

[54] **CIRCUIT BREAKER**
 [75] Inventor: **Yoshio Yoshioka**, Hitachi, Japan
 [73] Assignee: **Hitachi, Ltd.**, Tokyo, Japan
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 [51] **Int. Cl.**..... **H01h 33/70**
 [58] **Field of Search**..... **200/148 A, 150 G**

3,551,625 12/1970 Fischer 200/148 A
 3,621,171 11/1971 Yoshioka 200/148 A

Primary Examiner—Robert S. Macon
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

A circuit breaker comprising at least two electrically series-connected puffer type breaking units which extinguish an arc produced between the contactors by blowing a high pressure arc-extinguishing gas produced by compression simultaneously with the start of breaking action against the arc and which are driven by an electromagnetic driving device, consisting of a primary coil and a shorting ring or shorting coil electromagnetically coupled to the primary coil, into which a current to be broken is diverted at the time of breakage.

10 Claims, 5 Drawing Figures

[56] **References Cited**

UNITED STATES PATENTS			
2,381,244	8/1945	Arnold	200/150 G
2,781,435	2/1957	Heilmann et al.	200/150 G
2,850,600	9/1958	Prince	200/150 G
2,913,556	11/1959	Leeds	200/148 A
3,549,842	12/1970	Fischer et al.	200/148 A

