Nov. 22, 1955 F. GIEFFERS 2,724,756

LOW LIQUID-CONTENT POWER-CIRCUIT BREAKERS

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Fig. 1

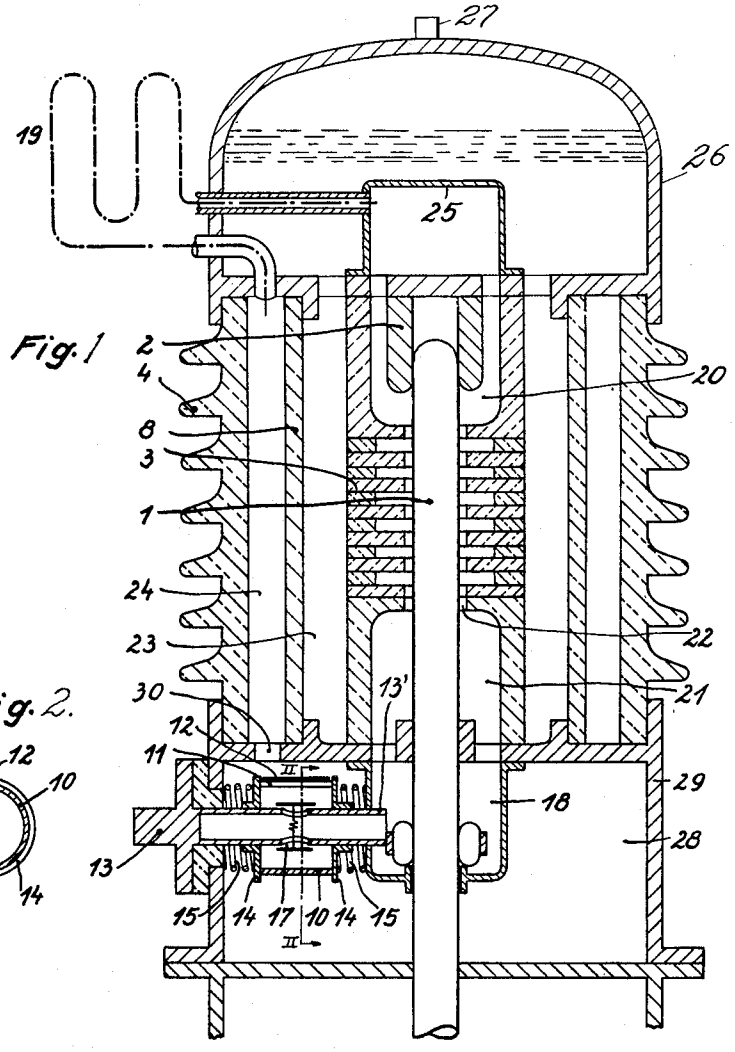


Fig. 2.

