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[54] **CIRCUIT BREAKING SECTION OF A GAS CIRCUIT BREAKER OF THE PUFFER TYPE**

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[51] **Int. Cl.²** **H01H 33/70**

[58] **Field of Search** ..... 200/148 A, 150 G

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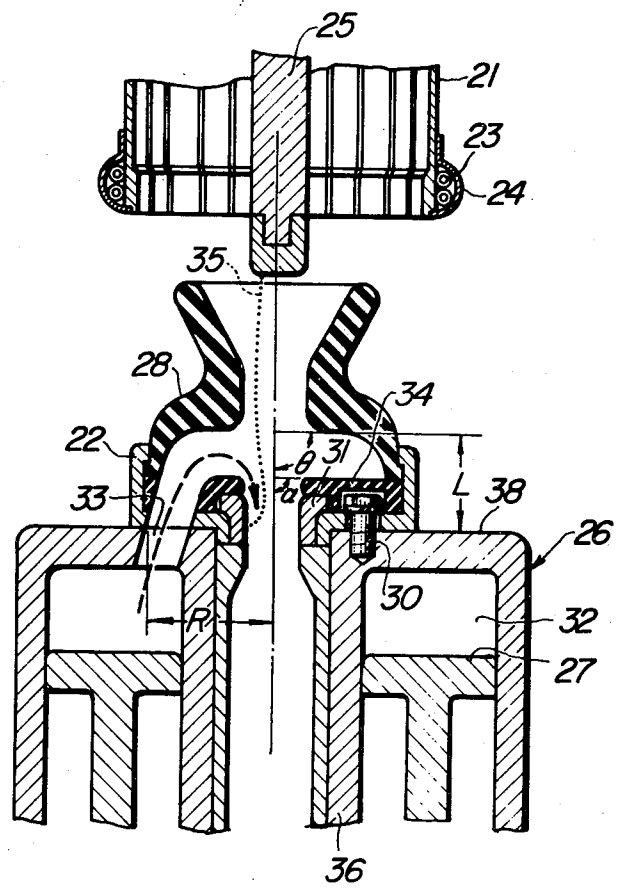
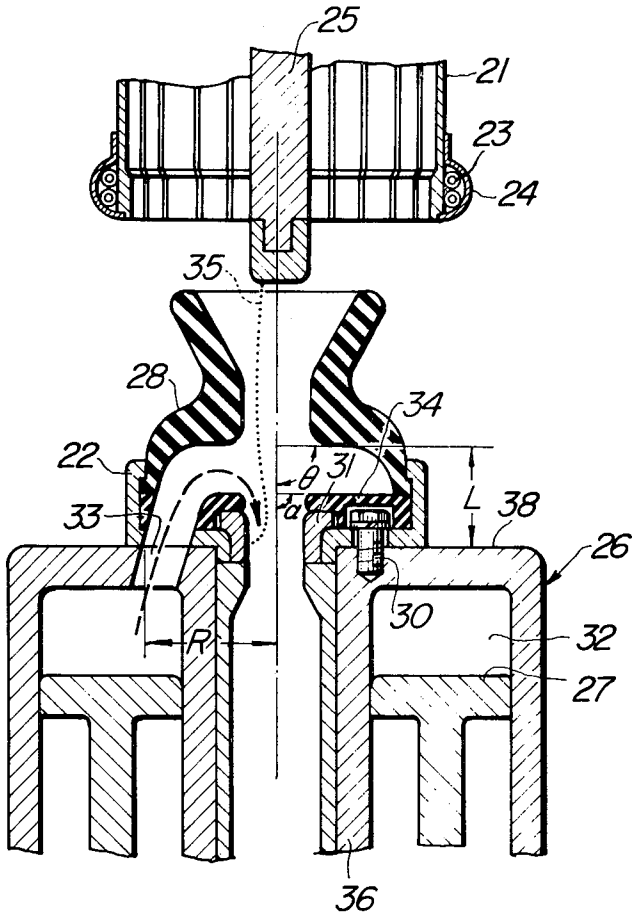
[57] **ABSTRACT**

A circuit breaking section of a gas circuit breaker of the puffer type comprising a nozzle made of an insulating material for directing an arc extinguishing gas pressurized by the movable cylinder and the fixed piston toward an arc produced between the fixed arc contact of the block shape and the movable hollow arc contact. The pressurized arc extinguishing gas is caused by the nozzle made of an insulating material to move in two directions or toward the orifice of the nozzle disposed on the downstream side thereof and the bore of the movable hollow arc contact. The nozzle is constructed such that its inner wall surface disposed on the upstream side of the nozzle and contiguous with the orifice forms an obtuse angle with the line of flow of gas directed toward the upstream side of the nozzle, so that more than half the volume of the pressurized arc extinguishing gas can be led toward the bore of the movable hollow arc contact.