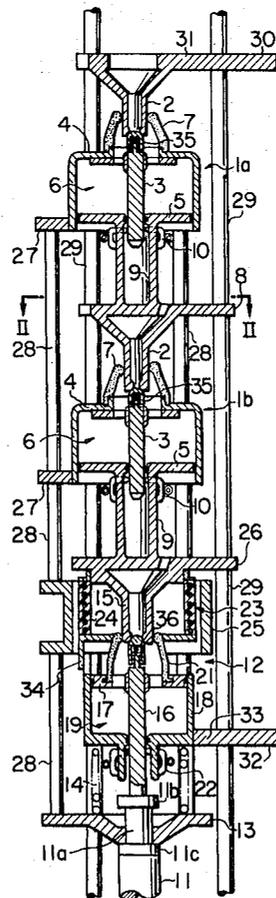


FIG. 1

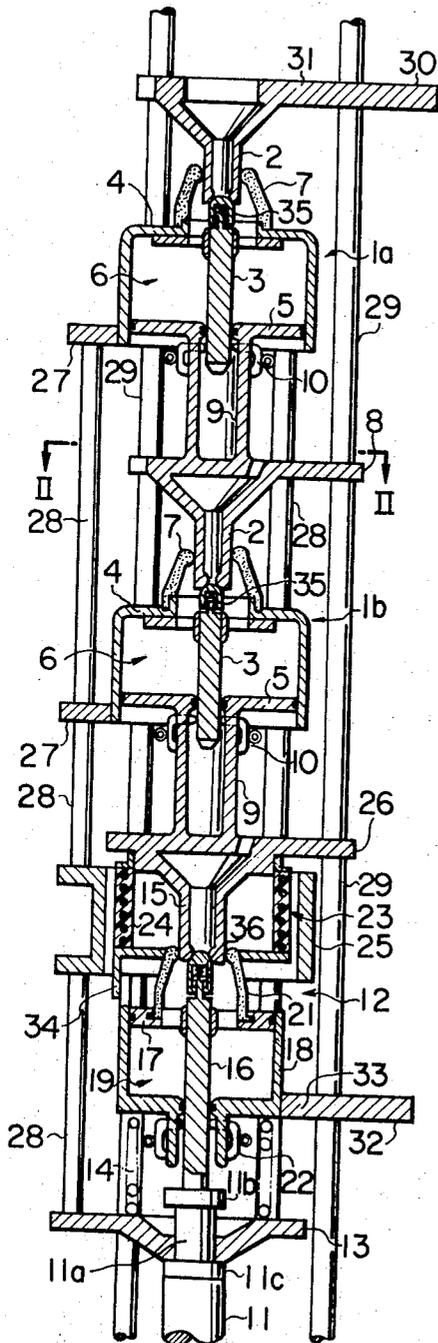


FIG. 2

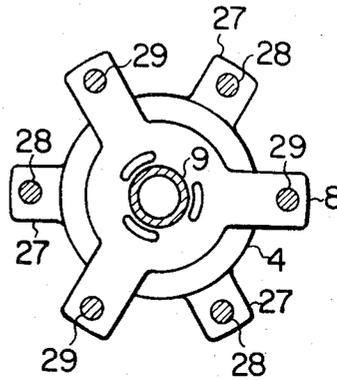


FIG. 3

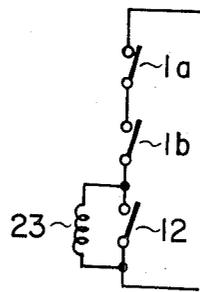


FIG. 4

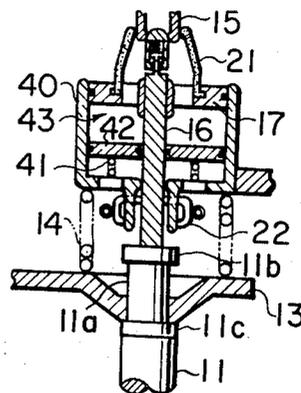
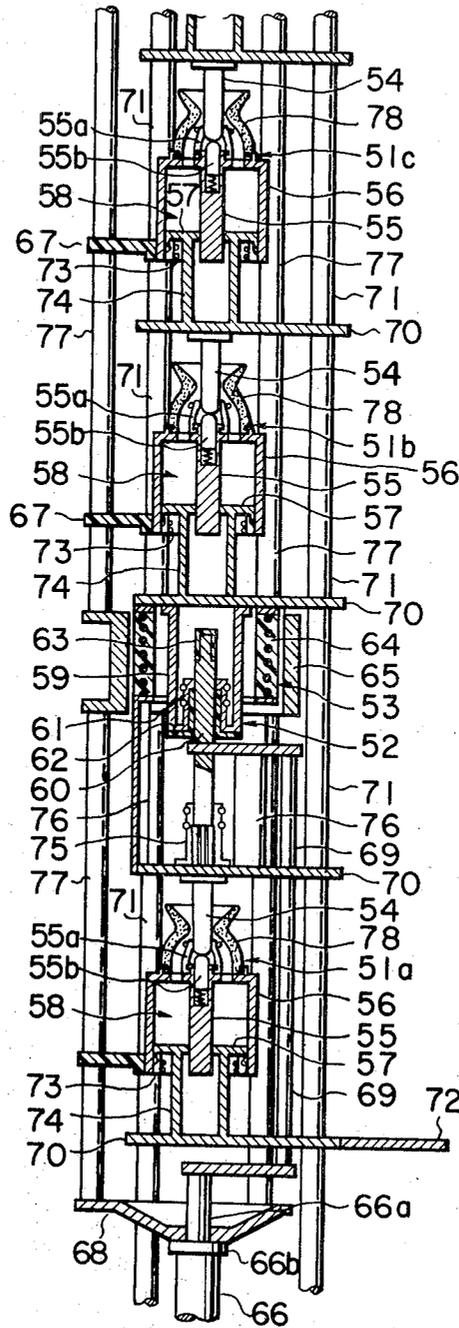


FIG. 5



CIRCUIT BREAKER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a circuit breaker, and more particularly to a gas puffer type circuit breaker having a multiple breaking part which is driven by the electromagnetic force developed by a current to be broken.

2. Description of the Prior Art

Recently, with an increasing demand of electric power a transmission line is becoming more and more of high voltage and of high current for enabling high capacity power transmission. A circuit breaker which is utilized as a protective device for such a high capacity transmission line must be such as one as can break an electric power of high voltage and high current.