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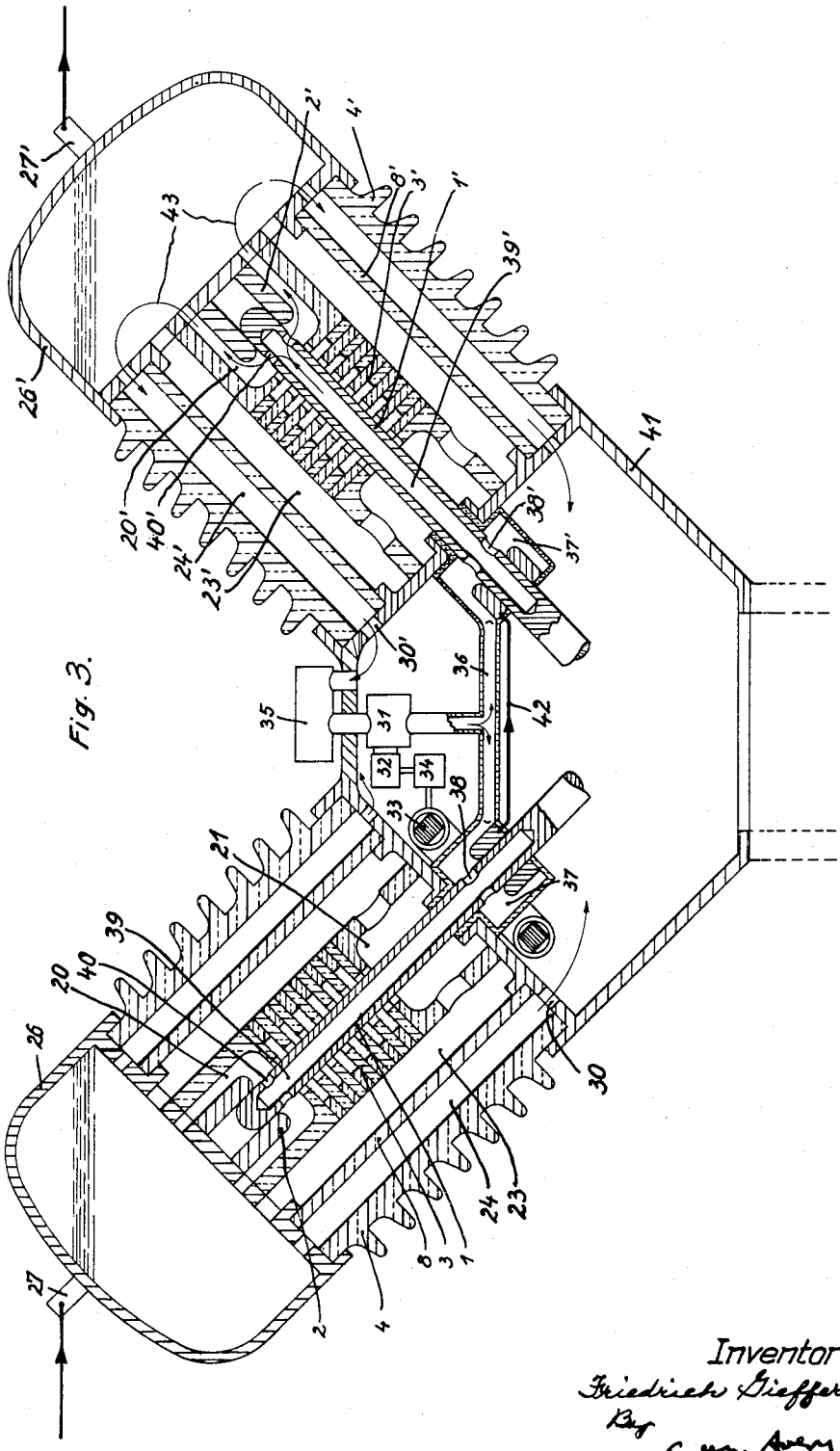


Fig. 3.

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2,724,756

LOW LIQUID-CONTENT POWER-CIRCUIT BREAKERS

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Application June 10, 1952, Serial No. 292,670

Claims priority, application Germany July 11, 1951

10 Claims. (Cl. 200—150)

My invention relates to electric power-circuit breakers of the low liquid-content type, often simply referred to as oil-poor breakers, in which oil or other liquid is used for arc extinction by blast action and in which the quantity of liquid is much smaller than in the conventional tank-type oil breakers.

It is an object of my invention to provide such an oil-poor power breaker with circulatory liquid cooling by means of a pump of sufficiently small dimensions to permit combining it with the breaker structure without requiring an appreciable increase in the overall space requirements and without danger of subjecting the pump to excessive loading.

To this end, and in accordance with one of the features of my invention, I connect the arc chamber of the oil poor breaker in a circulatory system for cooling liquid which includes an electrically driven pump, and I connect the electric control circuit of the pump with the load circuit of the breaker so that cooling becomes effective only when the current flowing through the closed circuit breaker exceeds a given minimum magnitude.

According to a more specific feature of my invention, I provide an electrically operating pump whose delivery varies in response to the electric energizing current so that an effective delivery of cooling liquid commences when the current reaches a sufficient value and increases with an increase in the current loading of the breaker.

According to another feature of my invention, I provide the pump with an auxiliary control which responds to a given magnitude of current and connects the pump to a current transformer only when the breaker current exceeds that magnitude, the pump being electrically de-energized at lower currents.

The pump may be electrically arranged on ground potential, in which case the liquid is supplied to and discharged from the pump through insulating tubing. This permits a wider choice of the kind and power rating of the breaker drive to be used and makes the pump readily accessible without high-voltage danger. In many cases, however, it is desirable to place the pump on high-voltage potential, for instance, if the breaker liquid is electrically conductive as is the case with water, or merely for reasons of economy.

It may also be advantageous to insert a cooler or heat exchanger into the circulatory conduit system that connects the pump with the arc-enclosing chamber of the breaker.

The foregoing and other features of the invention are apparent from the embodiments exemplified by the drawings and described in the following.

