Jan. 16, 1968 H. MANZ 3,364,328

FLUID PRESSURE ACTUATED ELECTRIC POWER CIRCUIT BREAKER

Filed March 30, 1965 3 Sheets-Sheet 1

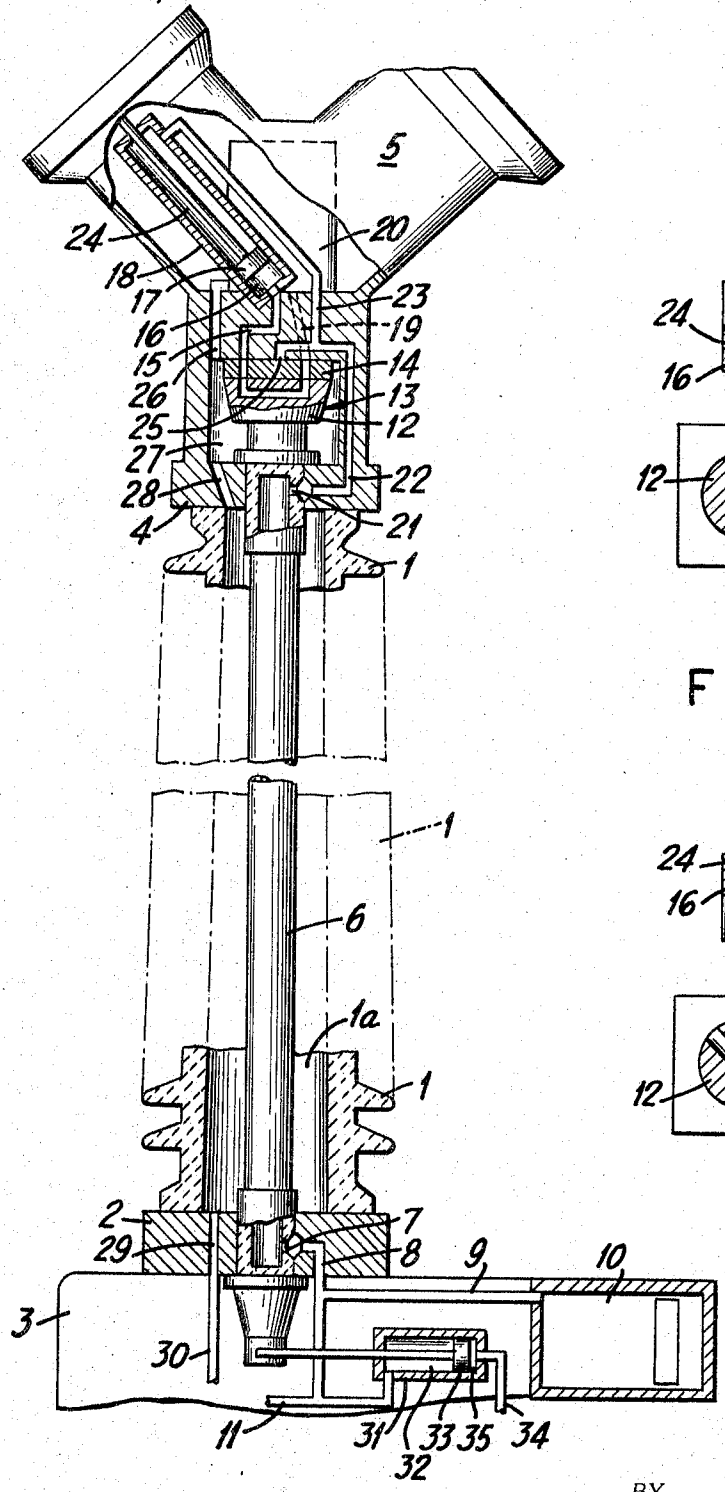

FIG. 1

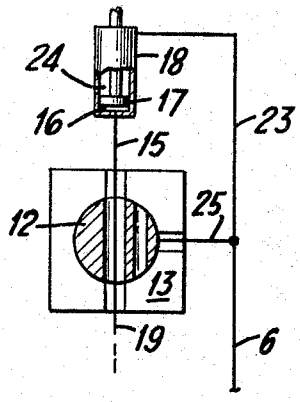

FIG. 2b

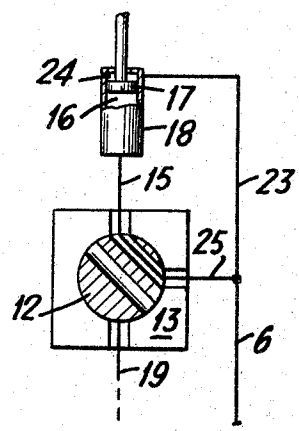

FIG. 2a

