United States Patent [19]

Hosokawa

[11] **3,745,284**

[45] **July 10, 1973**

[54] **GAS BREAKERS**

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[73] Assignee: **Hitachi, Ltd.,** Tokyo, Japan

[22] Filed: **May 16, 1972**

[21] Appl. No.: **253,712**

[30] **Foreign Application Priority Data**

May 21, 1971	Japan	46/34045
May 21, 1971	Japan	46/34047
Nov. 12, 1971	Japan	46/89817
Nov. 22, 1971	Japan	46/93152

[52] **U.S. Cl.** ..... **200/148 A,** 200/144 AP

[51] **Int. Cl.** **H01h 33/70**

[58] **Field of Search** ..... 200/148 A, 144 AP

[56] **References Cited**

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Primary Examiner—Robert S. Macon

Attorney—Paul M. Craig, Jr., Donald R. Antonelli et al.

[57] **ABSTRACT**

In a puffer type gas breaker in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, an auxiliary cylinder is provided along the outer wall of a puffer cylinder in which the arc-suppressing gas is compressed, and a piston to operate a resistance movable contactor is slidably disposed in said auxiliary cylinder and constantly urged in a closing direction by a spring. When the electric circuit is to be closed after it has been broken, the volume of the puffer cylinder is expanded contrary to the case when the circuit is broken and, therefore, SF_6 gas pressure in said puffer cylinder becomes lower than the pressure of the gas enclosing the contactor, so that the piston is moved in a closing direction by virtue of the gas pressure difference against the biasing force of the spring and hence the resistance movable contactor is brought into its closing position, whereby resistance is positively inserted into the power transmission line prior to closing of main contactors. After the main contactors are closed, the resistance movable contactor is moved in a breaking direction by the spring through the piston as the SF_6 gas pressure is restored in the puffer cylinder, and therefore, main contactors can be disconnected from each other immediately after a breaking command is given. This enables the breaking time to be shortened and makes a high speed breaking operation possible.

