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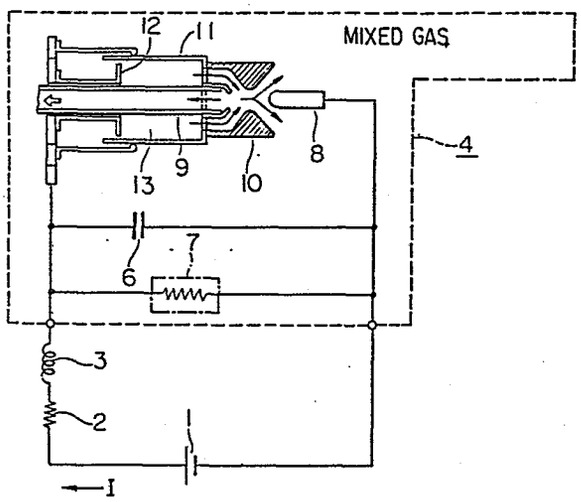
(54) Direct current circuit breaker.

(57) A d.c. circuit breaker comprising in parallel with a circuit breaker section (5) a current commutating auxiliary circuit formed by a capacitance (6) and/or an inductance (3), wherein a gas mixture consisting essentially of an SF_6-gas and nitrogen or of an SF_6-gas and air is used as an arc-extinguishing and insulating medium for said breaker section (5).



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DIRECT CURRENT CIRCUIT BREAKER

This invention relates to a direct current circuit breaker and, more particularly, to a direct current circuit breaker in which the current is commutated by its own action at the time of current interruption and in which unstable arc characteristics are utilized for establishing current zero point or zero crossing for breaking the circuit.

The piror-art construction of the current breaker of the above described type is shown in the wiring circuit of Fig. 1, wherein a direct current source 1 indicated conveniently as a voltage source is connected to a resistance 2 and an inductance 3 proper to the transmission line for providing a direct current system. To this system is connected a current breaker unit 4 comprised of a current breaker section 5 adapted for breaking the circuit, a capacitor 6 and a surge absorber 7 formed by metal oxide resistor. The capacitor 6 is connected in parallel with the section 5 and used for current commutation.

With the direct current"I"flowing through the current breaker section 5 of the unit 4 when the section 5 starts its circuit breaking operation, that is, its contacts start to be separated from each other, an arc is generated between the contacts of the section 5 and the direct current then flows through the arc.

It is well-known that, for a certain current range, the relation between the steady-state arc voltage e_s and the steady-state arc current is through a variety of gases may be approximated by the following formula:

$$e_s \cdot i_s^{\alpha} = \eta \qquad (1)$$

where α and η are positive constants with α being usually between zero/ (0) and unity (1.0).

On the other hand, the arc produced in the circuit shown in Fig. 1 and having the characeristics represented by the formula (1) becomes unstable on the condition that

$$\frac{L}{C} \leqq \frac{\alpha \cdot e_s}{\theta} \qquad (2)$$

where θ represents a thermal time constant of the arc, "C" a capacitance of the capacitor 6, "I" a d.c. current and "e_s" a steady-state arc voltage, with α being as defined in the equation (1). When the condition given by the equation (2) is satisfied, the arc produced in the circuit breaker section 5 becomes unstable.

The voltage/current characteristics prevailing at this time are shown in Fig. 2. In this figure, e_a represents the voltage across the terminals of the breaker section 5, I the d.c. current, i_a the current flowing into the breaker section 5 and i_c the unstable oscillating current flowing from capacitor 6 into the arc.

Since the above described oscillating current has current zero points, the current can be interrupted at the zero crossing points. In other words, it is possible to interrupt the d.c. current when the condition of the equation (2) is satisfied. By selecting the right side term of the equation (2) to a larger value, the term of the d.c. current I that can be interrupted can also be selected to a larger value for thereby improving the current braking capacity of the current breaker unit.

In the SF_6-gas blowing type conventional d.c. current breaker, it is the conventional practice to increase the force of gas blowing or make use of a construction of an arc-extinguishing chamber designed for extending the arc length. However, since the SF_6-gas tends to be liquefied under an elevated pressure, a certain limitation is placed on increasing the gas pressure for producing a strong gas blowing force. On the other hand, the overall device tends to be complicated by the provision of the arc-extinguishing chamber.

In view of the foregoing, it is a principal object of the present invention to obviate the above described deficiency of the SF_6-gas blowing type d.c. circuit breaker and to provide a d.c. circuit breaker having a higher current breaking capacity. According to the present invention, a gas mixture consisting essentially of the SF_6-gas and air or nitrogen is used and blown into the arc as an arc-extinguishing and insulating medium for the gas blowing type d.c. circuit breaker.

One way of carrying out the invention is described in detail below with reference to drawings, in which

Fig. 1 is a diagrammatic view showing the construction of the conventional circuit breaker of the type in which the current is commutated spontaneously at the time of current interruption,

Fig. 2 is a chart showing the voltage and current characteristics with time in the circuit breaker shown in Fig. 1, and

Fig. 3 is a diagrammatic view showing the construction of the current breaker according to an embodiment of the present invention.