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FLUID PRESSURE ACTUATED ELECTRIC POWER CIRCUIT BREAKER

Filed March 30, 1965 3 Sheets-Sheet 2

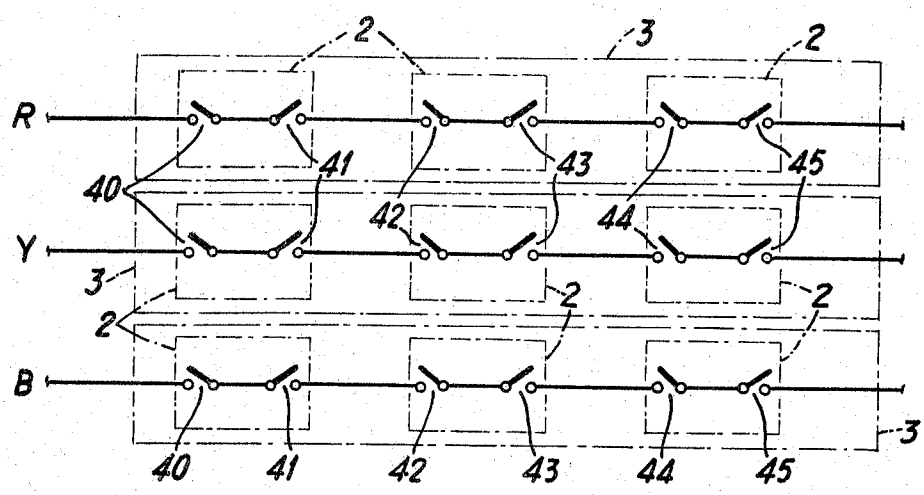

FIG. 3

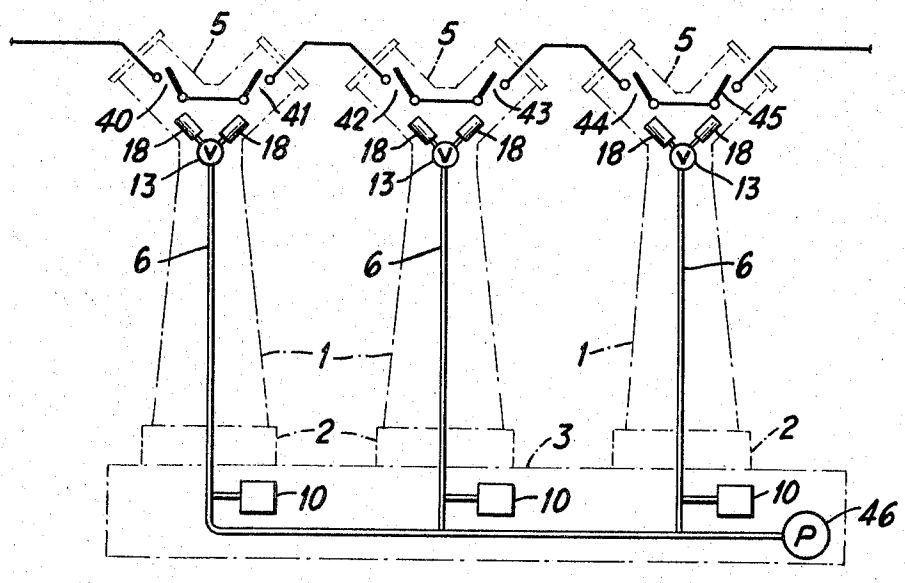

FIG. 4

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Jan. 16, 1968 H. MANZ 3,364,328

