Nov. 12, 1957 E. T. EBERHARD ET AL 2,813,177

CIRCUIT BREAKER

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FIG. 1.

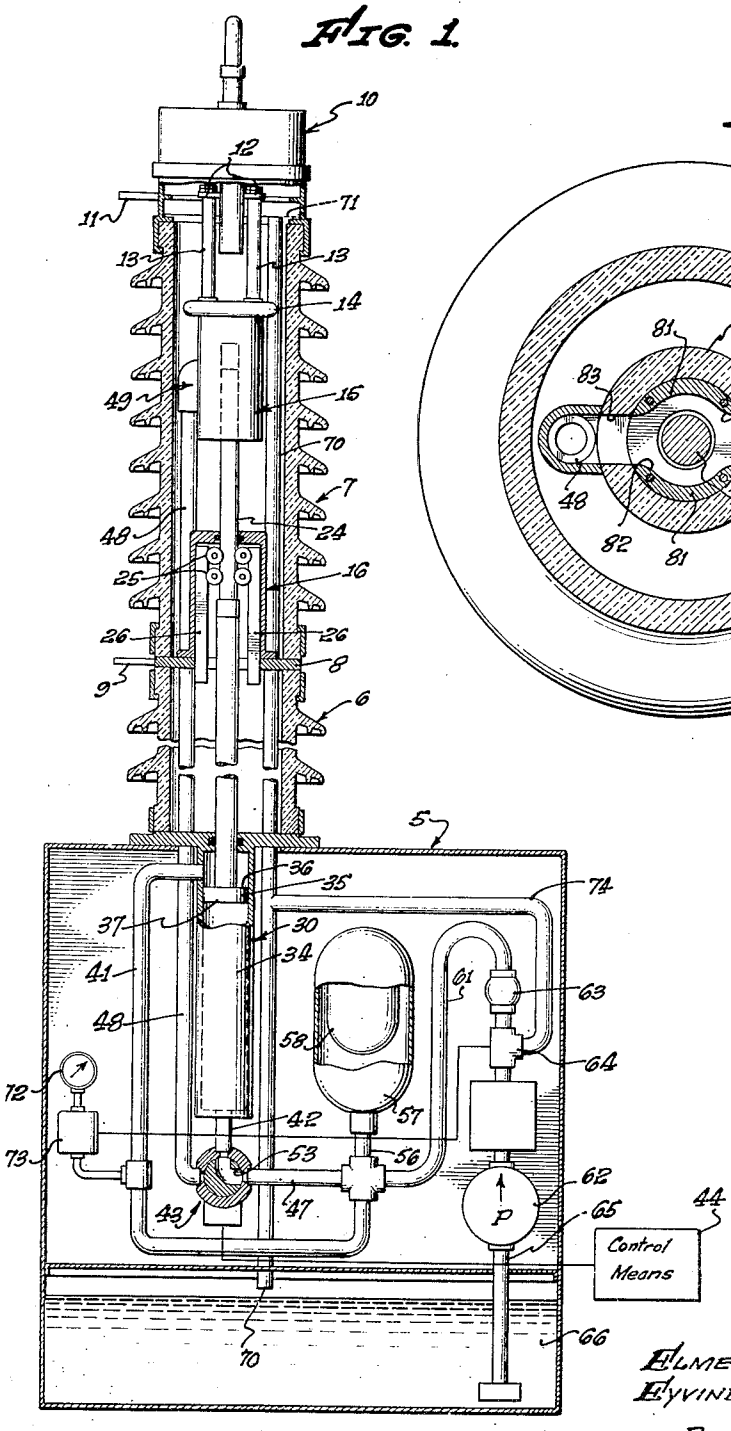


FIG. 3.

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FIG. 2.