Fig. 1 shows schematically and in cross section a portion of an oil-poor power circuit breaker;

Fig. 2 is a cross section of parts pertaining to the circulating pump of the breaker shown in Fig. 1, the sectional plane being indicated in Fig. 1 at II—II;

Fig. 3 illustrates a sectional view of another circuit breaker with two series-connected breaker units for high current-carrying duty.

The breaker shown in Figs. 1 and 2 has a movable switch pin 1 and a stationary contact piece 2 surrounded by a composite arc-chamber structure 3 which forms an upper chamber space 20 around the stationary contact 2 and a lower space 21. The two spaces 20 and 21 communicate with each other through the annular interstice 22 between the switch pin 1 and the chamber structure 3. The chamber structure 3 is concentrically surrounded by an insulating cylinder 8 which is also concentrically spaced from the insulator 4 so as to provide two annular spaces 23 and 24. The chamber space 20 is closed by a cap 25 within the top structure 26 of the breaker. The stationary contact piece 2 is mounted on the top structure 26, and the latter forms the electric connection between the stationary contact piece 2 and a terminal 27. The space 21 is downwardly extended into a metal cover 18 which is mounted in the interior 28 of the supporting metal structure 29 of the breaker. The enclosed spaces 20, 21, 23, 24 and 28 are filled with liquid, such as oil, which also extends into the interior of the top structure 26. A communication between space 21 and the interior 28 of the support structure 29 is established by a tubular member 13'. Space 28 also communicates with the annular space 24 through a number of bores of which one is visible at 30.

The pump for maintaining the liquid in circulation as long as the breaker circuit is closed has a particularly simple and small design. It has a variable-volume chamber consisting of a hollow cylinder 10 of magnetizable material such as steel or a ferromagnetic alloy. The cylinder is longitudinally slitted at 11 as is best apparent from Fig. 2. Disposed in the axis of the cylinder is the above-mentioned tubular member 13' which forms part of a current supply terminal piece 13 that is mounted on the supporting structure 28 and insulated therefrom. The tubular part 13' is a good electric conductor and is conductively joined with the support structure 28 and hence with the switch pin 1. Consequently, the breaker current passing between the terminals 13 and 27 through the contact piece 2 and the switch pin 1 when the breaker is in the illustrated closed condition, flows through the member 13' and produces in the magnetizable pump cylinder 10 an alternating magnetic field which is closed through the slit 11. The force of this field in the air gap formed by the slit changes at twice the frequency of the alternating current and causes the cylinder 10 to contract and expand oscillatorily while alternately reducing and widening the peripheral width of the slit. During the reduction in volume, the liquid contained in the cylinder 10 is forced to the outside of the cylinder, for instance, through the slit 11. During the increase in cylinder volume, the liquid is inducted from the space 18 through the tubular member 13' into the cylinder. The proper induction and expulsion of the liquid is secured by check values. In the illustrated embodiment, for instance, the slit 11 is covered by a flexible lid 12 which is mounted upon the exterior surface of the cylinder so that it opens the slit when the cylinder is contracting and closes the slit during cylinder expansion. In the illustrated embodiment, the two lateral covers 14 of the cylinder 10 are also designed as check valves. To this end, the two covers 14 are displaceably seated on the member 13' and are pressed against the respective axial ends of the cylinder 10 by springs 15. The check valves formed by the covers 14 open together with the check valve provided by the lid 12 when the cylinder is contracting. The interior of the tubular member 13' communicates with the interior of the cylinder 10 through openings which are controlled by two additional check valves 17. These valves consist of two discs at the outer surface of member 13' which are biased toward closed position by a connecting spring. The valves 17 open during the expanding interval of the cylinder 10 to

permit the induction of liquid from space 18 through member 13' into the cylinder 10.

During the operation of the pump, that is when the circuit breaker is closed and traversed by current, the liquid is periodically inducted from the space 18 into the pump cylinder 19 and is ejected from the cylinder and forced through the openings 30 into the annular space 24 between the insert cylinder 6 and the exterior insulator 4. From space 24 the liquid passes through a cooler, for instance of the heat-exchanger type, as schematically indicated at 19. From the cooler, the liquid returns into the space within the cap member 25 and thus into the arc space 20.

Instead of a single slit, the cylinder 19 may be given several longitudinal slits, and the cylinder slits may be closed by diaphragm members so that the cylinder together with the diaphragms forms a variable-volume chamber whose volumetric variations occur at twice the frequency of the alternating current.

