A puffer type circuit breaker comprises a contactor device including at least one set of a fixed contactor and a hollow movable contactor provided in a pressure container in which an arc-extinguishing gas of unitary pressure is filed, the contactors being separable relatively from each other, a puffer device for compressing the arc-extinguishing gas in conjunction with a breaking operation, an insulating nozzle formed with an orifice portion surrounding the outer diameter portions of the fixed contactor for driving the arc-extinguishing gas compressed to a high pressure by the puffer device at an arc produced between the contactors, and valve mechanisms provided on the side of the fixed contact and on the side of the movable contactor, respectively, the mechanisms blocking the arc-extinguishing gas until the movable contactor is separated a predetermined distance away from the fixed contactor and thereafter being substantially simultaneously opened. This allows the arc-extinguishing gas to be compressed at pressure permitting the breaking operation and to be blown against the arc in a state where the contactors are separated by a distance permitting the breaking operation with the result of the breaking of a large current.
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PUFFER TYPE CIRCUIT BREAKER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a circuit breaker, and more particularly to a puffer type circuit breaker in which an arc-extinguishing gas is compressed in conjunction with a breaking operation to extinguish an arc generated between contactors by blowing the thus obtained high pressure arc-extinguishing gas against the arc.

2. Description of the Prior Art

Recently, with an increasing demand for electric power transmission lines carrying greater higher voltages and higher currents to enable larger capacity power transmission, a circuit breaker which is utilized as a protective device for such large capacity transmission lines must be able to cut off a large electric current at a high voltage.

A puffer type circuit breaker is of such a type that an arc-extinguishing gas is compressed in conjunction with a breaking operation to extinguish an arc generated between contactors by blowing the thus obtained high pressure arc-extinguishing gas thereagainst. For the arc-extinguishing gas there is used an arc-extinguishing insulating medium having good extinguishing and insulating properties such as SF₆ (sulfur hexafluoride) gas.

In order to break a high current circuit by means of the puffer type circuit breaker it is necessary to blow the high pressure arc-extinguishing gas against the arc developed between the contactors. In the aforementioned puffer type circuit breaker, however, difficulty is encountered in obtaining the arc-extinguishing gas at a high pressure at the beginning of the breaking operation because the high pressure of the arc-extinguishing gas is generated by compressing the arc-extinguishing gas in conjunction with the breaking operation. For this reason, conventional circuit breakers have been constructed in such a manner that one contactor is permitted to move to a predetermined distance to follow the other contactor at the beginning of the breaking operation or otherwise have been constructed so as to include a wipe structure adapted to slide one contactor relative to the other over a certain distance, thereby opening the contactors for arc generation in a state where an increased breaking speed of the movable contactor and hence an increased pressure at a pressure generating portion have been attained subsequent to the initial breaking operation. With this arrangement, however, the wiping structure could not be made large enough, and in addition, special attention had to be paid to the timing when the high pressure arc-extinguishing gas is to be blown and to what extent the movable contactor is moved away from the fixed contactor. Thus, a large volume of arc-extinguishing gas was blown against the contactors at the beginning of the breaking operation when the pressure of the arc-extinguishing gas and the distance between the movable and fixed contactors were insufficient to extinguish the arc produced therebetween, thus resulting in a reduced amount of high pressure arc-extinguishing gas available for arc extinguishment. Further, the conventional insulating nozzle for driving the high pressure arc-extinguishing gas generated by a puffer device against the arc produced between contactors could not always efficiently blow the high pressure arc-extinguishing gas compressed by the puffer device against the arc produced therebetween.

For these reasons, the conventional circuit breakers required a great amount of high pressure arc-extinguishing gas for effecting the breaking of a high current circuit, thus resulting in increased capacity of the puffer device for compressing the arc-extinguishing gas in order to generate the high pressure arc-extinguishing gas. In this respect, the driving of the movable contactor and the puffer device serving as a blowing pressure generator required the large driving force with the result of the large-sized devices for use in the circuit breakers such as the external operational device. This brought about the causes of the large-sized and complicated circuit breakers. Further, the thus increased driving force causes an excessive force to be exerted on the operational rod for mechanically connecting the movable contactor and the puffer device each held at high potential to the operational device held at earth potential in electrically isolated manner. Thus, difficulty was encountered in manufacturing the insulating operational rod resistant to such a force.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a puffer type circuit breaker being capable of effecting a breaking operation with high capacity.