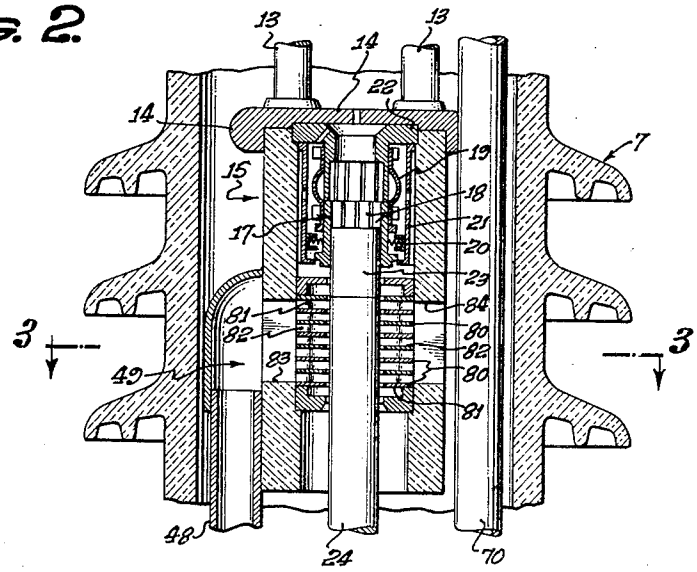
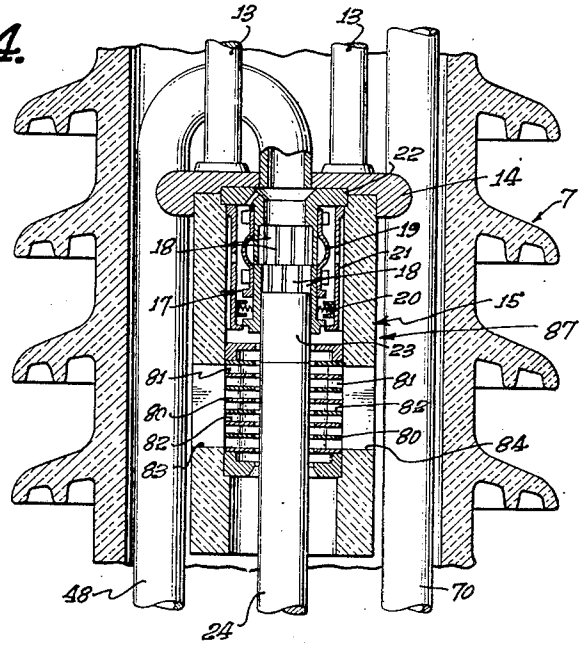


FIG. 4.



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CIRCUIT BREAKER

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7 Claims. (Cl. 200—150)

The present invention relates in general to circuit breakers and, more particularly, to a high-voltage circuit breaker of the type wherein the contacts are immersed in oil, or other suitable dielectric fluid, to extinguish or quench any arc formed upon breaking of the contacts, jets of oil frequently being directed at the contacts in circuit breakers of this type upon breaking of the contacts to aid in quenching or extinguishing any arc. However, while the present invention is particularly applicable to circuit breakers of this type, it will be understood that various features thereof are applicable to circuit breakers of other types.

Conventional circuit breakers employ complex linkage mechanisms to separate the contacts at a high rate of speed so as to minimize arcing, a primary object of the present invention being to provide a circuit breaker having means for separating the contacts at a high rate of speed without the use of such complex linkage mechanisms.

More particularly, a primary object of the invention is to provide a fluid-operated means for maintaining the contacts in engagement, the fluid-operated means being reversible to break the contacts and operating at a high rate of speed in reverse to separate the contacts at a high rate of speed so as to minimize arcing. A related object is to provide control means for the fluid-operated means which is responsive to the current through the circuit breaker.

Still more particularly, an object of the invention is to provide a fluid-operated means which includes a differential-area piston connected to a movable contact or contacts of the circuit breaker, the differential-area piston having a small area facing in the direction of contact-closing movement of the piston and having a large area facing in the opposite direction, whereby the piston maintains the contacts closed when the large and small areas of the piston are subjected to the same operating fluid pressure.

Another object is to provide a control means which includes a control valve for connecting the large-area side of the piston to a discharge means, whereby the piston moves in the contact-opening direction to break the contacts.

An important object is to provide a source of operating fluid under pressure which includes a pump and an accumulator, the pump normally maintaining the fluid system under pressure and the accumulator supplying fluid to the small-area side of the piston at a high rate upon connection of the large-area side of the piston to the discharge means so that quick opening of the contacts is assured, which is an important feature of the invention.

Another important object is to provide a discharge means for spent operating fluid on the large-area side of the piston which leads to the contacts so as to deliver a jet of oil, or other suitable dielectric fluid, to the contacts to extinguish or quench any arc formed between the contacts upon separation thereof, the jet of fluid being produced by displacement of the spent operating fluid from the large-area side of the piston as it moves in the contact-opening direction.

