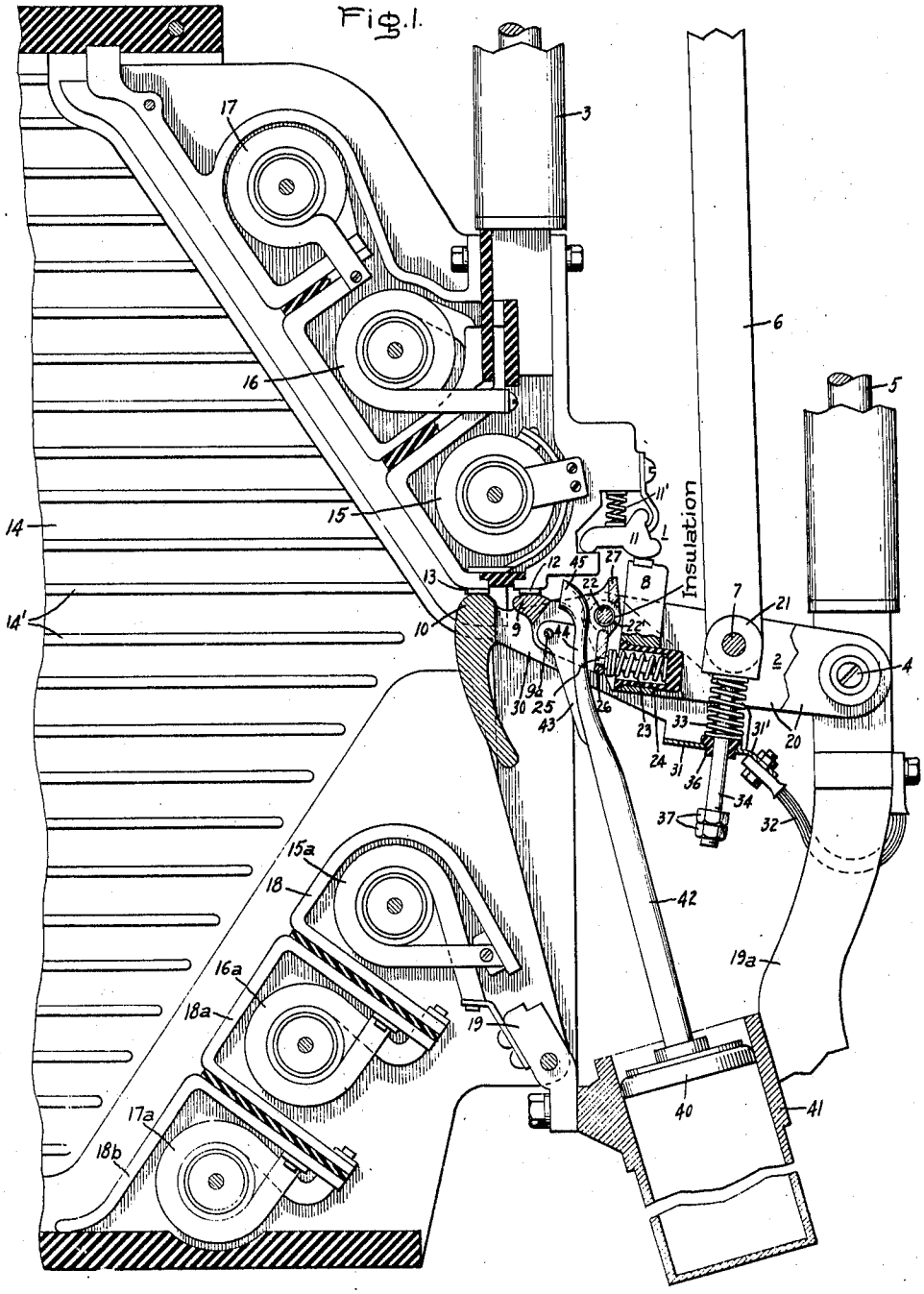
May 2, 1944. R. J. BASKERVILLE 2,347,984

ELECTRIC CIRCUIT BREAKER

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Fig. 1.



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Fig. 2.

