Feb. 3, 1942. D. C. PRINCE 2,271,989

ELECTRIC CIRCUIT BREAKER

Filed Sept. 13, 1939

Fig. 1.

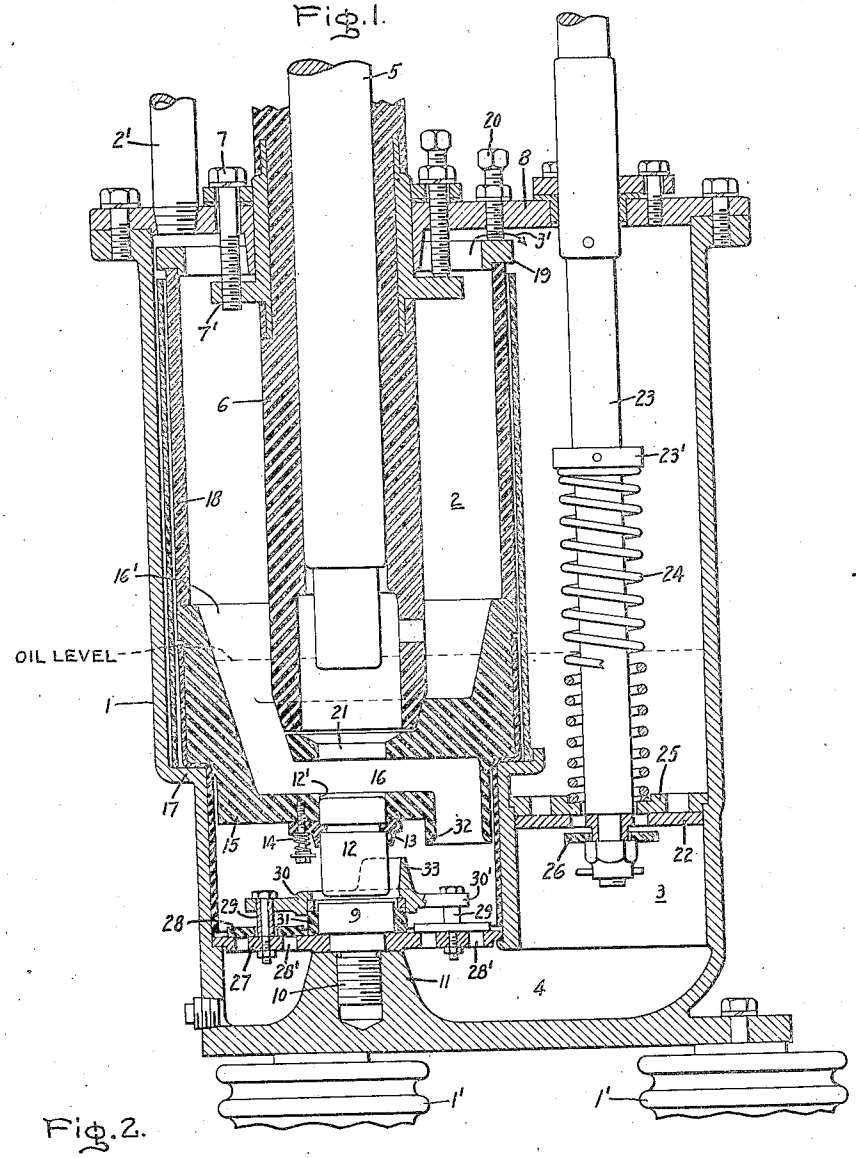


Fig. 2.

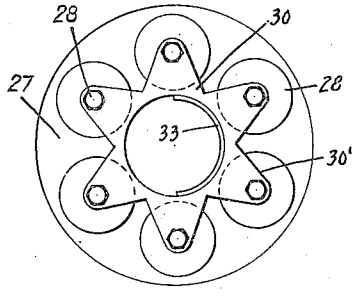
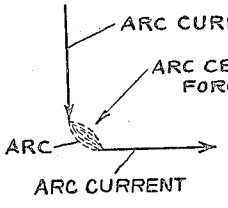


Fig. 3.



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ELECTRIC CIRCUIT BREAKER

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Application September 13, 1939, Serial No. 294,642

8 Claims. (Cl. 200—150)

My invention relates to electric circuit breakers, particularly to circuit breakers of the fluid jet type wherein an arc extinguishing fluid, such as oil, is directed under pressure through an arc gap formed upon opening of the circuit. More specifically, my invention relates to the "impulse" type circuit breaker wherein a piston, or the equivalent thereof, is utilized to force oil or the like through the interrupting gap to extinguish the arc, and has for its principal object the provision of auxiliary means for appreciably increasing the interrupting capacity of this type breaker, particularly in the case of heavy overload and short circuit currents.