Another object is to provide means for producing a plurality of jets of oil, or other dielectric fluid, which extend transversely of the path of separation of the contacts and which are spaced along such path so as to insure quenching of the arc upon a relatively slight separation of the contacts.

Another object is to provide a quenching chamber in which the contacts are immersed in oil, or other dielectric fluid, a return conduit being provided to return the fluid from a level above the contacts to a reservoir to which the intake side of the pump is connected.

The foregoing objects, advantages and features of the present invention, together with various other objects, advantages and features thereof which will become apparent, may be attained with the exemplary embodiments of the invention which are illustrated in the accompanying drawings and which are described in detail hereinafter. Referring to the drawings:

Fig. 1 is a semidiagrammatic view, partially in elevation and partially in section, of a circuit breaker which embodies the invention;

Fig. 2 is an enlarged sectional view duplicating a portion of Fig. 1 and illustrating a quenching means of the invention;

Fig. 3 is a sectional view taken along the arrowed line 3—3 of Fig. 2; and

Fig. 4 is a view similar to Fig. 2 but illustrating another embodiment of a quenching means of the invention.

Referring particularly to Fig. 1 of the drawings, the circuit breaker of the invention includes a housing **5** which serves as a base for tubular insulator sections **6** and **7**, an annular conductor **8** being clamped between the insulator sections **6** and **7** and having a terminal **9** for connection to an external circuit. The insulator section **7** is closed at its upper end by a cap assembly **10** having a second terminal **11** for connection to the external circuit, the purpose of the circuit breaker being to break this external circuit in the event of an overload. The terminal **11** is electrically connected to a conductor **12** carried by the cap assembly **10**, the conductor **12** being connected by conducting bolts **13** to a conducting cap **14** on the upper end of and carrying a tubular insulator **15** disposed within and spaced inwardly from the insulator section **7**. A conducting support **16** is carried by the annular conductor **8** as discussed previously.

Disposed within the upper end of the tubular insulator **15** in conducting relation to the cap **14** is a stationary contact or contact means **17** having the form of a socket which includes a plurality of fingers **18** biased inwardly by spring means **19** and **20**, the latter being disposed between the fingers **18** and an outer shell **21**. The contact or socket **17** is maintained in position by being provided with an annular flange **22** seated in a recess in the upper end of the tubular insulator **15** and maintained in such recess by the cap **14** on the tubular insulator **15**.

Engageable with the stationary contact or socket **17** is a movable contact or plug **23** formed by the upper end of a rod **24** which extends through the support **16** and is suitably sealed relative thereto, as by an O-ring. Mounted on the rod are rollers **25** which make electrical contact with tracks **26** carried by the support **16** in electrical contact therewith, the support, in turn, making electrical contact with the annular conductor **8**.

Thus, as will be apparent, when the plug **23** is inserted into the socket **17**, the circuit between the terminals **9** and **11** is made, and when the plug **23** is withdrawn from the socket **17** by downward movement of the rod **24**, the circuit between these terminals is broken. Movement of the rod **24** to make or break the contacts **17** and **23** is produced by a fluid-operated means **30** of which the rod

24 forms a part, the fluid-operated means 30 being considered in the following paragraphs.

The fluid-operated means 30 includes a cylinder 34 having therein a piston 35 to which the rod 24 is connected, the rod 24 being referred to as a piston rod hereinafter. A seal between the cylinder 34 and the piston rod 24 is provided by an O-ring, or other suitable sealing means. The presence of the piston rod 24 provides the piston 35 with a small area 36 on one side thereof and a large area 37 on the opposite side thereof, thereby making the piston 35 a differential-area one. The small and large areas 36 and 37 respectively face in the directions of contact closing and contact opening movement so that, when the pressures applied to the areas 36 and 37 are equal, the contacts 17 and 23 are closed, and, when the area 36 is exposed to high pressure while the area 37 is exposed to low pressure, contact opening movement of the piston 35 occurs.

