

Feb. 11, 1941.

P. DUFFING
CIRCUIT BREAKER

2,231,708

Filed Aug. 22, 1939

Fig. 1.

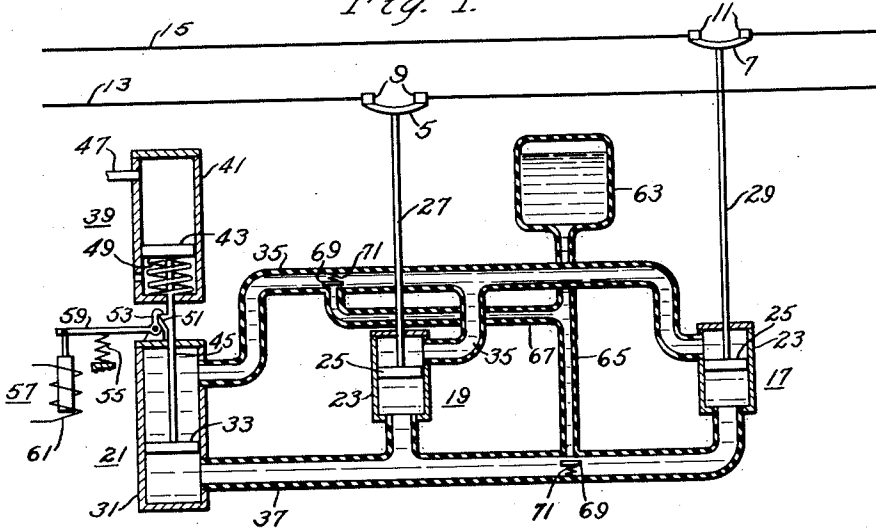
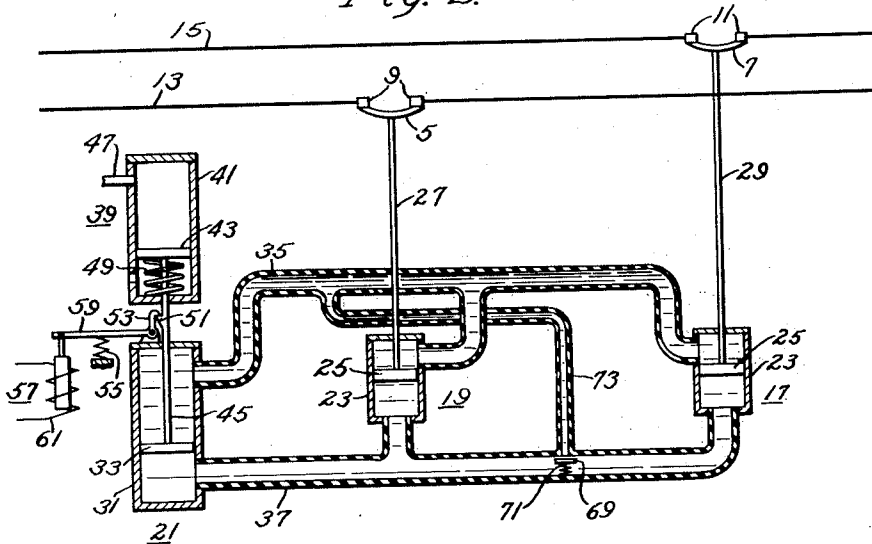


Fig. 2.



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2,231,708

CIRCUIT BREAKER

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Application August 22, 1939, Serial No. 291,315
In Germany August 22, 1938

11 Claims. (Cl. 200—82)

The invention relates to circuit interrupters, and more particularly to operating mechanisms of the hydraulic type for high voltage circuit breakers capable of interrupting a high power electrical circuit.

In the copending application of Fritz Kesselring et al., Serial No. 254,614, filed February 4, 1939, and assigned to the assignee of the present invention, there is shown and described a hydraulic operating mechanism for high voltage multi-phase circuit breakers, in which the contact structure of each phase has a separate hydraulically actuated operating device connected mechanically thereto. The opening and closing movement of the operating devices is carried out by means of insulating liquid columns serving as power transfer means, which act on the individual operating pistons connected with the moving contacts of the breaker phases.

