United States Patent [19]

Yoshioka

[11] **3,745,281**

[45] **July 10, 1973**

[54] **GAS-BLAST CIRCUIT BREAKER HAVING A FLOATING PUFFER PISTON DRIVEN BY ELECTROMAGNETIC FORCE**

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[22] Filed: **Feb. 22, 1971**

[21] Appl. No.: **117,415**

[30] **Foreign Application Priority Data**

July 1, 1970	Japan	45/56919
Mar. 11, 1970	Japan	45/20163
Feb. 20, 1970	Japan	45/14190

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

[51] **Int. Cl.** **H01h 33/82**

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

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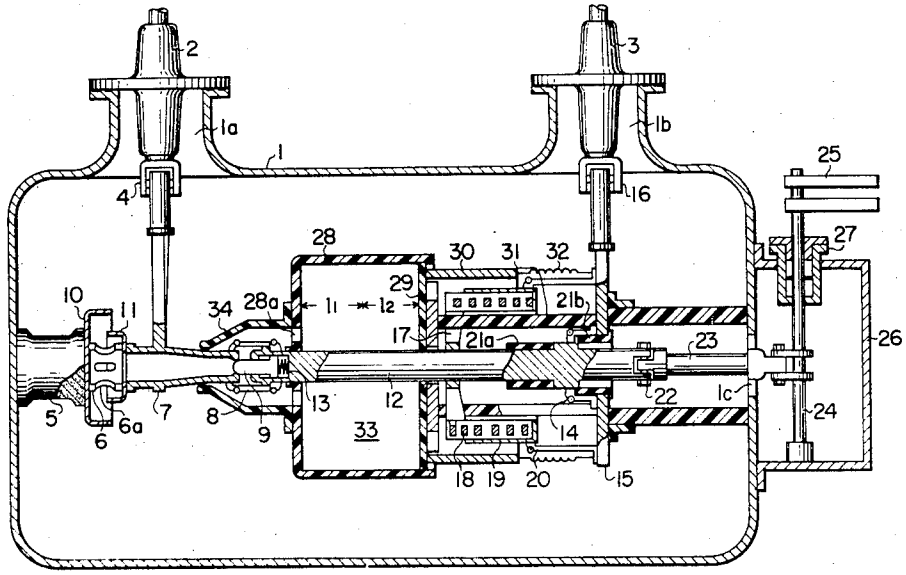
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[57] **ABSTRACT**

A gas breaker wherein an electromagnetic force is generated between a primary coil fixed to an operating rod manipulating a movable contact element and an end ring or a short ring fixed to a floating puffer piston slidably supported against said operating rod, said floating puffer piston being driven to compress arc-extinguishing gas in said puffer cylinder by an electromagnetic repulsive force and an arc is extinguished by compressed arc extinguishing gas which is blasted to the contact element.

A movement of the puffer piston for compressing arc-extinguishing gas is shut off from that of the operating rod, so that the electromagnetic repulsive force is utilized for compression of the arc-extinguishing gas in the puffer cylinder, whereby the electromagnetic force is not effected to the operating rod, thus resulting in making the control system for the operating rod more compact.

22 Claims, 10 Drawing Figures



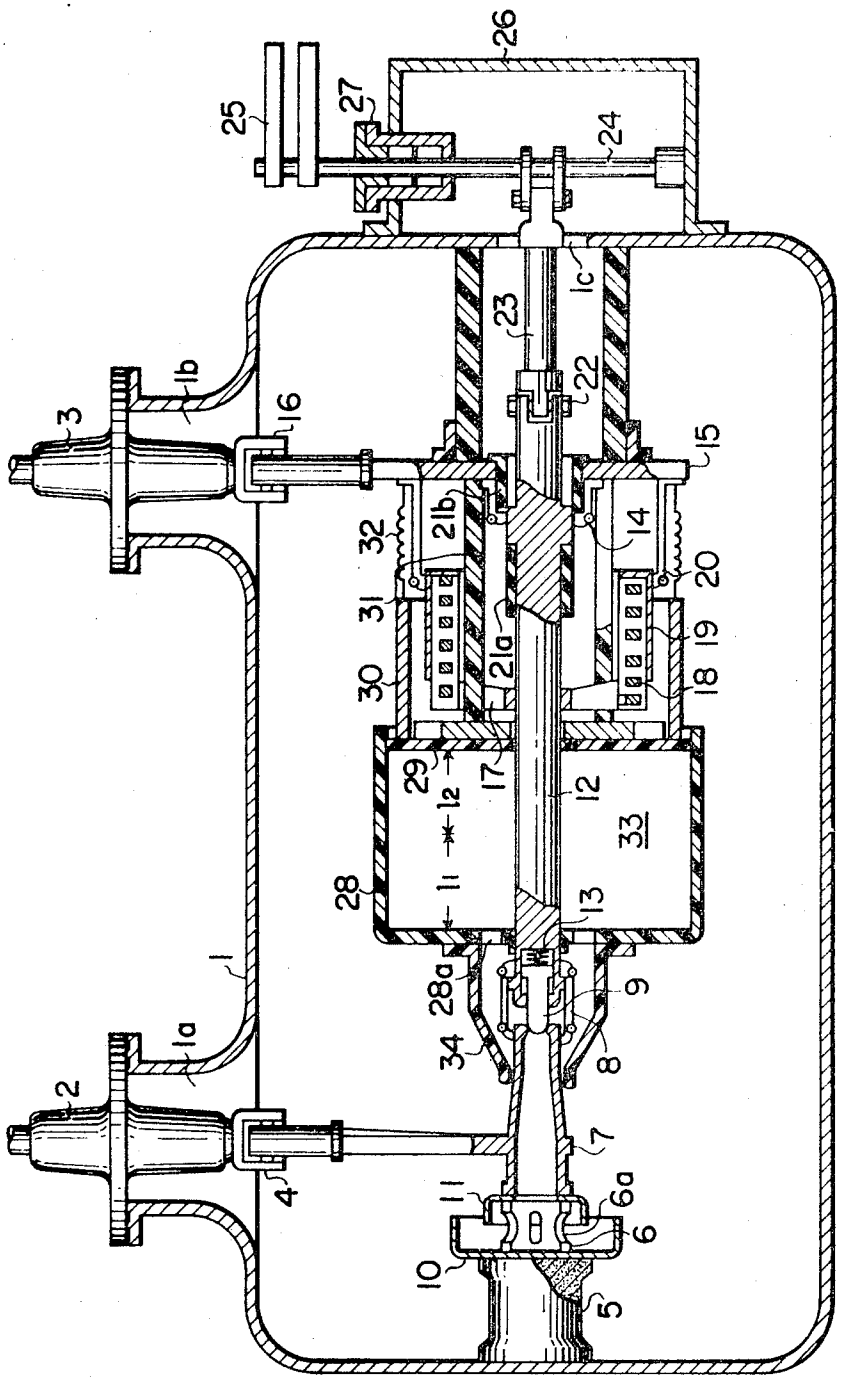


FIG. 1

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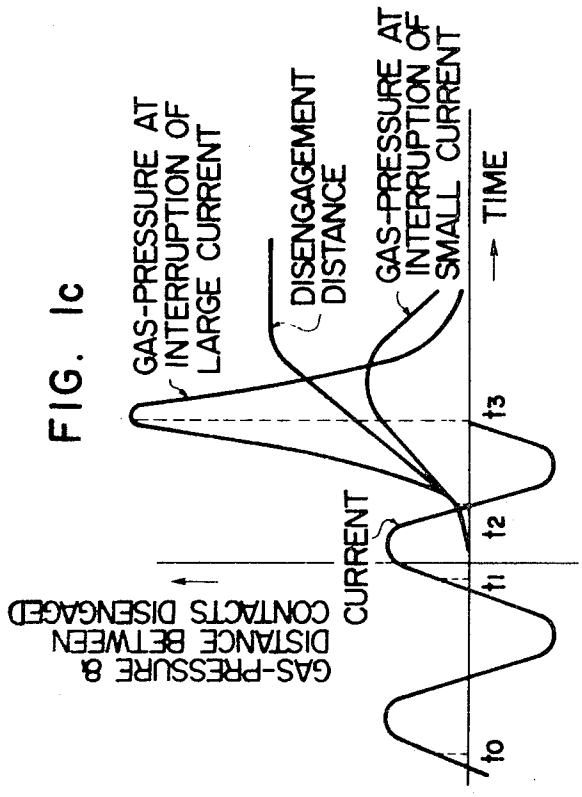