FLUID PRESSURE ACTUATED ELECTRIC POWER CIRCUIT BREAKER

Filed March 30, 1965 3 Sheets-Sheet 3

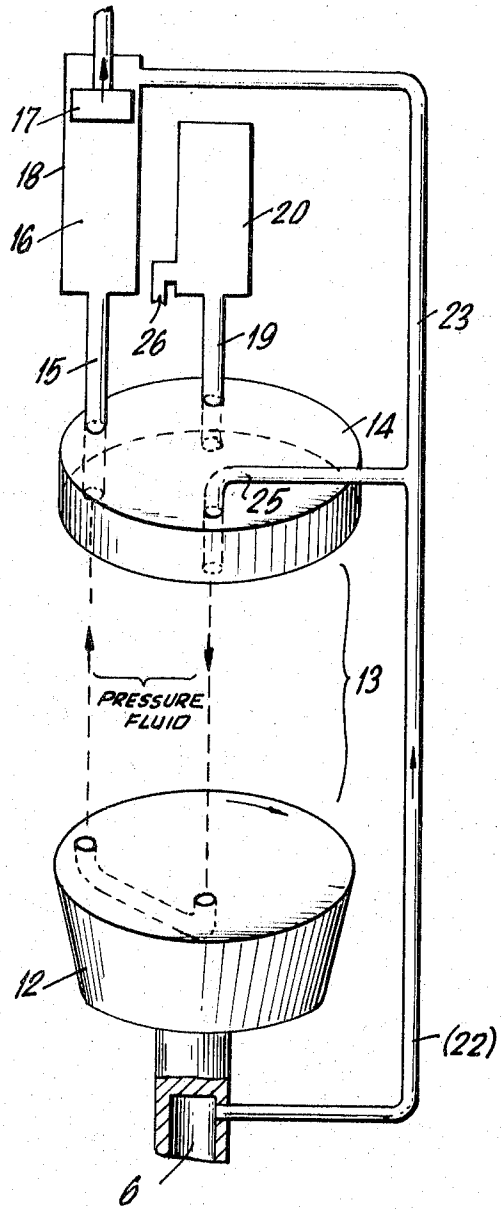

FIG. 5

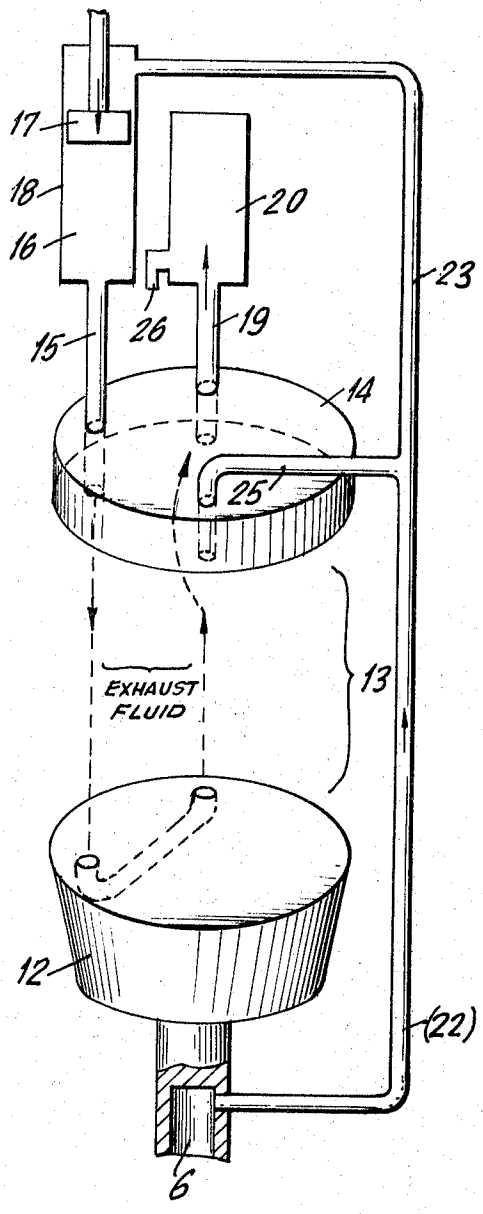

FIG. 6

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FLUID PRESSURE ACTUATED ELECTRIC POWER CIRCUIT BREAKER

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10 Claims. (Cl. 200—150)

ABSTRACT OF THE DISCLOSURE

A fluid pressure actuated circuit breaker comprises a base, a hollow insulator on the base and at least one head on the insulator carrying a circuit interrupter and a piston-cylinder device for operating the interrupter. A single pipe is mounted rotatably on the base and extends coaxially through the insulator to define, with the interior surface of the latter, an annular clearance.

