

May 29, 1951

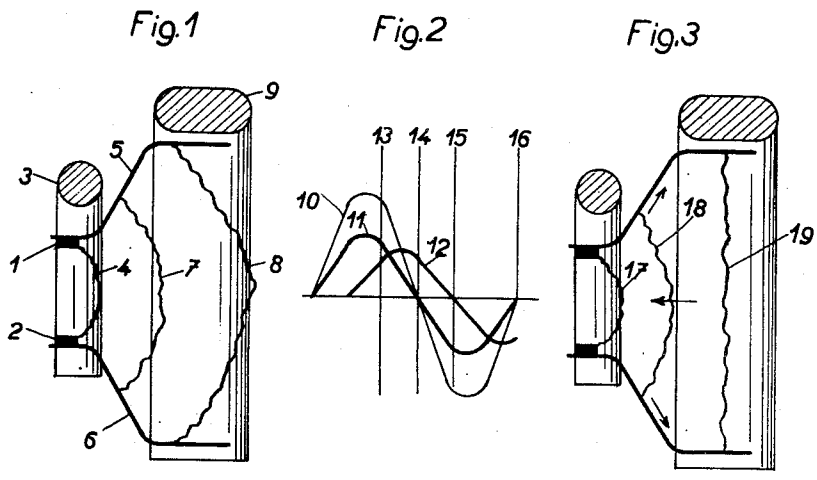
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MAGNETIC BLOWOUT CIRCUIT BREAKER FOR ALTERNATING CURRENT

Filed May 29, 1948

2 Sheets-Sheet 1



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Fig 4

2 Sheets-Sheet 2

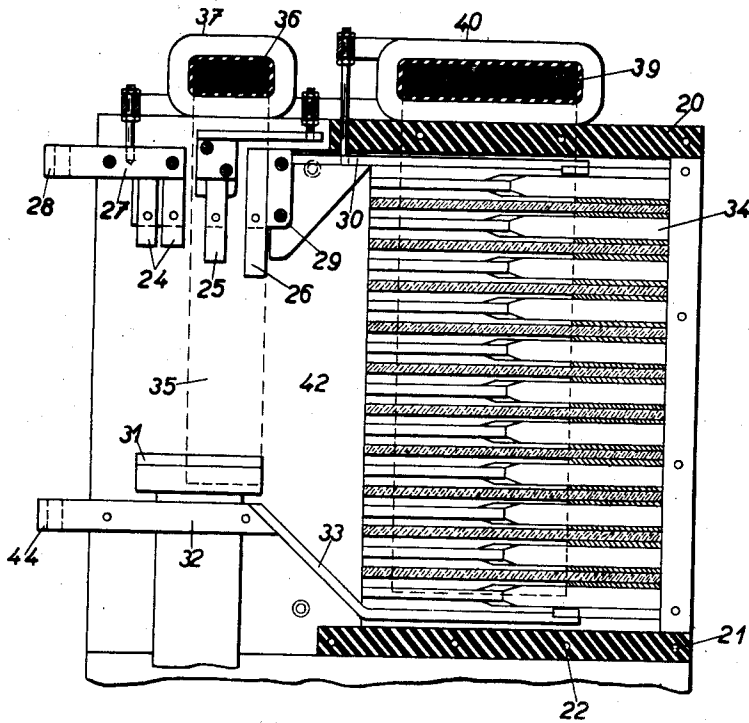


Fig. 5

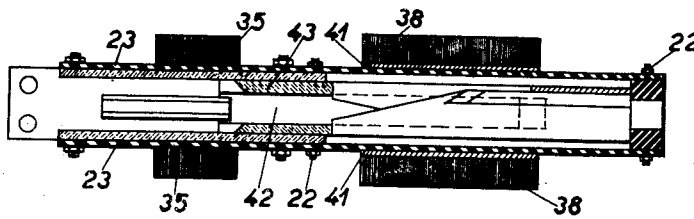


Fig. 6

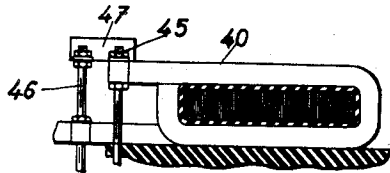
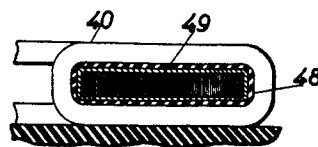


Fig. 7



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MAGNETIC BLOWOUT CIRCUIT BREAKER FOR ALTERNATING CURRENT

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7 Claims. (Cl. 200-147)

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This invention relates to magnetic air circuit breakers of the type in which the arc resulting from opening of the breaker contacts is magnetically directed or biased into an arc quenching chamber or chute. More particularly, the invention is directed to means for assuring a uniform entry of the arc into the quenching chute and a uniform distribution of the arc over the quenching elements.