Communicating with the cylinder 34 on the small-area side of the piston 35 is a first conduit 41 and communicating with the cylinder on the large-area side of the piston is a second conduit 42, the latter being controlled by a solenoid valve 43 which is connected to a suitable control means 44. For example, the latter may actuate the solenoid valve 43 in response to an overload in the external circuit to which the terminals 9 and 11 are connected. Also, communicating with the solenoid valve 43 are a supply conduit 47 and a discharge means or conduit 48 leading to a quenching means 49 for directing a jet of oil, or other dielectric fluid, at the contacts 17 and 23 as they break to extinguish or quench any arc formed therebetween, as hereinafter described in more detail. The solenoid valve 43 is provided with a passage 53 which, in one position of the valve, connects the conduit 42 to the conduit 47, and, in another position of the valve, connects the conduit 42 to the discharge conduit 48. The function performed by the solenoid valve will be discussed hereinafter when considering the operation of the circuit breaker of the invention.

The conduits 41 and 47 communicate with a conduit 56 leading to an accumulator 57. The latter may be of any suitable type, the particular type shown being equipped with a bladder 58 which is filled with nitrogen, or other suitable gas, which is compressed by the oil, or other operating fluid, when the system is under pressure, the gas expanding to maintain system pressure in response to a tendency for the pressure to drop, all as will be discussed in more detail hereinafter.

Communicating with the conduits 41, 47 and 56 is a conduit 61 which leads to the discharge side of a pump 62 through a reverse-flow-preventing check valve 63 and a pressure relief valve 64. The intake side of the pump 62 is connected, by a conduit 65, to a reservoir 66 containing oil, or other dielectric fluid. An overflow or return conduit 70 communicates between the reservoir 66 and the interior of the insulator section 7 at a level well above the contacts 17 and 23 to maintain the fluid level within the insulator section 7 at the level indicated by the numeral 71. Thus, the contacts 17 and 23 are constantly immersed in oil.

A pressure gauge 72 and a pressure sensitive switch 73 communicate with the discharge side of the pump 62 by being connected in the conduit 41. The switch 73 is connected to the pressure relief valve 64, which bypasses fluid from the pump 62 to the reservoir 66 by way of a conduit 74 and the overflow conduit 70 in the event of the development of an excessive pressure.

Considering the operation of the invention as thus far described, as long as no overload exists, the solenoid valve 43 is in the position shown in Fig. 1 of the drawings so as to maintain the conduit 42 in communication with the discharge side of the pump through the conduits 47 and 61. Under such conditions, the same operating fluid pressure is applied to both the small area 36 and the large area 37 of the piston 35 with the result that the contacts 17 and 23 are maintained in engagement. Also, under such conditions, the accumulator 57 is energized, the gas within the bladder 58 being compressed.

When the solenoid valve 43 is actuated by the control means 44, as upon the occurrence of an overload in the external circuit to which the terminals 9 and 11 are connected, the solenoid valve connects the conduit 42 to the discharge conduit 48. This has the effect of reducing the pressure in the cylinder 34 on the large-area side of the piston 35 to a low value equal only to the head of fluid thereabove. Consequently, since the system pressure is still applied to the small area 36 of the piston 35, the contact 23 is disengaged from the contact 17, an adequate supply of fluid under pressure to insure separation of the contacts at a high rate of speed being provided by the accumulator 57. Thus, a high rate of contact separation to minimize arcing is attained without complex linkage systems, or the like, which is a feature of the invention.

The fluid displaced by the piston 35 during movement of the piston in the contact-opening or contact-breaking direction flows through the solenoid valve 43 into the discharge conduit 48 and thence to the quenching means 49 to quench any arc that may be formed between the separating contacts, such jets assisting in extinguishing the arc as is well known in the art. Any tendency for the fluid level 71 to rise as a result of the introduction of fluid into the insulator section 7 in the foregoing manner is prevented by the overflow or return conduit 70.

Considering the structure of the quenching means 49, it includes a stack of annular elements 80 having interspersed therebetween pairs of crescent-shaped spacers 81 providing radial passages 82 each of which communicates at one end with an inlet port 83 and at its other end with an outlet port 84. These ports are formed in the tubular insulator 15 and the inlet port 83 communicates with the upper end of the discharge passage 48, the outlet port communicating with the interior of the insulator section 7. The quenching means 49 encircles the piston rod 24 so that jets of oil are directed through the passages 82 between the inlet and outlet ports 83 and 84 and around the rod 24, when the rod is in a position such that it projects entirely through the quenching means 49. As the rod 24 is moved downwardly during contact-opening movement of the piston 35, successive jets of oil traversing the passages 82 traverse the space between the contacts 17 and 23 to provide a plurality of arc quenching jets of oil between the separating contacts, the number of jets of oil increasing as the rod 24 is moved downwardly. Each jet of oil traversing one of the passages 82 tends to blow the arc into the corresponding passage 82 in the direction of the outlet port 84, blowing the arc into each passage 82 in this manner being extremely effective in quenching the arc. Usually, the arc is completely quenched by the time the contact 23 has cleared one or two of the passages 82.

