

[54] COMPRESSED GAS SWITCH HAVING
COLUMNAR CONSTRUCTION

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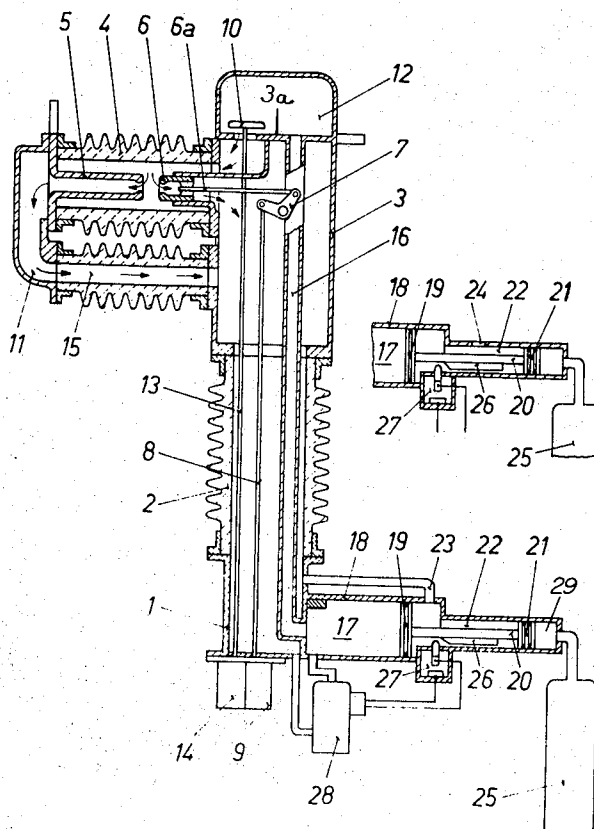
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[57] ABSTRACT

An electrical circuit breaker in which a pressurized gas such as SF₆ operating on a closed gas circuit is utilized to extinguish the arc drawn between the switching contacts and perhaps also to actuate the contacts themselves includes an upstanding hollow insulator column at the top of which is supported a switch contact chamber and an adjacently located readiness tank containing the pressurized gas ready for delivery to the contact chamber as soon as a switching-out sequence is initiated.

To assure rapid replenishment of the gas in the readiness tank so that a second switching-out operation can take place immediately, and at the same gas pressure as the first one should this be necessary, for example, due to the persistence of a short circuit on the line to which the breaker is connected, replenishment gas is stored in a cylinder at the lower end of the insulator column and this cylinder contains a piston which is driven in a direction to expell the gas stored in the cylinder and deliver it to the readiness tank through an interconnecting pipe line as soon as the gas pressure drops in the readiness tank as a result of delivery of the pressurized gas from the latter into the switch contact chamber. Thus the drop in gas pressure in the readiness tank resulting from the first disconnection of the switching contacts is compensated for and restored immediately by the re-pressurizing action resulting from the displacement of the piston.