For the satisfactory operation of such hydraulic drives, it is particularly important that the driving liquid shall contain no air. The proposal has already been made in the aforementioned copending application to carry out the packing between the liquid conducting and the air containing parts of the driving system by means of flexible metallic bellows. Such packings are designed for the purpose of preventing the atmospheric air and the air contained in the compressed air drive for the control piston from entering the hydraulic system.

It has been found, however, that the liquid itself of the hydraulic system may have air particles dissolved therein which have a tendency of separating out of the liquid. Such conditions arise for one reason because of the fact that comparatively large moving liquid quantities are involved in the hydraulic system, which are displaced rapidly over a comparatively large path, thereby producing a foam in the liquid of the system. The air coming out of the liquid renders the power transfer medium, i. e., the liquid, compressible to a certain extent, or on the low pressure side produces a suction effect, thus preventing the simultaneous operation of all of the poles or phases of the high voltage breaker.

One apparent solution of the problem of preventing air emission from the liquid of the system appears to be the use of specially treated liquids. The use of such appropriately pretreated liquids, however, is not practical for a number of reasons arising from the technique of the operation.

An object of the invention is the provision of an improved hydraulic operating mechanism for

multi-pole circuit breakers which insures that all of the breaker poles will be operated simultaneously even though air is present in the liquid of the system.

Another object of the invention is the provision of an improved hydraulic operating mechanism for multi-pole circuit breakers in which means is provided for preventing the air dissolved in the liquid of the system from separating out of the liquid; thus insuring that all of the poles will be operated simultaneously.

In carrying out the invention, back pressure valves or check valves are provided in one or more portions of liquid conductors of the hydraulic system. The valves connect the portion or liquid conductor to a source of liquid pressure greater than atmospheric pressure, thus maintaining the liquid of the portion or portions of the system at a pressure greater than atmospheric pressure and preventing the air dissolved in the liquid from separating out of the liquid.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will best be understood from the following detailed description of several embodiments thereof when read in conjunction with the accompanying drawing, in which:

Figure 1 is a sectional view, partly diagrammatic, of the circuit breaker operating mechanism of the present invention; and

Fig. 2 is a sectional view, partly diagrammatic, of a modified form of the circuit breaker operating mechanism.

Referring to Figure 1 of the drawing, the multi-pole circuit breaker which is shown diagrammatically as a two-pole breaker, comprises a pair of movable contact members 5 and 7, one for each pole unit of the breaker. The contact members 5 and 7 are movable into and out of engagement with cooperating stationary contacts 9 and 11, which are electrically connected in the separate lines 13 and 15.

Although the invention is disclosed as a two-pole circuit breaker mechanism, it is to be understood that the invention is applicable to a breaker having any number of poles, and may be used to control a number of separate circuits, or the lines of a multi-phase circuit.

The multi-pole circuit breaker may be of any conventional construction, as for example, of the construction disclosed in the copending application of Fritz Kesselring et al., Serial No. 254,614,

filed February 4, 1939, and assigned to the assignee of the present invention.

The circuit breaker is operated by a hydraulic operating mechanism which is operable to effect simultaneous actuation of the two movable contact members 5 and 7 to open or to closed circuit position. The hydraulic operating mechanism comprises, in general, a pair of individual liquid actuated operating means indicated generally at 17 and 19, one for each of the movable contact members, for moving the contact members 5 and 7 to open and to closed circuit positions, and a liquid moving means or controlled pump means indicated generally at 21 for controlling the simultaneous operation of the two individual operating means 17 and 19.

Each of the individual liquid actuated operating means comprises an operating cylinder 23 preferably of metal, and an operating piston 25 which is reciprocally movable in the cylinder 23. The operating pistons 25 are mechanically connected directly to the movable contact members 5 and 7 respectively, by means of operating rods 27 and 29 which extend through packed openings 25 provided therefor in the heads of the operating cylinders 23.