A fluid pressure accumulator in the base communicates constantly with the lower end of the pipe, and the annular clearance is connected to sump. A rotary valve on the upper end of the pipe, which is rotatable therewith and communicates with the pipe, controls the supply of fluid under pressure to the piston-cylinder device as well as connection of the latter to an intermediate reservoir connected to the annular clearance. A fluid pressure actuator in the base, which may be a piston-cylinder device, is selectively operable to angularly displace the pipe to change the connections to the piston-cylinder device operating the circuit interrupter, to open and close the interrupter.

Several of the circuit breakers may be connected in series with each other, for example, and have pressure fluid supplied to pressure accumulators in their bases through a common pump.

Background of the invention

This invention relates to electric power circuit breakers of the type having circuit interrupters which are operated by a fluid pressure type actuator. More particularly, the present invention is directed to an electric power circuit breaker of this type including novel and improved means for controlling the operation of the actuator or actuators.

Electric power circuit breakers of the type to which the present invention is directed includes a head structure carrying a fluid pressure actuated, and usually hydraulically actuated, main interrupter, this head structure being supported on a base structure by means of a hollow post insulator. The base structure preferably includes a carriage for the circuit breaker, and the hollow post insulator has a length requisite to afford the necessary electrical insulation. Frequently, the head is a V-head carrying two interrupters connected in series.

It has already been proposed to construct the insulator as a hollow cylindrical post and to accommodate, within the insulator, the pressure fluid pipes or contacts for the interrupters. In such instances, the actuator control is effected by means of a two-way valve located at the lower end of the post. Two fluid pressure pipes run from this valve through the post to each main interrupter actuator, one being connected to the contact opening port of the actuator and the other to the contact closing port thereof.

In this arrangement, the pipes alternate in carrying the fluid under pressure used for contact opening and contact closing operation of each actuator. Thus, the length of pipe which is subject to possible leakage is considerable, and the risk of loss of pressure fluid is correspondingly high. Furthermore, during each operation of an actuator, the fluid under pressure must circulate through both pipes, with the circulation being reversed for consecutive opening and closing operations. Particularly in a rapid sequence of breaker operations, the fluid in the high pressure pipe tends to build up oscillations which may impair the smooth operation of the actuator and hence the smooth movement of the movable contact of the interrupter.

An object of the present invention is to provide an electric power circuit breaker of the type mentioned and in which the disadvantages of prior art circuit breakers are eliminated.

Another object of the invention is to provide an electric power circuit breaker of the type mentioned including a single displaceable pipe extending longitudinally within the insulator post to convey fluid under pressure to a change-over valve mounted at the top of the post and controlling operation of the actuator for each interrupter.

A further object of the invention is to provide an electric power circuit breaker including such a displaceable pipe carrying the fluid under pressure from the base structure to a change-over valve in the head, and in which risk of pressure fluid oscillations is minimized by permanently or continuously connecting one port of the actuator to the supply pipe.

Still another object of the invention is to provide an electric power actuator including a single displaceable pipe extending longitudinally within the insulator post to convey fluid under pressure from an accumulator to a change-over valve mounted on the top of the insulator post and controlling the actuator operation, and further including a displaceable valve element in the valve mechanically connected to the displaceable pipe and operating means in the base connected to the pipe to displace the same angularly to displace the valve member.

Yet another object of the invention is to provide an electric power circuit breaker including a single rotary pipe extending longitudinally within the insulating post and conveying fluid under pressure from a respective accumulator in the base structure to a change-over valve mounted on top of the post and controlling the actuator for an interrupter, and in which the single rotary pipe defines, with the inner peripheral surface of the insulator post, an annular clearance extending longitudinally of the insulator and serving as part or the exhaust of fluid return circuit from the actuator for the interrupter.

Still a further object of the invention is to provide, in a multi-bank circuit breaker controlling a number of separate power conductors, a separate pressure accumulator for each circuit breaker instead of the conventional arrangement using only one common accumulator for all of the circuit breakers.

