Feb. 22, 1949. J. M. CUMMING 2,462,724

CIRCUIT INTERRUPTER

Filed Feb. 1, 1945

Fig. 3.

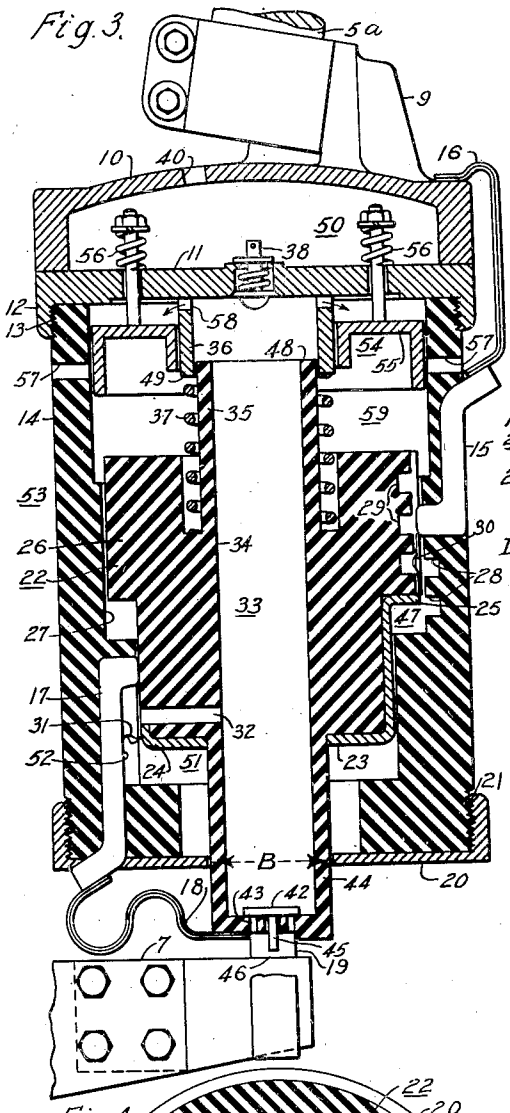


Fig. 2.

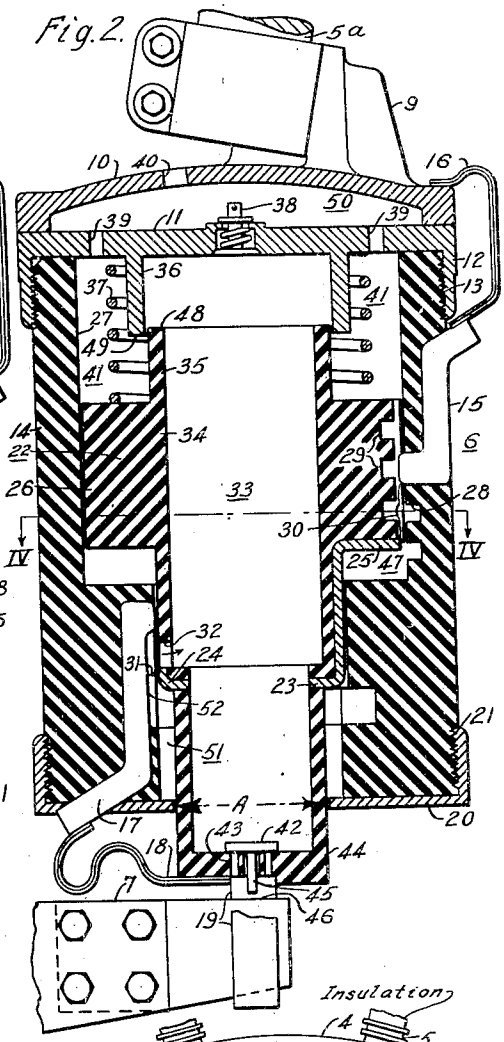


Fig. 4.