Circuit breakers of the type to which the present invention is directed include a make-and-break contact structure arranged in advance of an arc quenching chamber or arc chute. The contact structure usually includes a set of main contacts and one or more sets of auxiliary contacts arranged between the main contacts and the arc chute. The contacts are so designed that the main contacts separate before the auxiliary contacts open, so that the resulting arc is progressively moved toward the arc chute.

To assist this transfer action, a pair of arcing horns extend from the auxiliary contacts into the arcing chamber, and magnetic field inducing means are connected in circuit with the auxiliary contacts and the arcing horn. Thus, as the arc passes onto the auxiliary contacts and the arcing horn, one or more magnetic fields are created which act to force the arc into the quenching chamber or arc chute. As the energizing circuits for these magnetic fields include the arc, the fields are maintained until the arc is extinguished.

The quenching chamber includes interleaved arc extinguishing elements extending longitudinally of an insulating housing. These elements serve to elongate and distort the arc path, and to effect a cooling of the arc with the result that the increased arc path length and the chilling of the arc atmosphere effect a breaking of the arc. The number of quenching elements is selected in accordance with the supply voltage, which latter determines the maintainable length of the arc.

In order for an arc of a selected voltage to be properly extinguished by a minimum number of quenching elements, it is necessary that the arc be distributed uniformly transversely of the quenching elements, and that the arc contact all of the elements substantially simultaneously. If these conditions are not met, a greater number of quenching elements are required for a selected operating voltage, thus increasing the size and cost of the arc chute and the circuit breaker.

In actual practice, as the arc is urged along the arcing horns, by an auxiliary magnetic field, for

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example, the center of the arc tends to lead the arc ends which run along the arcing horns. As the resulting bowed arc enters the main magnetic field, this bowing tendency is increased due to the main field acting upon the advanced outer portion of the arc before the ends of the arc enter the main field. Consequently, the quenching elements do not engage the arc front simultaneously, resulting in incomplete and inefficient utilization of the quenching chamber.

In accordance with the present invention, the arc is rectified or straightened between the auxiliary field and the main field so that all lineal increments of the arc contact the advance ends of the quenching elements substantially simultaneously. This straightening of the arc is effected in a rectification space separating the auxiliary field from the main field in the direction of bodily movement of the arc toward the arc chute. To effect the rectification of the arc, the phase of the main magnetic field is displaced so as to lag the phase of the auxiliary field.

As the energizing current of the auxiliary field is substantially in phase with the line or supply current, the auxiliary field is substantially in phase with such current. To effect the phase lag of the main field, delay elements are included in the energizing circuit of the main field and may comprise, for example, a short circuited turn or turns on the core of the main magnet, or may comprise reactive components in the energizing circuit of the main field.

As a result, the forwardly bulging control portion of the arc, as it leaves the auxiliary field, is retarded in the rectification space, so that the lagging ends of the arc still in the auxiliary field can "catch up" with the arc center. By proper selection of the amount of phase lag, the arc can be made rectilinear as it enters the main field. Consequently, the main field acts simultaneously on all lineal increments of the arc, and advances the arc as a straight element into the quenching chamber. The arc thus encounters all of the quenching elements simultaneously, resulting in efficient utilization of the arc chute and reducing the number of quenching elements required for a selected voltage.

With the foregoing in mind, it is an object of the present invention means to provide an improved arc quenching arrangement for an air circuit breaker.

Another object is to provide, in a magnetically quenched air circuit breaker, means to rectify the arc as it enters the arc chute.

These, and other objects, advantages and novel

features of the invention will be apparent from the following description and the accompanying drawings.

In the drawings:

Fig. 1 is a partial sectional view, somewhat schematic, illustrating the arc relations in a known air circuit breaker.

Fig. 2 is a set of curves graphically illustrating the principles of the present invention.

Fig. 3 is a view, similar to Fig. 1, illustrating arc relations resulting from use of the invention principles.

