



# UNITED STATES PATENT OFFICE

2,486,127

## AIR BLAST ELECTRIC CIRCUIT BREAKER

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3 Claims. (Cl. 200-148)

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My invention relates to electric circuit breakers, and more particularly to electric circuit breakers of the type employing a blast of air or other fluid to extinguish the arc formed when the circuit is broken between relatively movable contacts. Specifically, my invention is an improvement on United States Letters Patent 2,284,842, Prince et al., granted June 2, 1942, wherein a blast of gas is directed at high velocity transversely across the arc gap formed between the relatively separable contacts.

The cross gas blast circuit breaker disclosed in the above mentioned Prince et al. patent achieved very effective arc interruption by blasting the arc drawn between the separable contacts sidewise against and elongatingly around the edges of a plurality of transverse barriers arranged fanwise in a divergent arc chute. It is now recognized that the interrupting characteristics of this general type of cross blast breaker can be effectively improved by first transferring the arc drawn by the separable contacts to a pair of adjacent electrodes which constitute a so-called "fixed gap" whereby the arc length, and consequently the liberated arc energy, is effectively reduced. As a result of this limitation of arc length and energy, arc interruption can now be attained more efficiently even though but one transverse barrier is provided for suppressing the bowing of the arc downstream into the arc chute structure in the manner disclosed in U. S. Patent 2,452,953 to Paul et al., patented Nov. 2, 1948 and assigned to the same assignee as the present application.

My invention is directed to the further improvement of a fixed-gap, single barrier type of cross gas blast breaker whereby better control of the arc and extinguishment thereof is made possible. Also contemplated is an improved exhaust arrangement for a cross gas blast circuit breaker whereby the gas products of the single arc are dividingly diverted into at least two segregated exhaust passages for minimizing the possibility of restrike voltage breakdown through the ionized arc products.

It is therefore an object of my invention to provide an improved fixed gap across gas blast type of electric circuit breaker.

It is another object of my invention to provide a cross gas blast type circuit breaker having

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an improved intervening transverse barrier whereby arc extinguishment is made more effective.

A further object of my invention is to provide a cross gas blast circuit breaker wherein the ionized products of the single arc drawn by the relatively movable contacts are divided and segregatingly isolated into a pair of divergent insulating exhaust tubes.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 is an elevational view in section of an electric circuit breaker embodying my invention showing the circuit breaker in the closed position, and Fig. 2 is a somewhat schematic diagram of the contact structure of Fig. 1 with the contacts shown separated to a predetermined extent during the circuit interrupting operation.

Referring now to the drawings, I have illustrated an electric circuit breaker generally indicated at 1 in the form of a removable unit for use with metal-clad switchgear. The circuit breaker 1 is enclosed within a metal housing 2 from which extend a plurality of conductor studs 3, the terminals 4 of which are adapted to be electrically connected with cooperating terminals mounted within an associated metal enclosure (not shown).

Suitably supported within metal enclosure 2 is an insulating arc extinguishing structure 5 provided with a first passageway 6 therein, and a second passageway 7 arranged substantially transverse of said first passageway. A stationary contact 8 comprising a plurality of spring biased contact fingers 9 is mounted within passageway 6 and a movable arcuate contact 10 is adapted to move in passageway 6 to draw an arc therein upon relative separation from stationary contact 8. Stationary contact 8 is electrically connected to the upper conductor stud 3 as by means of conducting member 11. Movable arcuate contact 10, on the other hand, is illustrated as forming an integral part of a swinging link 12 pivotally

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 mounted at 13 to the end of lower conductor stud 3 which extends into housing 2. It will be obvious to those skilled in the art that swinging link 12 will be connected to a suitable operating mechanism (not shown) as by means of the link 14 to cause relative separation of contacts 8 and 10. When the contacts 8 and 10 are closed in the manner shown in Fig. 1 the circuit is completed between the terminals 4 of conductor studs 3 through contacts 8 and 10.

The second passageway 7 is preferably connected to a conduit 15 which in turn is connected to a source of fluid under pressure, such as air or other gas, through a suitable blast valve (not shown). As was mentioned above, the passageway 7 is substantially transverse to the passageway 6 within which the arc is drawn whereby the circuit breaker 1 may be correctly termed a cross gas blast circuit breaker. Also arranged within insulating arc extinguishing structure 5 are a pair of diverging passageways 16 and 17 arranged in divergent relationship to each other and each connected to passageway 7 near its intersection with passageway 6, as is clearly shown in Fig. 1 of the drawing. Diverging passageways 16 and 17 might well be considered as branches of passageway 7.