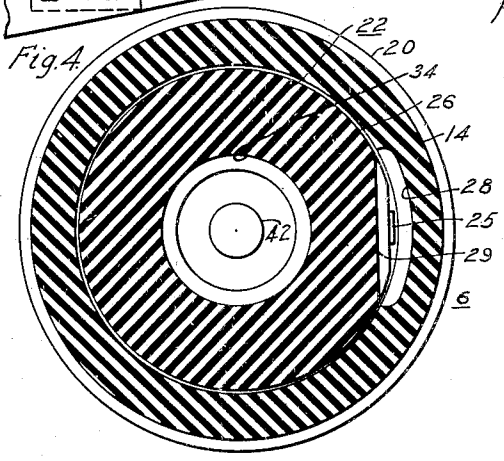
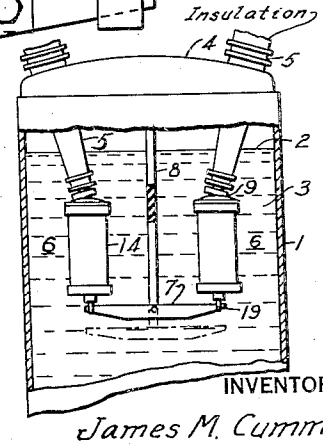


Fig. 1.



INVENTOR

James M. Cumming.

BY

Ralph W. Cummings

ATTORNEY

Patented Feb. 22, 1949

2,462,724

UNITED STATES PATENT OFFICE

2,462,724

CIRCUIT INTERRUPTER

James M. Cumming, Turtle Creek, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application February 1, 1945, Serial No. 575,589

4 Claims. (Cl. 200—150)

1

This invention relates to circuit interrupters in general, and more particularly to circuit interrupters of the liquid break type.

In a divisional patent application filed December 22, 1945, Serial No. 636,941 by Leon R. Ludwig, Winthrop M. Leeds and Benjamin P. Baker and assigned to the assignee of the instant application, there is disclosed and claimed the concept of utilizing a differential piston in a circuit interrupter spring-biased toward the open circuit position. The parent application of this divisional application is entitled "Circuit interrupter" and was filed November 11, 1942, Serial No. 465,244, now U. S. Patent No. 2,406,469, issued August 27, 1946 to Leon R. Ludwig, Winthrop M. Leeds and Benjamin P. Baker, and assigned to the assignee of the instant application. My invention is concerned with various improvements relating to this type of structure.

A more specific object is to provide an improved circuit interrupter in which piston means are utilized for facilitating the extinction of an arc, and biasing means are provided to bias the piston means toward the open circuit position. Preferably, I provide a second arc, which may be a serially related arc, to assist the biasing means to move the piston means to the open circuit position.

Another object is to provide an improved circuit interrupter of the liquid break type in which novel piston means are employed to effect the extinction of one or more arcs drawn therein.

In United States Patent 2,253,009, which issued August 19, 1941, to Benjamin P. Baker, and which was assigned to the assignee of the instant application, there is disclosed a novel circuit interrupter in which a piston member having surface irregularities and carrying the movable contact separates from a stationary contact to establish an arc. The structure is such that the arc is positioned adjacent the surface irregularities disposed on the piston member carrying the movable contact, and the piston member moves into the piston chamber which also has a plurality of surface irregularities. The consequence of this interrupting structure is that the arc is drawin adjacent the surface irregularities on both the piston member and on the inner wall of the piston chamber, and the fluid-flow provided by the piston action is effective to travel longitudinally of the established arc to effect the extinction thereof.

The surface irregularities provided on the piston member and on the inner walls of the piston chamber serve to retain a plentiful supply of fluid

2

adjacent the arc to be acted upon to facilitate the latter's extinction and also the irregularities increase the electrical creepage distance between electrodes. This type of circuit interrupter has proved to be very effective in interrupting relatively low and medium values of current with very low arc energy. It is an object of my invention to improve and adapt this structure for the interruption of higher currents without the necessity of employing heavier accelerating springs to provide a high enough speed for the piston member, against the back pressure from the arc, to ensure an adequate flow of oil to effect extinction of the arc.

Further objects and advantages will readily become apparent upon a reading of the following specification taken in conjunction with the drawing, in which:

Figure 1 is a circuit interrupter, partly in section embodying my invention and shown in the closed circuit position.