6 Claims, 1 Drawing Figure

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CIRCUIT BREAKING SECTION OF A GAS CIRCUIT BREAKER OF THE PUFFER TYPE

BACKGROUND OF THE INVENTION

This invention relates to circuit breaking sections of double flow gas circuit breakers of the puffer type, and more particularly it is concerned with improvements in or relating to the shape of a nozzle made of an insulating material for directing toward the arc an arc extinguishing gas pressurized by the puffer cylinder and puffer piston.

In recent years, there has been an increase in the demand for electric power which has made it necessary to transmit a current of high voltage and high value. With this tendency, the circuit breaking capacity required of circuit breakers is also on an increase. There is nowadays a demand for circuit breakers with a breaking current of 40 to 50 kilovolt amperes for use in a circuit of a voltage of over 100 kilovolts.

In gas circuit breakers of the puffer type, an arc extinguishing gas under high pressure is produced by operating the puffer cylinder and blown against an arc produced between the contacts to extinguish the same, thereby interrupting the current. SF_6 gas or other insulating extinguishing medium is employed as an arc extinguishing gas.

In double flow gas circuit breakers of the puffer type of the prior art, the movable hollow arc contact juxtaposed against the fixed contact of the block shape and the movable main contact composed of a plurality of conducting pieces and surrounding the movable hollow arc contact are both positioned in a hollow space disposed on the upstream side of the nozzle made of an insulating material for blowing an arc extinguishing gas produced by the puffer piston and puffer cylinder against the arc. Because of this arrangement, the fixed contact and the movable contact (including the movable hollow arc contact) are brought into contact with each other in the interior of the nozzle. This makes it necessary to increase the volume (or diameter) of the portion of the nozzle disposed on the upstream side thereof, with an inevitable increase in the dead space within the nozzle. Thus, the arc extinguishing gas pressurized by the puffer cylinder and puffer piston is markedly lowered in pressure when it reaches the arc, thereby causing a reduction in the circuit breaking efficiency of the circuit breakers of this type.

The diameter of the orifice of the nozzle is selected such that it is larger than the diameter of the fixed contact to enable the fixed contact to pass through the orifice. This results in the major portion of the pressurized arc extinguishing gas moving through the orifice toward the downstream side of the nozzle, so that the volume of the pressurized arc extinguishing gas led into the bore of the movable hollow arc contact is greatly reduced. As a result, the movement of the arc along the inner wall of the movable hollow arc contact and cooling thereof are interfered with, thereby causing a reduction in the circuit breaking efficiency of the circuit breakers of this type.

With the orifice of the nozzle having a large diameter, a portion of the pressurized arc extinguishing gas is discharged through the orifice without contributing to the extinguishing of the arc. Because of this, it is necessary to produce more pressurized arc extinguishing gas than is necessary by the puffer cylinder and puffer piston. This in turn makes it necessary to increase the size of the puffer cylinder and puffer piston, thereby making it impossible to obtain an overall compact size in a circuit breaker operating device.

SUMMARY OF THE INVENTION

An object of the invention is to provide a circuit breaking section of a double flow gas circuit breaker of the puffer type which exhibits a high circuit breaking performance.

Another object of the invention is to provide a circuit breaking section of a double flow gas circuit breaker of the puffer type in which substantially the total volume of an arc extinguishing gas pressurized by the puffer cylinder and puffer piston contributes to the extinguishing of the arc.