FIG. 1c

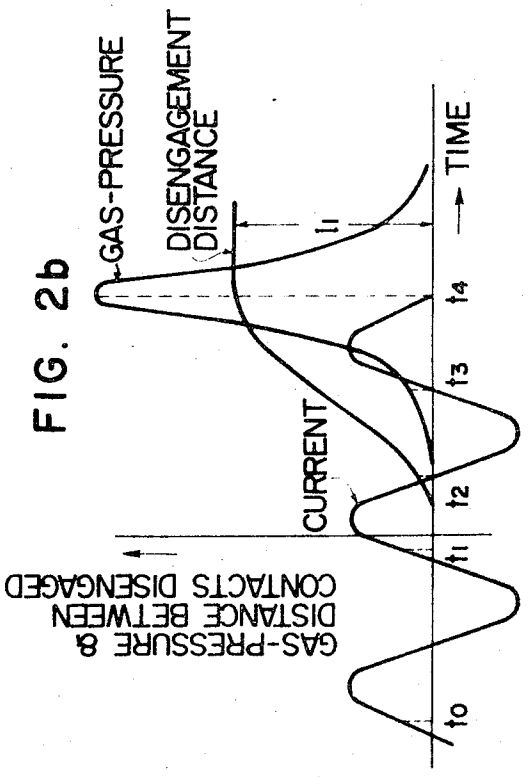


FIG. 2b

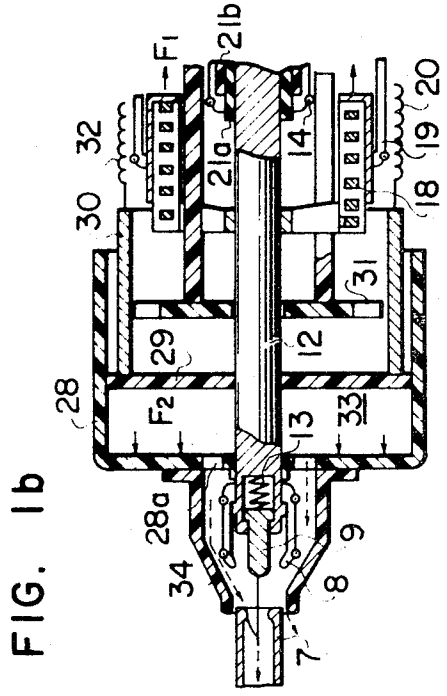


FIG. 1b

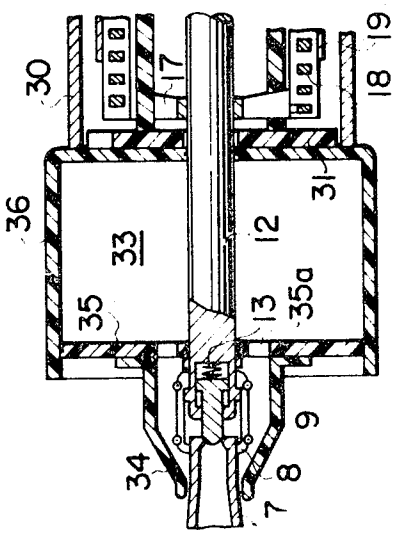


FIG. 2a

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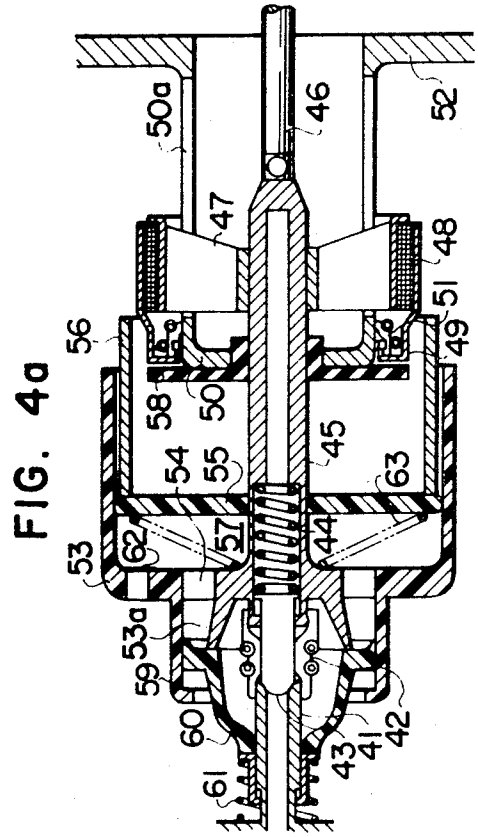


FIG. 4a

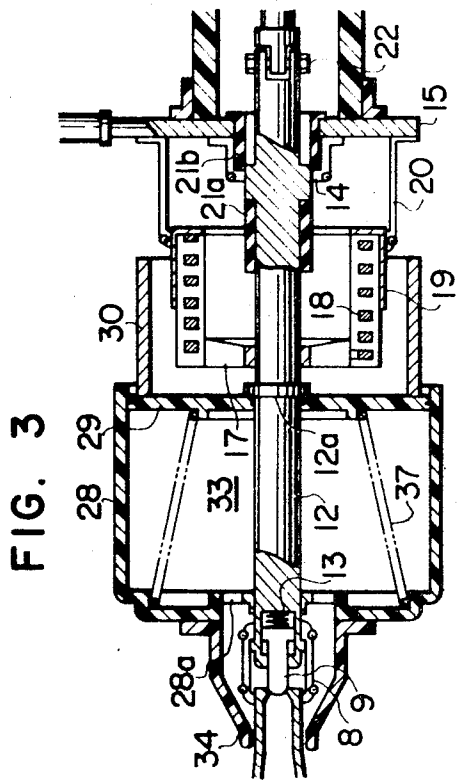


FIG. 3

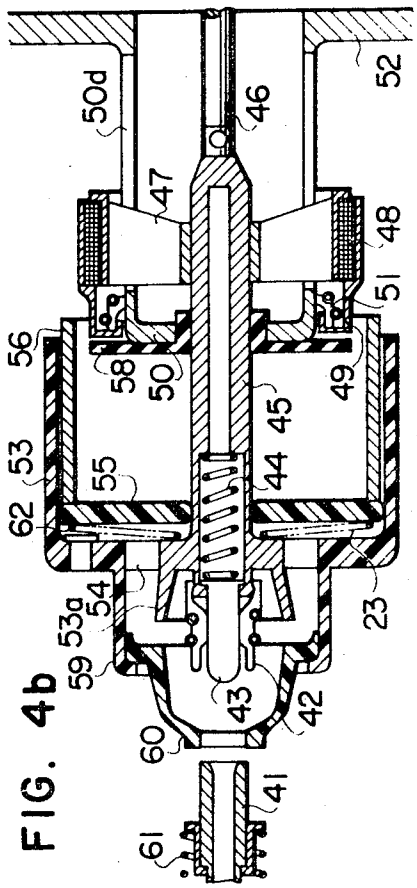


FIG. 4b

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FIG. 5a

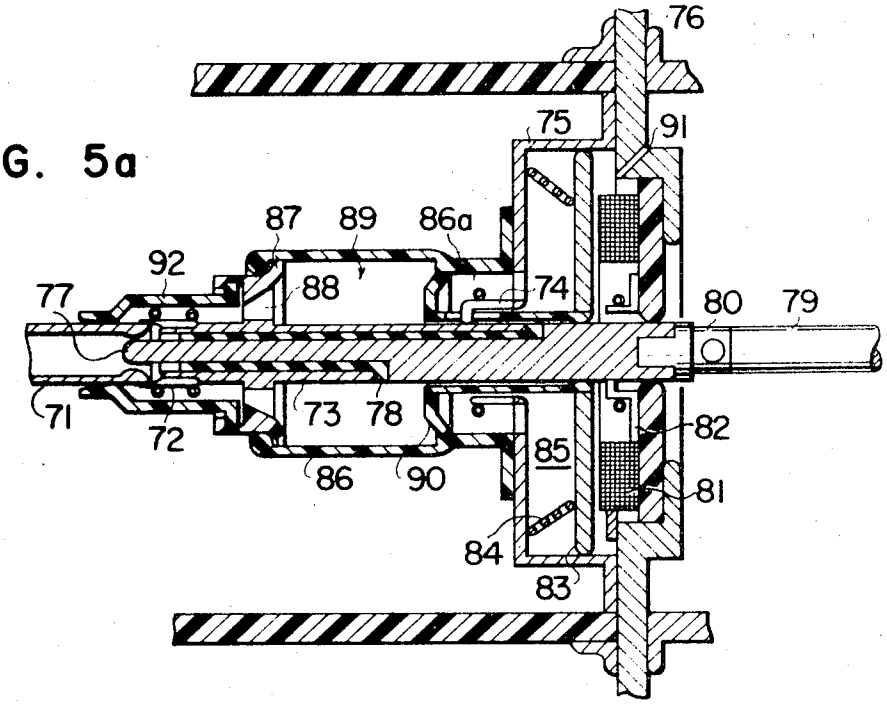
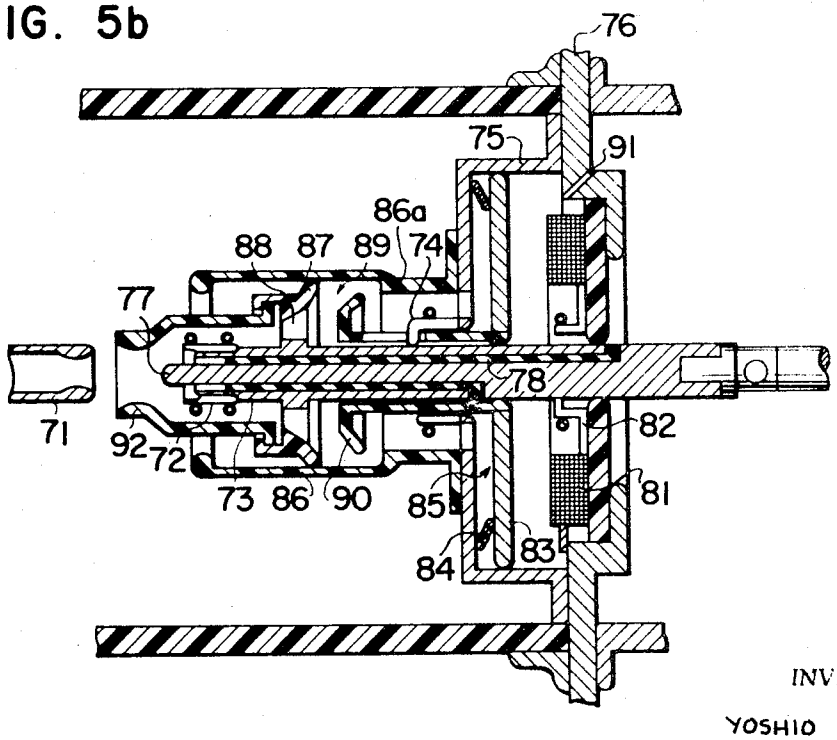