Fig. 4 is a vertical sectional view through an air circuit breaker embodying the present invention.

Fig. 5 is a transverse sectional view of the circuit breaker.

Figs. 6 and 7 are partial vertical sectional views illustrating alternative embodiments of the invention.

Referring first to Figs. 1, 2 and 3, an air circuit breaker is schematically illustrated as including circuit breaking contacts 1, 2 arranged within the field of an auxiliary magnet 3. When contacts 1, 2 are separated, an arc 4 is produced between the contacts. Under the influence of the magnetic field of magnet 3, arc 4 moves to the right along arcing horns 5, 6, with the center of the arc leading the ends thereof as shown at 4 and 7. The bowed shape of the arc is accentuated, as indicated at 8, as the arc enters the field of main magnet 9 which latter moves the arc into the arc chute for quenching of the arc. Such accentuation of the bowed shape of the arc is due to the central portion of the arc entering the field of main magnet 9 before the trailing arc ends enter the field. As a result of such bowing of the arc, the quenching elements are not all engaged simultaneously, so that there is an inefficient utilization thereof necessitating more elements for a selected operating voltage.

To rectify the arc shape, a lag of the phase of the field of magnet 9 is effected relative to the phase of the field of magnet 3. Referring to Fig. 2, curve 10 represents the time characteristic of the interrupted line current and curve 11 the time characteristic of the field of magnet 3. Curves 10 and 11 are substantially in phase. The time characteristic of the field of magnet 9 is represented by curve 12.

If, at point 13, an arc is formed, it is forced to the right by the field of magnet 3. At point 14, the direction of curves 10 and 11 changes, while curve 12 continues in its same direction. If the bowed center of arc 16 (Fig. 3) has already entered the main magnetic field, it is forced back to the rectification space between magnets 3 and 9, while the arc ends are moved forwardly by magnet 3. Thus, in the time interval between points 14 and 15, the arc is rectified as shown at 19 (Fig. 3).

If, at point 14, the bowed center of arc 16 has not yet entered the main magnetic field, it is repelled by the latter and so delayed that the trailing arc ends "catch up" with the center. As soon as the main field changes direction, as at point 15, the rectified arc is forced to the right by the field of magnet 9, engaging all the quenching elements simultaneously. When the arc current again passes through zero, the arc is extinguished.

Figs. 4 and 5 illustrate an air circuit breaker embodying the arc rectifying arrangement schematically shown in Figs. 1 and 3. Referring to Figs. 4 and 5, the breaker mechanism is arranged in an enclosure comprising top wall 20 and bot-

tom wall 21 to which side walls 23 are secured by bolts 22, all the walls being of dielectric fireproof material. The circuit closures include fixed main contacts 24, intermediate fixed contacts 25 and final fixed contacts 26. Contacts 25 are longer than contacts 24, and contacts 26 are longer than contacts 25.

Main contacts 24 are mounted in a holder 27 conductively secured to one line terminal 28. The final or firing contacts 26 are mounted in a holder 29 conductively secured to the upper arcing horn 30 extending into the arc chute or quenching chamber.

The circuit breaking mechanism includes a vertically movable contact member 31 in conductive relation with a holder 32 through sliding contact members (not shown), and holder 32 is conductively connected to the other line terminal 44 and the lower arcing horn 33 extending into the arc chute. Suitable mechanism (not shown) is provided to effect movement of contact 31 to engage and disengage the fixed contacts. Due to the differing lengths of contacts 24, 25, 26, these will be successively disengaged by contact 31, during opening movement of the breaker, so that the potential arcing path is progressively advanced toward the quenching chamber.

The quenching elements 34 in the arc chute may be of the type and arranged in the manner shown and described in our copending application Serial No. 35,310, filed June 26, 1948, or may be any other desired type. The illustrated elements 34, as set forth in said copending application, have a rail-like cross section and arc interfitted to form an elongated tortuous path for the arc to assure rapid extinguishment thereof.

Two magnets are arranged around the exterior of the breaker housing. The first magnet includes pole pieces 35, core 36 and coil 37, the pole pieces 35 being arranged in transverse alignment with contacts 25 and 26. Coil 37 is connected between contact holder 27 and contacts 25. The second magnet includes pole pieces 38, a core 39 and a coil 40, with pole pieces 38 embracing a substantial extent of the arc chute. Coil 40 is connected between contacts 25 and contacts 26.