14 Claims, 6 Drawing Figures

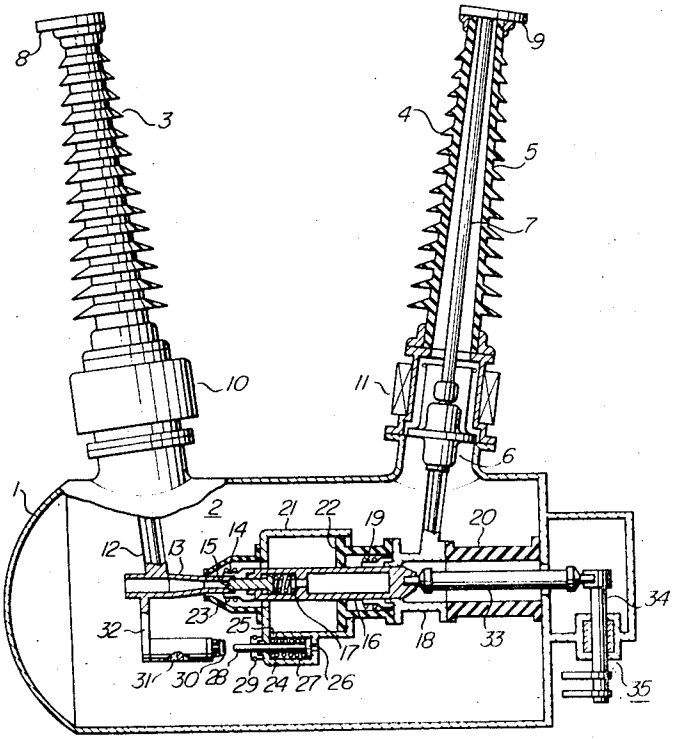


FIG. 1

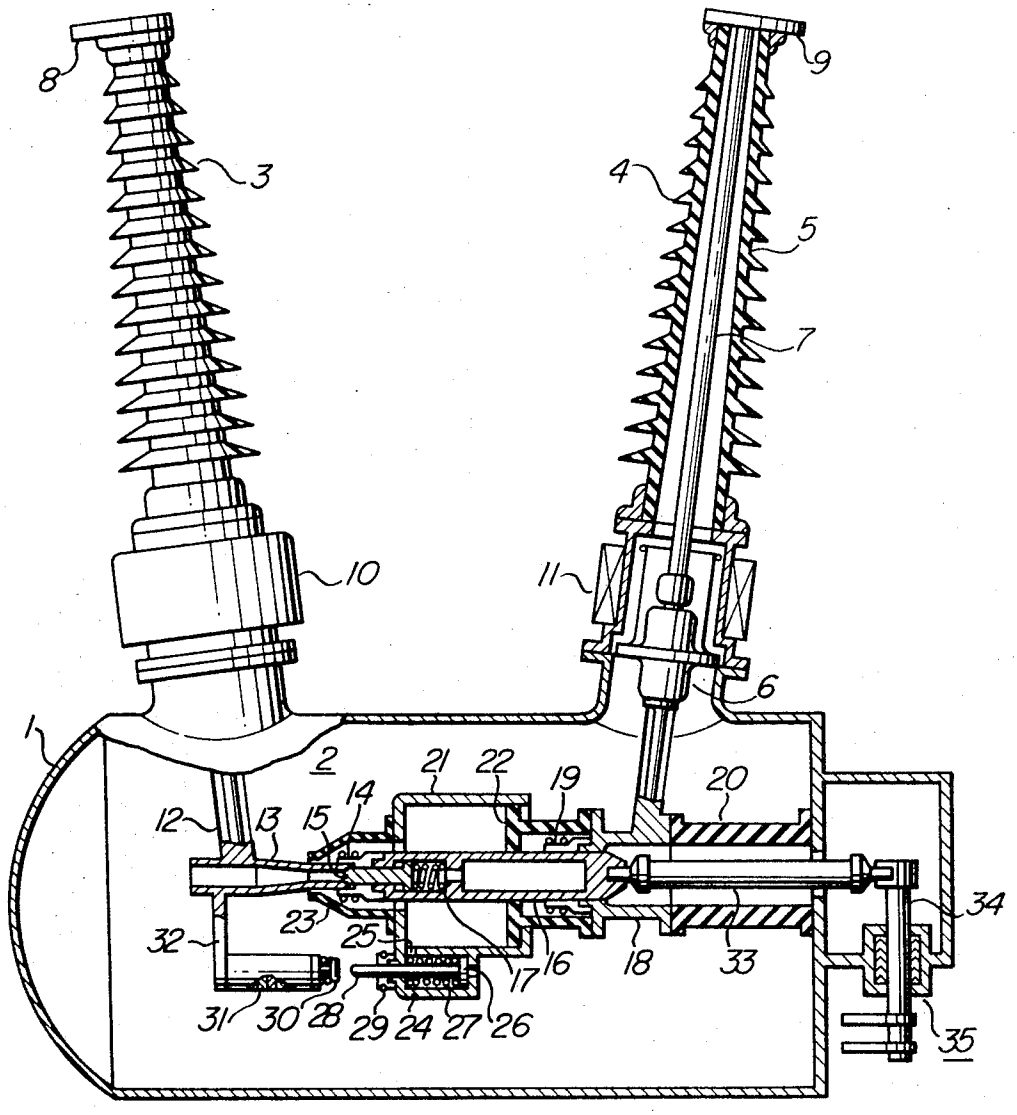

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FIG. 2

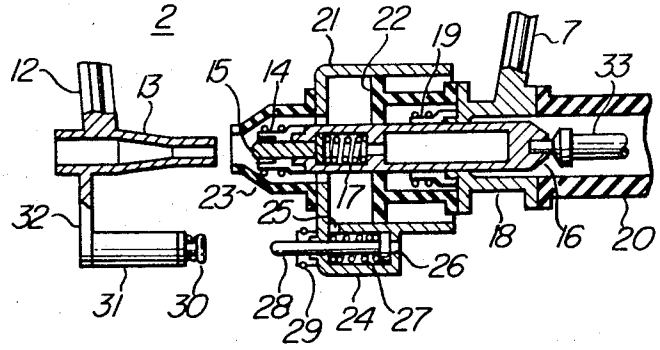

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FIG. 3

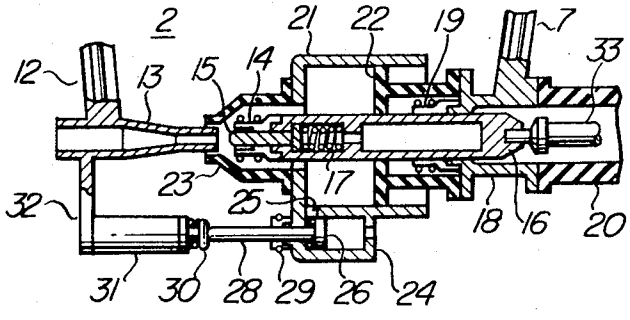

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FIG. 4

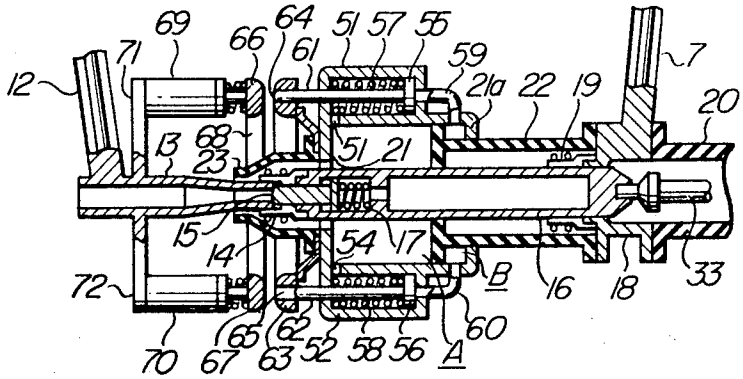


FIG. 5

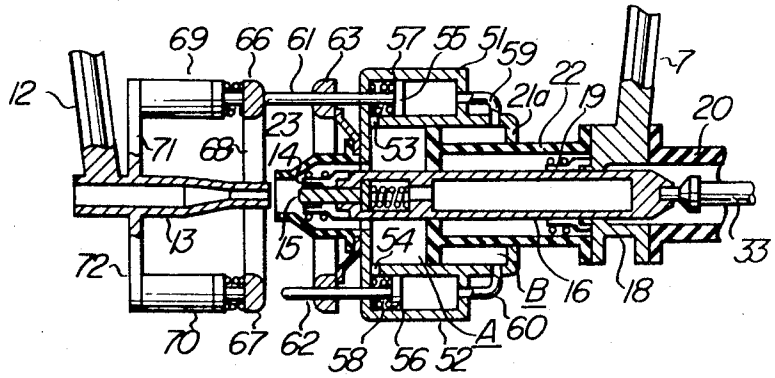
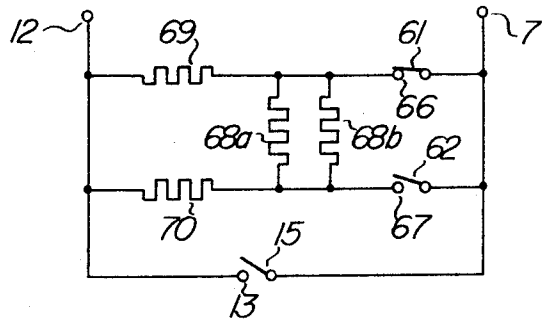


FIG. 6



GAS BREAKERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a gas breaker and more particularly to the operation of contactors for inserting resistance into the power transmission line in a puffer-type gas breaker in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between the contactors to extinguish said arc.

2. Description of the Prior Art

In closing a non-loaded power transmission line by means of a breaker, a large overvoltage occurs in the transmission line, imposing loads on the transmission equipments. In order to suppress the occurrence of such overvoltage, a resistance insertion method has been frequently used in which a resistance provided parallel to main contactors of the breaker is inserted into the transmission line by means of a resistance contactor prior to closure of said main contactors.

On the other hand, when a power transmission line is broken by means of a breaker, a resistance is also provided parallel to the main contactors of the breaker to suppress a restriking voltage. However, if the resistance is used in the closing operation only, for alleviating the thermal duty, the resistance contactor must be shifted into its closing position prior to closure of the main contactors, as a matter of course, but, in the breaking operation, it must be shifted to its opening position before the main contactors are opened. To this end, there has been proposed a breaker so designed that the resistance contactor is shifted to its opening position in response to a breaking command prior to opening of the main contactors, but the resistance contactor operating mechanism has been rendered extremely complicated due to the necessity of adjusting the preceding time and the adjustment of the preceding time has been quite difficult per se.

Moreover, since the main contactors are opened after the resistance contactor has been shifted to its opening position, the opening of the main contactors is delayed by the adjusted time and this has been a cause of making a high speed closing operation of the breaker impossible.

For making the high speed operation possible, a method is effective in which the resistance contactor is shifted into its closing position in response to a closing command and is shifted into its opening position subsequent to closure of the main contactors, so that the main contactors only may be opened when a breaking command is given.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a gas breaker capable of high speed operation, in which a resistance contactor makes a series of closing and opening operations in response to a closing command and main contactors only are opened in response to a breaking command.