FIG. 5b



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GAS-BLAST CIRCUIT BREAKER HAVING A FLOATING PUFFER PISTON DRIVEN BY ELECTROMAGNETIC FORCE

BACKGROUND OF THE INVENTION

This invention relates to an electromagnetic puffer type gas-blast circuit breaker wherein an arc is extinguished by blasting an arc-extinguishing gas, which is compressed by taking advantage of an electromagnetic energy generated by breaking current, against the arc which is generated when a contact element is opened in a container in which an arc-extinguishing gas is airtightly sealed. More specifically, it relates to a gas-blast circuit breaker which is equipped with a system compressing the arc-extinguishing gas by a floating type puffer piston which is movably mounted on a movable contact element and driven by electromagnetic energy.

DESCRIPTION OF THE PRIOR ART

In a gas-blast circuit breaker, wherein the arc-extinguishing gas is compressed prior to current cut-off, a compressing operation starts after a cut-off command is given, so that the gas compressing time is extremely limited.

In order to compress the arc-extinguishing gas up to the necessary gas pressure for blasting within a limited period of time, a great deal of manipulating force is required. A technique in which there is used a breaking current or electromagnetic energy contained in a large current, such as a short-circuit current, is disclosed in Japanese Patent publication No. 8052/1968.

In a conventional electromagnetic puffer type gas-blast circuit breaker, there is a means for obtaining the electromagnetic energy contained in a current, i.e., a method in which the attracting and repulsive coil as described in the above publication is used as an electromagnetic driving system or an other method in which a primary coil having a coil width and an end ring or a short ring or short-circuit coil are used.

The combination of a cylinder and a piston is also used as the simplest means for compressing the arc-extinguishing gas and the cylinder or piston is designed to be driven by the above-mentioned driving system.

To minimize the loss of highly-pressurized gas obtained by the compressing means and introduce it to the arc most simply, the compressing means is fixed adjacent to the contact element of the operating rod which is to actuate the movable contact element, thus being associated with the movement of the movable contact element.

The association of the compressing means with the movable contact element is based on the following consideration. That is, during the dead period from the time of a breaking command to the time when current flows into said driving system and then compression of the arc-extinguishing gas starts, the arc-extinguishing gas is compressed to a certain pressure by the outside operating device other than said driving system for opening the movable contact element, i.e., for driving the movable contact element and, when said driving system starts to operate, the arc-extinguishing gas is compressed regularly.

Further, in view of said driving system, the system will increase the operating speed of the contact element.

The driving system, however, is connected to the outside operating device, so that the weight of the system

operated by said driving system is naturally large, so that the electromagnetic energy is unnecessarily consumed as kinematic energy in the operating system and, as a result, it is not perfectly utilized to efficiently compress the gas and, despite the fact that especially large electromagnetic energy is obtained, it does not effect a rapid pressure increase.

When attempting to obtain greater electromagnetic energy to remove this defect, more inertia energy accumulates in the whole movable portion, so that it requires damping means to absorb this energy at a later stage of breaking and additionally, the flow of current in a multi-turn coil to obtain large electromagnetic energy may be made difficult.

Further, when comparing the operating energy of said outside operating device with that (electromagnetic) of said driving system, the latter is much larger than the former, so that the operating speed of the latter will be greater than that of the former, whereby the outside device will operate as a resistance for said driving system. For this reason, when said driving system is operated, a cut-off means is needed to break the connection with the outside operating device.

Still further, since said driving system is connected to the outside operating device, for instance when the outside operating device is constructed to operate three single-phase breakers simultaneously, a single-phase breaker affects the other two breakers via the outside operating device. Especially, for a different phase grounded short-circuit, a short-circuit current flows only in a cut-off phase, so that said driving system of the single phase breaker may operate the other two phases, so that the electromagnetic energy is not so efficiently utilized as compared with the case when said driving system is used in each breaker as is the case of a three-phase short-circuit breaker.

Still further, during breaking, the driving system is inserted in a circuit to be cut-off, so that the electric current flows in the driving system by the preceding arc, initiated by drawing the movable contactor near to the fixed contractor upon switch-in, to thereby generate the electromagnetic repulsive force which actuates in an opposite direction to the switch-in direction or in a cut-off direction, so that it may cause the inferior switch-in condition which requires the means for short-circuiting said driving system prior to the preceding arc, to prevent the above-mentioned inferior switch-in condition.

On the other hand, for cutting off such a small current as the exciting or charging current, the current value is so small that a large electromagnetic force cannot be obtained, so in such a case the compression of the arc-extinguishing gas is mostly performed only by the outside operating force.

In general, in the electromagnetic puffer type circuit breaker, a remarkable advantage lies in the fact that the outside operating force can be reduced. Therefore, upon breaking such a small current, a strong blast of the arc-extinguishing gas is not necessary for the arc, but it is slower than the opening speed of an electrode. When performing such a weak blast of the arc-extinguishing gas, there cannot occur a chopping current, so disturbances in the system due to a high tension current resulting from this chopping current can be removed, and especially it is effective in cutting-off the exciting current.

For cutting off the charging current, however, a higher voltage may be applied across the electrodes after 0.5 cycle from cut-off, so when the opening speed of the electrodes is slow, re-ignition may occur easily. To improve the breaking performance of such a charging current, it is necessary to use a large capacity-large mass puffer piston constructed to cut off a large current or to operate a puffer piston with a certain opening, so that a larger operating force than the one required for breaking a small current is required, so that an outside operating device must be larger to a certain extent.

SUMMARY OF THE INVENTION

An object of this invention is to provide an electromagnetic puffer type gas-blast circuit breaker wherein electromagnetic energy is effectively utilized for gas compression and a high gas pressure can be obtained for the blasting gas.

Another object of this invention is to minimize the capacity of an electromagnetic energy-generating means for increase of gas pressure, thereby simplifying the electromagnetic energy-generating means itself and ensuring the driving operation of an electromagnetic force.

A further object of this invention is to provide an electromagnetic puffer type gas-blast circuit breaker wherein the electromagnetic energy is used in an individual breaker and which is constructed so as to have no effect on the driving of the other breakers.

Still a further object of this invention is to provide an electromagnetic puffer type gas-blast circuit breaker wherein no influence is imposed on a switch-in operation even if the preceding arc occurs upon switching-in of a movable electrode.

Another object of the present invention is to provide an electromagnetic puffer type gas-blast circuit breaker in which not only a large current but also a small current such as a charging current may be readily shut off.

Still a further object of this invention is to provide an electromagnetic puffer type gas-blast circuit breaker capable of compressing the arc-extinguishing gas prior to a breaking command and of reducing the cut-off time in such a way as to blast a high-pressure arc-extinguishing gas to a cut-off portion at the same time of the breaking command.

In accordance with the present invention, there is provided with an electromagnetic puffer type gas-blast circuit breaker comprising at least a pair of a contact elements that are opened to induce the arc, means for generating an electromagnetic force including a primary coil and a short-circuit body electromagnetically connected to said coil means driven by said electromagnetic force-generator to compress an arc-extinguishing gas, and means for blasting said compressed arc-extinguishing gas to an arc generated at a high speed between contact elements, whereby said compressing means acts floatingly to operate the manipulating means of the contact elements, so that most of the electromagnetic repulsive force generated in said electromagnetic force-generating means is substantially consumed to compress the arc-extinguishing gas.