For this reason, as such a circuit breaker is one which extinguishes an arc produced between contactors by blowing an arc-extinguishing insulating medium having good extinguishing ability such as an SF₆ gas against the arc. However, even this kind of circuit breaker has a limitation to break a high voltage and a high current with only one breaking unit, and hence the circuit breaker is provided with a multiple breaking part consisting of a plurality of series connected breaking units.

On the other hand, a gas puffer type circuit breaker requires a strong operational or driving force. This is because in the gas puffer type circuit breaker an arc-extinguishing gas is compressed substantially simultaneously within the breaking or detaching operation or motion of the contactors thereof to blow the compressed high pressure arc-extinguishing gas again an arc produced between the contactors to extinguish the arc. Further, since the compressing distance of the compressor device for compressing the arc-extinguishing gas is considerable, the breaking distance of the contactors is long.

If the gas puffer type circuit breaker has multiple breaking units which are conventionally to be simultaneously and collectively operated or driven by an operational piston which in turn is driven by compressed air, an operating medium, the driving force must be a further stronger one. In order to overcome this difficulty the breaking units may be divided into a number of sets. However, if separate sets are to be driven by separate drivers, a good and stable breaking characteristic cannot be expected because the operations of the individual sets would not be balanced.

There is another type of circuit breaker which utilizes the electromagnetic energy of the current to be broken as the operational force. This is constructed such that the current to be broken is diverted into the primary coil at the time of the breakage to produce an electromagnetic repulsive or attractive force between the primary coil and the secondary inductive device electromagnetically coupled thereto. Since the electromagnetic force produced by this electromagnetic driving device is proportional to the current to be broken squared, the breaking unit is surely driven for any high current.

However, the circuit breaker in which an electromagnetic driving device as stated above is provided to each breaking unit is complicated in its structure to render it difficult to adjust the mechanism such that the breaking units are evenly operated. For this reason, it is diffi-

cult to provide a circuit breaker having a good breaking characteristic.

SUMMARY OF THE INVENTION

5 An object of the present invention is to provide a circuit breaker having multiple gas puffer type breaking units which can be driven by a weak external operational force.

Another object of the present invention is to provide 10 a circuit breaker in which the structure of the entire circuit breaker and the structure of each breaking unit are simplified by providing an electromagnetic driving mechanism for the multiple breaking units.

According to the present invention the above objects 15 can be achieved by a circuit breaker comprising a multiple breaking part having at least two electrically series connected breaking units each comprising at least a pair of contactors performing arc-inducing breakage or detachment, compressor means for compressing an arc-extinguishing gas, and nozzle means for blowing a high pressure arc-extinguishing gas compressed by the compressor means against the arc; electromagnetic driving means consisting of a primary coil and a shorting ring or shorting coil electromagnetically coupled to the primary coil; current diverting means actuatable by 20 external operating means in accordance with a breaking instruction for diverting a current to be broken into the electromagnetic driving means; and connecting means for electrically insulatedly connecting the electromagnetic driving means and the multiple breaking part so that the moving portion of the multiple breaking part can be driven. By this circuit breaker any current can be broken with a weak external manipulating or operational force.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational cross-sectional view of an embodiment of the circuit breaker according to the present invention.

40 FIG. 2 is a cross-section along the line II — II in FIG. 1.

FIG. 3 is an equivalent circuit of the circuit breaker of FIG. 1.

45 FIG. 4 is a cross-sectional view of a part of another embodiment of the circuit breaker according to the present invention.