Fig. 2 is an enlarged vertical sectional view through the right-hand arc extinguishing unit of Fig. 1, the parts being shown at an intermediate point in the opening operation,

Fig. 3 is a modified type of arc extinguishing unit which may be used in place of the unit shown in Fig. 2, the parts being shown in an intermediate position during the opening operation, and

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 2.

Referring to the drawing, and more particularly to Fig. 1 thereof, the reference numeral 1 designates a tank filled to the level 2 with a suitable arc extinguishing liquid 3, in this instance circuit breaker oil. Depending from the cover 4 of the tank 1 are two insulating bushings 5, of identical configuration, through which extend terminal studs 5a. Threaded to the lower ends of the terminal studs 5a and suitably clamped thereto are two arc extinguishing units, generally designated by the reference numeral 6.

The two units 6 are electrically interconnected in the closed circuit position, as shown in Fig. 1, by a conducting cross-bar 7 which is reciprocally operated in a vertical direction by an insulating operating rod 8 operated by a suitable actuating mechanism, not shown.

Referring to Fig. 2, which shows more clearly the construction of the arc extinguishing unit 6, it will be observed that integrally formed with the contact foot 9 is a cover member 10. The cover member 10 is suitably secured by means, not shown, to a conducting plate member 11, having a portion 12 threadedly secured at 13 to an insu-

lating casing member 14. The casing member 14 supports a relatively stationary contact 15, the latter being electrically connected by a conductor 16 to the cover member 10.

The casing member 14 also supports a relatively stationary contact 17 connected by a conductor 18 to a pair of disconnect fingers 19, which may be engaged by the conducting cross-bar or bridging member 7. A cover plate 20 is threadedly secured at 21 to the lower end of the casing member 14, and assists in guiding a piston member, generally designated by the reference numeral 22. The piston member 22, shown in the middle of its stroke, is composed of insulating material and carries a conducting strap 23 having a contacting portion 24 which engages the stationary contact 17 and a contacting portion 25 which engages the stationary contact 15 when in the closed circuit position of the interrupter as shown by the full lines in Fig. 1.

The piston member 22 has an enlarged portion 26 which slidably moves in an enlarged portion 27 formed in the casing member 14. Immediately below the stationary contact 15 and formed in the casing member 14 are a plurality of surface irregularities 28. Also formed on the enlarged portion 26 of the piston member 22 above the contacting portion 25 are a plurality of surface irregularities 29.

During the opening operation, an interrupting arc 30 is established between the contacts 15, 25 and a pressure-generating arc 31 is established between the contacts 17 and 24. The pressure formed at the pressure-generating arc 31 acts through a port 32 and into a region 33 formed by removing a cylindrical portion 34 from the piston member 22. The upper portion 35 of the piston member 22 is cylindrical in shape and slidably engages a downwardly depending cylindrical portion 36 integrally formed with the plate member 11. An accelerating compression spring 37 is disposed between the plate member 11 and the piston member 22. A valve 38 is provided in the plate member 11. Also apertures 39 are provided in the plate member 11 which, together with one or more apertures 40, permit the region 41 above the piston member 22 to be at substantially atmospheric pressure.

A valve 42 controls the passage of oil through a plurality of apertures 43 provided at the lower end 44 of the piston member 22. The valve 42 has a stem 45 which is actuated during the closing stroke by a portion 46 of the cross-bar or bridging member 7.

The operation of the arc extinguishing unit 6 will now be explained. In the closed circuit position, the electrical circuit extending therethrough comprises terminal stud 5a, contact foot 9, cover member 10, conductor 16, stationary contact 15, contact 25, conducting strap 23, contact 24, stationary contact 17, conductor 18, disconnect fingers 19 through the conducting bridging member 7 and through the left-hand arc extinguishing unit 6 in an identical manner to the other terminal stud 5a of the interrupter.

During the opening operation the bridging member 7 moves downwardly to permit the accelerating compression spring 37 to force the piston member 22 downwardly to cause a simultaneous separation between the contacts 15, 25 and 17, 24. This separation of the several contacts draws a pressure-generating arc 31 of constant length and an interrupting arc 30 of increasing length.

