United States Patent

Barkan

[15] **3,674,964**

[45] **July 4, 1972**

[54] **HIGH VOLTAGE ELECTRIC CIRCUIT BREAKER WITH RAPID RESPONSE TRIPPING MEANS**

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[22] Filed: **May 20, 1971**

[21] Appl. No.: **145,415**

[52] U.S. Cl. .... **200/148 R**, 200/148 B, 200/145

[51] **Int. Cl.** **H01h 33/54**

[58] **Field of Search** ....200/148 B, 148 R, 148 E, 148 D, 200/145

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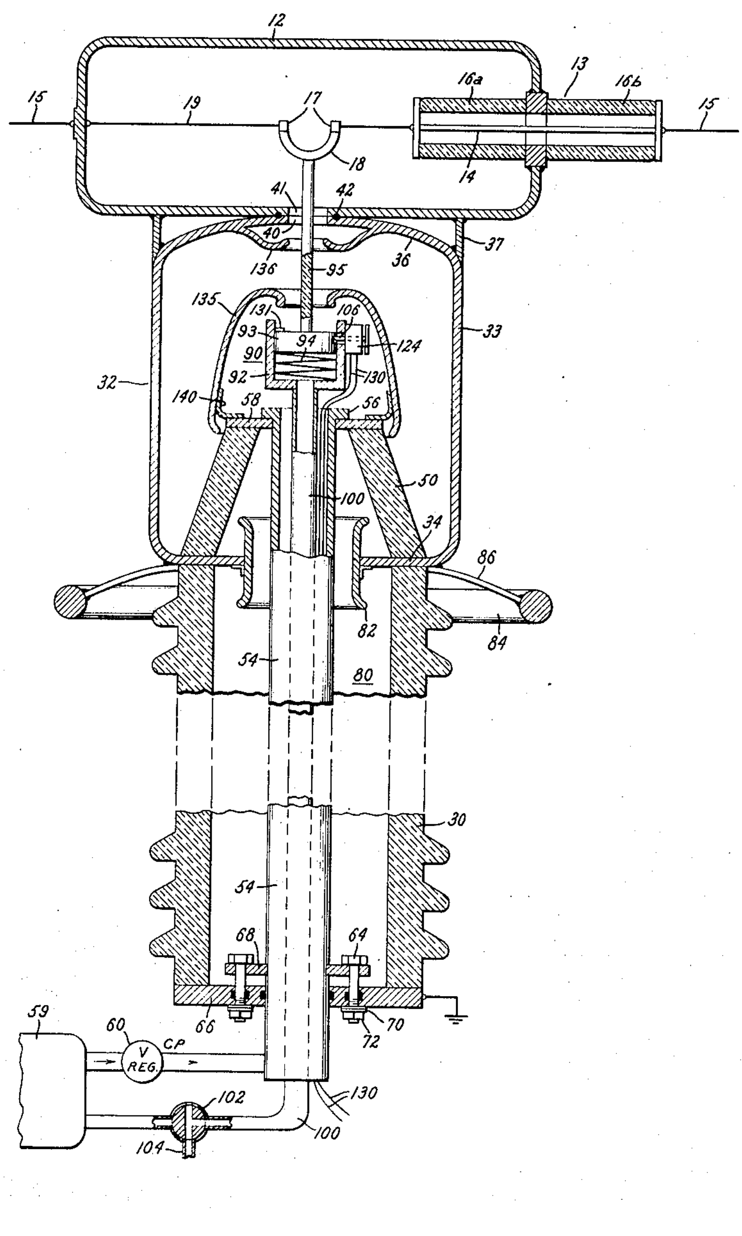
[57] **ABSTRACT**

A high voltage electric circuit breaker comprising a high potential tank mounted atop an insulating column. Opening of the circuit breaker is initiated by an operator located atop the insulating column in a housing filled with high dielectric strength fluid. The operator is maintained at ground potential by electroconductive structure extending vertically through the column between the operator and the base of the column. The operator is connected to control means within the high potential tank by a short operating rod of insulating material that extends through said dielectric fluid.