7 Claims, 2 Drawing Figures



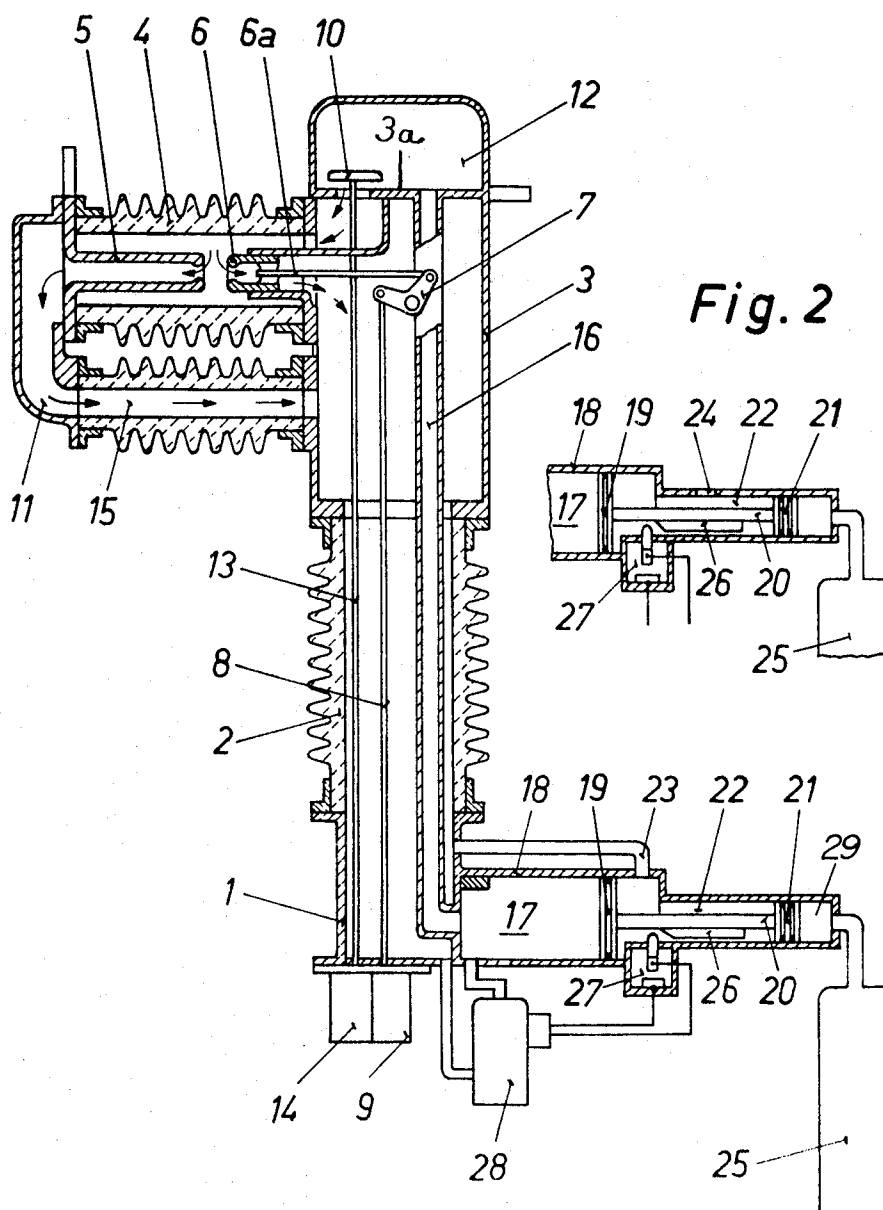


Fig. 1

Fig. 2

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This invention relates to the art of electrical power circuit breakers and more particularly to circuit breakers of the type operating with compressed gas, and particularly those having a closed gas circuit and which utilize SF_6 as the gaseous agent, the gas circuit being closed to prevent wastage of the gas which is quite expensive.

Such circuit breakers are often supported at the top of a hollow insulator column, there being located adjacent the chamber enclosing the switching contacts a so-called "readiness" tank containing the gas in a highly pressurized state and from which the gas can be delivered with a minimum delay to the contact chamber for arc extinction, and also if desired, to drive the contacts themselves to a disengaged position. The switch contact chamber and the readiness tank are at high voltage potential, and the readiness tank is connected to a storage tank at ground potential, which is located at the bottom of the insulator column, by way of a gas line made of insulating material which extends through the hollow insulator column. After the switch contacts have been actuated, with a resultant flow of gas into the contact chamber from the readiness tank, the latter is replenished with fresh gas from the storage tank so as to ready the circuit breaker equipment for a subsequent switching operation.