The pressure formed at the pressure-generating arc 31 acts through the port 32 and into the region 33 to assist the accelerating compression spring 37 to drive the piston member 22 downwardly. It will be observed that a cross-sectional area A of the piston member 22 is moved out of the unit 6; consequently, the piston member 22 functions as a differential piston during the opening operation.

In other words, considering Fig. 2 pressure from the pressure-generating arc 31 acts downwardly on the area A of the piston 22 moving out of the unit 6 and also downwardly on the relatively small annular area 48. Also the pressure from the pressure-generating arc 31 acts upwardly on the piston 22 in the region 51. Further, an upward force is exerted by the interrupting arc 30 on the piston 22 in the region 47. Consequently, the downward force on the small area 48 is approximately balanced by the upward force exerted in the space 51, and the area A of the piston is made larger than the annular area of the piston projected in the space 47. Thus the arcing pressure, considering both arcs 30, 31, acts to drive the piston 22 out of the unit 6 and so assist the accelerating compression spring 37.

During the opening operation, the interrupting arc 30 is drawn adjacent to the surface irregularities 28, 29 and is subjected to a longitudinal flow of oil, caused by the piston action of the enlarged portion 26, moving from the region 47 below the enlarged portion 26 upwardly adjacent the interrupting arc 30 and into the freely vented region 41 which is substantially at atmospheric pressure.

It will be noted that the initial downward movement of the cross-bar 7 permits the valve 42 to close the apertures 43 as a result of pressure within the region 33, the cross-bar 7, nevertheless, maintaining sliding electrical contact with the disconnect fingers 19.

The foregoing interruption process quickly effects the extinction of the interrupting arc 30 to interrupt the electrical circuit passing through the interrupter. Continued downward movement of the piston member 22 causes a flushing flow of fluid to pass from the region 47 upwardly adjacent the region between the contacts 15, 25 to flush contaminated fluid into the freely vented region 41. Also the upper end 48 of the portion 35 separates from the lower end 49 of the cylindrical portion 36 to permit a communication between the region 41 and the region 33.

The pressure within the region 33, consequently, is released and the valve 38 opens to permit fresh oil to enter the region 33 from the freely vented region 50. Also the continued downward motion of the piston member 22 forces a flushing stream of oil from the region 51 upwardly adjacent the region between the separated contacts 17, 24 to flush contaminated oil which had been adjacent the pressure-generating arc 31 through the port 32 and into the now vented region 33.

When the piston member 22 strikes the cover plate 20 following circuit interruption, the conducting bridging member 7 separates from the disconnect fingers 19 to introduce an isolating gap into the circuit. In the open circuit position the piston member 22 engages the cover plate 20 in abutting relation and the valve 38 is open which, together with the apertures 39, permits fresh oil to enter the regions 33, 41.

During the closing operation, the upward movement of the bridging member 7 opens the valve 42 and picks up the piston member 22 to effect a reengagement of the contacts 15, 25 and 17, 24 to effect a closure of the electrical circuit

through the interrupter. The accelerating compression spring 37 is charged and the unit 6 is in a state ready for the next opening operation to occur.

From the foregoing description it will be apparent that I have provided a differential piston member 22 spring-biased to the open circuit position and have utilized a serially related pressure-generating arc 31 to assist the opening movement. The interrupting process effecting the extinction of the interrupting arc 30 is as described and claimed in United States Patent 2,253,009, which issued August 19, 1941, to Benjamin P. Baker, and which is assigned to the assignee of the instant application.

By a utilization of a serially related pressure-generating arc, the opening operation of the unit 6 is accelerated, especially during the interruption of high amperage currents without the introduction of additional accelerating compression springs. Consequently, the difficulty, which was previously encountered in adapting this type of interrupter to the higher powers, has been surmounted by the construction herein disclosed of utilizing a serially related pressure-generating arc to speed up the opening motion.

It will be observed that the pressure-generating arc drawn between the contacts 17, 24 runs down the side 52 of the stationary contact 17 to thereby provide a controlled arc which generates power. This controlled arc makes the opening stroke mechanically automatic under all current ratings after the arc is drawn. The controlled arc merely means that a constant pressure is available thereat at all current ratings to supply the additional opening power during interruption. This method of boosting the opening force by utilizing the gas pressure formed at a pressure-generating arc during interruption cuts down the load previously required to move this interrupter by spring force. This enables the breaker to work with less noise and minimum speed, although the initial stored spring energy is smaller than previously used.