Another object of the invention is to provide a gas breaker comprising a resistance inserting mechanism which enables the operational timing of a resistance contactor and main contactors in the closing operation of the breaker to be adjusted with ease and is simple in construction.

Still another object of the invention is to provide a gas breaker comprising a resistance inserting mechanism which enables the closing operation of the breaker to be effected not only in one step but also in a multiplicity of steps and yet in a simple manner.

A further object of the invention is to provide a gas breaker which is so designed that the poles are insulated from each other more positively when the breaker is in its breaking position, while in the closing operation a non-uniform field is established to cause a resistance contactor to perform a preceding discharge and thereby to extend the resistance insertion period.

Other objects of the invention will become apparent from the following description on embodiments of the invention.

According to the present invention there is provided a puffer-type gas breaker which is so designed that a resistance contactor is shifted into its closing position, prior to closure of main contactors to form a main electric circuit, by means of a drive piston connected to said resistance contactor, which is operated by a pressure difference between the pressure of an arc-suppressing gas in compressor means which is temporarily decreased below normal pressure during the closing operation of the breaker and the pressure of the arc-suppressing gas surrounding the main contactors, and after closure of the main contactors, is shifted to its opening position by suitable means such as a spring, as the gas pressure is restored in said compressor means, namely the resistance contactor makes a series of closing and breaking operations in response to a closing command.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a vertical sectional view showing an embodiment of the gas breaker according to the present invention.

FIGS. 2 and 3 are fragmentary vertical sectional views showing the gas breaker of FIG. 1 in its breaking position and closing position respectively.

FIG. 4 is a fragmentary vertical sectional view showing another embodiment of the gas breaker of this invention.

FIG. 5 is a fragmentary vertical sectional view showing the gas breaker of FIG. 4 in its closing position.

FIG. 6 is a diagram showing the electric connection of the gas breaker shown in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a breaker device 2 is housed in a ground tank 1 which is filled with SF_6 gas at a pressure of about 5 kg/cm^2 for insulation and extinction of arc, and a current is led to said breaker device 2 through bushings 3, 4. As seen from the cross-sectional view of the bushing 4, each of the bushings 3, 4 includes a bushing conductor 7 which is insulated from the ground tank by an insulator tube 5 and an insulation spacer 6, terminal plate 8 or 9 fixed to the top end thereof for connection with a transmission cable and a current transformer 10 or 11 at the other end for detecting the current passing in the bushing conductor 7. The output of the current transformer 10 or 11 is applied to control means for the breaker device 2 as is well known.