Another object of the present invention is to provide a puffer type circuit breaker having an improved breaking performance wherein an arc-extinguishing gas is held at the beginning of the breaking operation and is then blown against an arc produced between contactors in a state where the contactors are separated a predetermined distance.

A further object of the present invention is to provide a puffer type circuit breaker being capable of effectively extinguishing the arc by improving the configuration of the insulating nozzle for driving the high pressure arc-extinguishing gas to the arc produced between the contactors.

A still another object of the present invention is to provide a puffer type circuit breaker adapted to efficiently blow the high pressure arc-extinguishing gas generated by the puffer device against the arc produced between the contactors by disposing the contactors in the proximity of the puffer device for compressing the arc-extinguishing gas.

Still further objects of the present invention will be understood by way of embodiments in connection with the accompanying drawings.

A puffer type circuit breaker according to the present invention comprises a contactor device including at least one set consisting of a fixed contactor and a movable contactor in a pressure container in which an arc-extinguishing gas of unitary pressure is filled, the contactors being separable relatively from each other, a puffer device for compressing the arc-extinguishing gas in conjunction with a breaking operation, an insulating nozzle formed with an orifice portion surrounding outer diameter portions of the fixed contactor for driving the arc-extinguishing gas compressed to a high pressure by the puffer device at an arc produced between the contactors, and valve mechanisms provided on the side of the fixed contact and on the side of the movable contactor, respectively, the mechanisms blocking the arc-extinguishing gas until the mov-
able contactor is separated a predetermined distance away from the fixed contactor and thereafter being substantially simultaneously opened. This allows the arc-extinguishing gas to be compressed at pressure permitting the breaking operation and to be blown against the arc in a state where the contactors are separated away by a distance permitting the breaking operation with the result of the breaking of a large current.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross-section of a puffer type circuit breaker according to the present invention, showing a closed state.

FIG. 2 is a longitudinal cross-section of the puffer type circuit breaker of FIG. 1, but showing an opening state.

FIG. 3 is a longitudinal cross-section of another embodiment of a puffer type circuit breaker according to the present invention, showing a closed state.

FIG. 4 is a longitudinal cross-section of the puffer type circuit breaker of FIG. 3, but showing an opening state.

FIG. 5 is a longitudinal cross-section of still another embodiment of a puffer type circuit breaker according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1 to 2 show a puffer type circuit breaker according to the present invention, its closed state and opening state being shown in FIGS. 1 and 2, respectively.

In the figures there is shown a fixed member 11 on which a main fixed contactor 12 and a fixed arc contactor 13 are mounted. The main fixed contactor 12 is provided with a plurality of slits 12a thereon except for the upper end portion thereof and with spring means 14 at its tip end portion. The outer circumferential portion of the spring means 14 is provided with a shield 15 for limiting an electric field. On the central hollow portion of the fixed arc contactor 13 there is provided a guide rod 16 for guiding the fixed arc contactor 13 therealong and on the tip end portion thereof there is provided a slit 13a adapted to undergo a slight deformation relative to a force inwardly radially exerted thereon. On a movable portion, on the other hand, there is provided a puffer device comprising a puffer cylinder 17 and a puffer piston 18. An insulating nozzle support 20 on which a base portion of an insulating nozzle 19 is mounted is disposed on the upper surface of the puffer cylinder 17 on the side of the contactor and secured thereto by means of a bolt 21. On the central portion of the insulating nozzle 19 there is formed an orifice portion 19a to define a valve mechanism between the insulating nozzle 19 and an outer diameter portion of the fixed arc contactor 13. The tip end portion 19b of the insulating nozzle 19 is formed in tapered configuration. An inner diameter end portion of the insulating nozzle support 20 is provided with a movable arc contactor 22 formed with a hollow construction and the outer diameter end portion thereof is configured so as to define a main movable contactor 23. To a puffer chamber 24 defined by the puffer cylinder 17 and the puffer piston 18 there is introduced the arc-extinguishing gas, which is blown against the arc produced between the arc contactors 13 and 22 through an intake port 25 provided at the wall of the puffer cylinder 17 on the side of the contactor. The inner circumferential surface 19c of the insulating nozzle 19 on the side of the puffer cylinder 17 is disposed in the proximity of the upper surface of the puffer cylinder 17 with a gap required for introducing therein the high pressure arc-extinguishing gas. The gap is preferably configured so as to have substantially the same cross-sectional area as that of the intake port 25. On the central portion of the puffer cylinder 17 there is provided a puffer cylinder shaft 26 having a hollow construction communicating with the hollow portion of the movable arc contactor 22. A plurality of holes 27 are provided on the side wall of the puffer cylinder shaft 26. A support cylinder 28 for supporting the puffer piston 18 is disposed surrounding the puffer cylinder shaft 26 in slidable and gas-tight relation thereto. The support cylinder 28 is provided with a hole 29 for emitting the arc-extinguishing gas contained in the puffer cylinder shaft 26 outwardly through the hole 27 of the puffer cylinder shaft 26 when the latter moves a predetermined distance. The support cylinder 28 is fixed to a fixed portion.

