Dec. 19, 1967 H. MANZ 3,359,391

POWER CIRCUIT BREAKER WITH ARC QUENCHING MEANS

Filed March 30, 1965 2 Sheets-Sheet 1

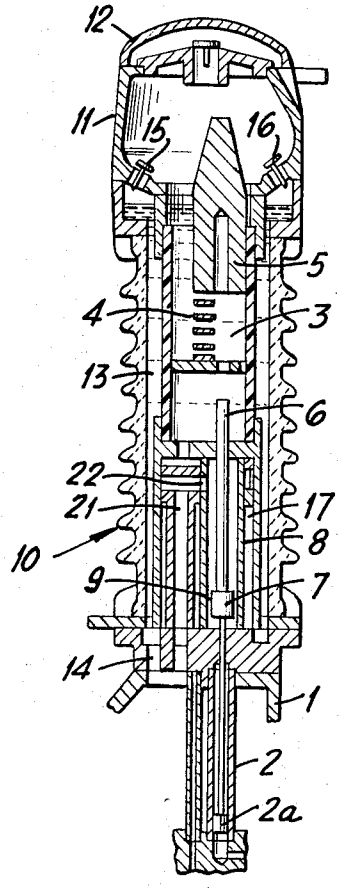

FIG. 1

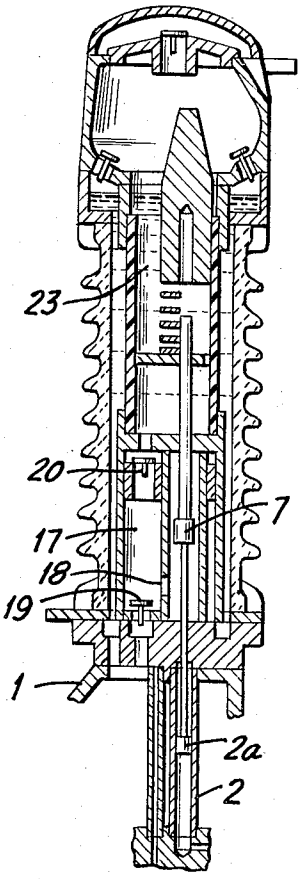

FIG. 2

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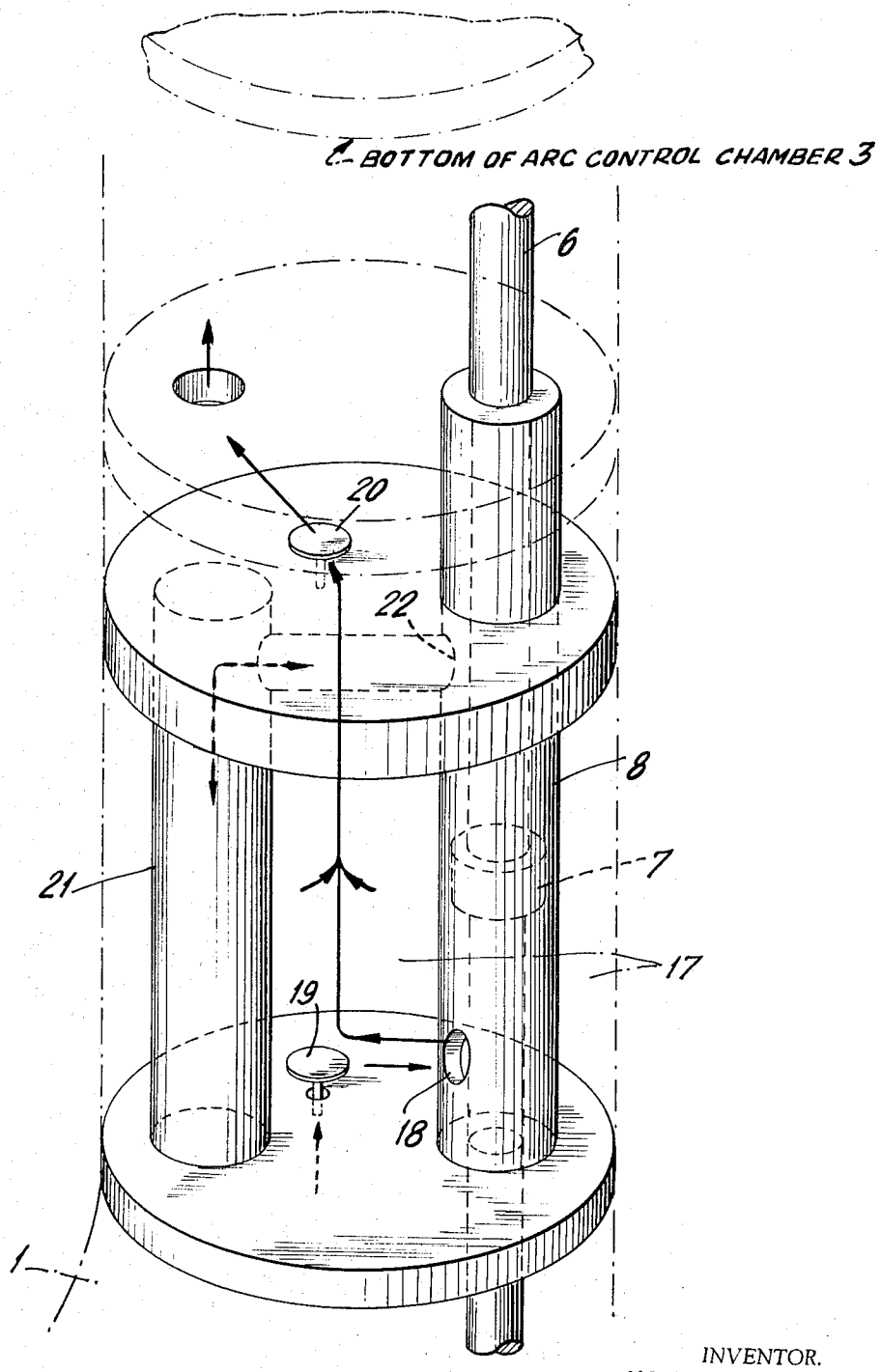