Now, the breaker device 2 will be described. A stationary contactor 13 is fixed to the conductor 12 of the bushing 3, and a movable main contactor 14 and a movable arc-generating contactor 15 are provided on a conductive operating rod 16 in opposed relation to said stationary contactor 13 for establishing a main electric circuit in cooperation therewith. A spring 17 is disposed between the movable arc-generating contactor 15 and the conductive operating rod 16 to cause said movable arc-generating contactor 15 to make a wiping motion.

The operating rod 16 is electrically connected to the bushing conductor 7 through a terminal block 18 by a collector 19 mounted on said terminal block. The terminal block 18 is fixed to the ground tank 1 by an insulation bracket 20.

To the end of the operating rod 16 adjacent to the stationary contactor is fixed a puffer cylinder 21 made of a light-weight, conductive material, such as aluminum, and a puffer piston 22 fixed to the terminal block 18 is slidably received in said puffer cylinder to constitute compressor means. The puffer cylinder 21 is provided with an insulation nozzle 23 to direct the SF_6 gas, compressed in the compressor means, toward the respective contactors.

On one side of the puffer cylinder 21 is provided an auxiliary cylinder 24 extending parallel to and made of the same material as said puffer cylinder 21. The auxiliary cylinder 24 is communicated with the puffer cylinder 21 by a communication hole 25 and has a drive piston 26 slidably disposed therein. The drive piston 26 is constantly biased in a direction opposite to the stationary contactor 13 or in the rightward direction as viewed in FIG. 1 by a spring 27.

A resistance movable contactor 28 is fixed to the drive piston 26, which is electrically connected to the auxiliary cylinder 24 by a collector 29. Opposite to the resistance movable contactor 28 is provided a resistance stationary contactor 30 which is fixed to a closing resistor 31 and electrically mechanically connected to the stationary contactor 13 by a conductive bracket 32.

The conductive operating rod 16 is connected to an insulation operating rod 33 which in turn is connected to a link 34. This link 34 extends outwardly of the ground tank 1 through a hermetic seal 35 and operated in a closing or breaking direction by an operating mechanism not shown.

When the breaker device is in its closed position as shown, the interior of the ground tank 1 is at normal pressure and the SF_6 gas pressure acting on each parts is equal. Therefore, the drive piston 26 is biased in a direction opposite to the stationary contactor or in a breaking direction by the biasing force of the spring 27 and hence the resistance movable contactor 28 is in its breaking position with respect to the resistance stationary contactor 30 and the current flows from the movable main contactor 14 to the stationary main contactor 13.

Now, when the current transformers 10, 11 actuate the control means, not shown, upon detecting an excess current passing in the bushing conductors 7, 12 and a breaking command is given to the operating mechanism also not shown, the link 34 is rotated by said operating mechanism, moving the operating rods 33 and 16 in a breaking direction or in the rightward direction as viewed in FIG. 1.

The movable arc-generating contactor 15 makes a wiping motion relative to the operating rod 16 incident to the movement of the operating rod 16 and then moves in the breaking direction together with said operating rod. Thus, the movable arc-generating contactor 15 is spaced apart from the stationary contactor 13 and an arc is formed across said contactors.

The puffer cylinder 21 also moves in the breaking direction incident to the movement of the operating rod 16. Since the puffer piston 22 is fixed in position, the SF_6 gas in the puffer cylinder 21 is compressed and the compressed gas is blown from the insulation nozzle 23 against the arc formed across the contactors 13, 15. This state is shown in FIG. 2.

In this case, the pressurized SF_6 gas within the puffer cylinder 21 is also supplied into the auxiliary cylinder 24 through the communication hole 25 and acts on the drive piston 26 from the left side, causing said drive piston to move in the breaking direction within said auxiliary cylinder incident to the movement of said auxiliary cylinder in the same direction.

Since the SF_6 gas within the puffer cylinder 21 is continuously compressed during the breaking operation, the arc is extinguished by the blast of cool SF_6 gas near the zero point of natural current. The operating rod 16 which has been shifted a distance (opening distance) predetermined to ensure extinguishment of the arc, is retained in its breaking position by the operating mechanism not shown, and the insulation between the stationary contactor 13 and movable arc-generating contactor 15 is secured by the highly insulative SF_6 gas enclosing said contactors. Then, normal pressure is restored in the ground tank 1.

Now, when a closing command is given to the operating mechanism and the operating rods 33 and 16 are moved in a closing direction or in the leftward direction as viewed in the Figure by said operating mechanism, the internal volume of the puffer cylinder 21 is expanded and the pressure of the SF_6 gas within said puffer cylinder drops below the pressure of the SF_6 surrounding the breaker device 2, namely a negative pressure appears in said puffer cylinder 21. Therefore, the SF_6 gas surrounding the breaker device 2 is sucked into the puffer cylinder 21 from the insulation nozzle 23, incident to the movement of said puffer cylinder in the closing direction, and the SF_6 gas within the auxiliary cylinder 24 is also sucked into the puffer cylinder 21 through the communication hole 25. As a result, the pressure of the SF_6 gas within the auxiliary cylinder 24 drops below the pressure of the SF_6 gas surrounding the breaker device 2, and the pressure difference thus created acts on the drive piston 26 urging it in the closing direction against the biasing force of the spring 27. By the movement of the drive piston 26, the free end of the resistance movable contactor 28 is shifted in the closing direction beyond the free end of the movable arc-generating contactor 15 and brought into contact with the resistance stationary contactor 30 as shown in FIG. 3, before the movable arc-generating contactor 15 is brought into contact with the stationary contactor 13 incident to the movement of the operating rod 16 in the closing direction, and thus the resistor 31 is inserted into the transmission line. Such operation as described above effectively prevents the occurrence of excessively large surging which would otherwise occur when the movable arc-generating contactor 15 contacts the stationary contactor 13 in its closing position.

