

Sept. 28, 1965

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3,208,220

CIRCUIT BREAKER CONTROL

Filed Dec. 3, 1963

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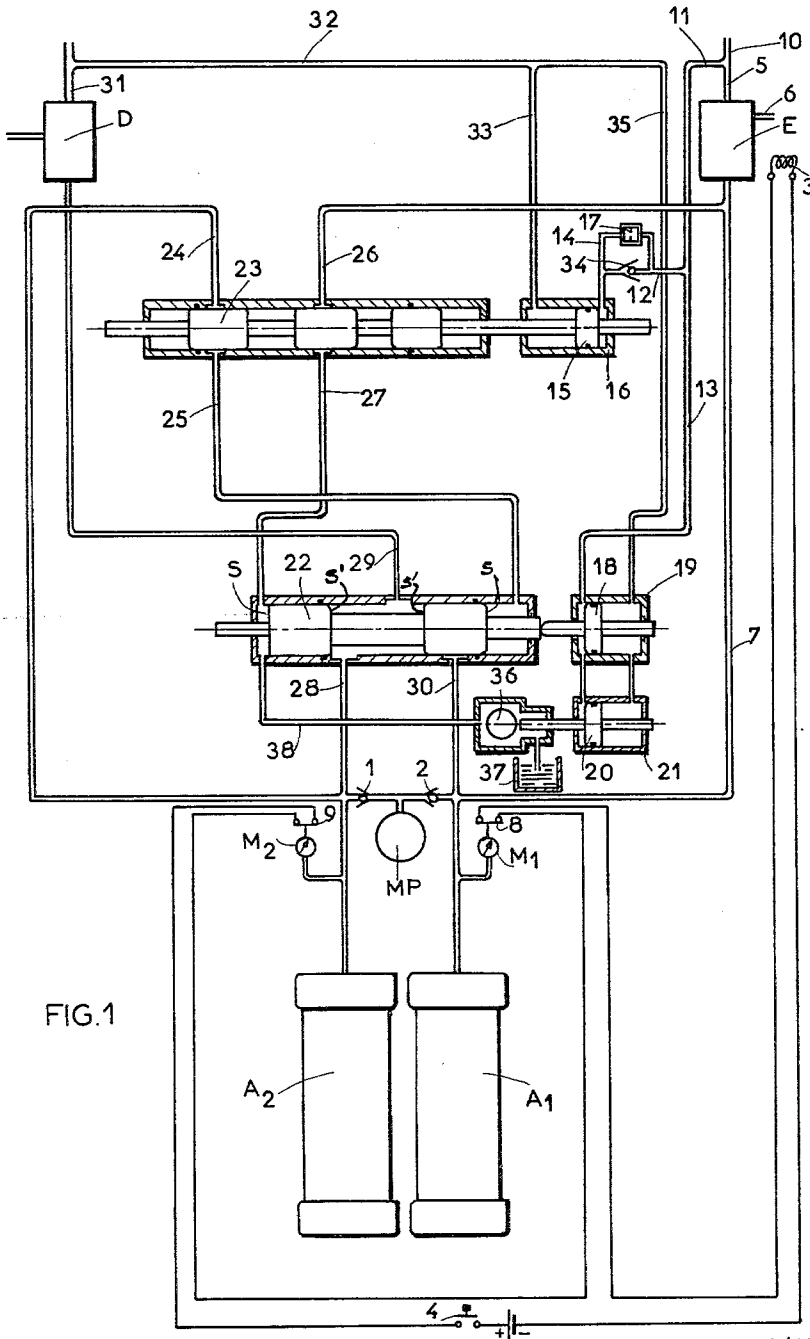
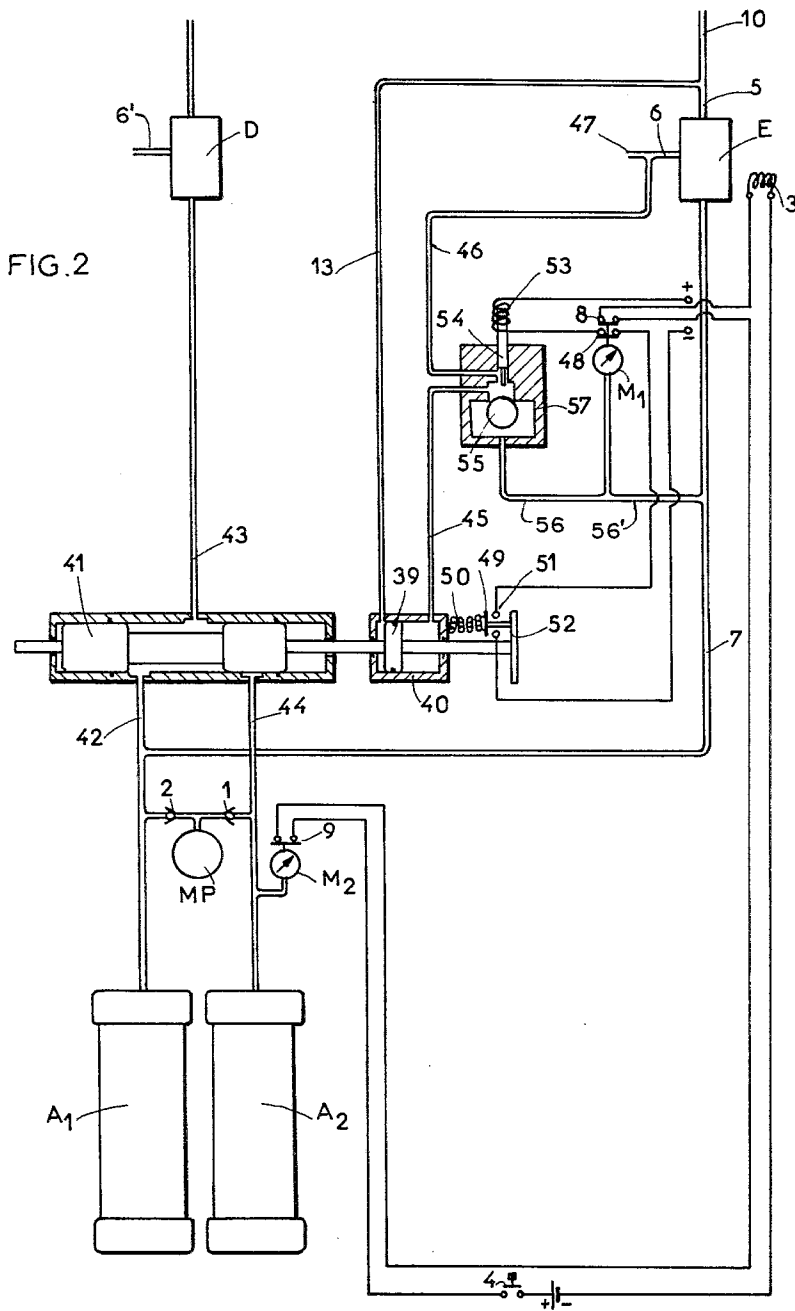