Said objects and further objects and also features of this invention will be clarified by the following detailed description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1*a* is a fragmentary sectional view showing the construction of an electromagnetic puffer type gas-blast circuit breaker in accordance with this invention;

FIG. 1*b* is a sectional view of a large-current breaking condition of the breaker illustrated in FIG. 1a;

FIG. 1*c* is a characteristic curve showing the variation of gas pressure and the distance between the contact elements at the time of current cut-off of the breaker illustrated in FIGS. 1*a* and 1*b*;

FIG. 2*a* is a sectional view of a modified gas-blast circuit breaker;

FIG. 2*b* is a characteristic curve at the time of current cut-off by the breaker shown in FIG. 2*a*;

FIG. 3 is a sectional view of the construction of a further modified breaker and FIGS. 4*a*,4*b*, 5*a* and 5*b* are sectional views showing other embodiments of the gas-blast circuit breaker according to the present invention;

DETAILED DESCRIPTION OF THE EMBODIMENT

In FIG. 1*a*, a grounded tank 1 which is sealed with bushings 2 and 3 equipped at openings 1*a* and 1*b* is filled with an arcextinguishing gas such as sulphur hexafluoride (SF_6) at a fixed pressure.

The bushing 2 is electrically connected, through a disconnector 4 having a knife-edge contact, to the fixed contact element 7 fixed to the grounded tank 1 by an insulating support 5 and a supporting structure 6.

In a switch-in condition, main current condition is ensured through a movable main contact element which is in contact with the peripheral surface of a hollow fixed contact element 7. A movable arc contact 9 engages the fixed contact 7 in such a manner that it extends slightly in the hollow portion of the contact 7 to induce the arc between the movable arc contactor 9 and the fixed contactor 7 as described later.

By using SF_6 gas as an arc-extinguishing medium, when water content is contained in gas, SF_6 the gas is subjected to the chemical reaction with the water content by the high temperature of the arc, thus making it possible to generate a decomposed substance which is harmful to the insulating material. Thus, shield members 10 and 11 are provided adjacent to the insulating support 5 to prevent the decomposed substance from contacting the insulating support 5, thus ensuring the regulation of gas flow after blasting the gas, by means of said shield material as well as an opening 6*a* prepared in the supporting structure 6.

The movable contact 8 and the movable arc contact 9 are both fixed to one and of the conductive operating rod 12. The arc contact 9 is constructed to slide in the operating rod 12 by means of a spring 13 in the hollow portion provided in an extreme end of the operating rod. The movable contact substantially disengages after a lapse of time after disengagement from the fixed contact 7, to thereby induce the arc.

There is a current collector 14 on the other end of the operating rod 12 which is electrically connected to the bushing 3 through a terminal 15 and disconnector 16 of the same construction as the disconnector 4.

Between the operating rod 12 and the terminal 15, there is a circuit comprising a spider like support 17, a primary coil 18 fixed to the operating rod 12 by the spider-type support 17, a collecting conductor 19 and a current collector 20. That is, the circuit is provided

in parallel to the collector **14**, but the primary coil **18** possesses an inductance; therefore most of current flows between the bushings **4** and **16** via the collector **14**. The operating rod **12**, moves towards the right direction in the drawing when the current is shut off, as the result of which the operating rod **12** is separated from the collector **14** by insulators **21***a* and **21***b* and the arc generated between the operating rod **12** and the collector **14** is extinguished by a slit formed between the insulators **21***a* and **21***b*, thus the entire current flows in the primary coil **18**.

In accordance with another embodiment, in the switch-in condition illustrated in the drawing, the collecting conductor **19** and collector **20** are insulated through a membrane insulator prepared on the surface of the collecting conductor **19**, and at a time of cutting off the current the collecting conductor **19** comes in contact with the collector upon movement of the operating rod in the right hand direction, thus making it possible to form a parallel circuit.

There is provided an opening **1***c* at one end of the grounded tank **1**, through which extends an insulating operating rod **23** that is secured to the operating rod **12** by a bolt **22**. The insulating operating rod **23** is designed to operate the operating rod **12** by the outside operating device (not shown) through a rotating spindle **24** and its lever **25**.

To prevent the arc-extinguishing gas from leaking from the opening **1***c* to atmosphere, an operating box **26** is provided to cover the opening **1***c* and is equipped with an airtightening device **27** between box **26** and the rotating spindle **24**.

Adjacent the movable contactors **8** and **9** of the operating rod **12**, preferably in the most accessible position, there is provided a puffer cylinder **28**.

A puffer piston **29** for the puffer cylinder **28** is fixed to an end ring **30** for the primary coil **18** and also is biased toward the terminal plate **15** by means of a tension spring **32** on a puffer piston supporting structure **31** fixed to the terminal plate **15**.

The high pressure gas in the puffer chamber **33** compressed by the puffer cylinder **28** and piston **29** is directed to the arc by means of an opening **28a** provided in the puffer cylinder **28** and an insulating nozzle **34** fixed to the puffer cylinder **28**.

An electromagnetic driving system comprising the primary coil **18** and end ring **30** is not limited to the circuit illustrated in the drawings, but it can fully attain the said objects of this invention if a different type of an electromagnetic driving system is applied thereto.

Furthermore, an electromagnetic driving system may also be employed, which comprises a fixed coil, a cylindrical conductor divided longitudinally at a plurality of places wherein a divided portion is short-circuited by a fixed short-circuit piece, and a supporting structure transferring a power to the outside part supporting said cylindrical conductor, whereby an induction current is produced by intersecting the magnetic flux, which is generated from the fixed coil, to the short-circuited cylindrical conductor, thereby operating the systems connected to the supporting structure with a constant strong driving force over the entire driving stroke by the current flowing in the fixed coil and the repulsive force of the induction current.

The puffer cylinder and the puffer piston do not make it difficult to compress the arc extinguishing gas even if the puffer piston **35** is located adjacent to both movable contact elements of the operating rod **12** and the puffer cylinder **36** is constructed integrally with the end ring **30**, as in FIG. **2a** showing only the essential part of the disconnector.

This invention relates to the operation of the puffer piston **29** and the puffer cylinder **36** of the breaker shown in FIGS. **1a** and **2a**, in which the puffer piston **29** and the puffer cylinder **36** are designed to be biased toward the supporting structure **31** by the tension spring **32** and to be operated independently of the movement of the operating rod **12**, that is, to the outside operating device and is constructed to have no connection with the operating rod **12**.

When a breaking command is given, the outside operating device starts to operate and the operating rod **12** is actuated towards the right direction on the figure, whereby the movable main contact **8** is separated from the fixed contact **7** and the arc contact **9** is opened after a certain time interval, so that the arc is generated between both contactors **7** and **9**. Since the operating rod **12** is being operated for a certain time after opening of the arc contact, the arc keeps its ignited condition with the increasing length.

On the other hand, the puffer cylinder **28** is also operated towards the right direction together with the movement of the operating rod and the puffer piston **29** is checked against its movement by the supporting structure **31**, so that the arc-extinguishing gas in the puffer chamber may be compressed. By the current collector **14** sliding on the surface of the insulator **21***a*, the current flows into the primary coil **18**, thus it generates the magnetic flux.

Where the current to be cut off is large, the magnetic flux generated in the primary coil **18** will also be large, and a large induction current flows in the end ring **30** to check this magnetic flux. As a result, there occurs an electromagnetic repulsive force therebetween and the puffer piston **29** starts away from the supporting structure, as shown in FIG. **1***b*, to be operated towards the right direction in the figure.

All driving energy by electromagnetic repulsion is consumed in the gas compression because the end ring **30** may not operate any part other than the puffer piston **29**. Especially, the air increasing ratio of the gas pressure after blasting has been greatly improved, as compared with a conventional system, by making mass of the puffer piston **29** much smaller. Thus, the required gas pressure may be obtained in a short time at the beginning of the current cut-off.

Accordingly, there is no problem of the fact that an igniting time in a conventional general puffer-type circuit breaker of this type is long and the breaking time is also long because the required gas pressure is unobtainable within a short time, and occasionally a high speed current cut-off is also possible. Further, since it is not necessary that the driving energy exerted by the electromagnetic repulsion should accelerate the system having a heavy mass as before, the driving energy itself can be made smaller than that in the conventional system.

For this reason, it has such features that the number of turns in the primary coil **18** is reduced, so that commutation (arc-extinguishing by commutation) of the current to the primary coil **18** is remarkedly simplified and the commutation is ensured. Further, during the breaking of a small current such as the exciting current of a non-load transformer, sufficient driving energy

cannot be obtained on account of a current valve being so small; therefore the arc-extinguishing gas will be compressed during the contacting with the supporting structure **31** instead of the puffer piston being operated. That is, the arc-extinguishing gas is to be compressed only by movement of the puffer cylinder **28** so a sufficient gas pressure cannot be obtained.

As a result, however, the arc is not extinguished with a strong blast of the arc-extinguishing gas, so there is no possibility of generating a high over-current attended with the current cut-off but contrarily, breaking is made smoothly.