By means of this latter feature of the invention, there is obviated the necessity for complex synchronizing mechanisms, such as are normally required in conventional multi-bank circuit breakers to overcome the difficulty of insuring simultaneous action of all the interrupter actuators, and due to the differences in the lengths of the various hydraulic circuit connections to the common accumulator.

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 an axial sectional view, partly schematic, of an electric power circuit breaker embodying the invention;

FIGS. 2*a* and 2*b* are schematic illustrations of a two-

way or change-over valve included in the circuit breaker, in respectively different operational positions;

FIG. 3 is a schematic wiring diagram of a multi-bank three-phase circuit breaker assembly embodying the invention;

FIG. 4 is a schematic side elevation of one phase unit of the multi-bank circuit breaker assembly illustrated in FIG. 3;

FIG. 5 is a schematic perspective view illustrating the position of the parts during closing of the circuit breaker; and

FIG. 6 is a view similar to FIG. 5, but illustrating the position of the parts during opening of the circuit breaker.

Referring first to FIG. 1 of the drawings, an electric power circuit breaker embodying the invention is illustrated as including a relatively elongated, generally-cylindrical hollow post insulator **1** extending upwardly from a base **2** mounted on a circuit breaker carriage **3**. A valve housing **4** is mounted on the upper end of post **1** and is surmounted by a V-head **5** carrying two main circuit interrupters (not shown in FIG. 1). A single, relatively elongated pressure fluid supply pipe **6**, of dielectric material, extends longitudinally of hollow post insulator **1** with radial clearance **1***a* and is mounted in bearings in base **2** and in valve housing **4**.

At its lower end, pressure fluid supply pipe **6** is provided or formed with a port **7** which communicates, through a channel **8** in base **2** and a pipe **9**, with a pressure fluid accumulator **10**, of which one is provide for each circuit breaker. Working pressure is maintained in accumulator **10** and in associated parts of the system by a pump (not shown in FIG. 1) through a pipe **11**. Channel **8** and ports **7** have circumferentially elongated registering mouths to maintain communication when pressure pipe **6** is rotated through a given angle corresponding to the limit of angular motion of a rotary valve member **12** fixed to the upper end of pressure pipe **6** to rotate therewith.

Referring also to FIGS. 2*a*, 2*b*, 5 and 6, rotary valve member **12** is part of a two-way change-over valve **13** having a fixed valve body **14**. A conduit **15** connects valve **13** to one port of an actuator cylinder **18**, this port opening into the space **16** below the piston **17** of the actuator. A second conduit **19** extends between the top of valve **13** and an intermediate exhaust reservoir **20** in V-head **5**.

The upper end of pressure pipe **6** is formed with a port **21**, within the portion fitting within housing **4**, and this port communicates with a duct or channel **22** in the housing **4**. Port **21** and channel **22** have circumferentially elongated registering mouths to maintain communication throughout the range of angular displacement of pipe **6**. Channel **22** divides into a first branch conduit **23** leading to the other actuator port, which opens into the space **24** in cylinder **18** above piston **17**, and a second branch conduit **25** in stationary body **14** of valve **13**. Through a channel **26**, a chamber **27** in valve housing **4**, and a channel **23** in the valve housing, intermediate reservoir **20** communicates with the interior of hollow insulator post **1**, and particularly with the annular clearance space between the outer periphery of pipe **6** and the inner periphery of hollow post cylinder **1**. In turn, the interior of post **1** communicates, through a channel **29** and a conduit **30**, with the reservoir or return line (not shown), connected to the pump mentioned above. Post **1** thus forms part of the fluid return or exhaust circuit of the pressure fluid system.

A fluid pressure motor **31** rotates pressure pipe **6**, the piston rod side **32** of motor piston **33** being permanently connected to accumulator **10**. Closure of the circuit breaker is effected by conventional control mechanism (not shown) which admits high pressure fluid, such as oil, through a pipe **34** to the "blind" side **35** of actuator piston **33**. The resultant thrust, due to the difference in area between the two faces of piston **33**, drives piston **33** to the left, as shown in FIG. 1, rotating pressure pipe **6** and valve member **12** of valve **13** to the position shown in FIG. 2*a* and in FIG. 5. In this position, both end spaces **16** and **24** of actuator **18** are connected to pipe **6**, so that piston **17** is moved into the contact closing position by the resultant force due to the pressure differential across the piston. The speed of displacement can be controlled by an orifice plate, not shown, in channel **15** or in conduit **23**.