FIG. 3

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POWER CIRCUIT BREAKER WITH ARC QUENCHING MEANS

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ABSTRACT OF THE DISCLOSURE

A power circuit breaker is disclosed as including stationary and movable contacts and an arc-control chamber containing a turbulator stack. A piston is fixed to the movable contact and is movable within a pump cylinder, this piston dividing the cylinder into a first compartment beneath the piston and a second compartment above the piston. A reservoir of quenching liquid communicates with the first compartment and is communicable with the arc-control chamber through a non-return valve.

A liquid supply chamber containing the arc quenching liquid is communicable with the reservoir through a non-return valve, and a return path for quenching liquid extends between the arc-control chamber and the liquid supply chamber.

During closing of the breaker contacts, quenching liquid is drawn from the supply chamber to the reservoir and the first compartment beneath the piston and, during separation of the breaker contacts, quenching liquid is forced out of the reservoir into the arc-control chamber and through the liquid return path back to the supply chamber.

Background of the invention

This invention relates to power circuit breakers of the type having an arc control chamber into which arc quenching liquid is injected and, more particularly, to a novel power circuit breaker of this type including novel means injecting a fresh supply of arc quenching liquid into the arc control chamber in each operation of the circuit breaker.

It is known, in power circuit breakers of the type having an arc control chamber into which arc quenching liquid is injected during opening of the breaker contacts, to effect such injection by means of a pump piston which is coupled to the movable breaker contact and movable therewith. Movement of the piston, during opening of the contacts, causes a jet of quenching liquid to be directed along the length of the moving contact and against the fixed contact. A disadvantage of circuit breakers of this type is that there is little or no increase in the liquid pressure in the arc control chamber during opening of the breaker contacts. To overcome this disadvantage, it has been proposed to assist quenching of the arc by injecting quenching liquid under pressure into the arc control chamber from a separate source. However, this arrangement has the disadvantage of requiring a special pump for so injecting the quenching liquid into the arc control chamber.

An object of the present invention is to provide a power circuit breaker of the type having an arc control chamber into which quenching liquid is injected by means

of a pump piston, during opening of the breaker contacts, and in which a fresh supply of quenching liquid is injected into the arc control chamber during each operation cycle of the circuit breaker contacts.

Another object of the invention is to provide a power circuit breaker of the type having an arc control chamber into which arc quenching liquid is injected, during opening of the breaker contacts, by means of a pump piston coupled to the movable breaker contact, and in which the pump piston is associated with a reservoir into which quenching liquid is drawn from a supply chamber during closing of the breaker contacts and quenching liquid is returned to the supply chamber during opening of the breaker contacts and through the arc control chamber and a return passage connected to the supply chamber.