With respect to the description of the Figures 1 and 2 it is referred to the above introduction.

Fig. 3 shows a preferred embodiment of the present invention wherein the same numerals 1 through 7 as those used in Fig. 1 are used to depict the same or corresponding parts. The d.c. breaker unit 4 is comprised of a fixed contact 8, a movable contact 9 that may be engaged with or disengaged from this fixed contact, a flow guide member 10 placed around these contacts and secured to said movable contact, a cylinder 11 secured to said flow guide member and operable with said movable contact, a buffer chamber 13 defined between the cylinder and a piston 12 slidable therein, a commutating capacitor 6 in parallel with said fixed and movable contacts, and a surge absorber 7.

In the operation of the d.c. circuit breaker unit 4, when the movable contact 9 is contacted with the fixed contact 8, the unit 4 being thus closed, the totality of the current supplied from the d.c. system flows through these contacts 8, 9. In this state, when the movable contact 9 is pulled towards left in the drawing by an operating mechanism, not shown, the contacts are separated from one the other so that an arc is produced between these contacts and the current flows through the arc. Since the arc voltage e_a between the contacts is increased with the increase in the distance between the contacts, a current i_c given by a formula

$$i_c = C \frac{de_a}{dt} \qquad (3)$$

flows through capacitor 6. On the other hand, a current i_a given by a formular

$$i_a = I - i_c \qquad (4)$$

flows through the contacts. As the distance between the contacts is increased so that the arc voltage e_s is increased to the extent that the condition shown by the above described formular (2) is satisfied, the arc becomes unstable and the oscillating current is increased in magnitude so as to cross zero points thus providing for an circuit breaking operation. Thus the current i_a flowing through the contacts becomes zero ($i_a = 0$). However, the current"I"is still flowing in the d.c. system through capacitor 6 so that

$$\frac{d_{ea}}{dt} = \frac{1}{C} i_c = \frac{1}{C} I$$

resulting in an increased voltage between the contacts. When the voltage between the contacts reaches a threshold voltage V_0 of the surge absorber 7, the current flows through the absorber 7 so as to be dissipated as joule's heat.

It is known in general that the value of α in equation (1) is higher for an arc blown by nitrogen or air than for an arc blown by SF_6. Thus, in the d.c. circuit breaker shown in Fig. 3, a higher value of α can be obtained by using a gas mixture consisting essentially of SF_6 and nitrogen or air as an arc blowing medium than in the case of using a gas consisting solely of SF_6. Moreover, the marginal or critical temperature at which the above gas mixture is

converted into the liquid phase is elevated than in the case of the SF_6-gas. Thus a stronger pressure of the arc blowing gas may be used, resulting in the stronger arc blowing force and the increase in the magnitude of the right side term of the equation (1).

It should also be noted that, while a higher pressure differential is difficult to achieve through compression with the aid of a cylinder and a piston such as buffer system a higher pressure differential can be achieved with ease with the aid of such buffer system upon addition of an SF_6-gas into these gases, thus enabling the buffer blowing system to be used advantageously in conjunction with the d.c. circuit breaker.

The mixture ratio of nitrogen or air to the SF_6-gas may preferably be in the range of 20 to 80 vol. percent of nitrogen or air to the SF_6-gas. The lower limit of 20 vol. percent is set because an increase in the value of α or arc voltage may not be increased for lower nitrogen or air contents while the upper limit of 80 vol. percent is set because the buffer operation ceases to be effective for higher nitrogen or air contents.

From the foregoing it is seen that the arrangement of the present invention provides a d.c. circuit breaker having a larger current breaking capacity through the use of the gas mixture consisting essentially of SF_6 gas and air or nitrogen as the arc-extinguishing and insulating medium.

Claims:

1. A d.c. circuit breaker comprising in parallel with a circuit breaker section (5) a current commutating auxiliary circuit formed by a capacitance (6) and/or an inductance (3), characterized in that a gas mixture consisting essentially of an SF_6 -gas and nitrogen or of SF_6 -gas and air is used as an arcextinguishing and insulating medium for said circuit breaker section (5).

2. The d.c. circuit breaker as claimed in claim 1, wherein a buffer type blowing unit consisting essentially of a cylinder (11) and a piston (12) is used as a gas blowing system for extinguishing the arc with the aid of the arc-extinquishing and insulating medium.

3. The d.c. circuit breaker as claimed in claim 1 or 2, wherein 20 to 80 vol. percent of nitrogen or air is mixed to SF_6.