To open the contacts of the circuit breaker, the control mechanism connects conduit **34** to exhaust. The pressure on the right face of piston **33** of actuator **31** is thereby collapsed, and the consequent reverse differential thrust returns the piston to the right to its former end position. This rotates pressure pipe **6** and movable valve member **12** in the direction for disconnecting pressure pipe **6** from the space **16** on the underside of piston **17**, and connecting the space **16** to channel **19**, as best seen in FIG. 2*b* and in FIG. 6. A volume of pressure fluid, such as oil, corresponding to the piston displacement is thus transferred, without the development of a significant pressure head, through duct **15**, valve member **12** and channel **19** into intermediate exhaust reservoir **20**. The reservoir then drain the fluid into the fluid return system through channel **26**, chamber **27**, channel **28** and the interior of hollow post insulator **1**.

One practical application of the present invention is in a high voltage three-phase system of the kind shown diagrammatically in FIGS. 3 and 4. Referring to FIG. 3, three-phase conductors or lines are shown at R, Y and B, each being controlled by a bank of six sets of contacts or interrupters **40–45** connected in series. Each successive pair **40** and **41**, **42** and **43**, and **44** and **45** in each bank is constituted by the two interrupters and a common V-head, such as shown in FIGS. 1 and 4. Each interrupter bank is part of a phase unit comprising three hollow insulator posts **1**, as shown in FIG. 4, each carrying a respective V-head **5** and mounted on a respective base **2**, the bases being, in turn, mounted on a common phase carriage **3**.

Normally, all of the interrupters **40–45** in each bank are tripped simultaneously. Furthermore, all three phases are tripped simultaneously. Consequently, simultaneous functioning of the interrupters in each bank is of considerable importance in reducing arcing of the contacts.

As illustrated, in accordance with the invention, separate accumulators **10** are provided for each V-head **5**, each group of three accumulators per bank being charged by a common pump **46** as shown in FIG. 4. This arrangement contributes substantially to reduction of contact arcing by insuring that the lengths of the hydraulic circuits between each accumulator **10** and its respective actuators **18** are equal. Thus, the possibility that relative time delays can occur in the operation of the several interrupters **40–45** in each bank, due to inequalities in the lengths of the hydraulic circuits, is eliminated or at least minimized. The separate accumulators **10**, of which nine are used in the instant example, may be charged by the common pump **46**.

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 is:

1. A circuit breaker comprising, in combination, a base structure; a pressure fluid accumulator in said base; a hollow post insulator extending from said base structure; a head on the end of said insulator remote from said base structure; a circuit interrupter in said head; a hydraulic working cylinder-piston actuator connected to said circuit interrupter; a rotary change-over valve in said head controlling the fluid circuit connections to the working cylinder; a single pressure fluid supply pipe extending longitudinally of said insulator and defining, with the inner peripheral surface of said insulator, an annular

clearance space extending longitudinally of said insulator; said pipe interconnecting said pressure fluid accumulator and said rotary valve, and said clearance space being included in the fluid exhaust circuit of the working cylinder; means mounting said pipe for rotation about its longitudinal axis; the upper end of said pipe being connected to said rotary valve to angularly displace the latter between two positions controlling the fluid circuit connections to the working cylinder; and means in said base structure connected to said pipe and operable to displace said pipe and said rotary valve, through said pipe, about the axis of said pipe; whereby said pipe serves simultaneously as an operating means for said rotary valve and as a pressure fluid supply line to said rotary valve.

2. A circuit breaker, as claimed in claim 1, wherein said last-named means comprises a second fluid pressure actuator in said base structure and operably connected to said pipe to angularly displace the latter about its axis.

3. A circuit breaker, as claimed in claim 10, including a piston rod interconnecting said piston to said circuit interrupter; means constantly connecting the piston rod surface of said piston to the upper end of said pipe; said rotary valve being selectively operable to connect the other side of said piston to the upper end of said pipe or to said clearance space.