The outstanding characteristics of the invention are as follows. The main fixed contact is composed of a plurality of conductive pieces arranged in the form of a circle; the main movable contact juxtaposed against the main fixed contact is disposed along outer periphery of the nozzle of an insulating material for permitting an arc extinguishing gas pressurized by the puffer cylinder and puffer piston to move toward the arc; and the movable hollow arc contact alone is disposed in the hollow interior of the nozzle disposed on the upstream side thereof. The fixed arc contact of the block shape is disposed concentrically with the main fixed contact and juxtaposed against the movable hollow arc contact, so that the fixed arc contact can move through the orifice of the nozzle made of an insulating material and come into contact with the movable hollow arc contact in the hollow interior of the nozzle disposed on the upstream side thereof.

The nozzle has an inner wall which is shaped such that, when the circuit breaker is in a full open position in which the main fixed contact and the main movable contact are out of contact with each other, the resistance offered to the stream of a pressurized arc extinguishing gas supplied from a puffer chamber defined by the puffer cylinder and puffer piston and moving toward the bore of the movable hollow arc contact is smaller than the resistance offered to the stream of a pressurized arc extinguishing gas which moves toward the orifice of the nozzle from the puffer chamber. By this arrangement, more than half the total volume of the arc extinguishing gas flows into the bore of the movable hollow arc contact.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a sectional view of the circuit breaking section of the double flow gas circuit breaker of the puffer type according to the invention, showing the circuit breaking section in a full open position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The drawing is a sectional view of the circuit breaking section of the double flow gas circuit breaker of the puffer type comprising one embodiment of the invention, showing the circuit breaking section in its operative position in which it breaks the circuit. In the drawing, the main contacts comprise a main fixed contact **21** and a main movable contact **22.** The main fixed contact **21** is composed of a plurality of conductive pieces arranged cylindrically and has spring means **23** mounted at its front end portion. A shield **24** for lower-

ing the electric field intensity is provided on outer periphery of the spring means **23.**

Provided in the central portion of the main fixed contact **21** is a fixed arc contact **25** of the block shape which is affixed to an immovable member (not shown) to which the main fixed contact **21** is also affixed. The fixed arc contact **25** has a forward end portion which is made of an arc resisting material.

On the other hand, puffer means comprising a puffer cylinder **26** and a puffer piston **27** is provided on the movable contact side. The main movable contact **22** serving concurrently as an insulator nozzle holding member to keep the base of an insulating nozzle **28** in place is connected through bolts **30** to a side wall **38** of the puffer cylinder **26** disposed on the contact side. The insulator nozzle **28** is formed on its downstream side with an orifice which has an inner diameter greater than the outer diameter of the fixed arc contact **25,** and which steadily diverges in going outwardly. A hollow movable arc contact **31** is provided in the interior of the main movable contact **22** and has a forward end portion which is made of an arc resisting material as is the case with the forward end portion of the fixed arc contact **25.**

The puffer cylinder **26** and puffer piston **27** define therebetween a puffer chamber **32** containing therein an arc extinguishing gas. Formed in the side wall **38** of the puffer cylinder **26** disposed on the contact side are gas supply ports **33** through which the arc extinguishing gas in the puffer chamber **32** moves and is blown against an arc produced between the fixed arc contact **25** and the movable arc contact **31.** Although only one gas supply port **33** is shown in the drawing, four gas supply ports **33** of the same sectional area are provided in this embodiment.

The insulator nozzle **28** is constructed such that its inner wall surface which is disposed on the upstream side thereof and contiguous with the orifice is planar, and that the planar inner wall surface of the nozzle **28** forms an angle θ with the longitudinal center axis of the circuit breaker which is over 90°. A flow control plate **34** made of an insulating material is provided on the outer side of the hollow movable arc contact **31** and constructed such that its main surface forms an angle α with the longitudinal center axis of the circuit breaker which is also over 90°. The provision of the flow control plate **34** is conductive to reduced dead space in the interior of the nozzle and prevention of ignition to the extension of the main movable contact **22** or the bolts **30** by the arc. Since the movable arc contact **31** is used only for producing an arc when the circuit breaker breaks the circuit, and the current flows through the main contacts **21** and **22** when the circuit breaker is in a closed position in which it makes a circuit. Thus, the movable arc contact **31** is small in size because a current of high value flows therethrough for a very short time interval.