The arrangement is made such that the contact between the resistance movable contactor **28** and the resistance stationary contactor **30** takes place about 8 ms in advance to the contact between the movable arc-generating contactor **15** and the stationary contactor **13**, and this period of advance is determined by the distance between the stationary contactor **13** and the movable arc-generating contactor **15** at the point when the resistance movable contactor **28** contacts the resistance stationary contactor **30** or, more strictly, the point when the preceding discharge occurs immediately before the contact between said resistance movable contactor **28** and resistance stationary contactor **30**, and the speed of movement of the movable arc-generating contactor **15** in the closing direction. Since the aforesaid inter-contactor distance and speed of movement are substantially constant, the period of advance will not vary even after repeated closing operations and the resistor **31** is inserted into the transmission line always with a constant time. On the other hand, the period of advance can be optionally adjusted by altering the inter-contactor distance and speed of movement, and once the period of advance has been determined, the adjustment of said period can be achieved very easily for the reason mentioned above.

As the SF_6 gas pressure inside the puffer cylinder **21** starts to rise to normal pressure, with the SF_6 gas outside the puffer cylinder being sucked into said cylinder through the insulation nozzle **23**, subsequent to the contact of the movable arc-generating contactor **15** with the stationary contactor **13** and the contact of the movable main contactor **14** with the stationary contactor **13** after the wiping motion of said movable arc-generating contactor, the pressure difference acting on the drive piston **26** decreases and said drive piston **26** is moved to the breaking direction against the decreasing pressure difference by the biasing force of the spring **27**, and the breaking device **2** is placed in the closing position shown in FIG. **1**. As described, the resistance movable contactor **28** makes a series of closing and breaking operation (movement into contact with an away from the resistance stationary contactor **30**) in response to the closing command, and the breaking command causes only the movable main and arc-generating contactors **14, 15** to be spaced apart from the stationary contactor **13**. Therefore, the time otherwise required for causing the advanced movement of the resistance movable contactor **28** during the breaking operation can be eliminated and a high speed breaking operation of the breaker device **2** becomes possible.

The speed of return movement of the resistance movable contactor **28** in the breaking direction subsequent to the closing operation is determined by the pressure difference acting on the drive piston **26**, i.e., the rate of recovery of the SF_6 gas pressure inside the puffer cylinder **21**, and the biasing force of the spring **27**.

FIG. **4** shows another embodiment of the invention which is a puffer type gas breaker so designed as to perform the closing operation in two steps.

In FIG. **4**, same reference numerals indicate same or equivalent parts as those shown in FIG. **1**. According to this embodiment, the puffer cylinder **21** is provided with two auxiliary cylinders, i.e., a first auxiliary cylinder **51** and a second auxiliary cylinder **52**, along the outer wall thereof. These auxiliary cylinders **51, 52** are communicated with the puffer cylinder **21** by communication holes **53, 54** respectively. Further, a first drive piston **55** and a second drive piston **56** are slidably disposed in the first and second auxiliary cylinders **51, 52** respectively, which are constantly biased in the breaking direction by springs **57, 58** respectively.

In the embodiment shown in FIG. **1**, the end of the puffer piston **21** closer to the terminal block **18** is open for the puffer piston **22**, but in this embodiment the end **21a** of the puffer cylinder **21** is in sliding engagement with the puffer piston **22** to be closed thereby to define a counter-puffer chamber B on the opposite side to the puffer chamber A with respect to the puffer piston **22**. In this counter-puffer chamber B occurs a pressure variation exactly contrary to the pressure variation of the SF_6 gas within the puffer chamber A. The counter-puffer chamber B is communicated with the auxiliary cylinders **51, 52** by pipes **59, 60** respectively and the pressure variation in said counter-puffer chamber B causes the drive pistons **55, 56** to make a desired closing and breaking operation to be described later, in cooperation with the pressure variation in the puffer chamber A.

The drive pistons **55, 56** respectively have resistance movable contactors **61, 62** fixed thereto and the free ends of said contactors **61, 62** are slidably secured in through-holes **64, 65** formed in a shield ring **63** respectively, which shield ring **63** is maintained at the same potential as the movable main contactor **14**. The free ends of the drive pistons **55, 56** staggered in position relative to each other so that the closing operation may be effected in two steps.