Circuit breakers of the type as described are more particularly disclosed, for example, in German Pat. No. 873,420. The readiness tank is connected by way of a check, i.e. a one-way valve to a compressed gas feed line which, in turn, is connected by way of a main valve with a storage tank at ground potential and from which the compressed gas in the readiness tank is replenished. For this purpose the main valve is opened mechanically, upon a decrease in gas pressure in the readiness tank, by way of a cam plate operating by way of an insulated shaft, or by actuation of the contact arrangement in the switch. In the latter case, a magnetic drive, or the like, is required for operation of the main valve. Because of the inertia force of the train of mechanical elements to be actuated, such an arrangement necessarily involves a high force requirement and hence entails a relatively high cost since it is essential that replenishment of the gas in the readiness tank takes place with a minimum delay, e.g. during a no-current interval on the occasion of an unsuccessfully brief interruption, so that the ensuing, second switching-off operation can start with practically the same initial gas pressure as the first but unsuccessful switching-off.

The primary object of the present invention is to provide a more simple and less expensive constructional arrangement for effecting the desired rapid delivery of replenishment gas to the readiness tank and which makes it possible to complete the gas replenishment operation during the no-current interval of a brief interruption switching sequence.

In accordance with the invention, this objective is achieved in that the readiness and storage tanks communicate with each other via an insulated gas line of relatively large cross section, the storage tank itself being constituted as a cylinder within which a first piston slides, this piston being mechanically connected, on the side away from the high pressure admission to the cylinder, with a second piston which is continuously admitted with gas from a pressurized gas reservoir, the forces acting on both pistons, in opposite directions being in equilibrium in the neutral state of the switch, i.e. when the switch contacts are in their closed position and the switch is in its "readiness" state.

In particular, when SF_6 is utilized as the pressurized gas, the improved construction in accordance with the invention enables one to maintain, in an advantageous manner the pressure in the high pressure part of the circuit breaker relative low in view of the heating expense in the case of low surrounding temperatures.

The foregoing, as well as other objects and advantages inherent in the invention will become more apparent from the following detailed description of a preferred embodiment thereof and from the accompanying drawings wherein:

FIG. 1 is a view in central vertical section of the improved compressed gas circuit breaker assembly, and

FIG. 2 is likewise a sectional view of a modified construction for a detail of the complete assembly of FIG. 1.

With reference now to the drawings, the circuit breaker assembly comprises a lower, base part 1 which is at the so-called "ground" potential of the installation, which has erected upon it a hollow insulator column 2 that serves as a support, at its upper end, for the high potential parts of the circuit breaker which include a tubular metallic casing 3 from which there extends in a lateral direction a switch contact chamber 4 made from insulating material and which houses the switching point that is constituted by a stationary hollow contact stud 5 and a movable contact stud 6. The contact members 5 and 6 are depicted in FIG. 1, in a disengaged position.

The movable switch contact stud 6 is actuated to and from engagement with the stationary contact stud 5 by a mechanical linkage train which includes a horizontally movable rod 6a, one end of which is secured to stud 6 and the opposite end articulated to one arm of a bellcrank lever 7, and a rod 8 of insulating material which extends downwardly from an articulated connection with the other arm of this bellcrank through casing 3 and insulator column 2 to a drive mechanism 9, known in itself, and hence represented only schematically in "block" form, the drive device 9 being mounted on the base part 1.

Formed at the upper end portion of the metallic casing 3 by means of a transverse partition wall 3a is the "readiness" tank 12 containing the arc extinguishing gas at high pressure, this tank being adapted to communicate with the interior of the switch contact chamber 4 by means of a blast valve 10 controlling a port through the wall 3a. Valve 10 is actuated by means of a vertically reciprocal rod 13 made of insulating material, the lower end of this rod being connected to another drive device 14, likewise known in itself, and hence represented only schematically in "block" form, the drive device 14 also being mounted on the base part 1.