FIG. 5 is an elevational cross-sectional view of a further embodiment of the circuit breaker according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 two breaking units 1a and 1b are connected electrically in series. Each of the breaking units 1a and 1b consists of a fixed contactor 2, a movable contactor 3 opposing the fixed contactor 2, a compressor composed of a puffer cylinder 4 and a puffer piston 5 and defining a puffer chamber 6 therein, and an insulating nozzle 7 which blows an arc-extinguishing gas such as sulfur hexafluoride (SF₆) gas against an arc produced between the fixed contactor 2 and the movable contactor 3. The movable contactor 3, the puffer cylinder 4 and the insulating nozzle 7 are interlocked. The puffer piston 5 of the breaking unit 1a and the fixed contactor 2 of the breaking unit 1b are supported by the same fixed support 8. The movable contactor 3 and a supporting conductive tube 9 of the puffer piston

5 are electrically in contact with each other through a current collector 10.

A manipulating or operational rod 11 connected with a not shown external manipulating or operational device has an axial portion 11a which transmits an operational force to a diverting device 12 to be described below and slidably passes through a support 13 which is connected to the moving portions of the breaking units 1a and 1b and stoppers 11b and 11c which restrict the extent of the movement of the support 13. For pressing the support 13 in the shown closed state downward against the stopper 11c there is provided a spring 14.

The diverting device 12 is composed of a hollow fixed contactor 15, a movable contactor 16 arranged to oppose the fixed contactor 15, a compressor having a movable puffer piston 17 and a fixed puffer cylinder 18 which together define a puffer chamber 19, and an insulating nozzle 21 which blows an arc-extinguishing gas compressed to a high pressure in the puffer chamber 19 against an arc produced between the fixed contactor 15 and the movable contactor 16. The movable contactor 16 is connected with the operational rod 11, while the movable contactor 16, the movable puffer piston 17 and the insulating nozzle 21 are operated by the operational rod 11 in an interlocked manner. The movable contactor 16 electrically contacts a current collector 22 provided at an end portion of the fixed puffer cylinder 18.

An electromagnetic driving device 23 is provided surrounding the fixed contactor 15. The electromagnetic driving device 23 has a primary coil 24 into which the current to be broken is diverted by the diverting device 12 and a shorting ring 25 electromagnetically coupled to the primary coil 24 so that an induction current is induced in the shorting ring 25 to render the shorting ring 25 repulsive to the primary coil 24. The shorting ring 25 may be a shorting coil which is a shorted winding.

The primary coil 24 is, for example, a molded integral unit and fixed to a fixed support 26 to which the puffer piston 17 of the breaking unit 1b and the fixed contactor 15 of the diverting device 12 are fixed. The shorting ring 25 is connected with connection rods 28 which are mechanically connected with metal fixtures 27 fixed to the puffer cylinders 4 of the breaking units 1a and 1b and which operate the movable portions of the breaking units 1a and 1b.

The primary coil 24 and the short ring 25 are arranged coaxially and have predetermined axial lengths, respectively, so that, in the shown state, the primary coil 24 is inserted in the shorting ring 25. By this arrangement, even when the shorting ring 25 moves, a predetermined electromagnetic force can be developed over a long distance.

The fixed portions of the breaking units 1a and 1b and the fixed portion of the diverting device 12 are supported by insulating support rods 29. In more detail, a fixed support 31 which supports the fixed contactor 2 of the breaking unit 1a and which is formed into a terminal 30 at its end part, the fixed support 8 provided between the breaking unit 1a and the breaking unit 1b, the fixed support 26 provided between the breaking unit 1b and the diverting device 12, and a fixed support 26 which supports the fixed puffer cylinder 18 of the diverting device 12 and which is formed into a terminal

32 at its part are supported by the insulating support rod 29.

Referring to FIG. 2 which is a cross-section along the line II — II in FIG. 1, the insulating support rods 29, three in number, support the fixed support 8, and the connection rods 28 are connected with the shorting ring 25 of the electromagnetic driving device 23 are arranged alternately with the insulating support rods 29. The connection rods 28 are fixed to the metal fixtures 27 fixed to the puffer cylinders 4 as described above.