The liquid moving means or control pump means 21 comprises a metal pump cylinder 31 and a pump piston 33 which is reciprocally movable in the cylinder 31.

The opposite ends of the pump cylinder 31 communicate with the opposite ends of the operating cylinders 23 through the agency of a pair of liquid carrying conductors 35 and 37, which comprise tubes of strong insulating material.

The hydraulic system is completely filled with an insulating liquid, for example, oil, chlorinized or fluorinized hydro-carbons or the like, which serves to transmit the force from the control pump means 21 to the operating pistons 25. The entire hydraulic system is made liquid-tight in a well known manner by providing suitable liquid-tight packings at the connections of various elements and for the openings in the cylinders.

The control pump piston 33 is adapted to be moved downwardly to effect a circuit closing operation of the circuit breaker by means of an air pressure actuating device 39 which comprises a metal cylinder 41, and an air pressure operated piston 43 movable in the cylinder 41. The air pressure operated piston 43 is mechanically connected directly to the control pump piston 33 through the agency of a connecting rod 45 which extends through suitable packed openings provided therefor in the ends of the cylinders 31 and 41. The upper end of the air pressure cylinder 41 communicates with a suitable source of compressed air (not shown) through the agency of an air pressure conducting tube 47, and through a suitable air pressure control valve (not shown). The control pump piston 33 is adapted to be moved upwardly to effect simultaneous circuit opening operation of the several pole units of the circuit breaker by means of an accelerating spring 49 which is disposed in the lower portion of the air pressure cylinder 41, and interposed between the lower end of the air pressure cylinder 41 and the air pressure operated piston 43.

A latching means is provided for releasably holding the circuit breaker in closed position. This latching means comprises a latch element 51 carried by the connecting rod 45 which is

adapted to be engaged by a pivoted latch 53 pivotally mounted on the upper end of the pump cylinder 31. The pivoted latch 53 is biased to latching position by means of a light spring 55, and is adapted to be moved to released position to effect opening of the circuit breaker by means of an electromagnetic trip unit 57. The movable core or trip plunger of the trip unit 57 is pivotally connected to an extending arm 59 of the pivoted latch 53. The energizing winding 61 of the electromagnetic trip unit may be energized under the control of a conventional overload protective relay, or manually from a remote point by a manual control switch.

The operation of the breaker operating mechanism is briefly as follows. The circuit breaker is releasably held in closed circuit position as shown in Fig. 1 by the engagement of the pivoted latch 53 with the latch element 51, which acts to hold the pump piston 33 in the down or circuit-closed position, as shown in Fig. 1, against the biasing force of the circuit opening spring 49. The liquid in the lower end of the pump cylinder 31, and in the liquid carrying conductor 37, and in the lower portions of the operating cylinders 23 acts to hold the operating pistons 25 in their uppermost or closed circuit position.

When the electromagnetic trip unit 57 is energized either in response to a predetermined overload condition, or by the closing of the manual control switch, the trip plunger is moved downwardly, causing the pivoted latch 53 to disengage the latch element 51, thus releasing the connecting rod 45. The circuit opening spring 49 moves the connected pistons 43 and 33 upwardly to their open circuit positions. The upward movement of the pump piston 33 causes movement of the liquid in the upper portion of the pump cylinder 31 into the liquid carrying conductor 35, forcing liquid into the upper ends of the operating cylinders 23 to cause simultaneous downward movement of the operating pistons 25 to their open circuit position. During this movement, the liquid in the lower portions of the operating cylinders 23 is moved through the liquid carrying conductor 37 into the lower portion of the pump cylinder 31 by the downward movement of the operating pistons 25.

To close the circuit breaker, air under pressure is admitted through the air pressure conductor 47 into the upper end of the air pressure cylinder 41. The air pressure moves the piston 43 and the connected pump piston 33 downwardly to closed circuit position, as shown in Fig. 1. The downward movement of the pump piston 33 moves the liquid in the lower portion of the pump cylinder 31 into the liquid carrying conductor 37, forcing liquid into the lower portions of the two operating cylinders 23. The operating pistons 25 are simultaneously moved upwardly to closed circuit position by the liquid, effecting closing of the breaker.