The shield ring **63** is opposed by another shield ring **68** which is made, for example, of a metallic resistance material and has resistance stationary contactors **66, 67** at portions thereof. This shield ring **68** is electrically and mechanically connected to the stationary contactor **13** by resistors **69, 70** and brackets **71, 72**. Since the shield ring **68** is substantially circular in shape and the resistance stationary contactors **66, 67** are provided thereon in point symmetrical relation with each other, the resistance valve of said shield ring **68** is equivalent to that of two resistors **68*a***, **68*b*** shown in FIG. **6** which are connected in parallel to the resistance stationary contactors **66, 67**. The resistance values of the resistors **68*a***, **68*b*** are made equal to each other and the resistance value of the resistor **69** is made larger than that of the resistor **70**, and further the resistance values of the resistors **68*a***, **68*b*** are made larger than those of the resistors **69, 70**. This is for the purpose of decreasing the resistance value of a resistance to be inserted in the transmission line as the closing operation proceeds, in the event when the resistance is inserted in two steps, and the practical manner of inserting the resistance will become apparent from the following description of operation:

In FIG. **4**, the breaker device is shown as being in its closing position. When the breaking command is given and the operating rods **33, 16** are shifted in the breaking direction toward the right as viewed in the figure, the movable arc-generating contactor **15** is spaced apart from the stationary contactor **13** by the spring **17** upon making a wiping motion and the arc formed across said contactors **15, 13** is extinguished by the blast of SF_6 gas pressurized in the puffer chamber A. During this breaking operation, the SF_6 gas is compressed in the puffer chamber A exactly as in the case of the embodiment shown in FIG. **1** and the pressurized

gas is led into the auxiliary cylinders **51, 52** through the communication holes **53, 54** to act on the drive pistons **55, 56** also as in the case of preceding embodiment.

In this embodiment, however, the counter-puffer chamber B defined by the puffer cylinder **21** and puffer piston **22** increases in its volume incident to the breaking operation and, therefore, the pressure in said chamber decreases relative to the pressure of SF_6 gas surrounding the breaker device. The decreased pressure acts in the first and second auxiliary cylinders **51, 52** through the pipes **59, 60** and attracts the first and second drive pistons **55, 56** to the right. Thus, the difference of the pressures acting on both faces of the pistons **55, 56** becomes larger and larger and holds said pistons against movement.

When the breaker device is in its breaking position, the SF_6 gas moves into the counter-puffer chamber B through the gap between the puffer cylinder **21** and puffer piston **22.** However, since the closing operation takes a very short period of time, a small hole may be formed through that portion of the puffer cylinder wall which defines the counter-puffer chamber B, so as to introduce the SF_6 gas into said chamber B therethrough to create a damping effect. The puffer chamber A and the counter-puffer chamber B are temporarily placed in a pressurized condition and a reduced-pressure condition in the process of the breaking operation, but after the breaker device has been placed in the breaking position, the pressure is restored and static pressure again appears in each chamber and the resistance movable contactors **61, 62** are held in their biased positions under the biasing forces of the springs **57, 58,** with their free ends located in the through holes **64, 65** in the shield ring **63,** respectively. The stationary and movable arc-generating contactors **13, 15** are placed in a uniform field through the shield rings **63, 68.**

Now, when the closing command is given under the breaking condition of the breaker device and the operating rod **16** is shifted in the closing direction or to the left as viewed in the figure, the volume of the puffer chamber A is expanded with the SF_6 gas pressure therein decreasing, while the volume of the counter-puffer chamber B is contracted with the SF_6 gas pressure therein increasing. The decreased gas pressure in the puffer chamber A is transmitted through the communication holes **53, 54** and the increased gas pressure in the counter-puffer chamber B is transmitted through the pipes **59, 60** to the first and second auxiliary cylinders **51, 52,** so that the drive pistons **55, 56** are shifted by the pressure difference against the biasing forces of the springs **57, 58** respectively. As a result, the resistance movable contactors **61, 62** are projected from the shield ring **63** and a non-uniform field is established between the shield rings **63, 68.**

Since, in this case, the free end of the resistance movable contactor **61** is located forwardly of the free end of the other resistance movable contactor **62,** the concentration of the electric field is more vigorous at the free end of the resistance movable contactor **61** than at the free end of the other resistance movable contactor **62.** Therefore, the preceding discharge occurs first between the resistance movable contactor **61** and resistance stationary contactor **66,** incident to the movement of the operating rod **16,** and thus the resistance is inserted into the transmission line.

According to this embodiment, as described above, a uniform field appears between the poles in the breaking state and a non-uniform field in the closing state. Therefore, the preceding discharge occurs earlier than in the case of closing operation in a uniform field and the resistance insertion period can be extended accordingly.

FIG. **5** shows the breaker device in the closing position, with the resistance movable contactor **61** and resistance stationary contactor **66** being in contact with each other, and FIG. **6** shows the electrical connection of the device in said state. In this case, the other resistance movable contactor **62** is still out of contact with the resistance stationary contactor **67** and the resistance values of the resistor **68***a*, **68***b* are made larger than that of the resistor **70,** so that the whole resistance value is essentially given by the resistors **68***a*, **68***b* and **69.**

When the resistance movable contactor **62** is brought into contact with the resistance stationary contactor **67** as the operating rod **16** is further shifted, the whole resistance value in this case is equivalent to that in the case when the resistors **68***a* and **68***b* are shorted, and is given by the parallel circuit of the resistors **69, 70.**

It will, therefore, be understood that the resistance value of the inserted resistance decreases as the closing operation proceeds until the movable arc-generating contactor **15** finally contacts the stationary contactor **13.** Thereafter, the first and second drive pistons **55, 56** return to their initial positions under the biasing forces of the springs **57, 58** respectively, as the SF_6 gas in the puffer chamber A and counter-puffer chamber B restores the initial pressure, and thus the closing state shown in FIG. **4** is brought about.