The current path in the closed state shown in FIG. 1 is terminal 30—fixed support 31—fixed contactor 2—movable contactor 3—current collector 10—supporting conductive tube 9—fixed support 8—fixed contactor 2—movable contactor 3—current collector 10—supporting conductive tube 9—fixed support 26—fixed contactor 15—movable contactor 16—current collector 22—fixed puffer cylinder 18—fixed support 33—terminal 32.

When the current flowing through the fixed contactor 15 and the movable contactor 16 of the diverting device 12 is broken at the initial stage of breakage, the current path becomes fixed support 26—primary coil 24—conductor 34—fixed puffer cylinder 18.

FIG. 3 is an equivalent circuit of the circuit breaker of FIG. 1. A series connection of the breaking units 1a and 1b is connected in series with a parallel connection of the diverting device 12 and the electromagnetic driving device 23. When the diverting device 12 is closed, only a small current flows through the electromagnetic driving device 23 because the resistance of the diverting device 12 is selected to be very low compared with that of the electromagnetic driving device 23.

In a breaking operation, when the operational rod 11 is driven downward on the drawing by a not shown external operating device, the movable portion of the diverting device 12 is driven downward to break the contact between the fixed contactors 15 and the movable contactor 16 causing the movable puffer piston 17, which is formed into an integral unit with the movable contactor 16, to compress an arc-extinguishing gas in the puffer chamber 19 to blow it against an arc generated between the fixed contactor 15 and the movable contactor 16. As a result, the arc voltage between the fixed contactor 15 and the movable contactor 16 rises. When the arc voltage becomes higher than the voltage drop of the circuit including the primary coil 24, the arc is extinguished by being blown by the highly pressurized arc-extinguishing gas before the current in the main circuit reaches the zero point so that the current is diverted into the circuit including the primary coil 24.

In this case, since the impedance of the primary coil 24 is about $10\mu\text{H}$, the voltage is only about 200 to 300 V for the breakage of 50 kA. Consequently, even when the compressing action on the arc-extinguishing gas accompanying the contactor breaking action is too low to provide a highly pressurized arc-extinguishing gas, the arc produced between the fixed contactor 15 and the movable contactor 16 can sufficiently be extinguished.

At this time, the support 13 only slides on the axial portion 11a of the operational rod 11.

When the current is diverted into the circuit including the primary coil 24 by the diverting device 12, a magnetic flux is produced around the primary coil 24 by the current to be broken. The magnetic flux induces by electromagnetic induction an induction current in

the shorting ring 25 which is electromagnetically coupled to the primary coil 24, causing electromagnetic repulsion between the primary coil 24 and the shorting ring 25 so as to drive the shorting ring 25 downward on the drawing. In other words, a strong electromagnetic force to shift the connection rod 28 in a breaking direction is produced between the primary coil 24 and the shorting ring 25.

By the movement of the connection rod 28 the puffer cylinders 4 of the breaking units 1a and 1b are driven to cause a breaking or detaching operation between the fixed contactor 2 and the movable contactor 3 which in turn compresses the arc-extinguishing gas in the puffer chamber 6 of the compressor. A wiping portion 35 capable of wiping operation is provided to the upper end portion of each movable contactor 3 so that an arc can be produced between the fixed contactor 2 and the movable contactor 3 in the state that the arc-extinguishing gas in the puffer chamber 6 is compressed to a predetermined pressure by the compressor. The highly pressurized arc-extinguishing gas compressed by the compressor is blown against the arc produced between the fixed contactor 2 and the movable contactor 3 to extinguish the arc, thereby completing the breaking operation of the circuit breaker.

The closing or making operation will next be described. When the operational rod 111 is driven upward on the drawing by a not shown external operational device, the operational rod 11 drives not only the movable contactor 16 of the diverting device 12 but also the connection rods 28 connected with the support 13 upward to drive the movable portions of the breaking units 1a and 1b in the closing or making direction because the support 13 is pressed against the stopper 11c. Thus the fixed contactor 15 and the movable contactor 16 close or make first, and then the fixed contactors 2 and the movable contactors 3 of the breaking units 1a and 1b close or make. If the wiping distance of the wiping portion 36 of the diverting device 12 is made larger than the wiping distances of the wiping portions 35 of the breaking units 1a and 1b, the making of the diverting device 12 is made earlier than the making of the breaking units 1a and 1b.