As has previously been pointed out, it has been found that a certain amount of air may be dissolved in the liquid of the hydraulic operating mechanism. Any air dissolved in the liquid has a tendency to separate out of the liquid whenever the liquid is subjected to a pressure less than atmospheric pressure. A pressure less than atmospheric pressure usually exists on the low pressure side of the hydraulic system during operation of the mechanism. When the air dissolved in the liquid separates out of the liquid, it renders the force transmitting medium in this portion of the hydraulic system compressible to

a certain extent, which results in the non-simultaneous operation of the individual pole units of the circuit breaker.

In accordance with the present invention, a means is provided for insuring simultaneous operation of the several poles of the breaker by maintaining the liquid in portions of the hydraulic system under a pressure at least greater than atmospheric pressure, thus preventing any air dissolved in the liquid from separating out of the liquid. This means comprises a container 63 which is disposed at a higher level than the hydraulic system, and which is filled with a liquid of the same composition as is used in the hydraulic system. The container 63 communicates with the liquid carrying conductors 35 and 37, which carry the circuit-opening and circuit-closing liquid, through the agency of liquid conductors 65 and 67, which are of insulating material. A pair of back pressure valves or non-return valves 69 are disposed at the points of communication of the liquid conductors 65 and 67 with the liquid carrying conductors 35 and 37. The non-return valves 69 are biased to closed position by means of light springs 71. The pressure of the liquid in the container 63 and in the liquid conductors 65 and 67 is supplied through the non-return valves 69 to the liquid in the two portions of the hydraulic system, and this liquid pressure acts to maintain the portions of the liquid of the hydraulic system at a pressure greater than atmospheric pressure, thus preventing any air dissolved in the liquid of the hydraulic system from separating out of the liquid. The non-return valves 69 prevent the return flow of liquid into the liquid conductors 65 and 67 and the container 63 during operation of the mechanism. When the control pump piston 33 is moved downwardly to effect closing of the breaker, the non-return valve 69 in the liquid carrying conductor 37 immediately closes and prevents the flow of the liquid under pressure in the lower portion of the hydraulic system from entering the liquid conductor 65. At the same time, the non-return valve 69 in the liquid carrying conductor 35 is maintained open by the pressure of the liquid in the container 63 and in the liquid conductor 67, thus maintaining the liquid in the upper portion of the hydraulic system, that is, the portion of the liquid in the upper ends of the operating cylinders 23, in the upper portion of the pump cylinder 31 and in the liquid carrying conductor 35, under a pressure greater than atmospheric pressure, thus preventing any air dissolved in the liquid of this portion of the system from separating out of the liquid. Conversely, when the control pump piston 33 is moved upwardly, the non-return valve 69 in the upper liquid carrying conductors 35 immediately closes and prevents the flow of liquid under pressure into the liquid conductor 67. At the same time, the non-return valve 69 in the lower liquid carrying conductor 37 is maintained open, causing the liquid in the lower portion of the hydraulic system, that is, in the lower portion of the pump cylinder 31, the lower portions of the operating cylinders 23 and in the liquid carrying conductor 37, to be maintained under a pressure greater than atmospheric pressure, thus preventing the air dissolved in the liquid of this portion of the hydraulic system from separating out of the liquid. A conventional expansion vessel for supplying the liquid pressure may be substituted for the separate liquid container 63, if desired.