18 Claims, 7 Drawing Figures



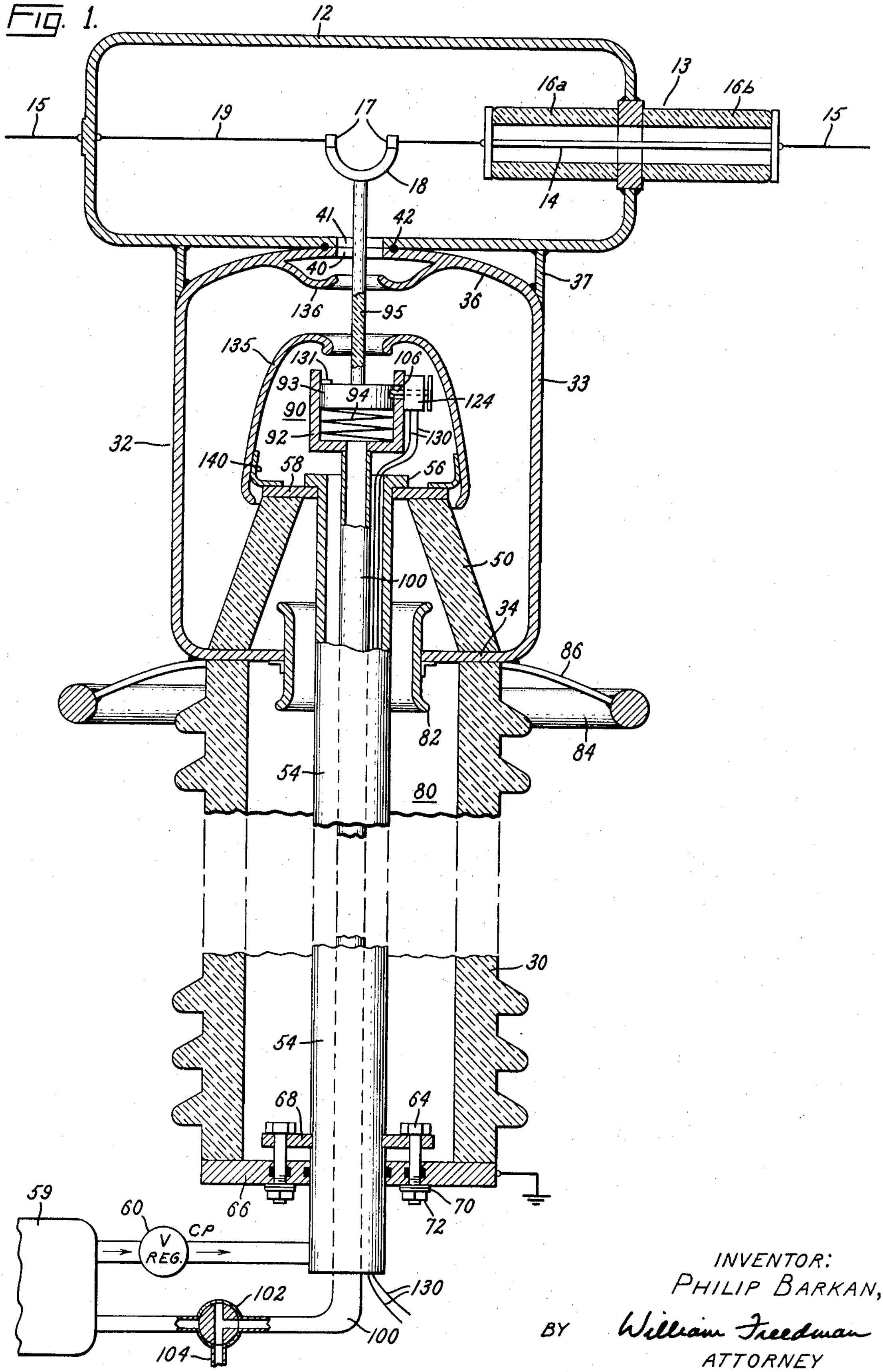


Fig. 1.

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Fig. 2.

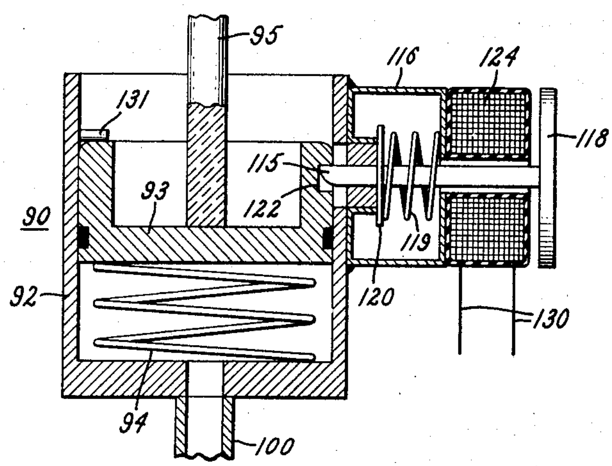

Fig. 3.

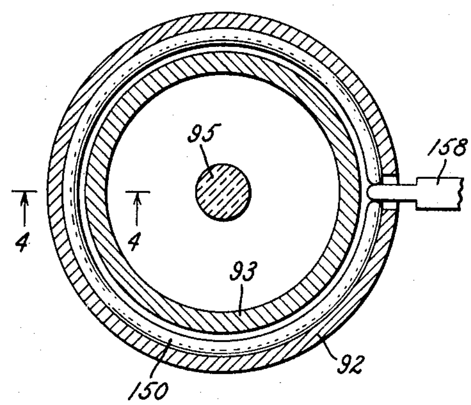

Fig. 4.

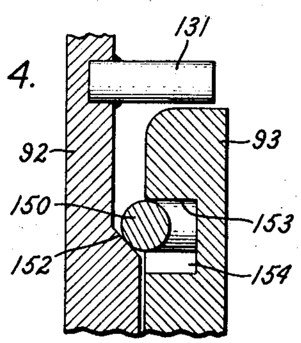

Fig. 5.