By this measure the diverting device 12 never performs a prior discharge at the time of making. Consequently, the phenomenon that an electromagnetic force appears between the primary coil 24 and the shorting ring 25 at the time of making due to the current flowing through the primary coil 24 by the prior discharge is prevented to smoothly perform the making operation.

FIG. 4 is a modification of the diverting device 12 of FIG. 1. Substantially at the central portion of a fixed puffer cylinder 40 there is provided a second movable puffer piston 42 which is pressed by a spring 41 in the opposite direction to the moving direction of the movable puffer piston 17 at the breaking time. By this expedient the volume of the puffer chamber 43 is reduced.

In operation, by the downward movement of the operational rod 11 the movable contactor 16 performs a breaking movement from the fixed contactor 15, and at the same time the movable puffer piston 18 compresses an arc-extinguishing gas in the puffer chamber 43. In this case, since the volume of the puffer chamber 43 is made smaller than that of the puffer chamber 19 in FIG. 1, the arc-extinguishing gas in the puffer chamber 43 is compressed at a higher rate by a smaller

stroke of the movable contactor 16. The second movable puffer piston 42 retracts while keeping the pressure in the puffer chamber 43 at a high value because it is pressed by the spring 41, thereby quickly extinguishing the arc produced between the contactors 15 and 16 and reducing the time necessary for the breaking operation of the entire circuit breaker.

FIG. 5 is another embodiment of the present invention. Though only three breaking units 51a, 51b and 51c are shown therein, any desired number of breaking units can be provided above the breaking unit 51c. Between the breaking unit 51a and the breaking unit 51b there are provided a diverting device 52 and an electromagnetic driving device 53. Each of the breaking units 51a to 51c is composed of a fixed contactor 54, a movable contactor 55, a compressor consisting of a puffer cylinder 56 and a puffer piston 57 which together define a puffer chamber 58, and a funnel shaped insulating nozzle 78 which directs an arc-extinguishing gas in the puffer chamber 58 to an arc produced between the contactors 54 and 55. The movable contactor 55 consists of a main contactor 55a and an arcing contactor 55b which produces an arc.

The diverting device is composed of a fixed contactor 59 and a movable contactor 60. The fixed contactor 59 is provided on its inner wall surface with an insulating layer 62 except the portion where a current collector 61 is provided. The movable contactor 60 is provided with an insulating layer 63 at its upper end portion spaced apart from the portion opposing the current collector 61 in the closed state by a predetermined distance. By this construction an arc is pushed into the insulating layers 62 and 63 to effect short arc extinction. Such a diverting device 52 is simpler in structure than those in FIGS. 1 and 4.

The electromagnetic driving device 53 is composed of a primary coil 64 and a shorting ring 65 electromagnetically coupled thereto similarly to that in FIG. 1, and therefore will not be described in detail. An operational rod 66 connected with an external operating device (not shown) has an axial portion 66a slidably passing through a support 68 connected through connection rods 77 with supports 67 fixed to the puffer cylinders of the breaking units 51a to 51c and the shorting ring 65 and a stopper 66b for restricting the movement of the support 68. The movable contactor 60 of the diverting device 52 is connected with the operational rod 66 by means of a connection rod 69.

Fixed supports 70 supporting the fixed parts of the breaking units 51a to 51c are supported by a supporting insulator rod 71.