The insulator nozzle **28** is constructed such that the distance L between its planar inner surface disposed on the upstream side thereof and contiguous with the orifice and the side wall **38** of the puffer cylinder **26** is smaller than the radius R of the base of the insulator nozzle **28.** This is conductive to reduced dead space in the interior of the nozzle **28** through which the arc extinguishing gas moves after it has passed through the gas supply ports **33** and before it reaches an arc produced between the arc contacts **25** and **31.** The nozzle **28** is constructed such that the planar inner surface thereof disposed on its upstream side and contiguous with the orifice and the main surface of the flow control plate **34** define therebetween a space of a sectional area which is disposed at right angles to the direction of flow of the pressurized arc extinguishing gas and substantially equal to the sum of sectional areas of the four gas supply ports **33.** Thus, the dead space in the nozzle **28** is further reduced.

A tubular puffer cylinder shaft **36** supporting the movable hollow arc contact **31** is provided in the central portion of the puffer cylinder **26** and formed integrally therewith. The device described above is bodily disposed in a pressurized container (not shown) filled therein with SF_6 gas and other arc extinguishing insulating gas.

The operation of the double flow gas circuit breaker of the puffer type constructed as aforementioned will now be described. When the circuit breaker is brought to a closed position in which it makes a circuit, the current passes through the main fixed contact **21,** main movable contact **22** and puffer cylinder **27.** In bringing the circuit breaker to an open position in which it breaks the circuit, the puffer cylinder shaft **36** is moved downwardly in the figure by a circuit breaker operating device (not shown). This moved downwardly the puffer cylinder **26,** insulator nozzle **28,** movable main contact **22** and movable arc contact **31** as a unit, thereby bringing the main contacts **21** and **22** out of contact with each other. When this is the case, the current passes though a path formed by the fixed arc contact **25,** movable arc contact **31** and puffer cylinder **26.** Further downward movement of the puffer cylinder shaft **36** brings the arc contacts **25** and **31** out of contact with each other, thereby producing an arc **35** therebetween.

On the other hand, the arc extinguishing gas contained in the puffer chamber **32** defined between the puffer cylinder **26** and puffer piston **27** is compressed and moves through the supply ports **33** to be blown against the arc **35.** The arc extinguishing gas blown against the arc **35** moves in two streams in two different directions or towards the bore of the movable hollow arc contact **31** and the orifice of the insulator nozzle **28.** Thus, the gas is vented to the lower pressure portion of the container through the two outlets. The arc **35** is extinguished as the pressurized arc extinguishing gas is blown thereagainst, thereby interrupting the flow of the current.

In the circuit breaking section of the circuit breaker according to the invention, the main contacts **21** and **22** are disposed outside the insulator nozzle **28** while the arc contacts **25** and **31** alone are disposed within the insulator nozzle **28.** Thus, the orifice of the insulator nozzle **28** can have a diameter which is large enough to receive therein the fixed arc contact **25** of low current capacity. This keeps more arc extinguishing gas than is necessary for extinguishing the arc from being discharged therethrough, so that the puffer chamber **32** can have a volume which is large enough to produce an essential minimum of pressurized arc extinguishing gas.

The planar inner surface of the insulator nozzle **28** disposed on the upstream side thereof and contiguous with the orifice forms an angle θ with the longitudinal center axis of the circuit breaker which is over 90°. The main surface of the flow control plate **34** forms an angle α with the longitudinal center axis of the circuit

breaker which is also over 90°. By virtue of these features, the pressurized arc extinguishing gas supplied through the gas supply ports **33** can be blown at right angles or at an obtuse angle against the arc **35** produced between the arc contacts **25** and **31**. As a result, the pressurized arc extinguishing gas can be introduced in a larger volume into the bore of the movable hollow arc contact **31** than into the orfifice of the nozzle **28**, and the arc **35** produced between the arc contacts **25** and **31** can be made to move along the inner wall of the movable hollow arc contact **31** in the same direction as the movement of the pressurized arc extinguishing gas, so that the arc can be readily cooled and positively extinguished.