The puffer cylinder shaft 26 is coupled to an insulating operational rod 30 which is, in turn, interlocked with an external operational device (not shown). A current collector 31 is provided surrounding the outer circumferential portion of the puffer cylinder 17. These devices are disposed in a container (not shown) in which the arc-extinguishing insulating gas of unitary pressure such as SF₆ is filled.

With such an arrangement, a current flows through a path extending from the fixed member 11 through the main fixed contactor 12, the main movable contactor 23, the insulating nozzle support 20, and the puffer cylinder 17 to the current collector 31 in the closed condition as shown in FIG. 1.

In the breaking operation, the insulating operational rod 30 and the puffer cylinder shaft 26 together with the puffer cylinder 17, the insulating nozzle 19, the main movable contactor 23 and the movable arc contactor 22 are driven downwardly by the external operational device (not shown). This first initiates the separating between the main contactors 12 and 23. In this state, the current flows through a different path extending from the fixed member 11 through the fixed arc contactor 13, the movable arc contactor 22 and the puffer cylinder 17 to the current collector 31. A further downward movement of the puffer cylinder shaft 26 causes the breaking of the arc contactors 13 and 22 with the result of the generation of the arc therebetween. On the other hand, the arc-extinguishing gas contained in the puffer chamber 24 defined by the puffer cylinder 17 and the puffer piston 18 is compressed due to the drive of the puffer cylinder 17. In this state, the arc-extinguishing gas in the puffer chamber 24 remains compressed only within a space formed by the valve mechanism defined by the orifice 19a of the insulating nozzle 19 and the outer diameter portion of the fixed arc contactor 13 and by the valve mechanism defined by the puffer cylinder shaft 26 and the support cylinder 28, thus generating no gaseous flow of the arc-extinguishing gas. When the fixed arc contactor 13 is further moved and drawn out of the orifice portion 19a of the insulating nozzle 19 to open the valve mechanism defined by the orifice portion 19a thereof and the outer diameter portion of the fixed arc contactor 13, the hole 27 provided on the puffer cylinder shaft
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26 coincides with the hole 29 provided on the support cylinder 28 of the puffer piston 18 to effect the simultaneous flow-out of the arc-extinguishing gas compressed to a high pressure through the space between the insulating nozzle 19 and the fixed arc contactor 13 and through the hollow portion of the movable arc contactor 22. The high pressure arc-extinguishing gas is blown from the puffer chamber 24 against the arc 32 to extinguish the latter.

Thus, with the arrangement, no arc-extinguishing gas is blown against the arc until it is compressed to a high enough pressure to extinguish the arc and the fixed arc contactor 13 is separated away from the movable arc contactor 22 to the extent of permitting the breaking operation. Consequently, the arc-extinguishing gas is efficiently utilized for arc extinguishment with the result of breaking a large amount of current with high efficiency. The efficient blowing of the arc-extinguishing gas permits the volume of the puffer chamber 24 to be made small and therefore the drive power for the external operational device to be reduced to drive the puffer cylinder 17. In other words, this shows that the use of the conventional external operating device makes possible the provision of the breaker having large breaking capacity.