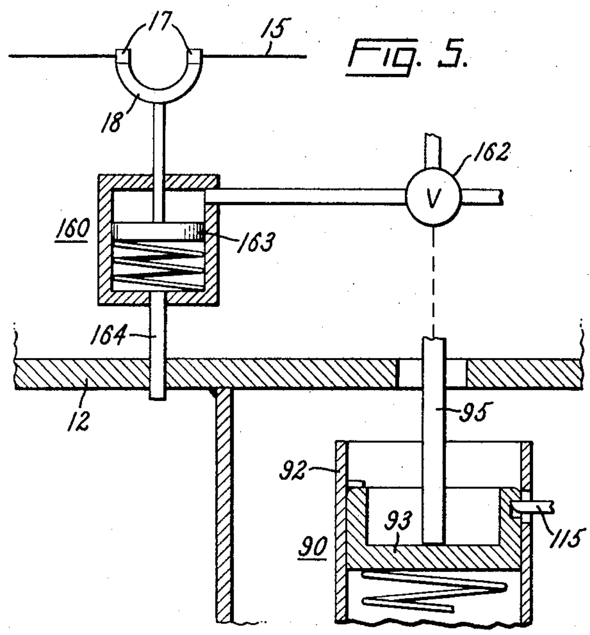

Fig. 6.

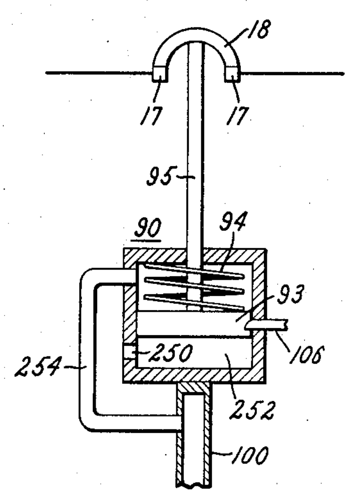

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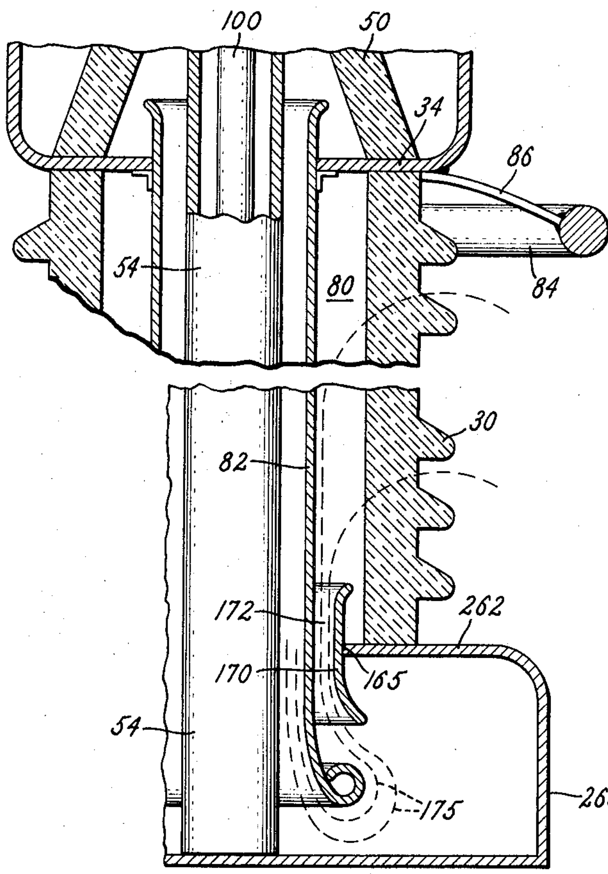
Fig. 7.



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HIGH VOLTAGE ELECTRIC CIRCUIT BREAKER WITH RAPID RESPONSE TRIPPING MEANS

BACKGROUND

This invention relates to a high voltage electric circuit breaker that comprises means for controlling its operation disposed in a location of high potential and, more particularly, relates to means for transmitting a tripping signal from ground to said high potential location at extremely high speed.

The type of high voltage circuit breaker that I am concerned with comprises a live tank, i.e., a tank at high potential, mounted on an insulating column; circuit interrupting means at high potential within the tank; and operation-control means also within the tank and at high potential for initiating operation of the circuit-interrupting means upon receipt of a tripping signal. In such a circuit breaker, the tripping signal is usually transmitted to the control means through a long rod of electrical insulating material that extends from a ground potential operator at the base of the insulating column to said control means. In a typical 500 KV circuit breaker, this actuating rod is about 20 feet long.

In such a circuit breaker the speed of response of the control means is seriously limited because of the great length of the actuating rod. Speed limitations are imposed by the relatively high mass of the long rod, by the considerable time needed for wave propagation along the length of the long rod, and by stretch in the rod. The longer the rod, the more these factors limit the speed of response that is obtainable.