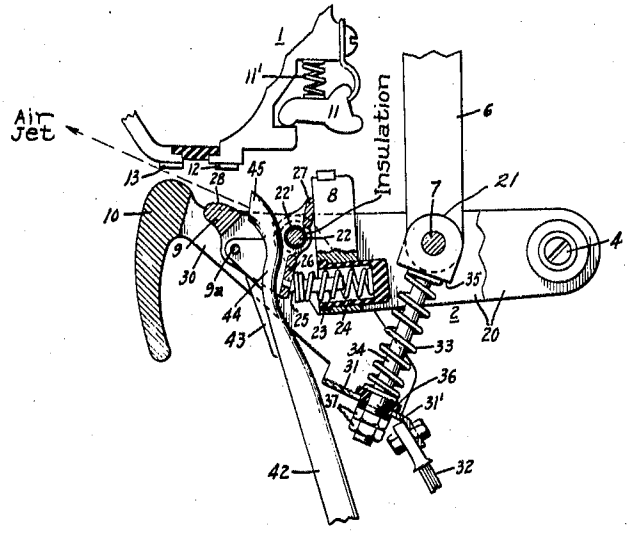
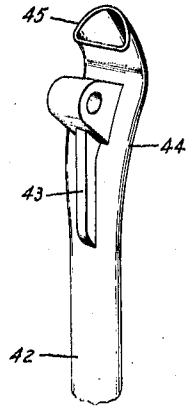


Fig. 3.



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ELECTRIC CIRCUIT BREAKER

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Application April 17, 1943, Serial No. 483,414

5 Claims. (Cl. 200—148)

My invention relates to electric circuit breakers, more particularly to air circuit breakers of the magnetic blow-out type, and has for its principal object the provision of improved circuit breaker structure that is efficient in operation throughout the entire rated current range of the breaker, compact and rugged in design and particularly adapted to carry, as well as to make and break, medium voltage power currents with minimum contact deterioration and heating.

It has been proposed to extinguish low-current arcs in circuit breakers of the magnetic blow-out type by a pneumatic device operatively connected to the movable contact structure and arranged so that a jet of air is directed across the arc in accordance with separation of the contacts. This air jet not only is intended to interrupt low-current arcs at 5000 volts, for example, which ordinarily tend to "hang on" due to the comparatively weak blow-out field, but also tends to drive the arc into the chute proper where it is more effectively cooled and extinguished. A circuit breaker of this type is disclosed for example in my Patent No. 2,280,616 issued April 21, 1942, for "Electric circuit breaker."

In the practical application of this scheme, I have encountered certain difficulties that tend to lessen the effectiveness of the air jet. For example, as the opening stroke of the breaker proceeds, the air jet may be directed in less effective directions and in certain instances the jet may to a large degree be blocked off in respect to the arc in certain positions of the movable contact structure.

In accordance with my invention, the pneumatic device or air jet apparatus is related to the movable contact structure so that the air jet is efficiently and consistently applied in the best manner to the arc to be extinguished throughout the entire interrupting stroke of the breaker. Therefore, in case the arc is not extinguished in the early stage of the opening operation, it is nevertheless still subjected to effective extinguishing action.

My invention will be more fully set forth in the following description referring to the accompanying drawings, 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.

Referring to the drawings, Fig. 1 is an elevational view, partly broken away and in section, of an air circuit breaker of the magnetic blow-out type embodying the present invention; Fig. 2 is a similar view of the movable contact structure of Fig. 1 shown in a partly open circuit position, and Fig. 3 is an enlarged detail view of the nozzle of the pneumatic device shown in Figs. 1 and 2.

The air circuit breaker shown by way of example is of the magnetic blow-out type employing an arc chute of any suitable form into which the arc is directed and extinguished. The power circuit to be interrupted includes relatively movable contacts between which the arc is formed at the entrance to the arc chute when the contacts separate. Specifically, the contacts comprise the fixed contact structure generally indicated at 1 and coacting movable contact structure generally indicated at 2. The fixed contact structure is electrically connected to the lower end of a lead-in conductor stud 3 defining one terminal of the breaker, and the movable contact structure comprises an arm electrically connected to and pivotally mounted at 4 on the conductor stud 5 defining the other breaker terminal. The pivoted contact 2 is suitably operated between open and closed circuit positions by an operating rod 6 that is suitably connected at 7 to the contact and also to the operating mechanism (not shown).

The breaker is shown in the closed circuit position, the coacting main, transfer and arcing contacts, 8, 9 and 10 respectively, of the movable contact arm being in engagement with the corresponding main, transfer and arcing contacts 11, 12 and 13 respectively of the fixed contact structure. Opening of the breaker by counter-clockwise rotation of the breaker arm 2 causes in sequence separation of the main current carrying contacts 8—11, the transfer contacts 9—12, and finally the arcing contacts 10—13 where the power arc is formed at the entrance of the arc chute 14. The arc chute per se is not my invention and may be for example of the type having insulating arc extinguishing baffles 14' as disclosed in Letters Patent No. 2,293,513 issued August 18, 1942, to L. G. Linde for "Electric air circuit breaker."