Since the distance between the planar inner surface of the nozzle **28** disposed on the upstream side thereof and contiguous with the orifice and the side wall **38** of the puffer cylinder **26** disposed on the contact side is smaller than the radius of the base of the nozzle **28**, the dead space in the path of movement of the arc extinguishing gas from the gas supply ports **33** to the arc **35** produced between the arc contacts **25** and **31** can be minimized, and a reduction in the pressure of the pressurized arc extinguishing gas can be prevented, thereby improving the circuit breaking efficiency of the circuit breaker. It should be understood in this connection that the distance between the planar inner surface of the nozzle **28** and the side wall of the puffer cylinder should be about ⅓ the radius of the base of the nozzle at a minimum, because the sectional area of the path of movement of the arc extinguishing gas will become too small and the resistance offered to the flow of gas will become too great if the distance is too small.

We claim:

1. A circuit breaking section of a gas circuit breaker of the puffer type comprising:

a. a hollow main fixed contact including a plurality of conductive pieces arranged in the form of a circle,
b. a fixed arc contact of the block shape arranged concentrically in a hollow space of said main fixed contact,
c. a movable cylinder disposed in juxtaposed relation with said hollow main fixed contact,
d. a side wall closing one end of said movable cylinder which is juxtaposed against said hollow main fixed contact,
e. a hollow cylinder rod disposed concentrically with and extending through said movable cylinder, said hollow cylinder rod being attached to said side wall,
f. a fixed piston disposed in said movable cylinder for cooperation therewith,
g. a movable hollow arc contact disposed in juxtaposed relation with said fixed arc contact and supported in said hollow cylinder rod,
h. a nozzle made of an insulating material disposed concentrically with said movable hollow arc contact and mounted on said side wall, said nozzle made of an insulating material being formed on its downstream side with an orifice of a diameter large enough to permit said fixed arc contact of the block shape to move therethrough,
i. a main movable contact mounted on outer periphery of said nozzle made of an insulating material and disposed concentrically therewith so as to be brought into and out/of sliding contact with said hollow main fixed contact, said main movable contact being electrically connected to said side wall, and
j. a plurality of gas supply ports formed in said side wall for permitting a pressurized gas produced in a chamber defined in said movable cylinder between said side wall and said fixed piston to pass therethrough and move toward the downstream side of said nozzle made of an insulating material as said movable cylinder is operated,

such circuit breaking section being characterized in that said nozzle made of an insulating material has an inner wall which is shaped that, when the circuit breaker is in a full open position in which the main fixed contact and the main movable contact are out of contact with each other, the resistance offered to a stream of gas moving from said plurality of gas supply ports toward the bore of said movable hollow arc contact is equal to or greater than the resistance offered to a stream of gas moving from said plurality of gas supply ports through the orifice of said nozzle made of an insulating material toward the downstream side thereof.

2. A circuit breaking section of a gas circuit breaker of the puffer type comprising:

a. a hollow main fixed contact including a plurality of conductive pieces arranged in the form of a circle,
b. a fixed arc contact of the block shape arranged concentrically in a hollow space of said main fixed contact,
c. a movable cylinder disposed in juxtaposed relation with said hollow main fixed contact,
d. a side wall closing one end of said movable cylinder which is juxtaposed against said hollow main fixed contact,
e. a hollow cylinder rod disposed concentrically with and extending through said movable cylinder, said hollow cylinder rod being attached to said side wall,
f. a fixed piston disposed in said movable cylinder for cooperation therewith,
g. a movable hollow arc contact disposed in juxtaposed relation with said fixed arc contact and supported in said hollow cylinder rod;
h. a nozzle made of an insulating material disposed concentrically with said movable hollow arc contact and mounted on said side wall, said nozzle made of an insulating material being formed on its downstream side with an orifice of a diameter large enough to permit said fixed arc contact of the block shape to move therethrough,
i. a main movable contact mounted on outer periphery of said nozzle made of an insulating material and disposed concentrically therewith so as to be brought into and out of sliding contact with said hollow main fixed contact, said main movable contact being electrically connected to said side wall, and
j. a plurality of gas supply ports formed in said side wall for permitting a pressurized gas produced in a chamber defined in said movable cylinder between said side wall and said fixed piston to pass therethrough and move toward the downstream side of said nozzle made of an insulating material as said movable cylinder is operated,

such circuit breaking section being characterized in that said nozzle made of an insulating material has an inner wall which is shaped such that, when the circuit

breaker is in a full open position in which the main fixed contact and the main movable contact are out of contact with each other, the volume of a pressurized gas moving from said plurality of gas supply ports toward the bore of said movable hollow arc contact is greater than or equal to the volume of a pressurized gas moving from said plurality of gas supply ports through the orifice of said nozzle made of an insulating material toward the downstream side thereof.