4. A circuit breaker comprising, in combination, a base structure; a relatively elongated hollow post insulator extending from said base structure; a head on said insulator carrying a circuit interrupter and a fluid pressure actuator for said interrupter; a change-over valve controlling fluid circuit connections to said actuator, housed within said head and including a rotary valve member; a pressure fluid accumulator in said base; a pressure fluid supply pipe extending longitudinally of said insulator and defining, with the inner peripheral surface of said insulator, an annular clearance extending longitudinally of said insulator; said supply pipe being mounted for rotation relative to said base structure and said head and being in constant communication, at its lower end, with said accumulator and, at its upper end, with said valve; said supply pipe being mechanically coupled to said rotary valve member; said annular clearance constituting a pressure fluid exhaust line; and means in said base structure coupled to said pipe to rotate the same to operate said valve; said actuator comprising a cylinder, a piston reciprocable in said cylinder, and a piston rod extending from one surface of said piston for operating said interrupter; said cylinder having cylinder ports on opposite sides of said piston; the cylinder port on the piston rod side of said piston being constantly connected to said supply pipe; the other cylinder port being connected to said change-over valve for alternative communication with said supply pipe or with said annular clearance.

5. A circuit breaker comprising, in combination, a base structure; a relatively elongated hollow post insulator extending from said base structure; a head on said insulator carrying a circuit interrupter and a fluid pressure actuator for said interrupter; a change-over valve controlling fluid circuit connections to said actuator, housed within said head and including a rotary valve member; a pressure fluid accumulator in said base; a pressure fluid supply pipe extending longitudinally of said insulator and defining, with the inner peripheral surface of said insulator, an annular clearance extending longitudinally of said insulator; said supply pipe being mounted for rotation relative to said base structure and said head and being in constant communication, at its lower end, with said accumulator and, at its upper end, with said valve; said supply pipe being mechanically coupled to said rotary valve member; said annular clearance constituting a pressure fluid exhaust line; and means in said base structure coupled to said pipe to rotate the same to operate said valve; said actuator comprising a cylinder, a piston reciprocable in said cylinder, and a piston rod extending from one surface of said piston for operating said interrupter; said cylinder having cylinder ports on opposite sides of said piston; the cylinder port on the piston rod side of said piston being constantly connected to said supply pipe; said change-over valve having an exhaust port connected to said annular clearance; the other cylinder port being connected to said change-over valve for alternative communication with said supply pipe or with the exhaust port of said change-over valve.

6. A circuit breaker comprising, in combination, a base structure; a relative elongated hollow post insulator extending from said base structure; a head on said insulator carrying a circuit interrupter and a fluid pressure actuator for said interrupter; a change-over valve, controlling fluid connections to said actuator, housed within said head and including a rotatable valve member; a pressure fluid supply pipe extending longitudinally of said insulator between said base structure and said valve to supply fluid under pressure to said valve, and defining, with the inner peripheral surface of said insulator, an annular clearance extending longitudinally of said insulator; said supply pipe being rotatable relative to said base structure and said head and being mechanically coupled to said valve member; said annular clearance constituting the fluid exhaust circuit of said actuator; means in said base structure coupled to said pipe to rotate the latter to operate said valve; an intermediate fluid reservoir within said head connected to said annular clearance; said actuator including a cylinder, a piston reciprocable in said cylinder, and a piston rod extending from one surface of said piston for operating said interrupter; said cylinder having cylinder ports on opposite sides of said piston; the cylinder port on the piston rod side of said piston being constantly in communication with said supply pipe; said change-over valve being selectively operable to connect the other cylinder port either to said supply pipe or to said intermediate fluid reservoir.