The arc chute is also illustrated as provided with magnetic blow-out coils 15, 16 and 17 at one side of the chute and coils 15*a*, 16*a* and 17*a* at the opposite side arranged so as to cause the arc formed between the contacts 10—13 to be blown by the magnetic field into the arc chute. The blow-out coils 15, 16 and 17 are normally shunted by the main and secondary contact structure in the closed circuit position but are cut into the circuit by the arcing contacts in a manner well known in the art. The blow-out coil 15*a*, one ter-

minal of which is connected to the arcing horn 18 within the arc chute and the other terminal to a conducting block 19 that is in turn connected to a conducting extension 19a of the terminal conductor stud 5, is cut in the circuit when the arc is drawn across the entrance of the arc chute and jumps to the arc runner 18. When this occurs, the arc current is shunted around the contact arm 2 through the coil 15a and terminal extensions 19 and 19a. As the arc moves toward the chute exhaust it jumps across the insulating gaps indicated between the other series connected sections 18a and 18b of the arc runner, thereby cutting in the coils 16a and 17a. Therefore, when the arc is at the arc runner section 18b all three blow-out coils are in series with the arc. The blow-out coils 15, 16 and 17 are cut in the interrupting circuit in a similar manner as is well known in the art.

Referring more particularly to the movable contact 2, the main switch arm comprises a pair of spaced plates 20 interconnected by the pivot pin 4 at opposite sides of the stud 5. The spaced plates 20 are also interconnected by the pin 7 which serves to connect the switch arm to the operating rod 6. Secured to the plates 20, as by welding, is the main current carrying contact 8. This element is formed as a block extending between the plates 20 in the manner of a partition. The upper or contact surface of the main contact is preferably coated with silver or other suitable contact material having low contact resistance.

Also mounted between the plates 20 at the outer ends thereof is the secondary or transfer contact 9. This contact is pivotally mounted on a pin 22 interconnecting the plates 20 and is spring-biased in a clockwise direction by means of a compression spring 23 seated at one end in a depression formed in an insulating cup 24 supported in the main contact block 8 and held in position at the other end by a member 25 connected to an extension 26 of the transfer contact 9. It will be noted that the extension 26 serves as a limit stop with respect to counter-clockwise rotation, and a second extension 27 in combination with the main contact 8 serves as a limit stop in the opposite direction. The contact structure is shown with the transfer and arcing contact springs stressed, the contacts being in the closed circuit position. The contact surface of the transfer contact 9 at 28 (Fig. 2) is preferably coated with an arc resisting metal, such as a suitable tungsten and copper alloy.

The proper function of the arcing contact 10 is very important since the power circuit is initially made and finally broken at these contacts. It is therefore essential that the arcing contacts initially close and remain closed under suitable contact pressure notwithstanding large magnetic forces tending to blow open the contacts upon closing. Weak or insufficient contact pressure upon closing may result in serious unnecessary arcing at the contacts tending to shorten the life thereof.

Nothwithstanding the fact that the main and transfer contact structures above described occupy to a great extent the available space at the contact end of the switch arm 2, I have provided means for insuring adequate spring pressure and mechanical advantage for the arcing contact member that is mounted at the very extremity of the switch arm. To this end, the arcing contact structure comprises a pair of elongated plate-like members 30 disposed at opposite sides of the switch arm 2 and co-pivotally mounted with the transfer contact 9 on the pivot pin 22. The plates 30, which extend generally parallel along the outer sides of the plates 20 for an appreciable distance are joined together at the outer extremity by the arcing contact 10 and at the opposite end by the plate 31 which bridges that end to serve both as a spring seat and as a terminal for directly electrically connecting the arcing contact at 31' to the terminal stud 5. By means of insulating bushings 22' and 36 at the pivot pin 22 and the plate 31 respectively, the arcing contact member is insulated from the main switch arm so that the arc current flows directly from the arcing contact 10 to the terminal stud 5 through the plates 30, terminal 31' and the flexible conductor 32 is illustrated by Fig. 1. The conductor 32 is preferably of spring steel and tensioned so as to increase the contact pressure. As in the case of the transfer contact, the contact and arcing surface of the contact 10 is coated with a suitable arc resisting metal, such as tungsten copper alloy.