A further object of the invention is to provide a power circuit breaker of the mentioned type having means, including a pump connected between a reservoir and the arc control chamber and having a liquid displacing element coupled to the movable contact for movement therewith, this means being operable, during closing movement of the movable contact, to force liquid under pressure into the control chamber and to draw liquid from the supply chamber into the reservoir.

Yet another object of the invention is to provide a power circuit breaker of the type just mentioned, in which said means is operable, during opening movement of the movable contact, to force liquid from the reservoir into the control chamber and from the control chamber through a liquid return passage into the supply chamber.

Still another object of the invention is to provide a power circuit breaker of the type mentioned including spring loaded valves interposed between the control chamber and the supply chamber, these valves being normally open and being designed to close when the liquid pressure within the control chamber exceeds a preselected value.

Still another object of the invention is to provide a power circuit breaker of the type mentioned including novel means for protecting the insulator of the circuit breaker from excessive loads.

A further object of the invention is to provide a power circuit breaker of the type mentioned, in which, if the pressure in the arc control chamber increases to such an extent such that the valve connecting the reservoir to the arc control chamber cannot open, the liquid within the arc control chamber may escape through a clearance between a pump piston and its cylinder and thereby blocking of contact opening movement of the movable contact is prevented.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a longitudinal sectional view of a circuit breaker embodying the invention, with the contacts being shown in their open position; and

FIG. 2 is a longitudinal sectional view of the circuit breaker shown in FIG. 1, and in a plane at a small angle to the plane of the longitudinal section of FIG. 1, the contacts in FIG. 2 being illustrated during their closing movement; and

FIG. 3 is a somewhat schematic and enlarged perspective view of the circuit breaker shown in FIGS. 1 and 2.

Referring to the drawings, a circuit breaker embodying the invention includes a lower compartment **1**, constituting an arc quenching liquid supply chamber which surmounts a supporting pedestal which is not shown in the drawings. Compartment **1** also houses a contact driving cylinder **2** in which there is movable a piston **2***a* for operating the circuit breaker contacts.

The circuit breaker mechanism proper comprises essentially an arc control chamber **3** containing a turbulator stack **4**, a relatively fixed contact **5**, and a movable contact or pin **6**. The latter is actuated by the piston **2***a* in the driving cylinder **2**.

Movable contact or pin **6** forms the piston rod of a piston **7**, which is slidable in a pump cylinder **8**, and whose peripheral surface has a relatively small annular clearance **9** with the inner surface of the cylinder wall. Piston **7** is fixedly connected to contact driving piston **2***a*, and thus is movable by the latter and with the contact **6**.

An insulator **10**, surmounted by a cowl **11** and a cover **12**, surrounds arc control chamber **3** and is separated therefrom by an annular space **13**. The lower end of annular space **13** is connected to arc quenching fluid supply chamber **1** by a duct, or liquid return passage, **14**. Compartment **1** and space **13** are filled with the arc quenching liquid. The upper end of annular space **13** is connected to the space within cowl **11**, and thus to arc control chamber **3**, through the medium of normally open spring loaded valves **15** and **16**.

A reservoir **17** is operatively associated with cylinder **8** extending longitudinally of the latter. Reservoir **17** is in communication with the lower portion of cylinder **8**, through an opening or port **18**, is in communication with arc quenching liquid supply chamber **1** through a valve **19**, and is in communication with arc control chamber **3** through a valve **20**. A pipe or duct **21** extends longitudinally of reservoir **17** and provides a connection between the upper end of cylinder **8**, through the medium of an opening or port **22**, and the supply chamber **1**.

The circuit breaker operates in the following manner:

As stated, chamber or compartment **1** and annular space **13** are filled with arc quenching liquid. During closing movement of the circuit breaker contacts, in which movable contact **6** moves toward fixed contact **5**, piston **7** moves upwardly in cylinder **8** and draws arc quenching liquid from supply chamber **1**, through valve **19**, reservoir **17**, and opening **18**, into cylinder **8** behind or beneath piston **7**. During such upward movement of piston **7**, the liquid above or ahead the piston is forced under pressure through opening **22** and, through pipe or duct **21**, into supply chamber **1**.