A modification of the invention is illustrated

in Fig. 2 of the drawing. In this modification, the hydraulic operating mechanism is identical to the hydraulic operating mechanism shown in Fig. 1, and hence, the same reference characters have been used to designate the corresponding identical parts. In the embodiment of the invention illustrated in Fig. 2, the means for preventing the air dissolved in liquid of portions of the hydraulic system from separating out of the liquid comprises a liquid conductor 73, containing the same liquid as is present in the hydraulic system, which communicates at its lower end with the liquid carrying conductor 37 through the agency of a non-return valve 69. The opposite end of the insulating liquid conductor 73 communicates with the liquid carrying conductor 35, which carries the liquid for opening the circuit breaker. In this embodiment of the invention the liquid pressure in the conductor 73 is obtained from the high pressure portion of the hydraulic system during an opening operation of the circuit breaker. The diameter of the liquid conductor 73 is considerably smaller than the diameter of the liquid carrying conductor 35 which carries the liquid for opening the circuit breaker so that the presence of the liquid conductor 73 will not affect the circuit opening operation of the two operating pistons 23.

During opening operation of the circuit breaker, the liquid in the conductor 73 is maintained under pressure, causing the non-return valve 69 to remain open and subjecting the liquid in the lower portion of the hydraulic system, that is, the circuit closing liquid, under a pressure greater than atmospheric pressure, thus preventing any air dissolved in this portion of the liquid from separating out of the liquid. During closing of the circuit breaker, the pressure in the lower portion of the hydraulic system maintains the non-return valve 69 closed, preventing any return flow of liquid into the liquid conductor 73.

If desired, a second liquid conductor similar to the conductor 73 may be provided between the liquid carrying conductors 35 and 37, and a non-return valve disposed at the point of communication of this second liquid conductor, to the liquid carrying conductor 35. This second liquid conductor and non-return valve will operate during closing operations of the breaker to maintain the liquid in the upper portion of the system, that is the circuit-opening liquid, under a pressure greater than atmospheric pressure, thus preventing any air dissolved in the liquid of the upper portion of the hydraulic system from separating out of the liquid.

The present invention constitutes a continuation-in-part and an improvement of the invention disclosed and claimed in the copending application of Fritz Kesselring et al., Serial No. 60 254,614, referred to above.

Although the invention has been disclosed as embodied in a hydraulic operating mechanism of a particular construction, it is to be understood that it is equally applicable to any other type of hydraulic operating mechanism for a multi-pole circuit breaker where separate operating devices are provided for each pole of the breaker.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details thereof may be made without departing from the spirit of the invention. It is desired, therefore, that the language of the appended claims be given the broadest

reasonable construction permissible in the light of the prior art.

I claim as my invention:

1. In combination, a multipole circuit interrupter having a plurality of movable contact members, an individual hydraulically actuated operating means for moving each contact member, hydraulic actuating means for controlling movement of said individual operating means, liquid carrying conductor means connecting said hydraulic actuating means and said operating means, and means effective in all positions of said hydraulic actuating means for preventing portions of the liquid in said system from being subjected to a pressure less than atmospheric pressure, thus preventing air dissolved in the liquid from leaving the liquid.

2. In combination, a multipole high voltage circuit interrupter having a plurality of movable contact members, an individual liquid actuated operating means for moving each contact member, liquid moving means for controlling the operation of said operating means, liquid carrying conductor means connecting said liquid moving means to said individual operating means, and means effective in all positions of said liquid moving means for preventing portions of the liquid in said system from being subjected to a pressure less than atmospheric pressure.

3. A multipole high voltage circuit interrupter having a plurality of movable contact members, an individual liquid actuated operating means for moving each contact member, liquid moving means for controlling the operation of said operating means, liquid carrying conductor means connecting said liquid moving means to said individual operating means, and means for preventing portions of the liquid of said system from being subjected to a pressure less than atmospheric pressure, thus preventing air dissolved in the liquid from coming out of the liquid.

4. A multipole high voltage circuit interrupter having a plurality of movable contact members, an individual liquid actuated operating means for moving each contact member, liquid moving means for controlling the operation of said operating means, liquid carrying conductor means connecting said liquid moving means to said individual operating means, and means connected to said liquid carrying conductor means effective in all positions of said liquid moving means for preventing portions of the liquid from being subjected to a pressure less than atmospheric pressure.