A variation of gas pressure at the time of breaking large and small current is shown in FIG. **1***c*, wherein t_0 is the time when the breaking command is given, t_1 is the time when the contact is opened, t_2 is the time when current is commutated to the primary coil **18**, and t_3 is the time when current is cut-off or the arc was extinguished, especially, at the time of breaking of maximum current. If an increase in the gas pressure is determined such that the gas pressure would be maximum at t_3, in the neighborhood of zero current at t_3, it is possible to perform a kind of synchronous breaking in such a way that current cut-off can take place during maximum pressure without necessitating any other composition even in a gas breaker of this kind.

Synchronous breaking can be performed only when a firm commutation takes place at time t_2. However, when commutation does not take place at time t_2 but at t_3 as shown in FIG. **2***b* and the puffer cylinder **28** compresses most of the puffer chamber **33**, no matter how much commutation may be performed and the electromagnetic device may be actuating, there is no space for the puffer piston **29** to operate, so a sufficient compression is not carried out, thus there is a fear of failure to break. In this case, it is determined that in FIG. **1***a*, the compressed part of the puffer cylinder **28** in the puffer chamber **33** may displace a distance l_1 and a compressed part of the puffer piston **29** driven by the end ring **29** may displace a distance l_2.

On the other hand, the compressed part l_1 of the puffer cylinder **28** is equal to the spacing distance of the contacts and if it is designed so that, when the puffer cylinder **28** is driven by the operating rod **28** in the right direction to compress the puffer chamber **33**, commutation may take place at the time t_3 and gas may be compressed by the puffer piston **29**, and gas pressure may become maximum adjacent to a next zero point of current or t_4; in other words, the compressed part l_1 may be compressed by the puffer piston **29**, then current will be broken at t_4. Even when a commutation does not take place at t_3 but at t_4, the puffer cylinder **28** compresses only its compressed part l_1 and still there remains a compressed part l_2 of the puffer piston **29** and current will firmly be cut off at a next current zero point by actuation of the puffer piston **29** after commutation. That is, according to this invention, since the arc-extinguishing gas is substantially compressed by actuation of the puffer piston **29** after commutation, the current can firmly be broken at a next current zero point.

Further, when the compressed distance l_1 by the outside operating device is still smaller, then the gas pressure generated by the outside operating device is also smaller, whereby the repulsive force of gas pressure decelerating the spacing speed of both movable contacts **8** and **9** will be so small that it would be possible to obtain a quick spacing speed with a comparatively small outside operating force, which is favorable for breaking of a charging current.

Additionally, the compressed part of the puffer piston **29** is kept at least l_2, and if these possible distances l_1 and l_2 are properly selected, it will be possible to increase a gas blasting quantity when breaking a large current $(l_1 + l_2) / l_1$ times as conventional without increasing the spacing distance (equivalent to l_1) of the contacts.

Although the puffer piston **29** is operated through the end ring at the breaking of a large current, a reaction force F_1 for driving acts upon the primary coil **18** as shown in FIG. **1***b*. However, a reaction force F_2 by the gas compression acts on the puffer cylinder **28** and as these reaction forces F_1 and F_2 are almost equal in intensity but opposite in direction, so they serve only as a tractive force, and they will give almost no effect to the outside operating device. Accordingly, in case of operating three phases simultaneously, the problem at the time of breaking different phase grounding specifically set forth before will substantially not occur at all.

A switch-in operation is completed by moving the operating rod **12** towards the left direction as viewed in the drawing and bringing the fixed contactor **7** in contact with both movable contactors **8** and **9**. In this case, the gas-blast circuit breaker of this invention is of an electromagnetic puffer type, so current flows in the primary coil **18** prior to switch-in by a preceding discharge to generate an electromagnetic repulsive force between the end ring **30** and the primary coil **18**. In the gas-blast circuit breaker of this type, means in short-circuiting the primary coil **18** prior to a preceding discharge is required and in this invention, even if an electromagnetic force is generated, only the puffer piston is operated and the operating rod **12** neither is operated in the breaking direction nor makes it impossible to effect the switch-in operation. The puffer piston **29** is scarcely completed with its switch-in when the primary coil **18** is short-circuited by the collector **14**, so it can return to the condition in FIG. **1***a* by the tension spring **32** to prepare for the next current cut-off. As mentioned above, in accordance with this invention, the problem of impossibility in the switch-in operation is removed but, especially when the puffer piston **29** is to be prevented from operating upon the switching-in operation, means for short-circuiting the primary coil has only to be applied.

In the embodiment set forth above, the spacing speed of the contacts **8** and **9** needs only the operating energy of the outside operating device, but as in a conventional gas-blast circuit breaker of this kind, when the spacing speed is desired to be accelerated, the spacing speed can be accelerated by forming the end ring in a part of the supporting structure **31** of the gas breaker shown in FIG. **1***a*, and by properly distributing the electromagnetic energy to drive the puffer piston **29** and drive the primary coil **18** by electromagnetic repulsion generated between this end ring and the primary coil **18**, that is, drive the operating rod **12** directly connected to the primary coil.

In this case, if most of the electromagnetic energy is used for driving the puffer piston **29**, the conventional defect attended by the drive of the primary coil **18** will almost disappear, especially in case each phase breaker processes an outside operating device independently. There is no effect to the other phase, thus an increase

in a spacing speed by a part of electromagnetic energy is effective to the breaking of a charging current.

FIG. 3 shows the other embodiment wherein the principle of this invention is applied, and it is designed such that the puffer piston **29** is biased toward the engaging projection **12***a* of the operating rod **12** by the compression spring **37** provided between the puffer cylinder **28** and the puffer piston **29.**

Now, in the same figure, like numerals as shown in FIG. **1**a refer to the same parts.

In accordance with a breaking command the operating rod **12** is manipulated and the point where it generates is the same as in FIG. **1***a*. More particularly, this embodiment differs from the other embodiment in that the puffer piston **29** is designed to follow the movement of the operating rod **12** by means of the compression spring **37.** Accordingly, when a sufficient electromagnetic repulsive force cannot be obtained, at the time of breaking a small current, the arc-extinguishing gas in the puffer chamber **33** cannot be compressed, but the arc will be extinguished in the arc-extinguishing gas according to the principle of the conventional knife-edge type breaker. In this case, a repulsive force of a gas pressure does not impose upon the outside operating device, so that the opening speed of the breaker will increase, which will be effective for breaking the charging current.

At the time of breaking a large current, the puffer piston **29** is operated by the end ring **30**; consequently the arc-extinguishing gas in the puffer chamber is compressed and a high pressure gas orientated by the insulating nozzle **34** will cool the arc down to extinction.

Since the movement at the switching-in operation is exactly the same as shown in FIG. **1***a*, a discussion thereof will be omitted herewith.

In the above-mentioned embodiments, although the structures of the contact means and the commutating device are illustrated as the same system, the object of this invention lies in the driving system of the gas compressing device, so that various modifications can also be used with respect to the structures of the contact means and the commutating device.

The embodiment described hereinafter relates to the gas-blast circuit breaker wherein the arc-extinguishing gas is compressed prior to a breaking command by the principle in the above-mentioned embodiments or by use of a floating piston and the breaking time is ensured to be shortened by blasting the high-pressure arc-extinguishing gas to the breaking portion at the same time of the breaking command.

In FIGS. **4***a* and **4***b*, reference numeral **41** is a fixed contact, **42** is a movable main contact performing main current conduction to the fixed contact **41, 43** is an arcing contact provided in opposition to the fixed contact **41, 44** is a spring to cause the arcing contact **43** to make a wiping motion with respect to the fixed contact **41, 45** is a conductive tube electrically and mechanically connected to the movable contact **42** and the arcing contact **43, 46** is an insulation operating rod for transferring an operating force of the outside operating device (not shown) to the conductive tube **45,** and **47** is a supporting conductor electrically and mechanically connected to the conductive tube **45,** and also connected to one end of a primary coil **48.**

Further, reference numeral **49** represents a conductor portion connected to the other end of the primary coil **48, 50** is a supporting tube electrically connected to the conductor portion **49** through a collector **51** and having a slit **50a** through which the supporting conductor **47** may move. Reference numeral **52** is a terminal of the breaker, **53** is a movable puffer cylinder having a stopper **53a** connected to the conductive tube **45, 54** is a hole prepared in the movable puffer cylinder **53, 55** is a floating piston sliding on the inside surface of the movable puffer cylinder **53, 56** is a short-ring integral with the floating piston **55, 57** is a puffer chamber, **58** is an insulation plate insulating the supporting tube **50** from the floating piston **55, 59** is a nozzle guide tube, and **60** is an insulating nozzle for introducing the arc-extinguishing gas to the breaking portion, which slides on the inside surface of the nozzle guide tube **59.**

Reference numeral **61** is a pressure-applying device providing contact pressure between stopper **53***a* and the insulation nozzle **60, 62** is a check valve provided at the opening of the movable puffer cylinder **53,** which makes an opening motion only when the pressure of the ambient gas which is larger than the pressure the puffer chamber **57** generates, and **63** is a restoring spring giving restoration force to the floating piston **55.**

The current path under the conditions shown in FIG. **4**a consists of the line of the fixed contactor **41**- movable main contactor **42** and arcing contact **43**- conductor tube **45** - supporting movable body **47** - primary coil **48** - conductor portion **49** - current collector **51** - supporting tube **50** - terminal **52.** That is, as a loading current or a small current is always flowing in the primary coil **48,** the electromagnetic repulsive force functioning between the primary coil **48** and the short ring **56** is small and the floating piston **55** retains the conditions in FIG. **4**a. The insulation nozzle **60** cooperates with the pressure applying device **61** through the stopper **53**a to thereby provide a nozzle-air -tightness.