FIG. 1

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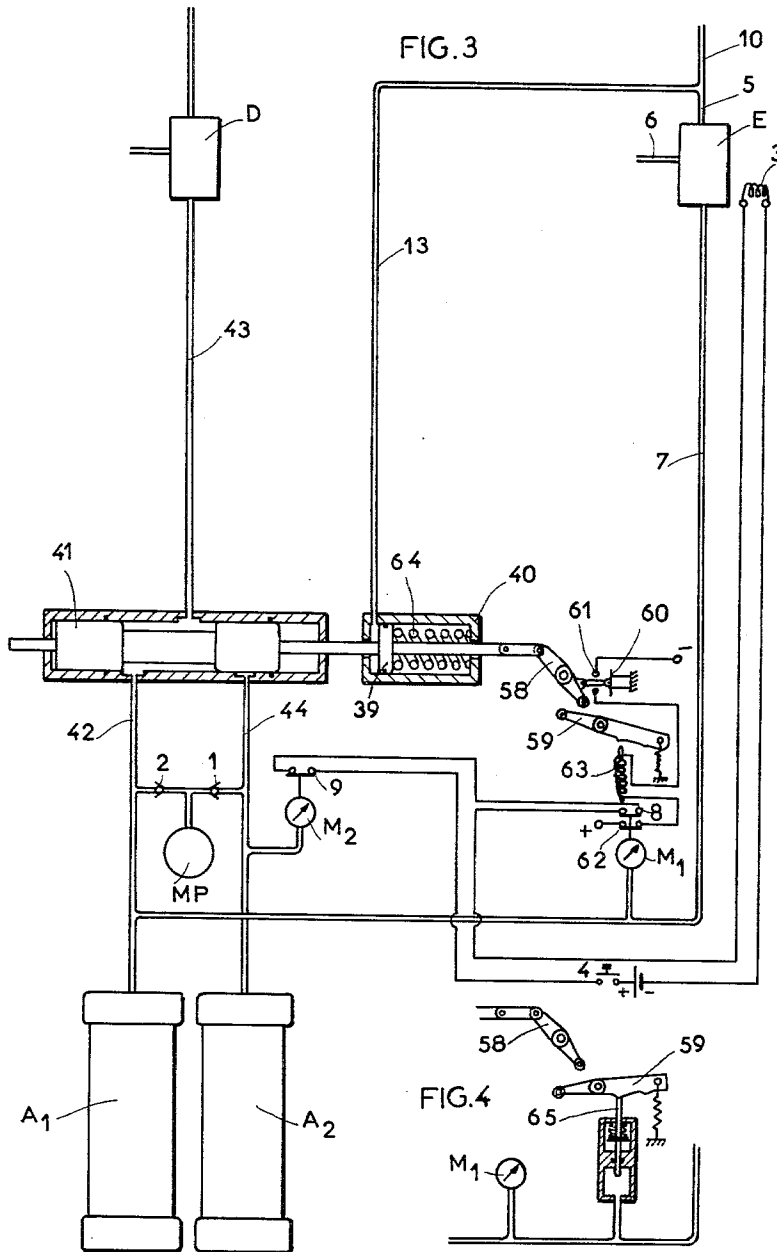
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4 Sheets-Sheet 3