To obviate the need for such a long rod, it has been proposed to locate the operator itself in the high potential region of the circuit breaker and to transmit a tripping signal to the high potential operator by nonmechanical means, such as optical means. But this approach has the disadvantage of requiring a rather complicated operator that usually includes a source of electrical energy that must be kept charged, thus necessitating involved charging means. Examples of this approach are illustrated in U.S. Pat. No 3,315,056–Furukawa and in my joint application Ser. No. 872,000 filed Oct. 29, 1969, and assigned to the assignee of the present invention.

SUMMARY

An object of my invention is to overcome the speed limitations imposed by a long actuating rod and still not incur the complications that usually result from locating the operator at high potential, such as the need to have a source of electrical control power at high potential.

Another object is to construct the high voltage circuit breaker in such a manner that an insulating actuating rod of exceptional short length can be used for transmitting a tripping signal at extreme high speed from ground to a high potential location.

In carrying out my invention in one form, I locate the operator that develops the mechanical tripping signal at the top of the insulating column on which the high potential tank is mounted. This operator is enclosed within a housing that contains a pressurized dielectric fluid that has a dielectric strength much higher than air at normal atmospheric pressure. The operator is maintained at ground potential by electroconductive structure extending through said insulating column between the operator and a ground location at the base of said column. The operator is connected to control means within the high potential tank by a short operating rod of electrical insulating material that extends through said dielectric fluid.

BRIEF DESCRIPTION OF DRAWINGS

For a better understanding of the invention, reference may be had to the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side-elevational view partially schematic and partially sectional showing an electric circuit breaker embodying one form of the present invention.

FIG. 2 is an enlarged detailed view of a portion of FIG. 1.

FIG. 3 is a detailed showing of a portion of modified latch means for use in the circuit breaker of FIG. 1.

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3.

FIG. 5 is a schematic showing of a modified form of the invention.

FIG. 6 is a schematic showing of another modified form of the invention.

FIG. 7 is a schematic showing of still another modified form of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT INTERRUPTING ASSEMBLY

Referring now to FIG. 1, the circuit breaker shown therein comprises a metal tank **12** at high potential and a conventional terminal bushing **13** projecting into the tank at one end. The terminal bushing comprises a conductive stud **14** extending axially thereof along its longitudinal axis and insulators **16a** and **16b** supporting the stud and electrically isolating it from the tank **12**. The tank **12** is filled with a compressed gas, preferably air, which is used in a conventional manner for circuit interrupting purposes.

Within tank **12** is an interrupting assembly that comprises a pair of separable contacts schematically shown at **17** and **18**. Contact **18** is a movable contact that conductively bridges the space between the two stationary contacts **17**. When the circuit breaker is closed, bridging contact **18** is in engagement with stationary contacts **17**, thus permitting current to flow through the circuit breaker via contacts **17** and **18**. The circuit breaker is connected in a high voltage power circuit **15** that extends through the breaker, when closed, via stud **14** of the bushing, contacts **17**, **18**, and a conductor **19** that connects the contacts to tank **12**.

Circuit interruption is effected by driving movable contact **18** downwardly to separate the contacts. This establishes an arc between each pair of contact and this arc is extinguished in a well known manner by the flow of pressurized air from the tank **12**. A typical air-blast circuit breaker of this type is shown in U.S. Pat. No. 2,783,338—Beatty assigned to the assignee of the present invention. For driving the bridging contact **18** through a downward opening stroke, an actuating rod **95** of insulating material is provided. The upper end of rod **95** is shown connected to bridging contact **18** and may be thought of in this embodiment as control means for the circuit interrupting assembly. This actuating rod **95** will be referred to hereinafter in more detail.

HOUSING ON WHICH TANK 12 IS MOUNTED

As shown in FIG. 1, the high potential tank **12** is mounted atop a hollow insulating column **30** which electrically isolates the tank from ground, the lower end of the column being at ground potential. Tank **12** is not mounted directly on column **30** but rather is mounted on a metal housing **32** which, in turn, is mounted directly on column **30**. HOusing **32** has a generally cylindrical body portion **33** and a flat bottom **34** that seats on the top of insulating column **30**. Housing **32** has a top portion **36** on which tank **12** seats. Top **36** includes a tank mounting ring **37** that aids in supporting the tank on housing **32**. Suitable fastening means (not shown) secures the tank **12** and housing **32** together.

The top **36** of housing **32** has a central opening **40** therein that aligns with an opening **41** in the wall of tank **12**, thus affording communication between the interiors of these two vessels. Accordingly, housing **32** is filled with pressurized air at the same pressure as the air within housing **12**. A suitable O-ring seal **42** is provided between the engaging walls of the two vessels **32** and **12** to prevent pressurized air from leaking therebetween to atmosphere. Similarly, suitable seals (in most cases not shown) are provided around all other openings that lead to atmosphere or to a low pressure region from the interior of housing **32**.