The two magnets are spaced substantially, in the direction of movement of the arc toward the quenching chamber, to provide an arc rectification space 42 defined laterally by fireproof dielectric side plates 43. The rectification space is further enclosed by arcing horns 30 and 33 and by the arc entry ends of quenching elements 34.

When the breaker is closed, current flows from terminal 28 through holder 27, contacts 24, contact 31, and holder 32 to terminal 44. When the breaker starts to open, contacts 24 are disengaged first, and current then flows from terminal 28 through holder 27, magnet coil 37, contacts 25, contact 31 and holder 32 to terminal 44. The magnetic field provided by coil 37 is due solely to the switching off current and is basically in phase with the latter, or bears a fixed phase relation thereto depending upon the impedance of the coil 37.

A phase lag of the field provided by magnet coil 40, relative to that provided by magnet coil 37, is accomplished by conductive plates 41 (Fig. 5) of copper, for example, disposed between pole pieces 38 and walls 23. As contact 31 disengages contacts 25, current flows from terminal 28 through holder 27, coil 37, coil 40, holder 29, contacts 26, contact 31 and holder 32 to terminal 44. Due to the time lag effected by plates 41, the

magnetic field of coil 40 has a phase lag relative to the field of coil 37.

As contact 31 disengages contacts 26, an arc is formed between contacts 26 and contact 31 which is quickly transferred to the arcing horns 30, 33 by the magnetic field due to coil 37 and extending between pole pieces 35. As the arc enters rectification space 42, it comes under the influence of the time lagging magnetic field between pole pieces 38 and due to coil 40. The arc is rectified in space 42, as described above, and then forced into the arc chute and extinguished.

Figs. 6 and 7 illustrate alternative arrangements for effecting the time delay of the main magnetic field. In Fig. 6, reactive impedance 47, such as an inductance or capacitance, is connected in parallel with coil 40 by clamps 45, 46. In Fig. 7, a layer of conductive material, such as copper, is disposed around core 39 within the insulation of coil 40, and resulting ohmic currents effect the desired time delay.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles thereto, it should be understood that the invention may be otherwise embodied without departing from such principles.

I claim:

1. In a magnetic air circuit breaker of the type including a set of main contacts and at least one set of auxiliary contacts successively disengaged during opening of the breaker and a pair of arcing horns extending from the last-disengaged auxiliary set into an arc chute to transfer the arc into the chute to effect extinguishment of the arc, one arcing horn being connected to a line terminal, an arc rectification arrangement comprising a first magnet having its pole pieces transversely aligned with the auxiliary contacts and an energizing coil connected between the other line terminal and a set of auxiliary contacts; a second magnet having its pole pieces substantially embracing the arc chute and an energizing coil connected in series between the energizing coil of said first magnet and the other arcing horn whereby, when the main contacts are disengaged, said first magnet will be energized to create a field advancing the arc toward the arc chute and, when the auxiliary contacts are disengaged, both said magnets will be energized; said magnets being spaced apart in the direction of movement

of the arc into the arc chute to provide an arc rectification space enclosed in part by the arcing horns and the entrance to the arc chute; and means associated with said second magnet to introduce a lag in the phase of the field thereof relative to the phase of the field of said first magnet, the phase lag having a value sufficient to assure the field of said second magnet having an arc repelling effect during travel of the arc across the rectification space toward the arc chute under the arc advancing influence of the field of said first magnet to retard any portion of the arc advanced beyond other arc portions, by the action of the first magnet field, to rectify the arc; whereby, when the direction of the second magnet field is reversed, the entire arc will enter the arc chute simultaneously.

2. An arrangement as claimed in claim 1 in which said last named means comprises means delaying building up of the flux in the magnetic field of the second magnet.

3. An arrangement as claimed in claim 1 in which said last named means comprises magnetizing current retarding means.

4. An arrangement as claimed in claim 1 in which said last named means comprises conductive elements arranged to have a current flow induced therein by the field of the second magnet.

5. An arrangement as claimed in claim 1 in which said last named means comprises conductive elements disposed between the pole pieces of the second magnet and the arc chute.

6. An arrangement as claimed in claim 1 in which said last named means comprises a reactance connected in circuit relation with the coil of the second magnet.

7. An arrangement as claimed in claim 1 in which said last named means comprises a conductor disposed around the core of the second magnet and within the coil thereof.

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