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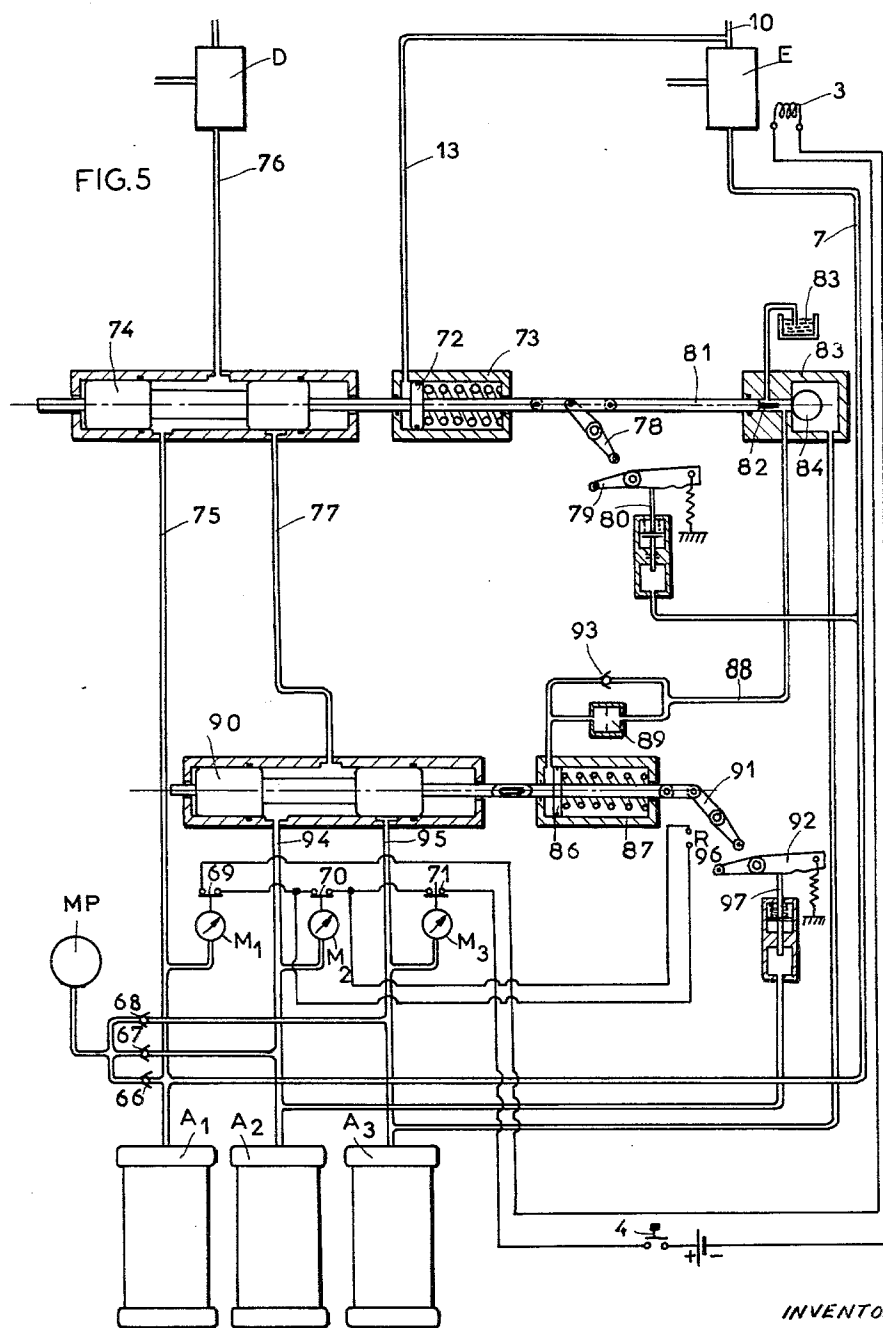
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4 Sheets-Sheet 4



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CIRCUIT BREAKER CONTROL

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Claims priority, application France, Dec. 4, 1962, 917,500

17 Claims. (Cl. 60—51)

The present invention relates to a control system for controlling the operation of circuit breakers, and more particularly to a hydraulically operated control system including at least two accumulators for storing therein liquid under pressure which is utilized for the opening and closing operations of the circuit breakers.

In some oleopneumatically controlled circuit breakers, the members for closing and opening the circuit breaker are fed by a common set of accumulators. When successive operations, for example "closing-opening" or "opening-closing-opening" cycles, are performed by such circuit breakers during a very brief period of time, a motor-pump set such as is usually employed to restore the pressure in the accumulators has not sufficient time to restore their initial pressure before the second opening, so that the latter operation takes place under a pressure below that which is set up in the course of the first opening. Since the speed of operation of the circuit breaker depends upon the pressure, it is necessary, in order to obtain the desired speed during the second opening, and more especially in order to avoid any restriking when the circuit breaker breaks electric lines under no-load, to adopt for the first operation a speed higher than that which would be necessary if the driving or actuating pressure remained constant. The transmission members, as also the shock absorption at the end of the travel of the rods carrying the contacts of the circuit breaker, must then be designed for this exceedingly high speed, whereby the cost of the circuit breaker is increased.

The present invention has the object of obviating these disadvantages, and essentially consists in separating the accumulators into a number of groups, one of which is designed always to effect the closing of the circuit breaker, while the others effect the opening of the circuit breaker under normal pressure.