For the purpose of biasing the contact 10 about the pivot pin 22 in clockwise direction so as to assure adequate contact engagement at the arcing contact surface, a plurality of nested springs 33 are positioned about an eyebolt 34 in the space defined by the plates 20 so as to seat between the bolt head 21 and the plate 31 bridging the extremities of the side plates 30. The springs 33 are positioned and guided by means of the eyebolt 34 that is connected at its upper end to the pin 7 and extends freely through the bridge 31. As shown, the springs 33 engage at one end a shoulder 35 connected to the lug and at the lower end engage an insulating bushing 36 for insulating the springs with respect to the plates 30. The lower end of the eyebolt is provided with adjustable lock-nuts 37 which define the amount of contact "wipe" at the arcing contacts. This adjustment is also particularly adapted to assure uniform opening and closing of three similar switch arms in a polyphase breaker.

In the arrangement shown, it will be apparent that when the operating rod 6 is lowered to open the breaker, the main contacts 8 and 11 separate practically at once, subject to limited wipe of the fixed main contact 11 as indicated at 11', so that the power current is shunted through the parallel conducting paths defined by the transfer contacts and arcing contacts. No arcing occurs at the main contacts since the transfer contact circuit has low resistance. As the contact arm continues to open, the spring 23 of the transfer contact maintains this contact in engagement with its coacting contact 12 until the limit stop 28 engages the contact 8. Separation of the transfer contacts then follows, and since the transfer of current to the arcing contact circuit now involves a path of somewhat higher impedance due to the blowout coil 15, slight arcing may occur at the transfer contacts. However, this arcing is readily extinguished so that the power current is completely transferred or shunted to the arcing contacts.

Since, as clearly indicated by Fig. 2, the springs 33 are effective to maintain the arcing contact in engagement for an appreciable time after initial contact movement, i. e. until the bridge 31 engages the adjusting nuts 37, it will be apparent that the arcing contacts 10—13 do not separate until after separation of the transfer contacts 9—12. At this time, the main arc is drawn and the arc interruption process takes place in the manner above indicated. By reason of the arcing contact

arrangement, it will be seen that high contact pressure can be maintained at the arcing contacts without using high pressure gradient springs with the disadvantages incident to the use thereof. By greatly increasing the mechanical advantage of the arcing contact arm without appreciably increasing the overall dimensions of the main switch arm, low pressure gradient springs may be used and in addition the switch arm as a whole can be more efficiently operated. Furthermore, the switch arm assembly, notwithstanding the compact and efficient arrangement is readily accessible for inspection and maintenance. The electrical efficiency of the switch arm is high due to the fact that the arcing contact arm is directly connected to the terminal stud **5** through the flexible jumper **32** so as to eliminate resistance at pivot pins, joints, et cetera.

Another factor tending to increase the efficiency of the arcing contact lever **30** is the increased arcing contact pressure caused by the magnetic forces of the current. It is well known that the magnetic forces of current flowing through a loop tend to expand the loop. Therefore, it will be observed that in the current loop defined by the conductors **3—30—32—5**, the expansive forces acting at the right of the fixed point **22** are preponderant and urge the lever **30** in a clockwise direction by reason of the greater length of the current path between pivot **22** and stud **5** as compared with the length between pivot **22** and contact **10**. This increase in contact pressure, which supplements the spring pressure, increases with the size of the current, thereby greatly decreasing contact heating. Also, this arrangement counteracts the tendency of the arcing contact pressure to decrease as where the magnetic forces urge the switch arm toward open position.

The interruption of low current arcs at moderate voltages, such as 5000 volts, is sometimes attended with difficulty due to the comparatively weak magnetic blow-out field. In such cases the arc may not even be driven into the chute proper. For the purpose of interrupting arcing under all conditions, the movable contact **2** is provided with pneumatic means for directing an arc extinguishing jet of air across the arcing surfaces of both the transfer and arcing contacts in accordance with opening movement of the breaker. Furthermore, this jet is so directed that it is effective during the entire arc interrupting operation regardless of the position of the contacts.

To this end, the transfer contact **9** is connected at **9a** to a piston **40** that is operable in the fixed cylinder **41**. The cylinder is suitably mounted on the main breaker structure and forms part of the conducting path between the terminal **19** and the conductor **19a** as illustrated. The connecting piston rod **42** is hollow as shown by Fig. 3 and communicates directly with the interior of the cylinder through the piston **40**, and at the opposite end is provided with a flange member **43** that is connected to the pivot pin **9a**. The hollow piston rod **42** is provided with a restricted part **44** terminating in an expanding nozzle or the like **45** (Fig. 3) adjacent to the secondary and arcing contacts.