Further, the inner circumferential surface 19c of the insulating nozzle 19 adjacent to the orifice portion 19a thereof and facing the movable arc contactor 22 is formed substantially perpendicular to the breaking direction between the contactors 13 and 22. This causes the high pressure arc-extinguishing gas to be blown along a direction perpendicular to the breaking direction of the contactors 13 and 22 to the space where the arc is produced, thus permitting a smooth blowing operation against the orifice portion 19a of the insulating nozzle 19 and the side of the hollow movable arc contactor 22 with a highly efficient arc-extinguishing operation.

In this case, the main contactors 12 and 23 are disposed outside of the insulating nozzle 19 for a current flow of large capacity and only the arc contactors 13 and 22 for cutting off the current are disposed within the insulating nozzle 19, so that the orifice portion 19a of the insulating nozzle 19 can be designed to have a cross-sectional area capable of passing therethrough a predetermined amount of arc-extinguishing gas necessary for extinguishing the arc 32. This prevents the arc-extinguishing gas from flowing in excess of an amount required for arc extinguishment, this ensuring the flow of the requisite amount of the arc-extinguishing gas without increasing the capacity of the puffer chamber 24. The movable arc contactor 22 is disposed in the proximity of the upper surface of the puffer cylinder 17 on the side of the contactor with the reduced dead space of the flow path extending from the intake port 25 of the puffer cylinder 17 to the arc 32 produced between the arc contactors 13 and 22. This allows almost all amounts of the high pressure arc-extinguishing gas generated in the puffer chamber 24 to be efficiently utilized for extinguishing the arc 32 with an improvement in breaking performance.

In the closing operation, the external operational device (not shown) drives the insulating operational rod 30 upwardly as viewed in the figure. This causes the upward drive of the puffer cylinder 17, the insulating nozzle 19, the movable contactor 23, and the movable arc contactor 22, so that the fixed arc contactor 13 is inserted to the orifice portion 19a of the insulating nozzle 19 with the first closing of the arc contactors 13 and 22 and then with the closing of the main contactors 12 and 23. The movement exceeding a certain stroke causes the closing operation of the valve mechanism defined by the orifice portion 19a of the insulating nozzle 19 and the outer diameter portion of the fixed arc contactor 13 and the valve mechanism formed in the hollow portion of the movable arc contactor 22, and thus provides the puffer piston 18 with a check valve, which is opened at the negative pressure established in the puffer chamber 24 to effect the direct introduction of the arc-extinguishing gas from the outside to the puffer chamber 24.

FIGS. 3 and 4 show modified embodiments according to the present invention in a closed state shown in FIG. 3 and in opening state shown in FIG. 4. The elements having the same function as those of FIGS. 1 and 2 are indicated with the same reference numerals with the detailed description omitted for the sake of clarity.

In the figures, a movable contactor is constructed in such a manner that a hollow movable arc contactor 42 is disposed inside of a main movable contactor 41 with the tip end portion of a fixed contactor 43 formed hollow and interposed between the main movable contactor 41 and the movable arc contactor 42. The hollow portion of the fixed contactor 43 does not communicate with the outside. An arc-proof member is mounted on the tip end portion of the fixed contactor 43. At the central portion of the insulating nozzle 19 there is provided an orifice portion 19a defining a valve mechanism between the orifice portion 19a and the outer diameter portion of the fixed contactor 43. The insulating nozzle 19 is necessarily made longer by an amount corresponding to an extension of the main movable contactor 41 and the movable arc contactor 42 with the result of the disadvantageously increased dead space by the same amount, but with the simplified construction as compared with that described in connection with the previous embodiment. The operations of the modified embodiment are substantially the same as those of FIGS. 1 and 2. At the beginning of the operation, the arc-extinguishing gas is enclosed in the insulating nozzle 19. At the substantially same time when the fixed contactor 43 is drawn out of the insulating nozzle 19, the hole 28 provided on the puffer cylinder shaft 26 of the puffer cylinder 17 coincides with the hole 29 provided on the support cylinder 28 of the puffer piston 18 to form the arc-extinguishing gas as a gaseous flow flowing out through the space between the insulating nozzle 19 and the fixed contactor 43 and through the hollow portion of the movable arc contactor 42 for effecting the blowing of the high pressure arc-extinguishing gas against the arc 32. This permits excellent arc-extinguishing with a high current cut off.