When the current to be cut off, such as an overcurrent or a short-circuited large current, flows under the condition as shown in FIG. **4**a and described above, a strong electromagnetic repulsive force is generated between the primary coil **48** and the short ring **56.** The primary coil **48** is fixed to the operating rod, so that the short ring **56** repulses to the left direction as an electromagnetic repulsive force functions, and the floating piston **55** integral with the short ring **56** compresses the arc-extinguishing gas in the puffer chamber **57.** In this case, the check valve **62** remains in its closed condition and the nozzle air-tightness is provided between the insulating nozzle **60** and the stopper **52**a so that the arc-extinguishing gas in the puffer chamber **57** cannot be released to the outside. This operation is performed independently of the breaking command and this condition is maintained until breaking command is given. When the breaking command is given, it will operate a movable part of the breaking portion to the right breaking direction through the insulation operating rod **46** from the outside operating device (not shown). In this case, the arcing contact **43** will make a wiping motion with respect to the fixed contactor **41** by the spring **44** and the insulating nozzle **60** will also make the wiping motion with respect to the stopper **53**a by means of the pressure-applying device **61,** so that at the beginning of breaking operation the arc-extinguishing gas in the puffer chamber **57** is not exhausted. Then the breaking operation advances further, the arcing contact **43** is separated from the fixed contactor **41** to ignite the arc. Next, the air-tightness between the insulating nozzle **60** and the stopper **53***a* will gradually be broken with the

wiping operation and the high pressure arc-extinguishing gas from the puffer chamber **57** will be directed toward the arc via the small hole **54** and nozzle air-tight portion to thereby extinguish the arc.

A motion at the time when current to be cut off is conducted for a short time and thereafter it returns to a normal current is that, when at first current to be cut off flows into the primary coil **48**, the floating piston **55** moves to the left direction in the figure by electromagnetic repulsive force generated between this primary coil **48** and the short-ring **56** to generate the arc-extinguishing gas in the puffer chamber **57**. When subsequent current returns to the normal current, the electromagnetic repulsive force between the primary coil **48** and the short ring **56** will be damped, then the floating piston **55** returns to the position shown in FIG. *4a* by means of the restoring spring **63**. That is, when the current to be cut off flows even if the breaking command is not given, it compresses the arc-extinguishing gas by the repulsive force due to that current or it does not start the breaking operation as long as the breaking command is not given.

Further, in case of breaking the small current such as the charging or exciting current, the repulsive force necessary for sufficiently compressing the arc-extinguishing gas to extinguish the arc cannot be obtained but it can be performed by compressing the arc-extinguishing gas by means of the operating force of the outside operating device. The pressure of the arc-extinguishing gas obtainable by the operating force of the outside operating device is enough pressure to break a small current.

A switch-in operation is effectuated by operation of the movable part of the breaking portion to the left switch-in direction in the figure by the outside operating device (not shown) through the insulation operating rod **46**. At this time the puffer chamber **57** will have a negative pressure by the movement in switch-in direction of the puffer cylinder **53**, and the check valve **62** opens due to a pressure difference between the a mbient gas and the pressure in the puffer chamber **57**, thus enabling it to suck fresh arc-extinguishing gas into the puffer chamber **57**. The floating piston **55** returns to the condition shown in FIG. *4a* by the restoring spring **63**.

According to the gas breaker of the above-mentioned construction, the current always flows through the primary coil **48**, and when an overcurrent or a short-circuited large current flows, it operates the floating piston **55** by the electromagnetic force generated by that current to compress the arc-extinguishing gas in the puffer chamber **57**, therefore, a difficult arc removal as in the conventional technique is not required. As the movement of the floating piston **55** is performed independently of the breaking command, it is possible to shorten a breaking time.

The embodiment set forth hereinafter, the same as the above-described embodiments, relates to a gas-blast circuit breaker provided with not only a floating puffer piston for breaking a large current, but also mechanical puffer means of a small capacity which operates mechanically when breaking a small current. In this gas-blast circuit breaker, the floating puffer has a shorter stroke than that of the mechanically operated puffer piston andis constructed to be equipped with a large loading pressure.

In FIGS. *5a* and *5b*, reference numeral **71** is a fixed contact, **72** is a movable main contact opposing the fixed contact **71**, **73** is a movable contact tube electrically connected with the movable main contact **72**, **74** is a collector, **75** is a fixed electromagnetic puffer cylinder connected to the collector **74**, **76** is a terminal of the breaker, **77** is a movable arc contact insulated from the movable contactor tube **73** by the insulating spacer **78**, **79** is an insulating operating rod, **80** is a joint metal connecting the movable arc contact **77** to the insulating operating rod **79**, **81** is a primary coil provided between the movable arc contact **77** and the terminal **76**, **82** is a collector connected to the primary coil **81** and slidably mounted to the arc contact **77**, **83** is a movable electromagnetic puffer piston combined with a short-ring opposing to the primary coil **81**, **84** is a spring to retain the electromagnetic puffer piston **83** at its initial position, **85** is an electromagnetic puffer chamber, **86** is a fixed puffer cylinder having a squeezer and connected to the electromagnetic puffer cylinder **75**, **87** is movable puffer piston with the hole **88** connected to the movable part of the breaking portion, **89** is a puffer chamber, **90** is a floating piston consisting of an insulator opening or closing the lead between the electromagnetic puffer chamber **85** and the puffer chamber **89** and connected to the electromagnetic puffer piston **83**. **91** is a small hole which sucks or exhaust the gas in the rear chamber of the electromagnetic puffer piston **83**, and **92** is an insulating nozzle.

In FIG. 5b showing the fixed puffer cylinder **86**, the left end shows a breaking condition which serves to be a shield to damp the electric field of the movable main contact **72** and the movable arc contactor **77**.

In the above described construction, the current path in the switching-in condition shown in FIG. *5a* consists of the line of the fixed contactor **71**- movable main contactor **72** - movable arc contactor **73**- collector **74** - electromagnetic puffer cylinder - **75** terminal **76**. The movable puffer piston **87** and the electromagnetic puffer piston **83** are located in respective positions shown in the figure. In this condition, the floating piston **90** disconnects the puffer chamber **89** from the electromagnetic puffer chamber **85**.

The breaking operation is carried out by operating the insulating operating rod **79** to the right direction in the figure by the outside operating device (not shown). In other words, since the puffer piston **87**, the insulating nozzle **92** and the movable main contact **72** are operated to the right direction all together, the arc occurs between the fixed contact **71** and the movable main contact **72** and, at the same time, they compress the arc-extinguishing gas in the puffer chamber **89**, with which the arc-extinguishing gas passes the blasting path along the arrow shown in the figure to be blasted against the arc, thus, the arc will move between the fixed contact **71** and the movable arc contact **77**. After movement of the arc, the current flows through the fixed contact **71**- movable arc contactor **77**- collector **82**- primary coil **81**- terminal **76**. Then, the primary coil **81** is excited, the magnetic flux thereby generated flows an induction current to the puffer piston **83** combined with the short ring, by which a strong electromagnetic force generates between the primary coil **81** and the electromagnetic puffer piston **83**. Then the electromagnetic puffer piston **83** is driven to the left direction in the figure, thus compressing the arc-extinguishing gas in the electromagnetic puffer chamber **85**.

The floating piston **90** connected to the electromagnetic puffer piston **83** is also driven in the same direction along with the electromagnetic puffer piston **83** to connect the puffer chamber **89** to the electromagnetic puffer chamber **85**, and the high pressure gas generated by the electromagnetic force by way of the puffer chamber **89** blasts the arc to extinguish it. The blast of this high pressure gas affects the movable puffer piston **87** and attempts to stop the movement of the moving parts of the breaking portion, but the area of loading pressure of the movable puffer piston **87** is enough small to provide a large effect. The primary coil **81** and the electromagnetic puffer piston **83** determines the interval distance regardless of the position of the breaking stroke of the breaker and the strongest force can be obtained when and at what breaking position the coil **81** may be excited, and the electromagnetic force obtained from the electromagnetic puffer piston **83** operating independently of the outside operating device can be used effectively for the compression of the arc-extinguishing gas in the electromagnetic puffer chamber **85**, thus enabling it to obtain a higher blasting pressure for a shorter time than that in the **79** conventional technique of this type.

Additionally, the reaction of a large electromagnetic force as in the conventional technique of this type is prevented from being imposed upon the moving part of the breaking portion and the outside operating device, so that, even in case a breaking of a short-circuit current is performed only with the single phase of the three phases as in a different phase grounding breaker, the same pressure characteristics as in **3**-phase simultaneous breaking can be obtained.