Fig. 3 shows a modified type of arc extinguishing unit generally designated by the reference numeral 53. This unit is similar to the unit 6 previously described and, consequently, similar reference numerals have, where possible, been employed. However, a second piston means, generally designated by the reference numeral 54 is provided which comprises an annular piston member 55 slidably guided by the casing member 14 and spring-biased to its upward closed circuit position by compression springs 56. Vents 57 are provided in the casing member 14 which are closed by the piston member 55 during the initial downward travel thereof. Also ports 58 are provided in the cylindrical portion 36, the purpose for which will appear more clearly hereinafter.

The operation of the modified type of arc extinguishing unit 53 will now be explained. The downward movement of the bridging member 7 permits the accelerating compression spring 37 to move the first piston means 22 downwardly, establishing both an interrupting arc 30 between the contacts 15, 25 and a pressure-generating arc 31 between the contacts 17, 24. The pressure formed at the pressure-generating arc 31, as previously described, passes through the port 32 and into the region 33 to assist the accelerating compression spring 37 in driving the piston member 22 downwardly, the piston member 22 during this portion of the opening operation serving as a

differential piston member. Also the pressure within the region 33 acts upwardly to close the valve 38 and passes through the ports 58 to act on the upper surface of the annular piston member 55, forcing said piston member downwardly to maintain superposed oil pressure adjacent the interrupting arc 30. By maintaining this superposed pressure in the region 59, the dielectric strength of the medium surrounding the interrupting arc 30 is considerably increased, and interruption of said arc is thereby accomplished more rapidly.

Considering the forces acting in Fig. 3 during the opening operation when the piston 55 covers the vents 57, it will be observed that pressure from the pressure-generating arc 31 tends to drive the entire tube 44 of area B out of the unit 53. Also this pressure from the arc 31 acts upwardly on the piston 22 in the region 51. Further the interrupting arc 30 acts upwardly on the piston 22 in the region 47. Preferably the area B is greater than the sum of the two areas of piston 22 exposed to the regions 47, 51 so that independently of action of the second piston 55, the piston 22 functions as a differential piston. As such, the arcing pressure of the two arcs 30, 31 assists the accelerating spring 37 as was the case in Fig. 2.

By the provision of the second piston 55 pressure from the arc 31 acts down on the piston 55 and through the oil in the region 59 to tend to force piston 22 exposed to the region 59 downwardly. Thus the net force exerted by both arcs 30, 31 is downwardly tending to assist the accelerating compression spring 37. Vents 57 remain covered by the piston 55 until interruption of the arcs is completed.

It will be observed that in the previous embodiment of my invention, as shown in Fig. 2, the oil passed upwardly adjacent the arc 30, out of the region 47 and into the freely vented region 41. The oil displaced from the region 47 was only sufficient in volume to fill the region 41 which enlarged as the piston member 22 in Fig. 2 moved downwardly. Consequently, in Fig. 2, the oil was not maintained under superposed pressure adjacent the interrupting arc 30. However, in Fig. 3 I have provided the second piston means 54 utilizing pressure established by the pressure-generating arc 31 to maintain oil under pressure in the region 59. Thus, the interrupting arc 30 is not only affected by oil passing upwardly from region 47 by the piston action of the piston member 22, but also the entire body of oil within the region 59 is maintained under superposed pressure by virtue of the downward travel of the second piston means 54 following the downward travel of the first piston means 22.

Interruption quickly ensues and the accelerating compression spring 37 continues to drive the first piston means 22 downwardly to provide a flushing flow of fluid adjacent the regions which were in contact with the pressure-generating arc 31 and the interrupting arc 30. The subsidence of pressure following the interruption of the arcs 30, 31 permits the springs 56 to retrieve the second piston means 54 to its upper closed circuit position, thereby opening the vents 57 to permit a release of pressure from the region 59 out of the unit 53 through the vents 57. The upper end 48 of the portion 35 separates from the lower end 49 of the cylindrical portion 36 to permit a communication of pressure between the regions 33, 59 and hence, through the vents 57 to the region exterior of the unit 53. The valve 38 then opens

to permit residual gas to escape and fresh oil to enter the regions 33, 59 from the region 58 which is freely vented through one or more apertures 40 to the region exterior of the unit 53.