In still another embodiment, the resistor **69** shown in FIGS. **4–6** is replaced by one having an indefinitely large resistance value, that is, an insulator. In this case, the resistance value of the resistance inserted in the transmission line after the resistance movable contactor **61** has been placed in the closing position is given by the resistors **68***a*, **68***b* and **70,** and that after the resistance movable contactor **62** has been placed in the closing position is given by the resistor **70.** Namely, exactly the same effect as that of the embodiment shown in FIGS. **4–6** can be obtained.

The embodiment shown in FIG. **4** is so designed as to effect the closing operation in two steps, but when it is desired to effect the closing operation in a greater number of steps, this can be achieved by arranging the desired number of stationary contactors radially with respect to the stationary contactor **13,** each through a resistor, connecting said stationary contactors annularly by the corresponding number of resistors constituting the shield ring, and arranging the corresponding numbers of the resistance movable contactors, the drive pistons and the auxiliary cylinders radially around the puffer cylinder opposite to said respective resistors.

I claim:

1. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the ac formed between contactors thereby to extinguish said arc, comprising

a. main contactor means for forming a main electric circuit arranged opposite to each other so as to form an arc therebetween,

b. means for compressing said arc-suppressing gas,

c. resistance inserting means consisting of a resistor and cooperating resistance contactor means,

d. means for operating said resistance contactor means so as to insert said resistor into the power transmission line incident to the gas pressure variation in said compressing means and prior to closing of said main contactor means, and

e. means for biasing said main contactor means and compressing means in a closing or breaking direction.

2. A gas breaker according to claim **1,** in which said main contactor means and resistance contactor means respectively have common shield rings for mitigating the interpole field and a movable contactor of said resistance contactor means is retracted inwardly of the associated shield ring when said main contactor means are in a breaking state.

3. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, comprising

a. a hermetically sealed container containing a highly insulative, highly arc-suppressing gas,

b. main contactors for forming a main electric circuit arranged opposite to each other within said container so as to form an arc therebetween,

c. means for compressing said arc-suppressing gas incident to the breaking operation of said main contactor means,

d. resistance inserting means consisting of a resistor and cooperating resistance contactor means,

e. means for operating a resistance movable contactor of said resistance contactor means in a closing direction by virtue of a gas pressure difference between the gas pressure in said compressing means and the arc-suppressing gas pressure in said container only at the time of closing operation in which the gas pressure in said compressing means becomes lower than the arc-suppressing gas pressure in said container, and thereby for inserting said resistor into the power transmission line prior to closing of said main contactor means,

f. means for biasing said main contactor means and compressing means in a closing or breaking direction, and

g. means for directing the pressurized gas in said compressing means toward said arc.

4. A gas breaker according to claim **3,** in which said means (e) for operating the resistance movable contactor comprises an auxiliary cylinder provided along the outer wall of a puffer cylinder which constitutes the compressing means, a drive piston slidably disposed in said auxiliary cylinder and carrying said resistance movable contactor, and a spring disposed between said auxiliary cylinder and drive piston and constantly biasing said resistance movable contactor in a closing direction other than when the gas pressure in the compressing means is lower than the gas pressure in the container.

5. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, comprising

a. main contactor means for forming a main electric circuit arranged opposite to each other so as to form an arc therebetween,

b. means for compressing said arc-suppressing gas,

c. counter-compressing means for providing a gas pressure variation exactly contrary to the gas pressure variation in said compressing means,

d. resistance inserting means consisting of a resistor and cooperating resistance contactor means,

e. means for operating said resistance contactor means so as to insert said resistor into the power transmission line by virtue of a progressively increasing gas pressure difference between the varying gas pressure in said compressing means and the varying gas pressure in said counter-compressing means prior to closing of said main contactor means, and

f. means for biasing said main contactor means, compressing means and counter-compressing means in a closing or breaking direction.

6. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, comprising

a. a hermetically sealed container containing a highly insulative, highly arc-suppressing gas,

b. main contactor means for forming a main electric circuit arranged opposite to each other within said container so as to form an arc therebetween,

c. means for compressing said arc-suppressing gas incident to the breaking operation of said main contactor means,

d. counter-compressing means for providing a gas pressure variation exactly contrary to the gas pressure variation in said compressing means,

e. resistance inserting means consisting of a resistor and cooperating resistance contactor means,

f. means for operating a movable contactor of said resistance contactor means so as to insert said resistor into the power transmission line by virtue of a gas pressure difference between the gas pressure in said compressing means and the gas pressure in said counter-compressing means prior to closing of said main contactor means only at the time of closing operation in which the gas pressure in said compressing means becomes lower than the gas pressure in said container,

g. means for biasing said main contactor means, compressing means and counter-compressing means in a closing or breaking direction, and

h. means for directing the pressurized gas in said compressing means toward said arc.

7. A gas breaker according to claim **6,** in which said compressing means and counter-compressing means are composed integrally of a cylinder and a piston slidably disposed in said cylinder to divide the interior of said cylinder into two chambers and one of said two chambers in which the arc-suppressing gas is compressed incident to the breaking operation of said main contactor means is utilized as the compressing means and the other one of them is utilized as the counter-compressing means.