This invention is also applicable when the operating conditions necessitate a number of successive reclosings in a short period, for example "opening-closing-opening—inoperative period—closing-opening" operations, the duration of this inoperative period being insufficient for the motor-pump set to have time to restore the initial pressure in the accumulators.

Accordingly, it is an object of the present invention to provide a circuit breaker control system of the type described hereinabove which obviates, by extremely simple means, the disadvantages encountered with the prior art constructions.

It is another object of the present invention to provide a circuit breaker control system for controlling the opening and/or closing operations of the circuit breaker which is simple in construction, yet assures sufficiently rapid operations, especially opening of the circuit breaker under all conditions.

A still further object of the present invention resides in the provision of a control system for oleopneumatically controlled circuit breakers utilizing a plurality of accumulators which assures proper operation of the circuit breaker without excessive cost in the auxiliary equipment.

Another object of the present invention resides in the provision of a control system for circuit breakers which assures proper opening of the circuit breaker even in case of successive openings thereof without requiring excessive speeds for the operation of the circuit breaker in a

given cycle, thereby eliminating increased costs in connection with the structural elements that otherwise would have to be designed for higher speed in operation.

Still a further object of the present invention resides in the provision of a multi-accumulator control system for controlling the operation of circuit breakers which is so designed and constructed that sufficient time exists to restore the fluid in the accumulators to the predetermined initial pressure during successive operations.

These and further objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein

FIGURE 1 is a somewhat schematic diagram of a first embodiment of a control system according to the present invention by means of which an "opening-closing-opening" cycle can be performed with the same speed in the first and second opening operations;

FIGURE 2 is a somewhat schematic diagram of a second constructional embodiment of a control system according to the present invention;

FIGURE 3 is a somewhat schematic diagram of a modified embodiment of the control system shown in FIGURE 2;

FIGURE 4 is a partial somewhat schematic view of a variant of the control of the latching device for the jack of the apparatus according to FIGURE 3, and

FIGURE 5 is a somewhat schematic diagram of still another control system in accordance with the present invention for the performance of two successive reclosing operations, in which the speed is maintained constant during the three opening operations.

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, FIGURE 1 illustrates the apparatus and control system according to the present invention for the control of a circuit breaker of any known conventional construction. The closing of this circuit breaker is effected by a jack or actuator also of any conventional construction (not shown), which is operatively connected to pipe 10 and is hydraulically actuated through pipes 5 and 10 by a flow of oil controlled by an electromagnetic valve E of conventional construction under the action of an electromagnet 3. The opening of the circuit breaker is effected by means of an electromagnetic valve D also of conventional construction and controlled by an electromagnet (not shown) of any suitable known type and responsive to predetermined circuit conditions warranting the opening of the circuit breaker.

Reference characters A_1 and A_2 denote respectively, two oleopneumatic accumulators, of which the pressure is maintained by means of a conventional motor-pump set MP through two conventional non-return valves 1 and 2. The delivery of the pump is lower than the delivery of the accumulators during an operation of the circuit breaker. The motor of the said set MP is started by means of electric contacts (not shown) forming part of the same contact structures as electric contacts 8 and 9 actuated by pressure-responsive contactors M_1 and M_2 connected to the accumulators A_1 and A_2 , respectively.

The electromagnetically operated valves E and D may be, as mentioned above, of any conventional construction and are so constructed and arranged as to normally connect lines 5 and 31 with the low pressure pipes 6 and 6', respectively, while closing at the same time the pipes 7 and 29, respectively. Upon energization thereof by any suitable means, a respective electromagnetic valve E and D becomes operable to close off the corresponding low pressure pipes 6 or 6' while providing a communication between the pipes 7 and 5 and the pipes 29 and 31, respec-

tively. Since control valves such as used with valves E and D as well as the electromagnetic actuation thereof are well known in the art and form no part of the present invention, a detailed showing thereof is dispensed with herein, it being understood that the valves E and D may be, for example, of rotary valve construction, slide valve construction, or any other conventional known construction. Similarly, the electromagnetic actuation of the valves E and D may take place in any suitable means. The valve E is actuated by energization of the electromagnet 3, as will be described more fully hereinafter, which may be realized either by operation of the push button 4, or any suitable automatic or semi-automatic control intended to initiate the closing operation of the circuit breaker. The electromagnetically actuated valve D is also actuated by an electromagnet (not shown) of any suitable construction which itself may be selectively energized either from a push-button and/or automatically or semi-automatically from a conventional control system calling for the opening of the circuit breaker as a result of a given condition or conditions in the line.

The accumulators A_1 and A_2 may also be of conventional construction, for example, may include pneumatic means to keep the hydraulic liquid stored therein and supplied from the motor-pump set MP under predetermined pressure. Again, since the details of such accumulators are well known in the art and form no part of the present invention, a detailed showing thereof is dispensed with herein.

As mentioned above, the motor of the motor-pump set MP driving the pump is automatically started every time the pressure in any one of the accumulators drops below a predetermined value. This may be accomplished by any conventional means well known, per se, in the prior art, for example, by means of a plurality of parallel contact switches connected in the energizing circuit of the motor whereby each contact switch is associated with a corresponding pressure responsive contactor M_1 or M_2 to close the energizing circuit when the pressure in a respective accumulator drops below the predetermined value. Since the control of the motor driving the pump is well known in the prior art and forms no part of the present invention, a detailed showing thereof is dispensed with herein, it being understood that any known control system of the prior art may be utilized therefor.