As is disclosed and claimed in the aforementioned Paul et al. Patent 2,452,953 improved interrupting capacity is obtained when the arc is extended to some short preferred gap length and extinguished. In accordance with the disclosure of the above mentioned copending Paul application, I provide a preferred arcing gap 18, formed between a stationary electrode 19 arranged in passageway 16 and a stationary electrode 20 arranged in passageway 17. Stationary or fixed arcing electrode 19 extends along diverging passageway 16 for a predetermined distance and similarly, fixed electrode 20 also extends along passageway 17 for a predetermined distance so as in effect to provide a pair of divergent fixed electrodes. Fixed or stationary electrode 19 is electrically connected to conducting member 11 and consequently stationary contact 8. Fixed electrode 20, on the other hand, is electrically connected to a sliding contact 21 in sliding engagement with movable contact 10. With this arrangement it is obvious that upon relative separation of contacts 8 and 10 an arc is drawn between them which arc is transferred to electrodes 19 and 20 which provide a fixed preferred gap 18 for optimum arc extinguishing action. The fixed gap 18 remains effective until movable contact 10 moves out of engagement with sliding contact 21 by which time the arc drawn will have been extinguished and the separation of movable contact 10 from sliding contact 21 will provide the desired isolating gap.

The diverging electrodes 19 and 20 provide a very desirable function in connection with my invention in that the current flowing through the loop formed by the diverging electrodes and the arc across gap 18 will produce a magnetic field tending to force the arc downwardly in opposition to the fluid blast from conduit 15. As a consequence thereof the arc tends to dwell near the point where the gas blast is most effective and furthermore is maintained short so that the energy liberated in the arc extinguishing structure is maintained at a minimum.

The above-mentioned magnetic effect influencing the arc which is transferred to the gap electrodes will be best understood by referring to Fig. 2. It is well-known that two spaced

parallel conductors carrying current in the same direction will be attracted toward each other by virtue of the magnetic lines of force produced around the conductors due to the current flowing in each. Conversely, two spaced parallel conductors due to the current flowing in each. Conversely, two spaced parallel conductors carrying current in opposite directions will be urged apart by the magnetic lines of force which crowd in between the two conductors. In either of these situations the magnitude of the force is proportional to the amount of current flowing and inversely proportional to the distance between the two conductors. When the downwardly extending portions of the electrodes 19 and 20 are connected in series, as when joined by the arc A, it will be evident that current flows through the downwardly extending portions of these electrodes in counter-directions, i. e., downwardly in one and upwardly in the other. Accordingly, in conformance to the above well-known theory, the magnetic effect will tend to force the electrodes apart, the magnitude of this force being greatest across the lowermost ends of the electrodes, i. e., where the distance between these ends of the electrodes is relatively small. Since electrodes 19 and 20 are fixed, they, of course, remain stationary and the arc A instead is moved downwardly by this crowding of the lines of force and, consequently, is bowed downwardly as shown. Stated more simply, the electrodes 19 and 20, together with the arc A define a loop circuit which tends physically to expand or get larger due to the crowding of the lines of force in the space between the electrodes. Since the arc portion of the loop is not fixed, the magnetic effect moves the arc downwardly against the fluid pressure so that the arc may assume a position such as that indicated at A in Fig. 2. Thus, it will be seen that this arc length and energy limiting feature is most effective at the very time when it is important that the arc length and energy be controlled, i. e., immediately after transfer of the arc to the electrodes 19 and 20 and before current zero is reached. After the current peak and as current zero is approached, the intensity of the arc A diminishes so that it is readily extinguished and its re-ignition is prevented by the gas blast. Should the arc persist and move upwardly along the downwardly extending portions of electrodes 19 and 20, the tendency for it to bow downwardly progressively decreases for the reason that the loop progressively becomes less clearly defined and will finally disappear altogether if the configuration thereof assumes the equivalent of a straight line conductor. Should this condition be reached, i. e., with the downwardly extending portions of electrodes 19 and 20 out of the circuit, the arc would then have no tendency to bow downwardly, but rather would bow upwardly due to the fluid blast to assume a position such as is indicated at B in Fig. 2. The wedgelike member 31 shown in Fig. 1 will ordinarily prevent the arc from assuming the position indicated at B in Fig. 2. Should the arc for any reason persist long enough to bend around the member 31, the loop configuration of the arc would still be preserved and the magnetic effect would still be operative to limit the length and energy of the arc.

Extending from diverging passageway 16 is a tube of insulating material 22 which is secured to the arc extinguishing structure 5. Similarly, extending from diverging passageway 17 is an insulating tube 23. These tubes 22 and 23 are ar-

5 ranged in diverging relationship with respect to each other with their upper ends extending into apertures 24 and 25, respectively, formed in the top of metal enclosure 2. These apertures are preferably covered by a suitable hood such as 26 and 27, respectively.