8. A gas breaker according to claim **6,** in which said means for operating the resistance movable contactor comprises an auxiliary cylinder provided along the outer wall of a puffer cylinder which constitutes the compressing means and counter-compressing means, a drive piston slidably disposed in said auxiliary cylinder and carrying said resistance movable contactor, and a spring disposed between said auxiliary cylinder and

drive piston and constantly biasing said resistance movable contactor in a breaking direction other than when the gas pressure in the compressing means is lower than the gas pressure in the container, and further one of the two chambers in said auxiliary cylinder divided by said piston in which said spring is disposed is communicated with said compressing means, while the other one of them is communicated with said counter-compressing means.

9. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, comprising

a. main contactor means for forming a main electric circuit arranged opposite to each other so as to form an arc therebetween,
b. means for compressing said arc-suppressing gas,
c. resistance inserting means consisting of two or more resistors of different resistance values and co-operating resistance contactor means,
d. means for operating said resistance contactor means incident to the gas pressure variation in said compressing means and prior to closing of said main contactor means so as to insert said resistors sequentially from one of the higher resistance value, and
e. means for biasing said main contactor means and compressing means in a closing or breaking direction.

10. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, comprising

a. main contactor means for forming a main electric circuit arranged opposite to each other so as to form an arc therebetween,
b. means for compressing said arc-suppressing gas,
c. resistance inserting means consisting of a first resistor group consisting of two or more resistors arranged radially with respect to a stationary contactor of said main contactor means, stationary contactors of resistance contactor means arranged in substantially the same plane as the free ends of the stationary contactors of said main contactor means on said first resistor group, a second resistor group connecting said stationary contactors annularly on said plane and movable contactors arranged opposite to said respective stationary contactors,
d. interpole field mitigating means consisting of said annularly arranged second resistor group and a shield ring arranged in substantially the same plane as the free ends of movable contactors of said main contactor means opposite to said second resistor group, said shield ring being adapted to receive said resistance movable contactors inwardly thereof,
e. means for inserting said first and second resistor groups into the power transmission line by sequentially bringing said respective resistance movable contactors into their closing positions incident to the gas pressure variation in said compressing means and prior to closing of said main contactor means, and
d. means for biasing said main contactor means and compressing means in a closing or breaking direction.

11. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, comprising

a. main contactor means for forming a main electric circuit arranged opposite to each other so as to form an arc therebetween,
b. means for compressing said arc-suppressing gas,
c. counter-compressing means for providing a gas pressure variation exactly contrary to the gas pressure variation in said compressing means,
d. resistance inserting means consisting of two or more resistors of different resistance values and co-operating resistance contactor means,
e. means for operating the resistance contactor means so as to insert said resistors into the power transmission line sequentially from one of the higher resistance value by virtue of a progressively increasing gas pressure difference between the varying gas pressure in said compressing means and the varying gas pressure in said counter-compressing means prior to closing of said main contactor means, and
f. means for biasing said main contactor means, compressing means and counter-compressing means in a closing or breaking direction.

12. A gas breaker of the type in which an arc-suppressing gas is compressed immediately before the current is broken and the resultant pressurized gas is blown against the arc formed between contactors thereby to extinguish said arc, comprising

a. main contactor means for forming a main electric circuit arranged opposite to each other so as to form an arc therebetween,
b. means for compressing said arc-suppressing gas,
c. counter-compressing means for providing a gas pressure variation exactly contrary to the gas pressure variation in said compressing means,
d. resistance inserting means consisting of a first resistor group consisting of two or more resistors arranged radially with respect to a stationary contactor of said main contactor means, stationary contactors of resistance contactor means arranged in substantially the same plane as the free ends of the stationary contactors of said main contactor means on said first resistor group, a second resistor group connecting said stationary contactors annularly on said plane and movable contactors arranged opposite to said respective stationary contactors,
e. interpole field mitigating means consisting of said annularly arranged second resistor group and a shield ring arranged in substantially the same plane as the free ends of movable contactors of said main contactor means opposite to said second resistor group, said shield ring being adapted to receive said resistance movable contactors inwardly thereof,
f. means for inserting said first and second resistor groups into the power transmission line by sequentially bringing said respective resistance movable contactors into their closing positions prior to closing of said main contactor means by virtue of a progressively increasing gas pressure difference be-

tween the varying gas pressures in said compressing means and counter-compressing means, and

g. means for biasing said main contactor means, compressing means and counter-compressing means in a closing or breaking direction.

13. A gas breaker according to claim **12,** in which said compressing means and counter-compressing means are composed integrally of a cylinder and a piston slidably disposed in said cylinder to divide the interior of said cylinder into two chambers and one of said two chambers in which the arc-suppressing gas is compressed incident to the breaking operation of said main contactor means is utilized as the compressing means and the other one of them is utilized as the counter-compressing means.

14. A gas breaker according to claim **12,** in which said means for operating the resistance movable contactors each comprises an auxiliary cylinder provided along the outer wall of a puffer cylinder which constitutes the compressing means and counter-compressing means, a drive piston slidably disposed in said ausiliary cylinder and carrying said resistance movable contactor, and a spring disposed between said auxiliary cylinder and drive piston and constantly biasing said resistance movable contactor in a breaking direction other than when the gas pressure in the compressing means is lower than the gas pressure in the container, and further one of the two chambers in said auxiliary cylinder divided by said piston in which said spring is disposed is communicated with said compressing means, while the other one of them is communicated with said counter-compressing means.

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