Within housing **32** there is a hollow frusto-conical insulating member **50** that is seated atop the bottom portion **34** of housing **32** and has a central axis aligned with the central axis of column **30**. Extending through insulator **50** and insulating column 30 along their central axes is a tubular metal air line 54. In addition to serving as an air line for high pressure air, the tubular member 54 acts as a tension member that maintains the insulator 50 and insulating column 30 in compression. In this connection, air line 54 has a flange 56 on its upper end which bears against an upper end cap 58 on insulator 50. When a downward force is applied to tension member 54 (in a manner soon to be described), the upper flange 56 thereon transmits this downward force to insulator 50, thus compressing insulator 50 and column 30 and clamping bottom 34 therebetween. This compressive effect preloads the insulating column in compression, strengthening it and improving its ability to withstand large mechanical forces such as might result, for example, from internal pressures, from cable pull, from heavy ice formations, or from high winds.

The air line 54 conveys high pressure air from a suitable high pressure source 59 at the base of column 30 to the housing 32 atop the column. A suitable pressure regulator valve 60 admits pressurized air to air line 54 whenever the pressure of the air in housing 32 falls below a predetermined level. At its lower end, the high pressure air line 54 extends in sealed relationship through a lower end cap 66 of the hollow column 30.

For applying a continuously acting downward force to air line 54, a series of bolts 64 are provided at the bottom end of the air line. These bolts extend in sealed relationship through the lower end cap 66 of the insulating column 30 and through a flange 68 affixed to the air line 54. Surrounding each bolt is a stack of spring, or Belleville, washers 70. When nuts 72 are tightened, the spring washers 70 are compressed, thus applying to the bolts a downward spring force, which is transmitted through flange 68 to the air line 54. Reference may be had to U.S. Pat. No. 3,380,009—Miller assigned to the assignee of the present invention for a disclosure of a high voltage current transformer with its insulators compressed in a manner similar to that illustrated in my circuit breaker.

Surrounding the air line 54 where it passes through the insulating column 30 and the hollow insulator 50 is a chamber 80 that is filled with a high quality dielectric fluid, preferably sulphur hexafluoride gas at a pressure of several atmospheres. This dielectric fluid provides high dielectric strength between the grounded air line 54 and the bottom 34 of the high potential housing 32 where the air line passes therethrough. For shaping the electric field in this high stress region in order to reduce electrical stress concentrations, a tubular shield 82 is provided. Tubular shield 82 surrounds the air line 54 in spaced concentric relationship thereto and is suitably supported on the radially inner periphery of the bottom 34. For further modifying the electric field to prevent undesirable stress concentrations adjacent the top of insulating column 30, an external electrostatic shielding ring 84 is provided around the top of the insulating column. This shielding ring 84 is supported on housing 32 by suitable radially-extending arms 86.

When it is desired to open the circuit breaker, a tripping signal, in the form of a downward opening force, is supplied to the movable bridging contact 18 through the actuating rod 95. For developing this tripping signal, I provide a pneumatic operator 90 atop the insulating column 30 and within housing 32. This operator 90, which is shown in a schematic simplified form, comprises a stationary cylinder 92 and a piston 93 that is vertically slidable therein. A closing spring 94 biases the piston in an upward closing direction. In the embodiment of FIG. 1, piston 93 is mechanically coupled to the bridging contact 18 by means of the actuating rod 95, which is connected at its respective opposite ends to the bridging contact 18 and piston 93. Actuating rod 95 is a relatively short rod of insulating material, preferably a high density ceramic, e.g., high-strength, high-density alumina.

The space above piston 93 freely communicates with the space in housing 32 and is therefore at the same pressure as the high pressure air in this latter space. The space beneath piston 93 is normally vented to atmosphere through a metal pipe 100 that extends to the base of column 30 through high pressure air line 54. A suitable three-way valve 102 in this line 100 normally vents line 100 to atmosphere through a passage 104 but can be operated from its normal venting position into another position to connect the line to high pressure source 59.

Piston 93 is normally held in its position of FIG. 1 by means of a suitable piston latch 106. When latch 106 is released, the high pressure air above the piston rapidly drives the piston downwardly, thus driving the actuating rod 95 and bridging contact 18 downwardly at high speed through a circuit-breaker opening stroke.

Circuit-breaker closing is effected by operating control valve 104 to its non-venting position, thus supplying pressurized air from source 59 to the space beneath piston 93. This allows the closing spring 94 beneath piston 93 to drive the piston upwardly through a contact-closing stroke. This piston latch 106 resets when piston 93 has moved upwardly through a closing stroke into its normally-closed position of FIG. 1, where it encounters a stop 131 fixed to the cylinder 92.

A simplified form of piston latch 106 is shown in the enlarged sectional view of FIG. 2. The illustrated latch comprises a movable latching member 115 that is slidably mounted for horizontal motion in a housing 116 that is secured to cylinder 92. The latching member has a disk 118 fixed thereto at its outer end. A compression spring 119 acting against the shoulder 120 on latch member 115 biases latch member 115 to the left into a notch 122 in the outer periphery of piston 193. A coil 124 mounted on housing 116 is used for developing a latch-releasing force. When energized, coil 124 develops a repulsive force on disk 118 that drives the disk and latching member 115 to the right to release the latch.