The pressure-responsive contactors are so adjusted that in the absence of any operation of the circuit breaker the pressures in the accumulators A_1 and A_2 are equal.

In order to close the circuit breaker, voltage is applied to the electromagnet 3 either by means of a push-button 4 or through a conventional remote control installation, for example, connected in parallel with push-button 4 or actuating the same. The electromagnetic valve E then breaks or interrupts the pre-existing communication between the pipe 5 and a low-pressure pipe 6, and it establishes communication between the pipe 5 and a pipe 7 communicating with the accumulator A_1 .

This operation is possible only as a result of the presence of contacts 8 and 9 in the series circuit if, on the one hand, the pressure in the accumulator A_1 is sufficiently high to render possible an effective closing of the circuit breaker on a short circuit, and if on the other hand, the pressure in the accumulator A_2 is sufficiently high for the breaking speed of the circuit breaker to be sufficient under any condition requiring opening thereof.

If the pressures in the accumulators A_1 and A_2 are sufficient to permit this operation, the oil under pressure is directed on the one hand through the pipes 5 and 10 to the operating jack or actuator (not shown) of the circuit breaker, and on the other hand, to pipes 11, 12 and 13. The oil passing through the pipe 12 and a pipe 14 acts on a piston 15 of a jack 16, with a rate of flow regulated by an orifice in diaphragm 17, so that the piston 15 performs its stroke in a time greater than the closing time of the circuit breaker. The oil passing through the pipe 13

acts on a piston 18 of a jack 19 and on a piston 20 of a jack 21. The feed of the said jacks is so adjusted that the stroke of the pistons is performed in a time shorter than the closing time of the circuit breaker.

Two cases may arise:

(1) The closing of the circuit breaker takes place with a line in which there is a fault. The opening which immediately follows must take place with full pressure. The apparatus according to the present invention satisfies this condition. A slide valve 22, which has remained in the position illustrated in FIGURE 1 in the course of the closing operation owing to equality in cross sectional areas of surfaces s' and S' , maintains the communication between the opening electromagnetic valve D and the accumulator A_2 , of which the pressure is sufficiently high, since the contact 9 has permitted the closing of the circuit including push button 4 and since this accumulator A_2 has not supplied any oil during this operation. The opening can therefore take place under the required speed conditions.

(2) The closing of the circuit breaker takes place with a line in which there is no fault. The circuit breaker remains in the closed position. At the end of this closing operation, as has been stated hereinabove, the piston 15 of the jack 16 ends its stroke, by which a slide valve 23 is moved to the left as viewed in FIGURE 1, and places in communication pipes 24 and 25, on the one hand, and pipes 26 and 27, on the other hand. The pressure of the accumulator A_2 acts through the pipes 24 and 25 on the annular section s of the slide valve 22, and the pressure of the accumulator A_1 acts through the pipes 26 and 27 on the annular section S of the slide valve 22, the sections s and S being such that when the pressures are equal to p in the accumulators A_1 and A_2 , the relation $ps = (p - \Delta p)S$ applies. Δp is a predetermined pressure difference corresponding to a fairly small fraction of the pressure p , for example, between 1% and 10% of the pressure p .

Thus, when the motor-pump set MP has restored the pressure in the accumulator A_1 , after a closing operation, to a value above the pressure in the accumulator A_2 , less Δp , which is a sufficient pressure to obtain the required speed, the slide valve 22 will be moved to the right, thus breaking communication between pipes 28 and 29, and therefore between the accumulator A_2 and the opening valve D, and establishing a communication between pipes 30 and 29, i.e., between the accumulator A_1 and the valve D.

An "opening-closing-opening" cycle will then be performed.

The first opening of the circuit breaker, brought about by conventional means, will take place by means of the accumulator A_1 , that is to say, at normal pressure. In the course of the opening, the piston 15 of the jack 16 is rapidly returned, by the oil flowing through pipes 31, 32, 33 to the right owing to the presence of a valve 34 which permits a higher rate of flow than the restriction in diaphragm 17. The communications between the pipe 24 and 25 and between the pipes 26 and 27 are shut off by movement of the slide valve 23 to the right. The piston 20 of the jack 21 and the piston 18 of the jack 19, which are fed by a pipe 35, are forced to the left, the rod of the piston 20 opening a valve 36 before the rod of the piston 18 comes into contact with the slide valve 22, so that the movement of the slide valve 22 can take place owing to the fact that a pipe 38 is connected to a tank 37. The operating period and the position of the jacks 19 and 21 are so chosen that the change-over of the slide valve 22 takes place at the end of the opening operation. The communication between the pipes 28 and 29 is therefore established at the end of the first opening.

The closing of the cycle, brought about by conventional means, takes place by means of the accumulator A_1 , and in the course of this operation the slide valve 22 remains stationary. The second opening operation, again brought about by conventional means, will therefore be effected by the accumulator A_2 , which has not supplied any oil in

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the course of the first opening and of the subsequent closing operation, and of which the pressure is normal. If this pressure were not normal, for example owing to a considerable leakage of oil from the pipe of the accumulator A_2 , the directly preceding closing of this cycle would be prevented by the contact 9 of the pressure gauge M_2 which opens in the absence of a predetermined pressure.