When contact **6** moves upwardly in arc control chamber **3**, it temporarily compresses the quenching liquid within chamber **3**. Valve **20** remains closed, and thus prevents liquid from escaping from arc control chamber **3** into reservoir **17**. The resulting increase in pressure in arc control chamber **3** increases the electrical breakdown resistance and thus suppresses a closing spark. During continued closing movement of contact **6**, arc quenching liquid flows through the slots in turbulator **4** and thence through a channel **23**, cowl **11**, and valves **15** and **16** into annular space **13**. Annular space **13** forms a liquid return passage or path leading to compartment or supply chamber **1** through duct **14**.

During opening of the breaker contacts, when movable contact **6** moves downwardly away from fixed contact **5**, piston **7** moves downwardly in cylinder **8**. Piston **7** thus forces the liquid beneath it in cylinder **8** through port **18** into reservoir **17**, and through valve **20** into arc control chamber **3**. This raises the pressure in arc control chamber **3** and produces cross jets through the slots of turbulator **4**, these cross jets being considerably increased in intensity. From arc control chamber **3**, the quenching liquid flows through channel **23** into cowl **11** and from there through valves **15** and **16** into space **13** between arc

control chamber **3** and insulator **10**. The liquid thus returns to supply chamber **1** through duct **14**.

As mentioned, valves **15** and **16** are spring loaded, and these valves are arranged to close when the liquid pressure within cowl **11** and arc control chamber **3** exceeds a preselected value. Thus, should a short circuit current occur, resulting in the evolution of an excessive quantity of gas, the increased pressure will close valves **15** and **16**, thus disconnecting space **13** from cowl **11**. Insulator **10** is thus protected from excessive loads.

As will be understood, liquid drawn into reservoir **17** from supply chamber **1** during closing of the breaker contacts, will be stored in reservoir **17** and injected into arc control chamber **3** during subsequent opening of contacts **5** and **6**. Thus, the quenching liquid is circulated and the same liquid is never used in arc control chamber **3** for consecutive operations of the circuit breaker.

If a very high current, such as a short circuit current, is interrupted by the circuit breaker, the pressure in arc control chamber **3** may rise to such an extent that valve **20** is prevented from reliably opening. In such a case, part of the liquid can escape through the clearance **9** during downward movement of piston **7**, and thus prevent blocking of the downward movement of the piston and opening of the contacts.

It will be apparent that an advantage of the present invention, as applied to power circuit breakers of the type described, is that the volume of quenching liquid can be kept to a minimum.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed:

1. A power circuit breaker comprising, in combination, an arc control chamber containing a turbulator stack; a stationary contact within said chamber; a movable contact engageable with and disengageable from said stationary contact; a pump cylinder; a piston fixed to said movable contact and movable within said pump cylinder, said piston dividing said pump cylinder into a first compartment, beneath said piston, and a second compartment, above said piston; a reservoir communicating with said first compartment and communicable with said arc control chamber; a first non-return valve controlling communication of said reservoir with said arc control chamber; a supply chamber containing arc quenching liquid and communicable with said reservoir; a second non-return valve controlling communication of said supply chamber with said reservoir; and means defining a return path for quenching liquid extending between said arc control chamber and said supply chamber; the arrangement being such that, during closing of the circuit breaker contacts, quenching liquid is drawn from said supply chamber to said reservoir and said first compartment and, during separation of the circuit breaker contacts, quenching liquid is forced out of said reservoir into said arc control chamber and through said liquid return path back to said supply chamber.

2. A power circuit breaker, as claimed in claim **1**, including a port connecting said first cylinder compartment to said reservoir.

3. A power circuit breaker, as claimed in claim **1**, including a duct connecting said second cylinder compartment to said supply chamber and extending through said reservoir.

4. A power circuit breaker, as claimed in claim **1**, in which there is an annular clearance between said piston and the inner circumferential surface of said pump cylinder.

5. A power circuit breaker, as claimed in claim **1**, in which said arc control chamber is disposed within

an insulator; the exterior lateral surface of said arc control chamber and the interior lateral surface of said insulator defining an annular space constituting said liquid return path.

6. A power circuit breaker, as claimed in claim 5, including pressure responsive valve means connecting said annular space to said arc control chamber, said pressure responsive valve means closing when the pressure in said arc control chamber exceeds a predetermined value.

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