For simplification, I have shown the latch 106 as comprising a simple pin 115 of appropriate shape cooperating with the notch 122 in the piston. However, in a preferred embodiment of the invention, I use a ring type piston latch of the form shown and described in application Ser. No. 36,288—Barkan et al., filed May 11, 1970, and assigned to the assignee of the present invention. In this latter type of latch, the latch force on the piston is well distributed around the periphery of the piston, and a relatively small releasing force can be used to release a very large force on the piston.

Such a latch is illustrated in FIGS. 3 and 4. Here, the latch comprises a split ring 150 of circular cross section that is carried in an annular groove 154 in the piston 93. This piston ring 150 is a resilient member that has a tendency to expand in diameter, but its expansion is limited by the internal wall of cylinder 92 and specifically by a conical shoulder 152 on the internal wall of cylinder 92. Downward force on piston 93 is transmitted to the piston ring through groove surface 153 and urges the piston ring against conical shoulder 152. The reaction force developed on the ring by the conical shoulder tends to contract the ring. The ring is normally prevented from contracting beyond the position shown in FIG. 4 by a latching member 158, shown in FIG. 3, that fits between the ends of the split ring. When latching member 158 is withdrawn radially outward from this position, the reaction force from conical shoulder 152 on the ring forces the ring to contract completely into groove 154, thus releasing the piston for downward movement.

For supplying electrical energy to the coil 124 in order to operate the latching member to release the piston 93 and thus initiate an opening operation, electric leads 130 (FIG. 1) are provided. These leads extend from a location at the base of column 30 to the coil 124 via a path disposed within the metal air line 54. The leads 130 are provided with suitable low voltage insulation capable of withstanding the low voltages present in a signal or control circuit. Locating the leads 130 within a grounded housing 54 assures that they are electrostatically shielded from the high voltage electrical field that is present between the high potential parts of the circuit breaker and the grounded housing 54. The solenoid comprising coil 124 and disk 118 is generally conventional but is designed in such a manner as to rapidly develop a high repulsive force on disk 118 upon energization of the coil.

It will be apparent that the operator 90, despite its location near the high potential tank 12, is at ground potential inasmuch as it is electrically connected to ground through the air lines 54 and 100. One reason why I am able to locate the operator 90 this close to the high potential tank 12 is that I position the operator in a high dielectric strength medium, i.e., the high pressure air within housing 32. Another reason is that the short operating rod 95 is always maintained in this high dielectric strength medium, whether the circuit breaker is open or closed, and this greatly reduces any chance for a flashover along its length. Still another reason is that the ground connection 54 to the operator 90 is located within a surrounding chamber 80 where a high quality dielectric medium is present to electrically isolate the ground connection 54 from the bottom 34 of the high potential tank and where excessive electrical stress concentrations are avoided.

For further reducing the likelihood of a flashover between the grounded operator 90 and the surrounding high potential housing 32, I provide a first electrostatic shield 135 around the operator 90 and another electrostatic shield 136 in front of the opening 40 in the top 36 of housing 32. These shields have smooth surfaces, free of sharp edges and points, for avoiding stress concentrations in the electric field thereadjacent. These shields 135 and 136 have aligned openings that allow the actuating rod 95 to pass therethrough. Suitable supports 140 are provided for attaching shield 135 to the top plate 58 of insulator 50.

Because operator 90 is exceptionally close to the high potential tank 12 and to the interrupting assembly therein, the length of the actuating rod 95 can be greatly reduced as compared to that of actuating rods used in conventional circuit breakers of corresponding voltage. This reduction in length very appreciably reduces the time needed to initiate motion of the upper end of the actuating rod 95 by the operator. This follows from the fact that the mass of the rod is reduced, the time needed for stress wave propagation between the ends of the rod is reduced, and the stretch in the rod is reduced.

A factor that further contributes to high speed response is that the actuating rod 95 is made of a high density ceramic, such as high strength alumina. The velocity of wave propagation through such a material is several times as high as that through the fiber-glass reinforced plastic commonly used for long circuit breaker actuating rods.

Another factor that contributes to high speed response is that my operator 90 is able to directly actuate the movable contact 18. It is customary in the high-potential tank type of circuit breaker to provide a separate contact operator within the tank 12, and to use a ground-potential operator to operate a control valve located within the high potential tank which, in turn, controls the separate contact operator. In the embodiment of FIG. 1, the high-potential operator is omitted and the ground-potential operator effects direct operation of the movable contact. A factor that enables such direct operation to be effected is that I use a ring-type piston latch (FIGS. 3 and 4) for controlling the ground potential operator; and with such a latch, only a small releasing force can be used to release a very large force on the piston. This large piston force can be used for directly actuating the movable contact, thus eliminating the time delays inherent when additional devices are interposed in the operating chain.