When the component parts are in the positions depicted in FIG. 1, which designates the beginning of a switching-off operation, the blast valve 10 has just opened by actuating rod 13 from the drive 14 thus permitting high pressure gas stored within the readiness tank 12 to flow in the direction indicated by the arrows. The gas passes into switch chamber 4, thence into and through the movable contact stud 6 into the lower pressure chamber portions of the circuit breaker which include the interconnected lower part 1, insulator column 2 and the upper casing part 3. Movement of contact stud 6 in the direction away from the opposite, stationary contact stud 5 is effected by means of the drive mechanism 9. The high pressure gas also flows from chamber 4 into and through the stationary contact stud 5, thence into a hollow metallic elbow type of fitting 11 and thence through a hollow insulator 15 located beneath the contact chamber 4 into the casing part 3 to join with the gas incoming from the other contact stud 6.

A tank for storage of gas at high pressure is provided at the lower base part 1 in the form of a hollow cylinder 18 the interior 17 of which communicates, at one end thereof with the lower end of a compressed gas pipe 16 of comparatively large cross-section to avoid an unduly large drop in pressure. This compressed gas pipe 16 which is made from an insulating material also extends upwardly through the hollow insulator 2 and casing 3, and is connected at its upper end with the interior of the "readiness" tank 12.

Slidably mounted within cylinder 18 is its associated piston 19 which is connected by rod 20 with a second piston 21 slidably mounted in a second cylinder 29 of smaller diameter than cylinder 18 which adjoins the latter. The common space 22 within the adjoining cylinders 18, 29 is connected via a pipe line 23 with the lower pressure section of the circuit breaker, i.e. within the base part 1.

In special cases, it may be advantageous to connect the space 22 permanently with the surrounding ambient atmosphere via a port 24. Such a modified arrangement is disclosed in FIG. 2. In such case, the pipe line 23 of FIG. 1 is then omitted.

As shown in FIG. 1, the outer end of cylinder 29 is in continuous communication with a separate compressed gas contained in a pressure reservoir 25, and hence the gas pressure within this end of cylinder 29 from the reservoir 25 is applied to the end face of piston 21. Advantageously, the pressure reservoir 25 may be constituted by a commercial type nitrogen bottle which is filled to a pressure of 100 or more atmospheres above atmospheric.

When the circuit breaker contacts 5 and 6 are closed, which is the normal steady-state condition of the breaker, the ratio of the SF_6 gas pressure existing in the readiness tank 12 and within storage cylinder 18 at the left side of piston 19 to the nitrogen gas pressure existing in the reservoir 25, and the ratio of the working face area of piston 19 to that of piston 21 is so chosen that the forces acting respectively on pistons 19 and 21 in opposite direction are essentially in equilibrium and the pistons will occupy the positions to the right — as depicted in FIG. 1. Thus SF_6 gas at high pressure fills readiness tank 12, the filling pipe 16 and cylinder space 17.

Should now a switching-off operation be triggered by actuation of the blast valve 10 to its open position, with a resultant flow of gas out of tank 12, the gas pressure at this tank drops which immediately communicates itself via the filling pipe 16 to the cylinder space 17. The two gas forces acting in opposite directions will then no longer be in equilibrium, with the result that the force on piston 21 now dominates and causes the integrated piston structure 19-20-21 to shift to the left thereby forcing the SF_6 gas stored within cylinder 18 to be discharged into and upwardly through pipe 16 into the readiness tank 12 to immediately replenish the gas which had been discharged from the latter, the blast valve 10 having now been reclosed. Thus the gas pressure within the readiness tank 12 is immediately restored to the same high value as it initially had prior to the first opening operation of the circuit breaker contacts, entirely without regard to the subsequent operation of compressor 28, and thus enables a second and immediate opening operation of the breaker contacts, if necessary, to take place at the initially prevailing high gas pressure in the readiness tank.