FIG. 5 shows a still further embodiment according to the present invention wherein a fixed contactor 51 is mounted on the fixed member. The fixed contactor 51 is made of hollow construction with a hole 53 provided on the side wall thereof. On the movable portion there is provided a puffer device comprising a puffer cylinder 54 and a puffer piston 55. On the upper surface of the puffer cylinder 54 on the side of the contactors there is secured an insulating nozzle support 57 for mounting an insulating nozzle 56 thereon. The tip end portion 56a of the insulating nozzle 56 is constructed so as to
I claim:

1. A puffer type circuit breaker comprising a contactor device including at least one set of a fixed contactor and a hollow movable contactor in a pressure container in which an arc-extinguishing gas of unitary pressure is filled, said contactors being separable relatively from each other, a puffer device for compressing said arc-extinguishing gas in conjunction with a breaking operation, an insulating nozzle formed with an orifice portion surrounding the outer diameter portion of said fixed contactor for driving the arc-extinguishing gas compressed to a high pressure by said puffer device at an arc produced between said contactors, and valve mechanisms provided on the side of said fixed contactor and on the side of said movable contactor, respectively, said mechanisms blocking said arc-extinguishing gas until said movable contactor is separated a predetermined distance away from said fixed contactor and thereafter being substantially simultaneously opened.

2. A puffer type circuit breaker according to claim 1, wherein said valve mechanisms provided on the side of said fixed contactor and on the side of said movable contactor are adapted to open in response to an operational stroke.

3. A puffer type circuit breaker according to claim 1, wherein said valve mechanism provided on the side of said movable contactor comprises a hole provided at the side wall of a cylindrical operational member having a hollow portion and coupled to a hollow portion of said movable contactor, and a valve member for blocking said hole at the beginning of the breaking operation and for releasing the blocking of said hole after said operational member is moved a predetermined distance.

4. A puffer type circuit breaker according to claim 3, wherein said valve member comprises a support member for supporting a fixed portion of said puffer device, said support member having a hollow portion surrounding said operational member.

5. A puffer type circuit breaker according to claim 1, wherein said valve mechanism provided on the side of said fixed contactor is defined by the orifice portion of said insulating nozzle and said fixed contactor inserted into said orifice portion.

6. A puffer type circuit breaker according to claim 1, wherein said fixed contactor is formed hollow and said valve mechanism provided on the side of said fixed contactor is defined by a hole provided at the side wall of said fixed contactor and a portion extending through the orifice portion of said insulating nozzle, said extending portion blocking said hole at the beginning of the breaking operation and releasing the blocking of said hole after said insulating nozzle is moved a predetermined distance.

7. A puffer type circuit breaker according to claim 1, wherein the inner surface of said insulating nozzle on the side of said movable contactor and in the proximity of said orifice portion is formed substantially perpendicular to a first direction along which said fixed contactor and movable contactor are oppositely disposed so that said arc-extinguishing gas may be blown from a second direction perpendicular to said first direction to a space in which the arc develops.

8. A puffer type circuit breaker according to claim 1, wherein said fixed contactor comprises a main fixed contactor disposed outside of said insulating nozzle and a fixed arc contactor defining said valve mechanism.
upon insertion thereof into the orifice portion of said insulating nozzle and wherein said movable contactor comprises a main movable contactor seperably contacting with said main fixed contactor and a hollow movable arc contactor seperably contacting with said fixed arc contactor.

9. A puffer type circuit breaker according to claim 8, wherein said main movable contactor is formed on the outer circumferential surface of an insulating nozzle support for fixing said insulating nozzle.

10. A puffer type circuit breaker according to claim 8, wherein said movable arc contactor is disposed in the proximity of the upper surface of said puffer device and the inner circumferential surface of said insulating nozzle on the side of said movable arc contactor is disposed in the upper surface on the side of said movable arc contactor with a gap provided therebetween for the flow of the high pressure arc-extinguishing gas.

11. A puffer type circuit breaker according to claim 8, wherein said fixed arc contactor is adapted to be inserted to the hollow portion of said hollow movable arc contactor and said fixed arc contactor is provided with means for applying a pressure contact to said movable arc contactor.

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