7. A circuit breaker comprising, in combination, a base structure; a relatively elongated hollow post insulator extending from said base structure; a valve housing, including a chamber, on said insulator; a head on said valve housing carrying at least one circuit interrupter and a fluid pressure actuator for said interrupter; a change-over valve mounted in said valve housing and controlling fluid circuit connections to said actuator; said valve including a rotatable valve member within said chamber; a pressure fluid accumulator within said base structure; a pressure fluid supply pipe extending longitudinally of said insulator between said base structure and said valve housing, and rotatably supported in said base structure and said valve housing; said supply pipe establishing constant communication between said accumulator and said valve, and defining, with the inner peripheral surface of said insulator, an annular clearance extending longitudinally of said insulator; the upper end of the pipe being mechanically connected to said valve member to rotate the latter; passage means connecting said chamber to said annular clearance; a fluid exhaust connection in said base structure connected to said annular clearance; an intermediate reservoir within said head to receive exhaust fluid from said actuator; said valve controlling communication between said supply pipe and said actuator and between said intermediate reservoir and said chamber; and means in said base structure coupled to the lower end of said supply pipe to rotate the latter to operate said valve.

8. A circuit breaker comprising, in combination, a base structure; a relatively elongated hollow post insulator extending from said base structure; a valve housing, including a chamber, on said insulator; a head on said valve housing carrying at least one circuit interrupter and a fluid pressure actuator for said interrupter; a change-over valve mounted in said valve housing and controlling fluid circuit connections to said actuator, said valve including a rotatable valve member within said chamber; a pressure fluid accumulator within said base structure; a pressure fluid supply pipe extending longitudinally of said insu-

lator between said base structure and said valve housing, and rotatably supported in said base structure and said valve housing; said supply pipe establishing constant communication between said accumulator and said valve, and defining, with the inner peripheral surface of said insulator, and annular clearance extending longitudinally of said insulator; the upper end of said pipe being mechanically connected to said valve member to rotate the latter; passage means connecting said chamber to said annular clearance; a fluid exhaust connection in said base structure connected to said annular clearance; an intermediate reservoir within said head to receive exhaust fluid from said actuator; said valve controlling communication between said supply pipe and said actuator and between said intermediate reservoir and said chamber; means in said base structure coupled to the lower end of said supply pipe to rotate the latter to operate said valve; and a fluid pressure pump in said base structure having an outlet connected to said accumulator and an inlet connected to said fluid exhaust passage.

9. A polyphase circuit breaker assembly comprising, in combination, plural circuit breakers for each phase; each circuit breaker including at least one circuit interrupter and the circuit interrupters for each phase being connected in series; each circuit breaker including a base, a relatively elongated hollow post insulator extending from said base, a head on said insulator carrying the circuit interrupter and a fluid pressure actuator for the associated circuit interrupter, a change-over valve controlling fluid circuit connections to said actuator and housed within the head and including a movable member, a single high pressure fluid supply pipe rotatably mounted in, and extending with radial clearance through, the associated hollow post insulator between the associated base and the associated valve and mechanically connected to the associated movable valve member and with its upper end in fluid communication therewith, a respective accumulator coupled to the lower end of the associated pipe and supplying fluid under pressure thereto, means connecting the associated valve to the associated fluid pressure actuator and to said radial clearance, and operating means for angularly displacing the associated pipe about its axis to operate the associated change-over valve; and a common pump for each phase connected to all of the accumulators for the respective phase; each pipe acting conjointly as a mechanical operator and a pressure fluid supply line for its associated valve.

10. A polyphase circuit breaker assembly comprising, in combination, circuit breakers for each phase, each circuit breaker including a pair of circuit interrupters and all of the interrupters for each phase being connected in series; each circuit breaker including a base, a relative elongated hollow post insulator extending from said base, a common head on said insulator carrying the pair of circuit interrupters and a fluid pressure actuator for each interrupter, a change-over valve housed within the associated head and controlling fluid circuit connections to the associated pair of actuators, said change-over valve including a movable valve member, a single high pressure fluid supply pipe rotatably mounted in, and extending with radial clearance through, the associated hollow post insulator between the associated base and the associated valve and mechanically connected to the associated movable valve member, a respective high pressure fluid accumulator coupled to the lower end of the associated pipe and supplying fluid under pressure thereto, means establishing cocmunication between the upper end of the associated single high pressure fluid supply pipe and the associated valve, between the associated valve and the associated pair of actuators, and between the associated valve and the associated radial clearance, and respective means for angularly displacing the associated pipe about its axis to operate the associated change-over valve; and a common high pressure fluid pump for each phase and connected to all of the accumulators of the respective phase; each pipe acting conjointly as a mechanical operator and a pressure fluid supply line for its associated valve.

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