Moreover, as soon as the piston structure 19-20-21 starts its movement towards the left, it will be seen that a slide type cam part 26 secured to rod 20 functions to close the contacts of an auxiliary switch 27 which then functions to activate an electric motor driven gas compressor 28. The compressor inlet is connected to the low pressure side of the SF_6 gas circuit, i.e. within the component parts 1, 2 and 3, and the compressor outlet is connected to the space 17 defined by the interior of cylinder 18 so as to ultimately restore the pressure within the space 17, pipe line 16 and readiness tank to its proper steady-state level, and effect return movement of piston structure 19-20-21 to the right to regain its initial, starting position.

I claim:

1. In an electrical circuit breaker of the type wherein a pressurized gas such as SF_6 is utilized for extinguishing the arc drawn between the switching contacts as said contacts disengage and flows in a closed gas circuit, the combination comprising an upstanding hollow insulator column, a switch contact chamber and a readiness tank located at the upper end of said insulator column, said readiness tank containing the pressurized gas ready for delivery to the switch contact chamber upon initiating a switching-out sequence involving opening of a blast valve which serves to interconnect said readiness tank and switch contact chamber, a storage tank for pressurized replenishment gas located at the lower end of said insulator column, said storage tank being constituted as a first cylinder,

a pipe line interconnecting said cylinder and readiness tank, a first piston slidable within said cylinder to expel the gas stored therein into and through said pipe line into said readiness tank, a second piston mechanically connected to said first piston and which is slidable in a second cylinder, a reservoir of pressurized gas and a connection between said pressurized gas reservoir and said second cylinder which continuously subjects said second piston to a force acting in a direction opposite to the direction of the force applied by the pressurized gas in said first cylinder on said first piston, said piston forces being in equilibrium under a condition of no gas flow when said switch contacts are closed, but becoming unbalanced in favor of the force applied to said second piston during a switching-out operation when pressurized gas is discharged from said readiness tank and the pressure therein and also within said first cylinder drops thereby effecting movement of said first piston in the direction to expel the pressurized gas therein and effect replenishment of the gas in said readiness tank upon re-closure of said blast valve and said breaker contacts and restoration of its pressure to its initial value thus preparing said circuit breaker for an immediately subsequent contact opening operation.

2. An electrical circuit breaker as defined in claim 1 wherein said second cylinder constitutes an extension of said first cylinder and establishes a space between the two pistons, and which further includes a pipe line communication between said space and a low gas pressure part of said circuit breaker such as the space within said hollow insulator and into which the pressurized gas from said readiness tank flows after performing its arc extinction function when said switch contacts disengage.

3. An electrical circuit breaker as defined in claim 1 wherein said second cylinder constitutes an extension of said first cylinder and establishes a space between the two pistons which is placed in communication with the surrounding atmosphere.

4. An electrical circuit breaker as defined in claim 1 wherein the working face area of said second piston is smaller than that of said first piston, the gas pressure in said reservoir which acts upon said second piston being accordingly higher than the gas pressure in said first cylinder which acts upon said first piston in order to effect the desired condition of equilibrium under a no-gas flow condition.

5. An electrical circuit breaker as defined in claim 1 and which further includes an electric motor operated compressor having its inlet connected to a low pressure portion of said circuit breaker and into which the pressurized gas from said readiness tank flows after performing its arc extinction function when said switch contacts disengage, the outlet from said compressor being connected to said first cylinder between said first piston and said pipe line leading to said readiness tank, and switch means actuated upon joint movement of said first and second pistons in the direction to expel gas from said first cylinder to effect starting of said compressor.

6. An electrical circuit breaker as defined in claim 1 wherein said reservoir of pressurized gas from which pressure is applied continuously to said second piston is constituted by a vessel containing nitrogen at a pressure exceeding 100 atmospheres above atmospheric, and the working face area of said second piston is smaller than the working face area of said first piston.

7. An electrical circuit breaker as defined in claim 1 wherein said pipe line interconnecting said storage tank cylinder and readiness tank has a relatively large flow area to further minimize the time involved in replenishing said readiness tank with the pressurized gas.

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