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FIG. 1 PRIOR ART

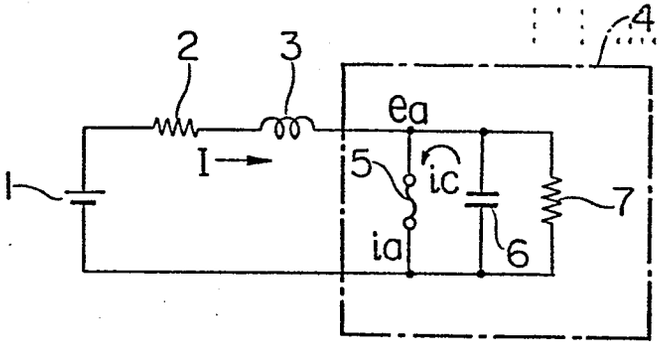

FIG. 2

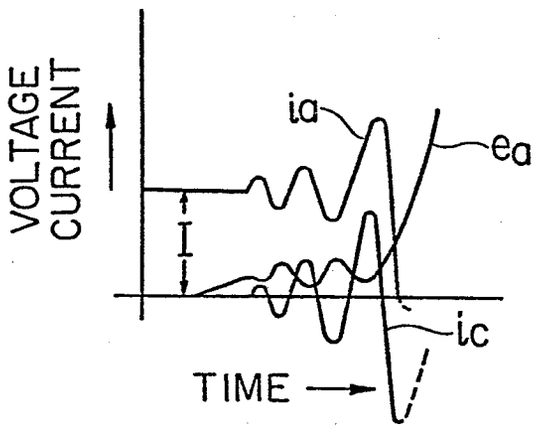

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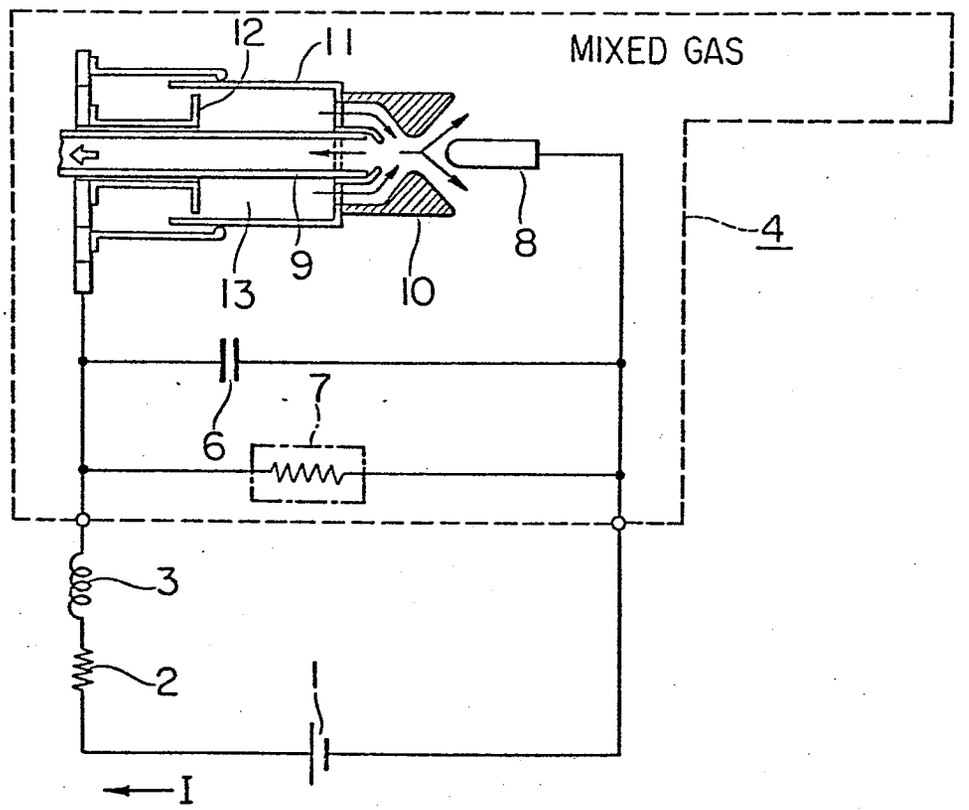
FIG. 3



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EUROPEAN SEARCH REPORT

Application number

EP 84 10 3251

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	US-A-2 798 922 (WESTINGHOUSE) * Column 1, lines 45-67; column 3, lines 32-64; column 6, line 59 - column 7, line 15; figure 1 *	1-3	H 01 H 33/22 H 01 H 33/59
A	EP-A-0 050 826 (TOKYO SHIBAURA) * Page 6, line 25 - page 7, line 10; figure 3 *	2	
A	IEEE TRANSACTIONS ON POWER APPARATUS AND SYSTEMS, vol. PAS-95, no. 1, January/February 1976, pages 140-144, IEEE, New York, US; R.D. GARZON: "The effects of SF6 - N2 mixture upon the recovery voltage capability of a synchronous interrupter" * Page 142 *	1,3	
A	US-A-4 171 474 (F.A. HOLMES) * Column 4, lines 27-48; figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

H 01 H 9/00
H 01 H 33/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11-07-1984	TOUSSAINT F.M.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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