In the breaker of this invention, in case of breaking a small current, such a strong-electromagnetic repulsive force as mentioned above will not occur, so that the floating piston **83** does not move up to the final stroke of breaking but remains in the position in FIG. **5**a and only the puffer chamber **89** will be compressed by the small movable puffer piston **87**. This fact makes it possible that (1) a reaction force of pressure applied on the movable puffer piston **87** so as to decelerate the opening speed of the contacts is small and (2) since it is not necessary to operate the primary coil **81** together with the moving part of the breaking portion by means of the outside operating device, the mass of the moving part of the breaking portion can so remarkably be reduced that the opening speed of the contacts can be accelerated by means of a small outside operating device.

A blasting quantity by a compression of the small puffer chamber **89** is so small that, in case of breaking a large current, it cannot be broken, but it is still enough for breaking a charging or exciting current and a generation of overcurrent by re-arcing due to the high opening speed of the contacts can be prevented.

Next, a switch-in operation will be described. As the electromagnetic repulsive force disappears upon the completion of breaking, the electromagnetic puffer piston **83** returns immediately to the initial breaking condition shown in FIG. **5**a by means of a spring **84**. A restoration of this electromagnetic puffer piston **83** can be performed upon the completion of breaking, so it can return to the initial position sufficiently until a next switch-in command is given, the insulating operating rod **79** is operated to the left direction in the figure by means of the outside operating device, so it will come to the switch-in condition in FIG. *5a*.

In the gas-blast circuit breaker of this invention mentioned above, since the movable puffer piston **87** and the electromagnetic puffer piston **83** are completely separated in operation and the area of loading pressure of the movable puffer piston **87** has been smaller, the outside operating device accelerates its opening speed with a small operating force and it can compress the arc-extinguishing gas in the puffer chamber **89** quickly, so that in case a small current is cut off by the electromagnetic force, the braking capacity of a charging current will be improved.

Although, in the embodiment shown in FIGS. *5a* and *5b* the gas-blast circuit interrupter has the floating piston **90** connected with the electromagnetic puffer piston **83**, the former **90** can be separated from the latter **83**. In this modification, the floating piston **90** is compressed by a spring member, which is inserted between the piston **90** and the movable puffer piston **87**, towards the piston **83**. The piston **90** is provided with a check valve capable of opening only towards the puffer chamber **89**.

When the piston **90** is driven by means of the insulating operating rod **9**, the piston **87** is moved against the force of the inserted spring member. During the mechanical movement **87** of the piston **90**, the check valve is kept closed because the gas pressure in the chamber **89** is higher than that in the electromagnetic puffer chamber **85**.

When the electromagnetic repulsive force is generated between the pistons **90** and **83**, the puffer piston **83** is moved with high speed towards the piston **90** to increase the gas pressure in the chamber **85** as high as enough to pen the check valve, whereby a compressed arc-extinguishing gas is blasted from the chamber **85**.

I claim:

1. An electromagnetic puffer type gas blast circuit breaker comprising a casing member confining an arc extinguishing gas, a pair of terminals through whic current flows during the closed condition of said breaker, a pair of contactors capable of such disengaging as to induce an arc a primary coil fixed to a rod member through which current flows into said coil member upon disengagement of said contactors for generating a magnetic field therein, a movable short-circuit body, said short-circuit body being magnetically directly connected with said coil upon disengagement of said contactors, said coil and short-circuit body being positioned at the rear side of the direction of gas blasting, and being movable in the direction of gas compression, connected magnetically to said primary coil, for producing a magnetic repulsive force between said primary coil and said short circuit body, a commutating device for inserting said primary coil into a circuit to be cut off in accordance with a breaking command, a device for compressing a part of said arc-extinguishing gas driven by said magnetic repulsive force, and a gas-guiding device blasting a high pressure gas obtained by said compressing device against said arc, wherein said compressing device is designed to be operated independently from an opening motion of said contactors after operation of said commutating device.

2. An electromagnetic puffer type gas-blast circuit breaker apparatus comprising:

a first stationary electrical contactor;

a second electrical contactor disengageably coupled with said first contactor, so that current flows be-

tween said first and second contactors during the closed condition of said breaker;

a first conductive element connected to said second contactor and being mechanically displaced during the breaking of said breaker;

a primary coil electrically engageable with said first conductive element upon separation of said first and second contactors, while being normally de-energized during the engagement of said contactors;

a conductive body magnetically directly coupled with said primary coil and displaceable with respect thereto for generating a repulsive magnetic force with respect to said primary coil, said coil and said conductive body being positioned at the rear side of the direction of gas blasting ;

first means for supplying current through said first contactor, said second contactor, said first conductive element and said primary coil to induce a magnetic field within said coil, whereby said magnetic field will be inductively coupled with said conductive body;

second means for supporting an arc extinguishing gas;

third means, coupled with and displaceable with respect to said second means and coupled with said conductive body, for compressing said arc extinguishing gas, the compression displacement of said third means being independent of the displacement of said first conductive element, so that substantially the entire magnetic repulsive force acting upon said third means is consumed for compressing said gas supported by said second means;

fourth means, coupled with said first means, for separating said first and second contactors, and for generating an electric arc therebetween, and

fifth means, responsive to the separation of said first and second contactors, and being coupled to said second means, for directing compressed arc extinguishing gas onto said arc, so as to extinguish said arc.

3. A gas blast circuit breaker comprising:

a. a casing member confining an arc extinguishing gas;

b. a pair of terminals through which current flows during the closed condition of said breaker;

c. a stationary contact member electrically connected to one of said terminals;

d. a movable contact member disengageably contacting with said stationary contact member, whereby current flows directly between said contact members during normally closed operation of said breaker and an arc forms between said contact members upon disengagement thereof during breaking;

e. means for compressing a part of said arc extinguishing gas comprising a cylinder member, a piston member disposed within said cylinder member and means for operating said compressing means, said operating means including an operating rod member, connected to an operating mechanism responsive to a breaking command, for initiating disengagement of said contact members and for engaging said contact members, and electromagnetic operating means for generating a magnetic repulsive force acting upon said cylinder member and said piston member,

said electromagnetic operating means comprising a movable coil member fixed to said rod mamber, normally short circuited when current flows between said terminals, for generating a magnetic field upon disengagement of said contact members, and a movable short circuit member, fixed to said piston member and directly magnetically coupled with said coil member, for producing said magnetic repulsive force between said coil member and said short circuit member to thereby actuate said piston member towards the direction of gas compression,

said piston member and said cylinder member being so designed that a compression movement of said piston member within said cylinder member is effected independently of said rod member to thereby minimize a gas compression reaction force acting upon said operating mechanism;

f. nozzle means for blasting said compressed arc extinguishing gas from said cylinder member onto said arc upon disengagement of said contact members, whereby said arc is extinguished, wherein said coil member is positioned at the rear side of said cylinder member with respect to the direction of gas blasting from said nozzle member; and

g. means for switching off said movable contact member from one of said terminals upon displacement thereof, whereby current flows between said coil member and one of said terminals to thereby produce said magnetic field.

4. A gas blast circuit breaker according to claim 3, wherein said short circuit member has a cylindrical shape and is fixed, adjacent to said coil member, to said piston member.

5. A gas blast circuit member according to claim 3, wherein said piston member is mechanically biased in the direction opposite to that of gas compression.

6. A gas blast circuit breaker according to claim 4, wherein at least one of said coil member and short circuit member have such an axial length so that the electromagnetic force has a flat characteristic.

7. A gas blast circuit breaker comprising:

a. a casing member confining an arc extinguishing gas;

b. first and second terminals through which current flows during the closed condition of said breaker;

c. a stationary contact member electrically connected to said first terminal;

d. a movable contact member disengageably contacting said stationary contact member and connected to said second terminal through a switching arrangement for switching a current path from the normally closed condition to the breaking condition, whereby current flows directly between said contact members during the normally closed condition of said breaker and an arc forms between said contact members upon disengagement thereof during breaking;

e. an operating rod member electrically connected to said movable contact member during the closed condition of said breaker and mechanically connected to an operating mechanism responsive to a breaking command;

f. a cylinder member, fixingly mounted on said rod member and having a bottom wall;

g. a piston member slidably mounted on said rod member and disposed within said cylinder member,

whereby a part of said arc extinguishing gas is compressed in said cylinder member;

h. a nozzle member, mounted on said bottom wall of said cylinder member and surrounding said contact members, for blasting compressed gas onto said arc;

i. a movable coil member, movable in the direction of gas compression, short circuited only during the normally closed condition of said breaker but having its short circuited condition removed upon displacement of said switching arrangement, for generating a magnetic field;

j. a movable short circuit member, directly magnetically connected with said coil member by said magnetic field and carrying said piston member, for producing a magnetic repulsive force between said movable short circuit member and said coil member,

said coil member and short circuit member being positioned at the rear side of the direction of gas blasting, so that a compression movement of said piston member is effected independently of said rod member to thereby minimize a compression reaction force acting upon said operating mechanism;

k. first means for fixingly supporting said coil member on said rod member; and

l. second means for movably supporting said rod member.