A pump of the above-described type is especially advantageous in conjunction with the invention because it occupies sufficiently little space to be readily accommodated within the confines of the customary circuit breaker dimensions, and also because this type of pump has a variable delivery responsive to the magnitude of the alternating current so that the liquid circulation is accelerated when the current load upon the circuit breaker increases. Pumps of the above-described type are also disclosed and are claimed in the copending application of Paul Duffing, Serial No. 287,671, filed May 14, 1952, now Patent No. 2,664,826, issued January 5, 1954, and assigned to the assignee of the present invention.

In circuit breakers with a plurality of series-connected interrupting gaps, only one pump need be provided for circulating the liquid through all arc chambers. An embodiment of this kind with two interrupting gaps is illustrated in Fig. 3. Each of the two interrupting gap units is designed largely in accordance with Fig. 1. Corresponding elements in Fig. 3 are denoted by the same respective reference numerals as in Fig. 1 except that a prime is added to the numerals applied to the right-hand breaker unit of Fig. 3.

The two breaker units have a common hollow supporting structure 41 which encloses the drive mechanisms (not shown) for simultaneously moving the two switch pins 1 and 1' from the closed to the open position and vice versa. The two switch pins are electrically interconnected, as schematically shown at 42 to establish a series connection of the two breaker units between the respective breaker terminals 27 and 27'.

The pump 31 for circulating the breaker liquid is also mounted in the interior of the support structure. The pump is driven by a motor 32 which is energized from a current transformer 33 whose secondary winding is connected with the motor 32 through the contacts of a control relay 34 when the current reaches a predetermined magnitude. The motor 32 consists of a self-starting (asynchronous) alternating-current motor so that the pump starts automatically as soon as the relay 34 responds. The oil or other breaker liquid is then inducted from the space 24' between the porcelain insulator 8' and the housing insulator 4' through a cooler, schematically shown at 35, which may be subjected to a cooling air stream from a blower kept at ground potential. From the cooler 35 the liquid enters the pump 31 and thence flows through a branched conduit 36 into the spaces 37 and 37'. From these spaces the liquid enters through lateral ducts 38, 38' into a central bore 39, 39' of each switch pin from which it passes through ducts 40, 40' into the space 20, 20'. Each flow of liquid thus passes along the stationary contact piece 2 or 2' into the top structure 27 or 27'. This flow of liquid is indicated by arrows 43 in the right-hand breaker unit of Fig. 3. Consequently, during the operation of the pump, which takes place only when the circuit breaker is closed and carries a sufficient current, the oil is continuously circulated through the arc chambers of both units.

While in the embodiment according to Fig. 1, all of the breaker liquid passes through the annular interstice between the switch pin and the arc chamber structure, such a circuit breaker may also be equipped with a hollow switch pin that serves also as part of the liquid-circulating conduit system in the manner apparent from Fig. 3.

It will be obvious to those skilled in the art upon a study of this disclosure that my invention permits of various modifications other than those specifically shown and described, without departing from the essential features of the invention and within the scope of the claims annexed hereto.

I claim:

1. An electric power breaker of the low-liquid content type comprising a hollow insulating structure forming an arc chamber, a breaker circuit comprising a stationary contact and a movable contact disposed in said chamber and electrically engageable with each other to close said circuit, a circulatory conduit system including said chamber and filled with cooling liquid, an electric pump forming part of said system for circulating said liquid, and means dependent upon current flowing through the power breaker and cooperative with said pump to cause an increase in liquid circulation therethrough with increase in current through the breaker, said means being inoperative when said circuit breaker is open-circuited, whereby variable cooling of the contacts is automatically effected prior to opening of the circuit breaker.

2. An electric power breaker of the low-liquid content type comprising a hollow insulating structure forming an arc chamber, a breaker circuit comprising a stationary contact and a movable contact disposed in said chamber and electrically engageable with each other to close said circuit, a circulatory conduit system including said chamber and filled with cooling liquid, an electric pump, and an electric circuit for said pump, said circuit being cooperatively connected with the circuit through said contacts, said electric pump having a delivery rate increasing with increasing current through said electric circuit, whereby the liquid circulation is variably controlled in dependence upon the magnitude of the current flowing in said breaker circuit.