In Fig. 4 of the drawings is shown in quenching means 87 which is similar to the quenching means 49, the only difference being that the discharge passage 48, instead of communicating with the port 83, communicates with the upper end of the stationary contact or socket 17 through the cap 14. With the quenching means 87, a stream of oil flows downwardly through the contact 17 and impinges on the contact 23, the oil stream being discharged through the passages 82 radially in both directions toward the ports 83 and 84, both of these ports being outlet ports with this construction. The quenching action is similar to that previously described and it is thought that a detailed description thereof is unnecessary.

Although we have disclosed exemplary embodiments of our invention herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiments without departing from the spirit of the invention as defined by the claims appearing hereinafter.

We claim as our invention:

1. In a circuit breaker, the combination of: a pair of contacts; fluid-operated means connected to one of said contacts for maintaining said contacts in engagement, said fluid-operated means being reversible to break the engagement between said contacts, said fluid-operated means including a cylinder having therein a differential-area piston connected to said one contact, said piston having a small area facing in the direction of contact-closing movement of said piston and having a large area facing in the opposite direction so that said fluid-operated means maintains said contacts in engagement when equal operating fluid pressures are applied to both of said areas of said piston; control means for reversing said fluid-operated means, said control means including means for reducing the operating fluid pressure applied to said large area of said piston so as to reverse said fluid-operated means; a source of operating fluid under pressure in constant communication with said small area of said piston; and passage means for conducting spent operating fluid from the large-area side of said piston to said contacts upon reversal of said fluid-operated means so as to quench any arc formed between said contacts upon breaking thereof.

2. In a circuit breaker, the combination of: a pair of contacts; fluid-operated means connected to one of said contacts for maintaining said contacts in engagement, said fluid-operated means being reversible to break the engagement between said contacts, said fluid-operated means including a cylinder having therein a differential-area piston connected to said one contact, said piston having a small area facing in the direction of contact-closing movement of said piston and having a large area facing in the opposite direction so that said fluid-operated means maintains said contacts in engagement when equal operating fluid pressures are applied to both of said areas of said piston; control means for reversing said fluid-operated means, said control means including means for reducing the operating fluid pressure applied to said large area of said piston so as to reverse said fluid-operated means; and a source of operating fluid under pressure in constant communication with said small area of said piston, said source including an accumulator.

3. In a circuit breaker, the combination of: a pair of contacts; fluid-operated means for making and breaking said contacts, including a cylinder having a piston therein and including a piston rod connected to one side of said piston and to one of said contacts, the presence

of said piston rod reducing the area of said side of said piston to a smaller value than that of the opposite side of said piston; a source of operating fluid under pressure; a first conduit connecting said source to said cylinder on the small-area side of said piston; a second conduit connecting said source to said cylinder on the large-area side of said piston; a discharge means; and a control valve in said second conduit for interrupting fluid communication between said source and said cylinder and for connecting said cylinder on the large-area side of said piston to said discharge means, said discharge means comprising passage means leading to said contacts so as to quench any arc formed between said contacts upon breaking thereof.

4. A circuit breaker as defined in claim 3 wherein said source includes a pump and an accumulator.

5. A circuit breaker as defined in claim 4 including a reservoir communicating with the intake side of said pump and including a quenching chamber surrounding said contacts, there being a return conduit communicating with said quenching chamber, at a level above said contacts, and said reservoir.

6. A circuit breaker as defined in claim 3 including a stack of annular elements having interspersed therebetween pairs of spacers providing diametral passages communicating with said passage means and spaced apart along the path of separation of said contacts.

7. An arc quenching device including a stack of annular elements having interspersed therebetween pairs of crescent-shaped spacers providing diametral passages spaced along the path of separation of a pair of contacts, and including means for flowing a fluid through said passages.

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