The current path of this embodiment is breaking unit 51c—breaking unit 51b—diverting device 52—breaking unit 51a—terminal 72, and in each of the breaking units 51a to 51c the current path is fixed support 70—fixed contactor 54—main contactor 55a—puffer cylinder 56—current collector 73—puffer piston 57—support 74—fixed support 70. The current path in the diverting device 52 is fixed support 70—fixed contactor 59—current collector 61—movable contactor 60—current collector 75—fixed support 70.

In breaking operation, when the operational rod 66 is moved downward, the movable contactor 60 of the diverting device 52 moves downward to interrupt the conduction with the current collector 61 and to push an arc into the insulator layers 62 and 63 so as to effect short arc extinction. The current to be broken which

has been flowing through the diverting device 52 is diverted into fixed support 70—primary coil 64—conductor 76—fixed support 70. The shorting ring 65 is actuated by the electromagnetic repulsive force induced by the current flowing through the primary coil 64 to drive the movable portions of the breaking units 51a to 51c, whereby the fixed contactor 54 and the main contactor 55a are detached to produce an arc between the fixed contactor 54 and the arcing contactor 55b. At the same time an arc-extinguishing gas in the puffer chamber 58 is compressed to a high pressure and blown against the arc to extinguish it through the insulating nozzle 78 to complete the breaking operation.

In closing or making operation, if the operational rod 66 is shifted upward, the diverting device 52 and the breaking units 51a to 51c are driven in the making direction, at which time the diverting device 52 is first closed, and then the breaking units 51a to 51c are closed. This is because the wiping distance of the diverting device 52 is made longer than those of the breaking units 51a to 51c, whereby a current is prevented from flowing through the electromagnetic driving device 53 which otherwise occurs by the prior discharge in the breaking units 51a to 51c at the making time to smoothly perform the making operation.

In all of the above embodiments the breaking units, the diverting device, and the electromagnetic driving device are put in a vessel filled with an arc-extinguishing gas having a good electrical insulating ability.

I claim:

1. A circuit breaker comprising:

at least two electrically series connected breaking units each comprising at least a pair of contactors performing arc-inducing breakage or detachment, compressor means for compressing an arc-extinguishing gas, and nozzle means for blowing a highly pressurized arc-extinguishing gas compressed by the compressor means against the arcs generated between the pair of contactors;

a single electromagnetic driving means including a primary coil and a shorting ring or shorting coil electromagnetically coupled to the primary coil; current diverting means adapted to be operated by an external operating means in accordance with a breaking instruction for diverting a current to be broken into the electromagnetic driving means; and

connecting means for electrically insulatedly connecting the electromagnetic driving means and movable portions of the breaking units so that the moving portions of the breaking units can be driven.

2. A circuit breaker according to claim 1, in which the primary coil of the electromagnetic driving means is fixed to a fixed member, and the shorting ring or shorting coil of the electromagnetic driving means is connected to the connecting means.

3. A circuit breaker according to claim 1, comprising an operational rod capable of collectively operating the diverting means and the breaking units and having a connection portion capable of operating the diverting means prior to the operation of the breaking units at the breaking time.

4. A circuit breaker according to claim 3, in which the connection portion comprising a support mechanically connected to the breaking units, an axial portion

of the operational rod slidably penetrating the support, and a stopper fixed to the operational rod for restricting the shift of the support to a predetermined extent.

5. A circuit breaker according to claim 3, in which the breaking units, the diverting means and the electromagnetic driving means are arranged coaxially; the current diverting means is disposed adjacent to the operational rod at a mirror position to the operational rod and the breaking unit which is the nearest of all the breaking units to the operational rod.