3. A circuit breaking section of a gas circuit breaker of the puffer type comprising:

a. a hollow main fixed contact including a plurality of conductive pieces arranged in the form of a circle,
b. a fixed arc contact of the block shape arranged concentrically in a hollow space of said main fixed contact,
c. a movable cylinder disposed in juxtaposed relation with said main fixed contact,
d. a side wall closing one end of said movable cylinder which is juxtaposed against said hollow main fixed contact,
e. a hollow cylinder rod disposed concentrically with and extending through said movable cylinder, said hollow cylinder rod being attached to said side wall,
f. a fixed piston disposed in said movable cylinder for cooperation therewith,
g. a movable hollow arc contact disposed in juxtaposed relation with said fixed arc contact and supported in said hollow cylinder rod,
h. a nozzle made of an insulating material disposed concentrically with said movable hollow contact and mounted on said side wall, said nozzle made of an insulating material being formed on its downstream side with an orifice of a diameter large enough to permit said fixed arc contact of the block shape to move therethrough,
i. a main movable contact mounted on outer periphery of said nozzle made of an insulating material and disposed concentrically therewith so as to be brought into and out of sliding contact with said hollow main fixed contact, said main movable contact being electrically connected to said side wall, and
j. a plurality of gas supply ports formed in said side wall for permitting a pressurized gas produced in a chamber defined in said movable cylinder between said side wall and said fixed piston to pass therethrough and move toward the downstream side of said nozzle made of an insulating material as said movable cylinder is operated,

such circuit breaking section being characterized in that said nozzle made of an insulating material has an inner wall which is shaped such that a stream of pressurized gas supplied through said plurality of gas supply ports and blown against an arc produced between said fixed arc contact of the block shape and said movable hollow arc contact moves toward the upstream side of said nozzle made of an insulating material.

4. A circuit breaking section of a gas circuit breaker of the puffer type comprising:

a. a hollow main fixed contact including a plurality of conductive pieces arranged in the form of a circle,
b. a fixed arc contact of the block shape arranged concentrically in a hollow space of said main fixed contact,
c. a movable cylinder disposed in juxtaposed relation with said hollow main fixed contact,
d. a side wall closing one end of said movable cylinder which is juxtaposed against said hollow main fixed contact,
e. a hollow cylinder rod disposed concentrically with and extending through said movable cylinder, said hollow cylinder rod being attached to said side wall,
f. a fixed piston disposed in said movable cylinder for cooperation therewith,
g. a movable hollow arc contact disposed in juxtaposed relation with said fixed arc contact and supported in said hollow cylinder rod,
h. a nozzle made of an insulating material disposed concentrically with said movable hollow arc contact and mounted on said side wall, said nozzle made of an insulating material being formed on its downstream side with an orifice of a diameter large enough to permit said fixed arc contact of the block shape to move therethrough,
i. a main movable contact mounted on outer periphery of said nozzle made of an insulating material and disposed concentrically therewith so as to be brought into and out of sliding contact with said hollow main fixed contact, said main movable contact being electrically connected to said side wall, and
j. a plurality of gas supply ports formed in said side wall for permitting a pressurized gas produced in a chamber defined in said movable cylinder between said side wall and said fixed piston to pass therethrough and move toward the downstream side of said nozzle made of an insulating material as said movable cylinder is operated,

such circuit breaking section being characterized in that said nozzle made of an insulating material is constructed such that the angle formed by its inner wall surface disposed on its upstream side and contiguous with said orifice with the line of flow of the gas directed toward the upstream side of the nozzle is over 90°.

5. A circuit breaking section of a gas circuit breaker of the puffer type as claimed in claim **4** further comprising:

k. a flow control plate made of an insulating material disposed in said nozzle made of an insulating material and providing cover to said side wall while exposing a bore of said movable hollow arc contact and said plurality of gas supply ports.

6. A circuit breaking section of a gas circuit breaker of the puffer type as claimed in claim **5** wherein said flow control plate is constructed such that it has a main surface disposed on a side opposite said side wall, said main surface and the line of flow of the gas directed toward the upstream side of said nozzle made of an insulating material forming an angle which is over 90°.

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