In accordance with my invention, the nozzle pipe **42** is hung in pivoted relation on the contact **9** so that the nozzle supporting pivot **9a** is approximately beneath the arcing surface of contact **9**. In this manner, the air jet from the expanding nozzle **45** tends to flow across the arc root on the contacts throughout the opening movement, in contrast to "over-shooting" or "under-shooting" the arc, or blocking-off of the jet by contact structure, in intermediate positions of the contacts.

It will also be noted, referring to Fig. 3, that the nozzle **45** has a generally triangle-shaped opening and is of the expanding type due to the constriction at **44**. This is advantageous since an adequate and more uniform supply of air is delivered to the arc gap notwithstanding variations in the arc back-pressure at the nozzle opening, as is now well known in the art.

By way of example, this more uniform and efficient application of the air jet to the interrupting arc makes possible quick interruption of low currents at 15,000 volts. Heretofore, this has been very difficult in air circuit breakers of the aforesaid type.

When the breaker is opened, the piston **40**, which is connected through the contact **9** to the coupling pin **22**, is forced downward at high speed with the result that air in the lower part of the cylinder **41** is rapidly forced under pressure into the hollow piston rod and through the nozzle **45** to extinguish high voltage low current arcs. As best illustrated by Fig. 2 a jet of air directed from the nozzle **45** blasts the arcing surfaces of both contacts **9** and **10**. Contact burning is thereby minimized, the arc is quickly blown into the chute and extinguished and the circuit is cleared within a cycle or so of arcing, thereby precluding unnecessarily long arc lengths.

It should be understood that my invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of my invention.

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

1. An electric air circuit breaker comprising contacts separable to form an arc gap, said contacts including a movable contact structure having a pivoted arcing contact, a pneumatic device operatively connected to said pivoted contact for directing an arc extinguishing jet of air across said arc gap in accordance with separation of said contacts, and means for pivotally connecting said device to said pivoted arcing contact at a point offset with respect to the pivotal mounting thereof so that the direction of said air jet is maintained substantially uniformly across the arcing surface of said contact during separation of said contacts.

2. An electric air circuit breaker comprising a fixed contact and a coacting movable arcing contact pivotally mounted with respect to said fixed contact, a pneumatic device operatively connected to said movable contact for causing an arc extinguishing jet of air to be directed across said arcing contact as said contact moves toward open circuit position, and means for pivotally connecting said device to said arcing contact at a point offset from the pivotal mounting of said arcing contact so that the direction of said air jet is maintained substantially uniformly across the arcing surface of said contact during the contact opening operation.

3. An electric air circuit breaker comprising fixed contact structure, a pivoted coacting movable contact structure including an arcing contact pivotally mounted thereon, a pneumatic pump operatively connected to said movable contact structure for causing an arc extinguishing jet of air to be directed across said arcing contact in accordance with circuit opening move-

ment of said movable contact structure, a nozzle communicating with said pump, and means for pivotally mounting said nozzle on a freely moving part of said arcing contact so that as said movable contact structure is opened the direction of said air jet is maintained substantially uniformly across the arcing surface of said arcing contact.

4. An electric air circuit breaker comprising fixed contact structure, a pivoted coacting movable contact structure including arc transfer and arc interrupting contacts pivotally mounted in general alignment thereon, a pneumatic pump operatively connected to said movable contact structure for causing an arc extinguishing jet of air to be directed across both said transfer and interrupting contacts in accordance with circuit opening movement of said movable contact structure, a nozzle of the expanding type communicating with said pump, and means for pivotally mounting said nozzle on a freely moving part of one of said last-named contacts so that as said movable contact structure is opened the direction of said air jet is maintained substantially uniformly across the arcing surfaces of both said transfer and interrupting contacts.

5. An electric air circuit breaker comprising fixed contact structure, a pivoted coacting movable contact structure including an arcing surface, a pneumatic pump operatively connected to said movable contact structure for causing an arc extinguishing jet of air to be directed across said arcing surface in accordance with circuit opening movement of said movable contact structure, a nozzle located adjacent to said arcing surface and communicating with said pump, said nozzle being of the expanding type and having a generally triangle-shaped opening, the base portion of the triangle being approximately opposite and in alignment with said arcing surface, and means for pivotally mounting said nozzle on a part of said movable contact structure so that as said movable contact structure is opened the direction of said air jet from said nozzle is maintained substantially uniformly across said arcing surface.

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