FIGURE 2 is a diagrammatic illustration of a second constructional form of the apparatus according to the present invention.

As in the preceding case, if the pressures are normal, the circuit breaker closes owing to the action of the oil supplied by the accumulator A_1 to the operating jack of the circuit breaker in passing through the pipes 7, 5 and 10. In the course of the closing, a piston 39 of a jack 40, which is rapidly forced to the right by the oil flowing through the pipe 13, drives a slide valve 41. The latter closes the communication between the pipes 42 and 43 and connects together pipes 44 and 43, whereby oil is conveyed under pressure from the accumulator A_2 to the opening valves D. In this way, if the circuit breaker closes under fault in the line, the opening which immediately follows takes place at a pressure corresponding to a sufficient pressure since the feed is supplied by the accumulator A_2 , which has not supplied any oil during the closing. In the course of the closing, the oil situated to the right of the piston 39 is restored to lower pressure by means of pipes 45, 46 and 47. An electric contact 48 of the pressure-responsive contactor M_1 opens at a pressure in the neighborhood of the high pressure which normally obtains in the accumulators A_1 and A_2 , i.e., as soon as the closing operation commences. A movable contact 49, urged to the right by a spring 50, closes a fixed contact 51 as soon as a push rod 52, driven by the piston 39, permits it to do so. Contact is established between the contact studs 49 and 51 after opening of the contact 48.

Closing at a fault is followed by opening under the normal pressure of the accumulator A_2 . If, on the other hand, the circuit breaker is closed with a line having no fault, the latter remains in the closed position. The motor-pump set MP restores to its maximum value the pressure of the accumulator A_1 which has served for the closing. When this pressure has returned to a sufficiently high value for the contact 48 to reclose, voltage is applied to an electromagnet 53. A push rod 54 first closes the orifice at the beginning of the pipe 46 and opens a valve 55, which permits the return to the left of the piston 39 and consequently of the slide valve 41. This return is effected slowly, for which purpose there is provided a duct 56 extending from a valve 57 and supplied with oil from pipe 7 by way of pipe 56'. Communication is broken between the pipes 43 and 44 and established between the pipes 42 and 43. Slightly before the end of the stroke of the piston 39, the push rod 52 interrupts the feed of the electromagnet 53 by acting on the contact 49, so that the electromagnet 53 is not left under voltage during the inoperative period of the circuit breaker, when the pressure in the accumulator A_1 is normal.

It will be assumed that a cycle comprising opening, closing and opening operations commences when the whole assembly has returned to the position of FIGURE 2. The accumulator A_1 , of which the pressure has returned to normal, supplies the oil necessary for the initial opening and that necessary for the reclosing. In the course of this last operation, the slide valve 41 is moved to the right, which permits feeding of the second opening by the accumulator A_2 , which has not supplied any oil and which is therefore at normal pressure.

A variant of the apparatus illustrated in FIGURE 2 is shown in FIGURE 3. The operation of the apparatus of the latter figure is similar to that described with reference to FIGURE 2, except with regard to the following detail: the return of the piston 39 to the left is effected by means of a spring 64 and not hydraulically, and the piston 39 is maintained in its position to the right after

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closing, as long as the pressure in the accumulator A_1 has not returned to a sufficiently high value, by means of a mechanical latching system 58, 59.

In the course of a closing operation, the piston 39 is forced to the right, whereby the opening valves D are fed, if necessary, by the accumulator A_2 through pipes 43 and 44. Since the accumulator A_2 has not supplied any oil during the closing, its pressure is normal and permits immediate opening, if necessary, at normal pressure. At the end of the stroke of the piston 39 to the right, a lever 58 becomes engaged with a lever 59 after having released a movable contact 60, which closes a contact 61.

The pressure-responsive contactor M_1 has opened a contact 62 at the beginning of the closing operation. If the circuit breaker remains in the closed position, the pressure in the accumulator A_1 returns to its normal value, and the contact 62 closes, whereby voltage is applied to an electromagnet 63. The latter cancels out the latching action by lowering the lever 59. The return to the left of the piston 39 and therefore of the slide valve 41 is effected by means of a spring 64. The accumulator A_1 is placed in communication with the opening valves D, so that the "opening-closing-opening" cycle previously described can take place, the two opening operations proceeding at the same speed.

FIGURE 4 is a variant of FIGURE 3. The electromagnet 63 of FIGURE 3 is replaced by a hydraulic push rod 65, which cancels the latching action between levers 58 and 59, when the pressure of the accumulator A_1 is normal.

FIGURE 5 illustrates an example of the application of the invention to a cycle of the opening-closing-opening—inoperative period—closing-opening type. This example comprises the latching device according to FIGURE 4.

Reference characters A_1 , A_2 and A_3 designate three accumulators, each of which has to control one of the three opening operations of the cycle, the set A_1 effecting in addition the two closing operations. The figure corresponds to the instant when the three sets are at normal pressure. The three accumulators are hydraulically separated by non-return valves 66, 67 and 68.

The circuit breaker is closed by depression of the push-button 4 feeding the electromagnet 3, three contacts 69, 70 and 71 of the pressure-responsive contactors M_1 , M_2 and M_3 being closed at that time owing to the presence of a predetermined pressure in each accumulator A_1 , A_2 and A_3 .