5. A multipole circuit breaker having a plurality of moving contact members, an individual liquid actuated operating means for moving each contact member, liquid moving means for controlling the operation of said operating means, liquid carrying conductor means connecting said liquid moving means to said operating means, and means comprising a source of liquid pressure connected to said liquid carrying conductor means for preventing portions of the liquid of the hydraulic system from being subjected to a pressure less than atmospheric pressure, thus preventing air dissolved in the liquid from coming out of the liquid.

6. A multipole circuit interrupter having a plurality of movable contact members, an individual liquid actuated operating means for moving each contact member, said individual operating means each including an operating cylinder containing liquid, and a liquid operated piston in said cylinder connected to its movable contact member, a

liquid moving means for controlling the operation of said liquid actuated operating means, liquid carrying conductors connecting said liquid moving means to the opposite ends of said individual operating cylinders, and means comprising a liquid container communicating through a liquid conductor and a non-return valve with at least one of said liquid carrying conductors for preventing portions of the liquid in the hydraulic system from being subjected to a pressure less than atmospheric pressure.

7. A multipole circuit interrupter having a plurality of movable contact members, an individual liquid actuated operating means for moving each contact member, said individual operating means each comprising an operating cylinder containing liquid and a liquid operated piston in said cylinder connected to its movable contact member, a liquid moving means for controlling the operation of said liquid actuated operating means, liquid carrying conductors connecting said liquid moving means to the opposite ends of said individual operating cylinders, and means comprising a liquid container communicating through liquid conductors and non-return valves to said liquid carrying conductors for preventing the liquid in the hydraulic system from being subjected to a pressure less than atmospheric pressure.

8. A multipole circuit interrupter having a plurality of movable contact members, an individual liquid actuated operating means for moving each contact member, said individual operating means each comprising an operating cylinder containing liquid and a liquid operated piston in said cylinder connected to its movable contact member, a liquid moving means for controlling the operation of said liquid actuated operating means, liquid carrying conductors connecting said liquid moving means to the opposite ends of said individual operating cylinders, and means comprising a conductor containing liquid communicating at one end through a non-return valve to at least one of said liquid carrying conductors and communicating at its other end with an expansion vessel, said last-mentioned means preventing portions of the liquid in the hydraulic system from being subjected to a pressure less than atmospheric pressure.

9. A multipole circuit breaker having a plurality of moving contact members, an individual liquid actuated operating means for moving each contact member, liquid moving means for controlling the operation of said operating means, liquid carrying conductor means connecting said liquid moving means to said operating means, and means comprising a liquid container communicating through a liquid conductor and through non-return valves with said liquid carrying conductor means for maintaining at least portions of the liquid in the hydraulic system under a pressure greater than atmospheric pressure.

10. A multipole circuit interrupter having a plurality of movable contact members, an individual liquid actuated operating means for moving each contact member, said individual operating means each comprising an operating cylinder containing liquid and a liquid operated piston in said cylinder connected to its movable contact member, liquid moving means for controlling the operation of said liquid actuated operating means, liquid carrying conductors connecting said liquid moving means to the opposite ends of said individual operating cylinders,

- and means comprising at least one liquid conductor connecting said liquid carrying conductors and communicating with one of said liquid carrying conductors through a non-return valve, said last-mentioned means maintaining portions of the liquid of the hydraulic system under a pressure greater than atmospheric pressure, thus preventing air dissolved in the liquid from separating out of the liquid.
- 10 11. A multipole circuit breaker having a plurality of moving contact members, an individual liquid actuated operating means for moving each contact member, liquid moving means for controlling the operation of said operating means, liquid carrying conductor means connecting said liquid moving means to said operating means, and means comprising a source of liquid pressure connected to said liquid carrying conductor means for preventing portions of the liquid in the hydraulic system from being subjected to a pressure less than atmospheric pressure, thus preventing air dissolved in the liquid from coming out of the liquid, and a non-return valve in the connection of said source of liquid pressure to said liquid carrying conductor.

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