8. A gas blast circuit breaker according to claim **7**, wherein said short circuit member has a cylindrical shape of such an axial length that the electromagnetic force has a flat characteristic.

9. A gas blast circuit breaker according to claim **7**, wherein said coil member has more than one turn in the axial direction.

10. A gas blast circuit breaker comprising:

a. a casing member confining an arc extinguishing gas;

b. first and second terminals through which current flows during the closed condition of said breaker;

c. a stationary contact member electrically connected said first terminal;

d. a movable contact member disengageably contacting said stationary contact member and connected to said second terminal through a switching arrangement, whereby current flows directly between said contact members during the normally closed condition of said breaker and an arc forms between said contact members upon disengagement thereof during breaking;

said movable contact member being electrically connected with an operating rod member mechanically connected to an operating mechanism responsive to a breaking command;

e. a cylinder member, electrically insulated from said rod member and slidably mounted on said rod member and having a bottom wall;

f. a piston member, disposed within said cylinder member, electrically insulated from and fixedly mounted on said rod member, whereby a part of said arc extinguishing gas is compressed in said cylinder;

g. a nozzle member, mounted on said piston member and surrounding said contact members, for blasting compressed gas onto said arc,

said nozzle member communicating with said cylinder through an aperture formed in said piston member;

h. a coil member, short circuited only during the normally closed condition of said breaker and fixed to said rod member through which current flows into said coil member upon disengagement of said contact members but having its short circuited condition removed upon displacement of said switching arrangement, for generating a magnetic field;

i. a cylindrical movable short circuit member, concentrically adjacent said coil member and directly magnetically coupled with said coil member during said breaking and fixed to said cylinder member, for generating a magnetic repulsive force due to induction current occurring therein,

said coil member and short circuit member being positioned at the rear side of the direction of gas blasting, so that a compression movement of said cylinder member is effected independently of said rod member to thereby minimize a compression reaction force acting upon said operating mechanism;

j. means for commutating current flowing between said terminals to said coil member;

k. first means for fixedly supporting said coil member on said rod member; and

l. second means for supporting movably said rod member.

11. A gas blast circuit breaker according to claim **10**, wherein said short circuit member has a cylindrical shape of such an axial length that the electromagnetic force has a flat characteristic.

12. A gas blast circuit breaker according to claim **10**, wherein said coil member has more than one turn in the axial direction.

13. A gas blast circuit breaker comprising:

a. a casing member confining an arc extinguishing as;

b. first and second terminals through which current flows during the closed condition of said breaker;

c. a stationary contact member electrically connected with said first terminal;

d. a movable contact member disengageably contacting with said stationary contact member and connected to said second terminal through a switching arrangement, whereby current flows directly between said contact members during the normally closed condition of said breaker and an arc forms between said contact members upon disengagement thereof during breaking,

said movable contact member being electrically connected with an operating rod member mechanically connected to an operating mechanism which is responsive to a breaking command;

e. a cylinder member, electrically insulated from said rod member and slidably mounted on said rod member and having a bottom wall;

f. a piston member, disposed within said cylinder member, electrically insulated from said rod member and fixedly mounted on said rod member, whereby a part of said arc extinguishing gas is compressed in said cylinder member;

g. a nozzle member, mounted on said piston member and surrounding said contact members, for blasting compressed arc extinguishing gas onto said arc,

said nozzle member communicating with said cylinder member through an aperture formed in said bottom wall;

h. a coil member, short circuited during the normally closed condition of said breaker and fixed to said rod member through which current flows into said coil member upon displacement of said switching arrangement but having its short circuited condition removed upon displacement of said switching arrangement, for generating a magnetic field;

i. a cylindrical movable short circuit member, concentrically adjacent said coil member and directly magnetically coupled with said coil member during said breaking and fixed to said cylinder member, for generating a magnetic repulsive force due to induction current occurring therein.

said coil member and short circuit member being positioned at the rear side opposite to that of the direction of gas blasting, so that a compression movement of said cylinder member is effected independently of said rod member, to thereby minimize a compression reaction force acting upon said operating mechanism;

j. means for commutating current flowing between said terminals to said coil member;

k. first means for fixedly supporting said coil member on said rod member;

l. second means for movably supporting said rod member; and

m. means for biasing said piston member towards the direction of gas compression, whereby said piston member follows said rod member until said magnetic repulsive force is exerted on said piston member.

14. A gas blast circuit breaker according to claim **13,** wherein said short circuit member has a cylindrical shape of such an axial length that the magnetic force has a flat characteristic.

15. A gas blast circuit breaker according to claim **13,** wherein said coil member has more than one turn in the axial direction.

16. A gas blast circuit breaker comprising:

a. a casing member confining an arc extinguishing gas;

b. first and second terminals through which current flows during the closed condition of said breaker;

c. a stationary contact member electrically connected with said first terminal;

d. a movable contact member disengageably contacted with said stationary contact member and connected to said second terminal through a switching arrangement, whereby current flows directly between said contact members during the normally closed condition of said breaker and an arc forms upon disengagement thereof during breaking,

said movable contact member being electrically connected to an operating electroconductive rod member mechanically connected to an operating mechanism responsive to a breaking command, said rod member being so designed that said movable contact member is disengaged from said stationary contact member;

e. a cylinder member, electrically insulated from said rod member and having a bottom wall provided with a cylindrical extending portion;

f. a nozzle member surrounding said contact members, slidably disposed within said extending portion and having a flange portion, whereby movement of said nozzle member is restricted, for blasting compressed gas onto said arc;

g. a piston member slidably mounted on said rod member, whereby a part of said arc extinguishing gas is compressed in said cylinder member;

h. first means for mechanically biasing said piston member against the direction opposite to that of gas compression;

i. second means for preventing blasting of said compressed arc extinguishing gas from said nozzle member until a gas pressure in said cylinder member reaches a predetermined value, said second means including said flange portion and said cylindrical extending portion;

j. a coil member, short circuited during the normally closed condition of said breaker and fixed to said rod member through which current flows into said coil member upon displacement of said switching arrangement but having its short circuited condition removed upon disengagement of said contact members, for generating a magnetic field;

k. a movable short circuit member, concentrically adjacent said coil member, directly magnetically connected with said coil member during said breaking and fixed to said piston member, for producing induction current therein due to said magnetic field, whereby a magnetic repulsive force is produced between said coil member and said short circuit member,

said coil member and short circuit member being positioned at the rear side of the direction of gas blasting, whereby a compression movement of said piston member is effected independently of said rod member, to thereby minimize a compression reaction force acting upon said operating mechanism;

l. third means for fixingly supporting said coil member on said rod member; and

m. fourth means for supporting movably said rod member.

17. A gas blast circuit breaker according to claim **16,** wherein said coil member has more than one turn in the axial direction.

18. A gas blast circuit breaker according to claim **16,** wherein said short circuit member has a cylindrical shape.

19. A gas blast circuit breaker comprising:

a. a casing member confining an arc extinguishing gas;

b. first and second terminals through which current flows during the closed condition of said breaker;

c. a stationary contact member electrically connected to said first terminal;

d. a movable contact member disengageably contacting said stationary contact member through a switching arrangement, whereby current flows directly between said contact members during the normally closed condition of said breaker and an arc forms upon disengagement thereof during breaking,

said movable contact member being electrically connected with an operating electroconductive rod member mechanically connected to an operating mechanism responsive to a breaking com-

mand, said rod member being so designed that said movable contact member is disengaged from said stationary contact member in accordance with said breaking command;

e. a stationary cylinder member electrically insulated from said rod member;

f. a first piston member slidably disposed within said cylinder member, having a sufficiently smaller axial length than said cylinder member and having a hook portion;

g. a nozzle member, surrounding said contact members, engaged with said hook portion, for blasting said arc extinguishing gas onto said arc upon disengagement of said contact members;

h. a second piston member, disposed within a chamber having a larger volume than said cylinder member and communicating with said cylinder through valve means;

i. a stationary coil member disposed at the rear side of the direction of gas blasting, de-energized during the normally closed condition of said breaker but being energized upon disengagement of said contact members, for generating a magnetic field therein;

j. a movable short circuit member disposed within said chamber, and magnetically directly connected with said stationary coil member upon disengagement of said contact members, whereby induction current is incuded in said short circuit member by the action of said magnetic field;

k. means for switchably displacing said rod member, to thereby cause current to flow into said coil member upon disengagement of said contact members; and

l. means for mechanically biasing said short circuit member against the direction opposite to that of gas compression.

20. A gas blast circuit breaker according to claim **19**, wherein said coil member has more than one turn in the axial direction.

21. A gas blast circuit breaker according to claim **19**, wherein said short circuit member has a cylindrical shape.

22. A gas blast circuit breaker according to claim **19**, wherein said valve means is a check valve for preventing the supplying of said arc extinguishing gas in said chamber until said piston member is actuated to compress said gas.

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