said arc-extinguishing unit being disposed within said pressurized enclosure, the gas-blast arc-extinguishing unit including a relatively stationary main contact disposed adjacent one end thereof, an intermediately disposed movable contact assemblage, a relatively stationary isolating contact disposed adjacent the other end thereof, means supporting the unitary gas-blast arc-extinguishing unit solely from the relatively stationary main contact thereof, insulating rod supporting means spacing the relatively stationary main contact and the relatively stationary isolating contact apart, said insulating rod supporting means also supporting said intermediately disposed movable contact assemblage, the movable contact assemblage including a movable main contact cooperable with said relatively stationary contact to establish a main arc, the movable contact assemblage also including a movable isolating contact cooperable with said relatively stationary isolating contact to provide an isolating gap, the movable main contact and the movable isolating contact being movable toward each other during the opening operation, means reclosing the main contacts following the establishment of the isolating gap in the fully open circuit position of the interrupter, a piston for moving the movable main contact, another piston for moving the movable isolating contact, and means for sequentially dumping the high pressure gas back of the first said piston and later from back of the said other piston.

8. A compressed-gas circuit interrupter including means defining a pressurized chamber, a hollow terminal bushing extending interiorly within said pressurized chamber and supporting an arc-extinguishing unit at its interior end, said arc-extinguishing unit including an orifice-shaped relatively stationary contact having an exhaust passage leading through the hollow terminal bushing, said hollow terminal bushing constituting the sole support for the arc-extinguishing unit and supporting the same at the orifice-shaped relatively stationary contact thereof, a cooperable piston-actuated movable contact, an annular movable blast valve movable in response to motion of the movable contact, elongated insulating rod support means secured at one end to the relatively stationary contact and supporting a relatively stationary isolating contact at the other end thereof, an operating cylinder supported by an intermediate portion of said elongated insulating support means within which is guided said piston-actuated movable contact, a piston-actuated movable isolating contact cooperable with said relatively stationary isolating contact, and the movable contact and movable isolating contact being movable toward each other during the opening operation of the interrupter.

9. A compressed-gas circuit interrupter including means defining a pressurized chamber, a hollow terminal bushing extending interiorly within said pressurized chamber and supporting an arc-extinguishing unit at its interior end, said arc-extinguishing unit including an orifice-shaped relatively stationary contact having an exhaust passage leading through the hollow terminal bushing, a cooperable piston-actuated movable contact, an annular movable blast valve movable in response to motion of the movable contact, elongated insulating support rod means secured at one end to the hollow terminal bushing and supporting a relatively stationary isolating contact at the other end thereof, an operating cylinder supported by an intermediate portion of said elongated insulating support means within which is guided said piston-actuated movable contact, a piston-actuated movable isolating contact cooperable with said relatively stationary isolating contact, pneumatic means including a common gas-dumping chamber rearwardly of both piston-actuated movable contacts for delaying the opening of said movable isolating contact until after arc extinction occurs at the movable contact during the opening operation, and the movable contact and movable isloating contact being movable toward each other during the opening operation of the interrupter upon exhausting of the gas out of said common gas-dumping chamber.

10. A compressed-gas circuit interrupter including means defining a pressurized chamber, a hollow terminal bushing extending interiorly within said pressurized chamber and supporting an arc-extinguishing unit at its interior end, said arc-extinguishing unit including an orifice-shaped relatively stationary contact having an exhaust passage leading through the hollow terminal bushing, a cooperable piston-actuated movable contact, an annular movable blast valve movable in response to motion of the movable contact, elongated insulating support means secured at one end to the hollow terminal bushing and supporting a relatively stationary isolating contact at the other end thereof, an operating cylinder supported by an intermediate portion of said elongated insulating support means within which is guided said piston-actuated movable contact, a piston-actuated movable isolating contact cooperable with said relatively stationary isolating contact, pneumatic means including a common gas-dumping chamber rearwardly of both piston actuated movable contacts for dumping the pressure in back of the piston-actuated movable contact prior to the dumping of pressure in back of the piston-actuated movable isolating contact during the opening operation to obtain timed sequential opening of the contacts, and the movable contact and movable isolating contact being movable toward each other during the opening operation of the interrupter.