6. A circuit breaker comprising:

at least two electrically series connected breaking units, each comprising at least a first pair of contactors performing arc-inducing breakage or detachment, a first compressor means for compressing an arc-extinguishing gas, and a first nozzle means for blowing a highly pressurized arc-extinguishing gas compressed by the first compressor means against arcs generated between the first pair of contactors; a single electromagnetic driving means including a primary coil and a shorting ring or shorting coil electromagnetically coupled to the primary coil; current diverting means adapted to be operated by an external operating means in accordance with a breaking instruction for diverting a current to be broken into the electromagnetic driving means, said current diverting means including at least a second pair of contactors which perform an arc-inducing detachment, a second compressor means for compressing an arc-extinguishing gas, and a second nozzle means for blowing highly pressurized arc-extinguishing gas compressed by the second compressor means against arcs generated between the second pair of contactors; and

connecting means for electrically insulatedly connecting the electromagnetic driving means and movable portions of the breaking units so that the moving portions of the breaking units can be driven.

7. A circuit breaker according to claim 6, in which the second compressor means comprises a first piston, a second piston spaced apart by a predetermined distance from the first piston and pressed by pressing spring means in the direction opposite to the direction in which the first piston is operated, and a cylinder constituting a compressor chamber together with the first and second pistons.

8. A circuit breaker comprising:

at least two electrically series connected breaking units each comprising at least a first pair of contactors performing arc-inducing breakage or detachment, a first compressor means for compressing an arc-extinguishing gas, and a first nozzle means for blowing a highly pressurized arc-extinguishing gas compressed by the first compressor means against arcs generated between the first pair of contactors; a single electromagnetic driving means including a primary coil and a shorting ring or shorting coil electromagnetically coupled to the primary coil; current diverting means adapted to be operated by an external operating means in accordance with a breaking instruction for diverting a current to be broken into the electromagnetic driving means, said current diverting means including at least a second pair of contactors, one of the second pair of contactors being inserted in a hollow portion of the other of the second pair of contactors, the outer

wall surface of the one contactor and the inner wall surface of the other contactor being provided with insulating layers, respectively, in such a manner that at the breaking time the insulating layers are opposing each other with a minimum interstice therebetween into which an arc is pushed to be extinguished; and

connecting means for electrically insulatedly connecting the electromagnetic driving means and movable portions of the breaking units so that the moving portions of the breaking units can be driven.

9. A circuit breaker comprising:
 at least two electrically series connected breaking units each comprising at least a pair of contactors performing arc-inducing breakage or detachment, compressor means for compressing an arc-extinguishing gas, and nozzle means for blowing a highly pressurized arc-extinguishing gas compressed by the compressor means against arcs generated between the pair of contactors;

a single electromagnetic driving means including a primary coil and a shorting ring or shorting coil electromagnetically coupled to the primary coil;

current diverting means adapted to be operated by an external operating means in accordance with a breaking instruction for diverting a current to be broken into the electromagnetic driving means, said current diverting means including at least a pair of contactors the wiping distance between which is larger than that between the contactors of each of the breaking units; and

connecting means for electrically insulatedly connecting the electromagnetic driving means and movable portions of the breaking units so that the moving portions of the breaking units can be driven.

10. A circuit breaker comprising:
 first and second end terminals;
 a plurality of breaking units electrically connected in series between said first and second end terminals, each of which breaking units comprises a pair of contactors between which an arc is generated upon separation thereof, compressor means for compressing an arc-extinguishing gas, and nozzle means for blowing a highly pressurized arc-extinguishing gas compressed by said compressor means against the arcs generated between said contactors;

an electromagnetic driving means, separate from said breaking units, but being electrically and mechanically coupled thereto, and including a primary winding and a shorting winding electromagnetically coupled to said primary winding;

current diverging means, coupled to said electromagnetic driving means and at least one of said breaking units, for providing a series current path between said breaking units and said first and second end terminals during the closed conditions of said circuit breaker, and for electrically inserting said electromagnetic driving means into said current path in response to a breaking instruction, thereby actuating said electromagnetic driving means; and

connecting means electrically insulatedly and mechanically connecting said electromagnetic driving means to displaceable portions of said breaking units, for effecting the mechanical separation of the contactors of said breaking units in response to the actuation of said electromagnetic driving means by said current diverting means, thereby breaking the current path between said first and second end terminals.

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