Heretofore, the operation of the impulse type breaker has mainly been dependent on a spring charged piston or the like for driving oil through the interrupting gap under all conditions of current and voltage. This arrangement is very effective throughout a wide range of interrupting conditions except in the case of heavy overload and short circuit currents where excessive arc pressure may halt or even reverse the movement of the piston so as to cause failure of the breaker.

In accordance with the present invention, the arc pressure itself is utilized automatically to effect interruption by means of a liquid blast when the arc pressure equals or exceeds the piston pressure.

My invention will be more fully set forth in the following description referring to the accompanying drawing, 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 drawing, Fig. 1 is an elevational view partly in section of an oil circuit breaker in the open circuit position embodying the present invention; Fig. 2 is a plan view of the valve structure and arc control ring shown in Fig. 1, and Fig. 3 is a graphical illustration relating to the arc control means of Figs. 1 and 2.

The oil circuit breaker illustrated by way of example comprises a main casing 1 that is divided into a switch chamber 2 for housing the relatively movable contacts and arc extinguishing structure, and a piston cylinder 3 arranged to be in communication with the switch chamber through a passage 4. The casing 1 which is provided with insulating supports at 1' is composed of metal such as steel and constitutes one terminal of the circuit breaker, the other terminal of which is suitably connected to the movable contact rod 5. This contact is slidably guided for coaction with the relatively fixed contact structure in an insulating bushing 6 that is in turn suitably mounted, as indicated at 7 and 7', in the cover plate 8 of the switch casing.

The complete contact structure comprises a fixed butt contact 9 having a threaded extension 10 that is secured to a frustro-conical portion 11 formed on the lower wall of the switch casing. The fixed contact is therefore in direct electrical contact with one switch terminal, i. e., the metal casing 1. Interposed between the movable rod contact 5 and the fixed contact is an intermediate or floating contact 12 that is carried by an insulating support 13 that is in turn resiliently mounted on the lower wall, as indicated at 14 of the insulating baffle 15. The contact 12 is slidably guided in the baffle as illustrated and for practical purposes seals at all times the baffle aperture 121. In the open circuit position shown, the floating contact 12 is biased at 14 upwardly and away from the fixed contact 9 so that a short gap (approximately ⅛") separates the contacts.

When the circuit breaker is to be closed, the rod contact 5 is lowered by suitable operating means (not shown) first to engage the upper butt contact surface of floating contact 12, and subsequently upon continued movement to complete the circuit by pressing the floating contact against the fixed contact 9. The reverse order is followed upon opening of the circuit, the arc initially formed between the contacts 9 and 12 being utilized to generate pressure for assisting in interrupting the arc between the contacts 12 and 5 in a manner that is now well known in the art.

The breaker casing is filled with a suitable arc extinguishing liquid, such as oil, to the level indicated so that the baffle 15 is practically immersed. This baffle forms two chambers within the main chamber 2, the chamber below the baffle being in effect a pressure chamber, and the one above the baffle being an exhaust chamber. The baffle is provided with a cross blast passage 16 that communicates at its lower end with the pressure chamber, and after passing transversely through the arc path between the contacts 5 and 12, exhausts at 16' to the upper chamber. The baffle 15 is constructed of a mechanically strong insulating material and is positioned in the casing between the casing shoulder 17 and an insulating sleeve 18 that is in turn firmly engaged by a positioning ring 19 and adjusting means 20 secured to the casing cover 8. The lower end of the tubular insulating bushing 6 enclosing the movable contact seats on the upper wall of the baffle 15 which is provided with an aligned aperture 21 for the movable contact.

The cylinder 3 is provided with a piston 22 having an operating rod 23 actuated by means suitably related to the operating means for the movable contact. Such operating means form no part of the present invention and may for

example be of the type disclosed and claimed in my Patent No. 2,025,549, granted December 24, 1935, for "Operating mechanism for electric circuit breakers." The piston is also provided with a resetting spring 24 seated between a stationary spider 25 and a shoulder 23' on the piston rod. A disc-type one-way valve 26 coacts with the piston as illustrated for the purpose of permitting the oil to flow back into the lower part of the casing upon the return or resetting stroke of the piston. Accordingly, when the piston 22 is driven downward from the position shown, oil is forced from the cylinder 3 through the passage 4 upwardly into the pressure chamber beneath the baffle 15, from whence it can escape only by way of the transverse blast passage 16 into the upper exhaust chamber.

In the case of low or moderate load currents, the oil driven solely by the piston across the arc between contacts 5 and 12 would generally be effective to interrupt arcing within a cycle or so. However, in the case of large overload or short circuit currents, the back pressure generated at the interrupting arc might be so great that the motion of the piston is actually reversed. In such a case, the piston is obviously ineffective and failure of the breaker generally results.