A piston 72 of a jack 73 is rapidly forced to the right by way of the pipes 7 and 13 and drives a slide valve 74, which interrupts the communication between two pipes 75-76 and establishes communication between 76 and a pipe 77 between the opening valves D and the accumulator A_2 . The opening valves D are subjected in that case to the normal pressure since accumulator A_2 has not supplied any oil during the closing operation. If the circuit breaker is closed at a fault, the opening of the circuit breaker can therefore proceed at normal speed. A lever 78 becomes engaged with a lever 79, a push-rod 80 being retracted owing to the pressure drop in the accumulator A_1 during the closing operation. A push rod 81 closes an orifice 82 leading to a tank 83 and opens a valve member 84 of a valve 85. As a result of this operation, pressure is applied to a piston 86 of a jack 87 through a pipe 88 and a calibrated orifice 89, and the piston is shifted to the right. The total duration of the movement must be greater than the duration of a closing operation followed by an opening operation, and shorter than the interval of time between the first and second parts of the cycle. In this way, the opening which follows the closing takes place by means of the accumulator A_2 , a slide valve 90 not yet having been moved.

A normal closing operation will now be considered, that is, closing with a line having no fault. The communication between the accumulator A_2 and the opening valves D is maintained after closing by means of ac-

cumulator A_1 as long as the pressure in the accumulator A_1 has not risen to the normal value. During this time, the piston 86 moves to the right. The latching of a lever 91 does not occur, since a lever 92 is retracted, the pressure in the accumulator A_2 being normal, since the latter has not supplied any oil during the closing operation. When the pressure in the accumulator A_1 has risen sufficiently, the push rod 80 cancels out the latching action between 78 and 79, and the piston 72 returns to the left, as also does the slide valve 74. The push rod 81 releases the valve member 84, which returns onto its seat, and unmasks or opens the orifice 82 leading to the tank 83. The piston 86 returns to the left rapidly owing to the presence of a valve member 93. The communication between 75 and 76 and that between 77 and a pipe 94 are restored.

If at this instant a cycle comprising opening, closing, opening, inoperative period of duration t , closing and opening commences, the first opening is effected at normal pressure by the accumulator A_1 , as also the succeeding closing, and during this time the slide valve 74 sends oil from the accumulator A_2 to the opening valves D, so that the second opening is performed by the accumulator A_2 at normal pressure. The contact 70 of the pressure gauge M_2 of which the pressure falls in the course of the second opening, opens and thus prevents the succeeding closure. At the end of a time shorter than t , the movement of the slide valve 90 to the right places the accumulator A_3 in communication with the opening valves D through the pipes 77 and 76 and a pipe 95. A contact 96 closed by the action of the lever 91 short-circuits the contact 70. A push rod 97, which is in the lower position because the pressure of the accumulator A_2 has fallen, enables the levers 91 and 92 to interlock. At the end of the period t , the second closure occurs owing to the action of the set A_1 , and the third opening takes place under the normal pressure of the set A_3 . The cycle is complete. The pressure of the accumulator A_2 is the first to rise to its normal value, and it disengages 91 and 92, whereafter the pressure of the accumulator A_3 and finally that of the accumulator A_1 reach their normal value. The pressure of the accumulator A_1 disengages the latching system 78-79 and the assembly returns to the position of FIGURE 5.

While I have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto, but is susceptible of numerous changes and modifications as known to a person skilled in the art, and I therefore do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

I claim:

1. In an electric circuit breaker control system having first means for controlling the closing of a circuit breaker under the action of a fluid under pressure and second means for controlling the opening thereof under the action of a fluid under pressure, the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and connecting means operatively connecting said accumulators with said first and second means in such a manner that only one of said two accumulators is connected to said first means, said connecting means including further means for controlling, within a cycle of opening and closing operations, the first opening operation and all closing operations following said first opening operation, in a given cycle, from one and the same accumulator.
2. In an electric circuit breaker control system having first means for controlling the closing of a circuit breaker under the action of a fluid under pressure and second means for controlling the opening thereof under the action of a fluid under pressure, the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and connecting means opera-