Although I am able to directly actuate the movable contact with my arrangement, it is to be understood that my invention in its broader aspects comprehends the use of a separate contact operator within tank 12 which can be triggered into operation by a ground potential operator located in the position illustrated. For example, referring to FIG. 5, I have shown within tank 12 a contact operator 160 that is controlled by a normally-closed control valve 162. Control valve 162 is mechanically connected to piston 93 by insulating actuating rod 95. Downward movement of piston 93 opens control valve 162, thus supplying high pressure air to the top of a piston 163. Since the bottom of this piston is vented through passage 164, the high pressure above the piston rapidly drives it downwardly, thereby driving movable contact 18 through a downward opening stroke.

FIG. 6 shows a modification of the circuit breaker of 1 where I where the actuating rod 95 instead of being loaded in tension during an opening operation is loaded in compression. Although not shown in FIG. 6, operator 90 is located in the tank 32 of FIG. 1 and the contacts 17 and 18 are located in tank 12 of FIG. 1. Actuating rod 95 passes between the tanks 32 and 12 in the same manner as shown in FIG. 1. A port 250 in cylinder 92 affords communication between the space 252 beneath piston 93 and the surrounding high pressure air. The space above piston 93 communicates through a line 254 with an air line 100 generally corresponding to air line 100 of FIG. 1 and is therefore at atmospheric pressure when the parts are in their position of FIG. 1. When latch 106 is released, the high pressure air beneath piston 93 drives the piston upwardly at high speed, transmitting opening force through rod 95 to movable contact 18. A subsequent closing operation is effected by supplying pressurized air through lines 100 and 106 to the space above piston 93, driving the piston downwardly with the assistance of spring 94. Aside from the above-described features the circuit breaker of FIG. 6 is basically the same as that of FIG. 1, and the same reference numerals are therefore used to designate corresponding parts.

The actuating rod 95 lends itself to compressive loading because it is exceptionally short, considering the high voltages involved. Compressive loading is advantageous because the ceramic of the rod is considerably stronger in compression than tension, thus enabling the rod to be stressed more highly in compression. This, in turn, allows the required opening forces to be transmitted with a rod 95 of a near minimum mass, and this further contributes to the desired high speed response at the start of an opening operation.

FIG. 7 shows a modified arrangement that includes means for reducing the voltage gradient in the air surrounding the upper end of insulating column 30. In this modified arrangement, the high potential shielding tube 82 is extended vertically downwardly through the insulating column 30 into an auxiliary tank 160 at the bottom of the column. The auxiliary tank 160 has a top portion 162 on which column 30 is mounted. Top portion 162 has a central opening 165 through which extends grounded air lines 54 and 100 and shielding tube 82. At the periphery of the central opening 165 there is another shielding tube 170, at ground potential, that is suitably supported on top portion 162. An annular gap 172 separates the high potential shielding tube 82 from the ground potential shielding tube 170.

The equipotential lines of the electrostatic field have the general configuration shown by dotted lines 175 in the region at the base of insulating column 30. The effect of extending the high potential shielding tube 82 downwardly into tank 160 as shown in FIG. 7 is to transfer the region of highest stress around the insulating column 30 from the top to the bottom of the column 30. This is advantageous because at the bottom of the column there is a large ground plane available to provide a shielding effect which reduces electric stress concentrations, thus making it easier to satisfy corona and radio interference voltage requirements.

Although there is a relative short gap between tubular shields 82 and 170, the gap is able to withstand the high voltage thereacross because the electric field is relatively uniform in this region and further because this region is filled with high quality dielectric. With respect to this latter point, sulphur hexafluoride at several atmospheres fills the column 30 and the auxiliary tank 160.

Although not shown, suitable insulators are preferably provided at the lower end of the shielding tube 82 to support this end on tank 160, thereby preventing any shifting of this end with respect to the tank and shield 170. The insulators are preferably located between the bottom of the tank 160 and the lowermost end of the shielding tube 82.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects; and I, therefore, intend herein to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States:

1. In a high voltage electric circuit breaker comprising a tank at high potential when the circuit breaker is energized, circuit interrupting means within said tank, and control means within said tank operable to initiate an opening operation of said circuit interrupting means, the combination of:

a. a hollow insulating column extending generally vertically from ground to the region of said tank,

b. means for mounting said tank atop said insulating column,

c. an operator for said control means positioned atop said insulating column,

d. an actuating rod of electrical insulating material extending between said operator and said control means for mechanically coupling together said operator and said control means, thereby enabling said operator to operate said control means,

e. electroconductive structure extending through said insulating column between said operator and ground for maintaining said operator at ground potential while said tank is at high potential,

f. and a housing at substantially the same potential as said tank surrounding said operator and filled with a dielectric fluid having a much higher dielectric strength than air at normal atmospheric pressure, at least a portion of the electrically-stressed insulating material of said actuating rod being disposed in said dielectric fluid.