For the purpose of utilizing the arc pressure to the best advantage in such a case, the initially formed or pressure generating arc at 9—12 supplements the piston action. To this end a valve plate 27 is mounted on the frustro-conical portion 11 so that it forms a partition between the arc pressure chamber and the cylinder 3. A plurality of disc-type one-way valves 28 are mounted on the valve plate to control the openings 28' communicating with the cylinder passage 4 and the arc pressure chamber. As shown, the valves which are slidably guided on the post supports 29 open freely when the pressure in the piston cylinder exceeds that in the arc pressure chamber, but seat tightly to close the openings 28' when the arc chamber pressure exceeds that in the piston cylinder. Therefore, in the case of the heavy current interruptions previously referred to, the arc pressure, when it exceeds the piston pressure, causes closing of the valves 28 and drives oil from the pressure chamber through the transverse blast passage 16 to interrupt the high current arc. The arc pressure is therefore utilized for arc interruption instead of being partially dissipated in causing reversal of the piston. It will be apparent that in other cases where the piston is effective, the pressure generated by the initial arc serves to augment or supplement the piston pressure to aid in interrupting the arc. The exhaust chamber is suitably vented at 2' to the usual separating chamber (not shown), and also at 3' to the piston cylinder for the purpose of equalizing pressure therein.

Under certain conditions, particularly in the case of large currents, the pressure generating arc formed between contacts 9 and 12 may be bowed or looped by the magnetic forces so as to strike the valve plate itself. This is due to the well-known magnetic effect in a current carrying conductor that may be in part offset with respect to its longitudinal axis. Where the conductor is very flexible, as in the case of an arc, the bowing effect is of course cumulative. The resulting long arc not only causes excessive pressure in the arc chamber but also may cause damage to the valves and valve seats. For the purpose of controlling the pressure generating arc so that it does not appreciably exceed in length that of the gap between contacts 9 and 12, I provide means for utilizing the magnetic forces so as to prevent or limit outward bowing or looping of the arc beyond a certain point.

To this end, a conducting ring 30 is mounted on an insulating cylindrical spacer 31 so as to surround in spaced relation the arc gap. The ring 30 is composed of a metal such as copper, and is held in position by the valve guide posts 29 which are also composed of conducting material for electrically connecting as indicated the ring 30 to the metal valve plate 27. As best illustrated by Fig. 2, the ring 30 is provided with a plurality of lateral apertured extensions 30' for connection to the guide posts. In the specific arrangement illustrated, the extensions correspond in number to the valves, six in all, which are concentrically positioned on the valve plate with respect to the centrally located fixed contact.

In case the arc is looped by unbalanced magnetic forces into contact with the ring 30, it will be noted that the magnetic forces established by the arc current flowing at right angles from the contact 12 through the ring to the valve plate by way of the extensions 30' and guide posts 29 act in a direction opposing the forces that originally caused looping of the arc. This is graphically illustrated by Fig. 3. In Fig. 3, the vertical current arrow indicates the current flowing down through the contact 12 and the horizontal current arrow indicates the current flowing out along an extension 30' so as to form a right-angle loop. Since, according to well-known electromagnetic principles, the magnetic forces set up in a current loop tend to expand the loop, it will be apparent that the resultant force, i. e. the arc centering force, acts on the arc generally as indicated to loop or bow the arc back towards the contact 9. In other words, the arc, once it strikes the arc control ring 30, shunts the arc current around the original gap by way of the extensions 30' so that the newly established arc is immediately acted upon by forces tending not only to limit further extension of the arc but also to center the arc with respect to the original gap, i. e. the normal region of arcing between the coacting contact surfaces. Therefore, the arc is automatically maintained within a comparatively short arc gap and excessive arc pressures and damage to adjacent structure are thereby effectively precluded.

In the case of large current interruptions, highly heated arc gases may be carried by the oil blast into the transverse passage 16 so as to cause difficulty in clearing the circuit. This is prevented in the present case by a form of baffle arrangement between the pressure generating arc and the intake of the blast passage comprising a spout or the like 32 extending beneath the baffle 15 into the pressure chamber and an oxset ridge or lip 33 mounted on the arc control ring 30 at a position between the arc gap and the spout 32. This arrangement forms no part of the present invention and is fully described and claimed in a copending application, S. N. 294,644, filed concurrently herewith by W. F. Skeats for "Electric circuit breaker," and assigned to the same assignee as the present invention.