11. A compressed-gas circuit interrupter including means defining a pressurized chamber, a hollow terminal bushing extending interiorly within said pressurized chamber and supporting an arc-extinguishing unit at its interior end, said arc-extinguishing unit including an orifice-shaped relatively stationary contact having an exhaust passage leading through the hollow terminal bushing, a cooperable piston-actuated movable contact, an annular movable blast valve movable in response to motion of the movable contact, elongated insulating supporting means secured at one end to the hollow terminal bushing and supporting a relatively stationary isolating contact at the other end thereof, an operating cylinder supported by an intermediate portion of said elongated insulating support means within which is guided said piston-actuated movable contact, a piston-actuated movable isolating contact cooperable with said relatively stationary isolating contact, pneumatic means including a common gas-dumping chamber disposed rearwardly of both piston actuated movable contacts for delaying the opening of said movable isolating contact until after arc extinction occurs at the movable contact during the opening operation, the movable contact and movable isolating contact being movable toward each other during the opening operation of the interrupter, and means reclosing the movable contact in the fully open-circuit position of the interrupter.

12. A gas-blast circuit interrupter including an arc-extinguishing unit, said unit having a relatively stationary contact and a piston-actuated movable contact cooperable therewith, said unit also having a relatively stationary isolating contact and a piston-actuated movable isolating contact cooperable therewith to establish a serially related isolating gap, a common gas-dumping chamber disposed rearwardly of both piston-actuated movable contacts, and

an apertured partition member within the common gas-dumping chamber to insure sequential opening of the movable contacts.

13. A gas-blast circuit interrupter including an arc-extinguishing unit, said unit having a relatively stationary contact and a piston-actuated movable contact cooperable therewith, said unit also having a relatively stationary isolating contact and a piston-actuated movable isolating contact cooperable therewith to establish a serially related isolating gap, a common gas-dumping chamber disposed rearwardly of both piston-actuated movable contacts, an apertured partition member within the common gas-dumping chamber to insure sequential opening of the movable contacts, an interlocking control valve provided in the common gas-dumping chamber, and the piston-actuated movable isolating contact actuating said control valve to halt the exhausting of gas back of the piston-actuated movable contact to effect reclosure thereof.

14. The combination in a gas-blast circuit interrupter of means defining a pressurized enclosure, a gas-blast arc-extinguishing unit disposed interiorly within said pressurized enclosure, the unit including a relatively stationary contact, a cooperable movable piston-actuated contact, said unit also including a relatively stationary isolating contact and a cooperable piston-actuated movable isolating contact, common gas-dumping means disposed rearwardly of both piston-actuated movable contacts, a gas-dumping conduit connected to said common gas-dumping means, valve means controlling the exhaust of gas out of said common gas-dumping means, and a partition member with restricted openings therein disposed between said gas-dumping conduit and said piston-actuated movable isolating contact.

15. The combination in a gas-blast circuit interrupter of means defining a pressurized enclosure, a gas-blast arc-extinguishing unit disposed interiorly within said pressurized enclosure, the unit including a relatively stationary contact, a cooperable movable piston-actuated contact, said unit also including a relatively stationary isolating contact and a cooperable piston-actuated movable isolating contact, common gas-dumping means disposed rearwardly of both piston-actuated movable contacts, a gas-dumping conduit connected to said common gas-dumping means, valve means controlling the exhaust of gas out of said common gas-dumping means, a partition member with restricted openings therein disposed between said gas-dumping conduit and said piston-actuated movable isolating contact, and an interlocking control valve actuated by the movable isolating contact to prevent continued exhausting back of the piston-actuated movable contact.

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