Suitable arc and gas cooling means are preferably disposed in insulating tubes 22 and 23. As illustrated, the cooling means comprise groups of perforated metal plates or grids 28 between which are disposed a plurality of metal balls 29. These metal balls might be brass or other suitable material. As illustrated, one group in each tube is preferably arranged near the entrance to the tubes.

In order to aid the interrupting operation, I preferably provide a resistor 30 connected across fixed electrodes 19 and 20 as is clearly shown in Fig. 2. In accordance with my invention, resistor 30 is preferably supported by being wound around diverging tubes 22 and 23, as is clearly shown in Fig. 1.

The operation of the circuit breaker I described above will be obvious to those skilled in the art in view of the detailed description included above. During the circuit opening operation movable contact 10 is separated from fixed contact 8 and an arc is drawn in first passageway 6. This arc is impelled by the air blast in passageway 7 to move to electrodes 19 and 20 which define fixed gap 18. Due to the inverse loop configuration of fixed electrodes 19 and 20 the current flowing through these electrodes and through the arc across gap 18 will produce a magnetic field in such a direction to produce a force on the arc which will oppose the force produced on the arc by the fluid blast thereby retaining the arc within the gas blast at the lower end of the fixed contacts 19 and 20. Also holding the arc physically in this desirable extinguishing zone is the wedge-form barrier structure 31. By this cooperation the arc is rapidly extinguished at the first current zero and the movable contact 10 continues to move to produce the necessary isolating gap.

It will be understood that the hot gases evolved during the interrupting operation are cooled within the two tubes before expulsion from the upper ends thereof to the exterior of the metal enclosure 2. As long as the movable contact 10 electrically engages sliding contact 21 the resistance 30 is connected in parallel with the arcing contacts. This arrangement will aid circuit interruption in a manner well understood by those skilled in the art.

It will be understood that where desired, more than two insulating tubes such as 24 and 23 may be provided for the arc extinguishing structure, and these tubes may be disposed in positions other than those indicated.

It will be seen that with the arrangement according to the invention the ionized gas produced upon interruption of current through the circuit breaker is divided into two or more independent streams which are adequately cooled before being discharged to the atmosphere and that this subdivision is obtained by means of discharge passages comprising insulating tubes separate from one another so that all hazardous intercommunication by leakage of the ionized gas between the passages is obviated. The above described arrangement therefore provides a cross gas blast circuit breaker possessing exceptional arc extinguishing characteristics which moreover is capable of withstanding high rates of recovery voltage without danger of the arc

6 restriking by re-establishment through the ionized arc products.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A gas blast electric circuit breaker of the cross blast type comprising an insulating arc extinguishing chamber including a first passageway therethrough, a pair of relatively movable contacts adapted to draw an arc in said first passageway, a second passageway substantially transverse of said first passageway, means for supplying a blast of gas under pressure to said second passageway, and means for limiting the energy of the arc drawn between said relatively movable contacts comprising a pair of electrodes mounted in said second passageway downstream from said contacts, one end of each of said electrodes being spaced from said contacts and from the corresponding end of the other of said electrodes, the other end of each of said electrodes being more remote from said contacts than said one end, and conducting means respectively connecting said other ends of each of said electrodes to different contacts to define a loop circuit for the current after transfer of the arc to said electrodes by the action of the gas blast during a circuit interrupting operation, thereby to limit the length and energy of the arc.

2. A fluid blast electric circuit breaker of the cross blast type comprising an arc extinguishing chamber including a first passageway therethrough, a pair of relatively movable contacts adapted to draw an arc in said first passageway, a second passageway substantially transverse of said first passageway, means for supplying a blast of fluid under pressure to said second passageway, a pair of branch passageways in said chamber terminating at the intersection of said first and second passageways, an electrode in each of said branch passageways, one end of each electrode being spaced from said contacts and from the corresponding end of the other electrode, the other end of each of said electrodes being more remote from said contacts than said one end, and conducting means respectively connecting said other ends of each of said electrodes to different contacts to define a loop circuit for the current after transfer of the arc to said electrodes by the action of the fluid blast during a circuit interrupting operation.

3. A gas blast electric circuit breaker of the cross blast type comprising an arc extinguishing chamber including a first passageway therethrough, a pair of relatively movable contacts adapted to draw an arc in said first passageway, a second passageway substantially transverse of said first passageway, means for supplying a blast of gas under pressure to said second passageway, a pair of branch passageways in said chamber terminating opposite the intersection of said first and second passageways, an electrode in each of said branch passageways, each electrode having a portion thereof disposed near the entrance of the branch passageways and another portion thereof downstream from the entrance of the branch passageways, and means for respectively

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interconnecting the downstream portion of each electrode and a different one of said contacts.  
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