3. An electric power breaker of the low-liquid content type comprising a hollow insulating structure forming an arc chamber, a breaker circuit comprising a stationary contact and a movable contact disposed in said chamber and electrically engageable with each other to close said circuit, a circulatory conduit system including said chamber and filled with cooling liquid, an electrically driven pump forming part of said conduit system for circulating said liquid, a current transformer connected with said breaker circuit, said pump having an electric control circuit, and current-responsive circuit means connecting said control circuit with said current transformer for controlling said pump to circulate said liquid only when the current in said breaker circuit exceeds a given magnitude.

4. A power circuit breaker, comprising a hollow insulating structure forming an arc chamber contact means having a stationary contact and a movable contact disposed in said chamber and engageable with each other, a hollow supporting structure of metal on which said insulating structure is mounted, a circulatory conduit system including said chamber and filled with cooling liquid, said conduit system having a portion extending through the interior of said supporting structure, an electrically operating pump forming part of said conduit system for circulating said liquid, said pump being also disposed in the interior of said supporting structure and having an electric control circuit connected with said contact means to circulate said liquid in dependence upon current flowing through said contacts.

5. A power circuit breaker, comprising a hollow in-

sulating structure forming an arc chamber, contact means having a stationary contact and a movable switch pin disposed in said chamber and engageable with said contact, a hollow supporting structure of metal having a wall portion on which said insulating structure is mounted, said switch pin extending through said wall portion into the interior of said supporting structure, a circulatory conduit system filled with liquid and including said chamber and the interior of said supporting structure, an electrically driven pump forming part of said system and being disposed in the interior of said supporting structure, said pump having an electric drive circuit series-connected with said switch pin to circulate said liquid in said system in dependence upon current flowing through said switch pin.

6. A power circuit breaker, comprising a hollow insulating structure having a centrally located arc chamber and an annular space around said chamber, contact means having a stationary contact and a movable contact disposed in said chamber and engageable with each other, a top structure covering said insulating structure and forming a communication between said chamber and said space, a hollow conductive supporting structure on which said insulating structure is mounted, said supporting structure forming another communication between said chamber and said space so that said top structure and said supporting structure form a circulatory system together with said chamber and said space, said conduit system having an amount of cooling liquid disposed therein, and a pump disposed in the interior of said supporting structure and forming part of said conduit system, said pump being electrically connected with said contact means to circulate said liquid in dependence upon current flowing through the breaker.

7. In a power circuit breaker according to claim 6, said pump having a current-responsive member electrically series-connected with said movable contact and forming a variable-volume chamber hydraulically series arranged between said chamber and said space.

8. A power circuit breaker, comprising a hollow insulating structure having a centrally located arc chamber and an annular space around said chamber, contact means having a stationary contact and a switch pin axially movable in said chamber and engageable with said stationary contact, a hollow supporting structure having a wall portion on which said insulating structure is mounted, said switch pin extending through said wall portion into the interior of said supporting structure and having a longitudinal bore, said pin having openings located in said chamber and in the interior of said supporting structure respectively and communicating with said bore, a top structure covering said insulating structure and forming a communication between said chamber and said space so that said top structure and said supporting structure and said bore and openings form a circulatory conduit system together with said chamber and said space, said conduit system having an amount of cooling liquid disposed therein, and a pump disposed in the interior of said supporting structure and forming part of said conduit system, said pump being electrically connected with said contact means to circulate said liquid in dependence upon current flowing through the breaker.

9. A power circuit breaker, comprising a hollow insulating structure having a centrally located arc chamber and an annular space around said chamber, contact means having a stationary contact and a switch pin axially movable in said chamber and engageable with said stationary contact, a hollow supporting structure having a wall portion on which said insulating structure is mounted, said switch pin extending through said wall portion into the interior of said supporting structure, a top structure covering said insulating structure and forming a communication between said chamber and said space so that said top structure and said supporting structure form a circulatory conduit system together with said chamber and said space, a current transformer mounted in the interior of said supporting structure around said switch pin to be energized in accordance with the current flowing through said contact means, and a pump also disposed in the interior of said supporting structure and forming part of said conduit system, said pump being electrically connected with said current transformer to circulate said liquid in dependence upon said current.

10. A liquid-poor power circuit breaker, comprising circuit-interrupting contact means forming an arc gap when in interrupting operation, an arc chamber structure enclosing said gap and containing liquid, a pump having a slitted cylinder of magnetizable material and having magnet-field means for periodically contracting said cylinder, conduit means connecting the interior of said cylinder with the interior of said chamber structure to circulate the liquid through said chamber structure, said field means being electrically joined with said contact means for operating said pump when said contact means are closed.

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