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 circuit breaker of the fluid blast type comprising relatively movable contact structure arranged to form two breaks in series, means defining a blast passage for directing arc extinguishing fluid under influence of pressure generated at one of said breaks through the other break to extinguish arcing, a piston also arranged to drive arc extinguishing fluid through said blast passage to extinguish arcing, and valve structure interposed with respect to said pressure generating break and piston arranged to close when the arc pressure exceeds the piston pressure.

2. An electric circuit breaker of the liquid blast type comprising relatively movable contact structure arranged to form two breaks in series, means defining a blast passage directly interconnecting said breaks for directing arc extinguishing liquid under influence of pressure generated at one of said breaks transversely through the other break to extinguish arcing, and a piston more remotely positioned with respect to the interrupting break than the pressure generating break operable in a passage also arranged to communicate with said blast passage, said piston being inoperative when the arc pressure exceeds the piston pressure.

3. An electric circuit breaker of the liquid blast type comprising separable contact structure arranged to form a pressure generating break and an interrupting break, means defining a blast passage interconnecting said breaks for directing liquid under pressure from the pressure break transversely through the interrupting break to extinguish arcing thereat, a piston also arranged to drive arc extinguishing liquid through said blast passage and interrupting break, and means controlling the passage interconnecting said pressure generating break and piston including a non-return valve arranged to close when the arc pressure at said break exceeds the piston pressure.

4. An electric circuit breaker of the liquid blast type comprising separable contact structure arranged to form a pressure generating break and an interrupting break, means defining a blast passage interconnecting said breaks for directing liquid under pressure from the pressure break transversely through the interrupting break to extinguish arcing thereat, a piston also arranged to drive arc extinguishing liquid through said blast passage and interrupting break, a partition between said pressure generating break and said piston, and a plurality of normally closed non-return valves mounted on said partition for controlling corresponding apertures in said partition, said valves being arranged to open when the piston pressure is greater than the arc pressure.

5. A circuit breaker of the fluid blast type including an arc extinguishing fluid, contacts separable in said fluid to form an arc, and arc centering means for preventing excessive lateral elongation of said arc with respect to the normal region of arcing between said contacts comprising a conductor positioned adjacent to said region and laterally spaced therefrom by a small insulating gap, said conductor having a portion extending laterally in a direction substantially transversely of said arc arranged so that the direction of arc current flowing through said lateral conductor is approximately at right angles to the direction of arc current flowing toward said region of arcing, and conducting means for electrically connecting said extending portion and one of said contacts to shunt said insulating gap so that the magnetic forces at said right angle current path tend to force the arc back toward said region of arcing.

6. An electric circuit breaker of the fluid blast type comprising an arc extinguishing fluid, separable contacts arranged to form an arc within said fluid, conducting arcing structure surrounding and spaced from one of said contacts adjacent to and laterally of the normal region of arcing between said contacts, said structure being insulated from said contact at said region, and conducting means electrically connected to said structure extending therefrom in a direction substantially transversely to said arc and electrically connected to said contact so as to shunt said insulated portion, the arc current when flowing through said transversely extending conductor being in a direction approximately at right angles to the direction of the arc current flowing towards said normal region of arcing so that the magnetic forces of an arc current traversing said structure and conducting means tend to center the arc with respect to said normal region.

7. An electric circuit breaker of the fluid blast type comprising an arc extinguishing fluid, separable contacts arranged to form an arc within said fluid, means for centering said arc with respect to the normal region of arcing between said contacts comprising a conducting arcing ring surrounding and spaced by an insulating gap from one of said contacts adjacent to said region, and conducting means for electrically connecting said ring and contact to shunt said insulating gap, said conducting means extending an appreciable distance laterally from said ring in a direction substantially transversely of said arc, the arc current when flowing through said transversely extending conductor being in a direction approximately at right angles to the direction of the arc current flowing towards said normal region of arcing so that the magnetic forces of an arc current traversing the ring and conducting means tend to center the arc with respect to said region.

8. An electric circuit breaker of the fluid blast type comprising an arc extinguishing fluid, separable contacts arranged to form an arc within said fluid and means for preventing excessive lateral elongation of said arc with respect to the normal region of arcing between said contacts comprising a conducting arcing ring surrounding and spaced by an annular insulating gap from one of said contacts adjacent to said normal region, said ring having a plurality of laterally disposed conducting portions extending radially from said region of arcing, and means for electrically connecting said conducting extensions adjacent the extremities thereof to said contact to shunt said insulating gap, the arc current when flowing through said conducting extensions being in a direction approximately at right angles to the direction of the arc current flowing towards said normal region of arcing so that the magnetic forces of an arc current traversing said ring and conducting extensions tend to center the arc with respect to said normal region.

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