During the closing operation, the bridging member 7 moves upwardly to open the valve 42 and to pick up the first piston means 22 to thereby establish the circuit through the simultaneous engagement of the contacts 15, 25 and 17, 24, thus charging the accelerating compression spring 37. In this position, the unit is in readiness for the next opening operation.

From the foregoing description of the modified type of unit shown in Fig. 3, it will be observed that the effectiveness of the unit shown in Fig. 2 is considerably improved by using the theory of arc interruption under oil with superposed pressure.

From the foregoing description it will be apparent that I have provided an improved circuit interrupter in which a differential piston is employed being spring-biased to the open circuit position and in which a serially related pressure-generating arc is employed to assist in the opening movement of the differential piston. During low current interruption, the differential piston may be moved by the spring pressure alone; during high current interruption the pressure from the serially related arc will be available to thereby facilitate opening movement of the differential piston. It will also be apparent that I have employed novel piston means to bring about superposed pressure adjacent the interrupting arc to facilitate the extinction thereof. During the opening operation there is obtained a flushing flow of fluid following circuit interruption to wash contaminated fluid away from the contacts to thereby minimize the possibility of restriking of the extinguished arc.

Although I have shown and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In a circuit interrupter, an arc extinguishing unit, a relatively stationary contact, a piston member carrying a movable contact, opening motion of the piston member causing a separation of the movable contact from the stationary contact to establish an interrupting arc and a forcing of fluid against the same, the piston member having a surface which is drawn adjacent the arc during the opening operation, means for establishing a serially related pressure-generating arc, the pressure-generating arc facilitating the opening motion of the piston member, and second piston means operated by the pressure created at the pressure-generating arc to increase the pressure maintained at the interrupting arc.

2. In a circuit interrupter, an arc extinguishing unit, a relatively stationary contact, a piston member carrying a movable contact, opening motion of the piston member causing a separation of the movable contact from the stationary contact to establish an interrupting arc and a forcing of fluid against the same, the piston member having a surface which is drawn adjacent the arc during the opening operation, means for establishing a serially related pressure-generating arc, the pressure-generating arc facilitating the opening motion of the piston member, second piston means operated by the pressure created at the pressure-generating arc to increase the pressure maintained at the interrupting arc, and venting means operated near the end of the opening motion of the second piston means.

3. In a circuit interrupter, an arc extinguishing unit, a relatively stationary contact, a piston member carrying a movable contact, opening motion of the piston member causing a separation of the movable contact from the stationary contact to establish an interrupting arc and a forcing of fluid against the same, the piston member having a surface which is drawn adjacent the arc during the opening operation, means for establishing a serially related pressure-generating arc, the pressure-generating arc facilitating the opening motion of the piston member, second piston means operated by the pressure created by the pressure-generating arc to increase the pressure maintained at the interrupting arc, and biasing means for retrieving the second piston means following the completion of the opening operation.

4. In a circuit interrupter, a casing member having an enlarged chamber and also a smaller chamber, a pair of relatively stationary contacts supported by the casing member, a differential piston member having an enlarged portion and a relatively smaller portion, the differential piston being movable within the casing member, the piston carrying a conductor which bridges the pair of relatively stationary contacts in the closed circuit position of the interrupter, the differential piston member also carrying a pair of disconnect fingers, and an isolating member which makes electrical contact with the disconnect fingers and serves to move the differential piston member upwardly during the closing stroke.

JAMES M. CUMMING.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,147,497	Prince et al.	Feb. 14, 1939
2,154,515	Leeds et al.	Apr. 18, 1939
2,199,607	Bakken	May 7, 1940
2,235,901	Ronnberg	Mar. 25, 1941
2,249,977	Penfold	July 22, 1941
2,372,589	Leeds et al.	Mar. 27, 1945