2. A circuit breaker as defined in claim 1 and further comprising:

a. a hollow insulator mounted within said housing atop said insulating column, electroconductive conveying electroconductive

b. said electroconductive structure comprising a tension member extending through said insulator and said insulating column,

c. force-transmitting means located between said tension member and the upper end of said insulator for loading said insulator and said insulating column in compression when said tension member is subjected to a tensile force,

d. and means for maintaining a tensile force on said tension member.

3. A circuit breaker as defined in claim 2 in which: said housing has a conductive portion extending radially between said insulator and said insulating column, said conductive portion including at its radially-inner end tubular stress-controlling means surrounding said grounded electroconductive structure in radially-spaced relationship.

4. A circuit breaker as defined in claim 1 in which said electroconductive structure comprises a metal conduit for conveying pressurized gas through h said insulating column to the interior of said housing.

5. A circuit breaker as defined in claim 1 and further comprising: a chamber partially within said insulating column and partially within said housing through which said electroconductive structure extends in passing from said operator to ground, said chamber containing a gas having a higher dielectric strength than air at normal atmospheric pressure.

6. A circuit breaker of claim 5 in which said chamber is sealed from the interior of said housing and contains gas at a different pressure from the dielectric within the interior of said housing.

7. A circuit breaker as defined in claim 1 and further comprising a metal conduit for conveying gas for controlling said operator, said meal conduit extending from said operator through said insulating column to a location near the bottom of said column.

8. A circuit breaker as defined in claim 1 in which said electroconductive structure comprises:

a. a first metal conduit at ground potential for conveying pressurized gas through said insulating column to the interior of said housing, and

b. a second metal conduit at ground potential for conveying gas for controlling said operator, said second metal conduit being disposed within said first conduit.

9. A circuit breaker as defined in claim 1 in which:

a. said operator comprises electromagnetic means located within said housing for initiating an opening operation of said operator, and

b. conductive leads are provided for conducting current between said electromagnetic means and a ground potential location at the bottom of said insulating column,

c. said electroconductive structure comprising a tubular member in which said conductive leads are disposed in the regions where said tubular member is in a high intensity electric field.

10. A circuit breaker as defined in claim 1 in which:

a. said operator comprises electromagnetic means located within said housing for initiating an opening operation of said operator,

b. conductive leads are provided for conducting electric current between said electromagnetic means and a ground location at the bottom of said insulating column,

c. said leads extending through said column in a position where they are electrostatically shielded by said grounded electroconductive structure from high intensity electric field.

11. The circuit breaker of claim 1 in which: said circuit interrupting means comprises a movable contact member and said control means comprises a control member mechanically connected to said movable contact member, and said actuating rod is mechanically connected at one end to said control member and at its opposite end to said operator whereby said operator directly actuates said movable contact member.

12. The circuit breaker of claim 1 in which:

a. said operator comprises a piston to which said actuating rod is connected, said piston having a surface on which pressurized gas in said housing normally acts in a direction to impart opening motion to said actuating rod,

b. latch means is provided for normally preventing opening motion of said piston but being releasable to allow pressurized gas on said piston to actuate said piston,

c. said latch means comprising a circumferentially-extending groove in the periphery of said piston, a split ring located in said groove, and a radially movable latching member located between the ends of said ring, said split ring engaging an annular shoulder on said cylinder tending to force said ring to contract within said groove into a noninterfering position with respect to said shoulder, said contraction normally being prevented by said latching member but occurring in response to withdrawal of said latching member from its position between the ends of said split ring.

13. The circuit breaker of claim 12 in which: said circuit-interrupting means comprises a movable contact member and said actuating rod is mechanically connected at one end to said movable contact member and at its opposite end to said piston.

14. The circuit breaker of claim 1 in which:

a. said operator comprises a piston to which said actuating rod is connected and a cylinder in which said piston is movable,

b. said piston having a surface on which pressurized gas in said housing normally acts in a direction to impart opening motion to said actuating rod,

c. a ring-type piston latch is provided for normally preventing opening motion of said piston but being releasable to allow pressurized gas on said piston to actuate said piston,

d. said piston latch comprising a latching member extending radially of said cylinder between said cylinder and said piston.

15. The circuit breaker of claim 1 in which said operator initiates an opening operation by supplying driving force to said actuating rod that loads said rod in compression.

16. The circuit breaker of claim 1 in combination with a conductive shielding tube surrounding said electroconductive structure in radially-spaced relationship, means for maintaining said shielding tube at substantially the same potential as said tank, said shielding tube extending from the upper end of said insulating column into a position near the lower end of said column.

17. The circuit breaker of claim 16 in combination with an auxiliary tank at ground potential at the lower end of said insulating column containing a dielectric fluid having a much higher dielectric strength than air at normal atmospheric pressure, said shielding tube extending past the lower end of said insulating column and into said auxiliary tank.

18. The circuit breaker of claim 17 in combination with a second conductive shielding tube at ground potential surrounding g the first of said shielding tubes in radially-spaced relationship in the region where said first shielding tube enters said auxiliary tank, thereby reducing dielectric stresses in said latter region.

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