- tively connecting said accumulators with said first and second means in such a manner that only one of said two accumulators is connected to said first means, said second means including valve means, at least one switching slide valve interposed between said last-mentioned valve means and said accumulators, and hydraulic jack means for operating said slide valve.
3. In an electric circuit breaker control system having first means for controlling the closing of a circuit breaker under the action of a fluid under pressure and second means for controlling the opening thereof under the action of a fluid under pressure, the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and connecting means operatively connecting said accumulators with said first and second means in such a manner that only one of said two accumulators is connected to said first means, said second means including valve means, at least one switching slide valve interposed between said last-mentioned valve means and said accumulators, and hydraulic jack means for operating said slide valve, and means including channel means operatively connected between said second means and said slide valve to control each of the successive openings of the circuit breaker by a different accumulator.
4. In an electric circuit breaker control system having first means for controlling the closing of a circuit breaker under the action of a fluid under pressure and second means for controlling the opening thereof under the action of a fluid under pressure, the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and connecting means operatively connecting said accumulators with said first and second means in such a manner that only one of said two accumulators is connected to said first means, said second means including valve means, at least one switching slide valve interposed between said last-mentioned valve means and said accumulators, and hydraulic jack means for operating said slide valve, and means for holding said hydraulic jack means in the rest position thereof.
5. The combination according to claim 4, wherein said means for holding said hydraulic jack means are mechanical means.
6. The combination according to claim 4, wherein said means for holding said hydraulic jack means include hydraulic means.
7. In an electric circuit breaker control system having first means for controlling the closing of a circuit breaker under the action of a fluid under pressure and second means for controlling the opening thereof under the action of a fluid under pressure, the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and connecting means operatively connecting said accumulators with said first and second means in such a manner that only one of said two accumulators is connected to said first means, said second means including valve means, at least one switching slide valve interposed between said last-mentioned valve means and said accumulators, and hydraulic jack means for operating said slide valve, and means for holding said hydraulic jack means in the rest position thereof, and release means for releasing said holding means.
8. The combination according to claim 7, wherein said release means include an electromagnet.
9. The combination according to claim 7, wherein said release means include a hydraulic push rod.
10. In an electric circuit breaker control system having first means for controlling the closing of a circuit

breaker under the action of a fluid under pressure and second means for controlling the opening thereof under the action of a fluid under pressure,

the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and connecting means operatively connecting said accumulators with said first and second means in such a manner that only one of said two accumulators is connected to said first means,

said connecting means including further means for controlling, within a cycle of opening and closing operations, the first opening operation and all closing operations following said first opening operation, in a given cycle, from one and the same accumulator, the first means being constituted by valve means directly connected to said one accumulator, said second means including valve means, at least one switching slide valve interposed between said last-mentioned valve means and said accumulators, and hydraulic jack means for operating said slide valve, and means including channel means operatively connected between said second means and said slide valve to control each of the successive openings of the circuit breaker by a different accumulator, and means for holding said hydraulic jack means in the rest position thereof, and release means for releasing said holding means, and pump means operatively connected with said accumulators for maintaining under pressure the fluid stored therein including check-valves between said pump means and said accumulators.

11. In an electric circuit breaker control system having first means for controlling the closing of a circuit breaker under the action of a fluid under pressure and second means for controlling the opening thereof under the action of a fluid under pressure,

the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and connecting means operatively connecting said accumulators with said first and second means in such a manner that only one of said two accumulators is connected to said first means,

said connecting means including further means for controlling, within a cycle of opening and closing operations, the first opening operation and all closing operations following said first opening operation, in a given cycle, from one and the same accumulator, the first means being constituted by valve means directly connected to said one accumulator, said second means including valve means, at least one switching slide valve interposed between said last-mentioned valve means and said accumulators, and hydraulic jack means for operating said slide valve, and means including channel means operatively connected between said second means and said slide valve to control each of the successive openings of the circuit breaker by a different accumulator, and pump means operatively connected with said accumulators for maintaining under pressure the fluid stored therein including check-valves between said pump means and said accumulators.

12. A control system for controlling the closing and opening operations of a circuit breaker by means of a fluid under pressure, comprising:

first means operable by the application thereto of the fluid under pressure for closing the circuit breaker, second means operable by the application thereto of the fluid under pressure for opening the circuit breaker,

at least two accumulators for storing therein the fluid under pressure,

first connecting means operatively connecting said first means at all times with one of said accumulators,

and second connecting means for selectively connecting said accumulators with said second means including selectively operable means for selectively connecting said second means only with an accumulator containing fluid at a predetermined pressure and control means operable upon actuation of one of said first and second means by fluid under pressure supplied by one of said accumulators for shifting, by said selectively operable means, the supply of fluid under pressure to said second means from said one to another accumulator within a given cycle of operation.

13. A control system for controlling the closing and opening operations of a circuit breaker by means of a fluid under pressure, comprising:

first means operable by the application thereto of the fluid under pressure for closing the circuit breaker, second means operable by the application thereto of the fluid under pressure for opening the circuit breaker,

at least two accumulators for storing therein the fluid under pressure,

motor-driven pump means for maintaining a predetermined pressure in said accumulators,

first connecting means operatively connecting said pump means with said accumulators including check valve means,

pressure-responsive contact means in the energization circuit for the motor driving said pump means to start operation of said pump means in the absence of a predetermined pressure in any one of said accumulators,

second connecting means operatively connecting said first means at all times with one of said accumulators, and third connecting means for selectively connecting said accumulators with said second means including selectively operable means for selectively connecting said second means only with an accumulator containing fluid at said predetermined pressure, and control means operable upon actuation of one of said first and second means by fluid under pressure supplied by one of said accumulators for shifting, by said selectively operable means, the supply of fluid under pressure to said second means from said one to another accumulator within a given cycle of operation.

14. A control system for controlling the closing and opening operations of a circuit breaker by means of a fluid under pressure, comprising:

first means operable by the application thereto of the fluid under pressure for closing the circuit breaker, second means operable by the application thereto of the fluid under pressure for opening the circuit breaker, at least two accumulators for storing therein the fluid under pressure, first connecting means operatively connecting said first means at all times with one of said accumulators,

and second connecting means for selectively connecting said accumulators with said second means including selectively operable means for selectively connecting said second means only with an accumulator containing fluid at a predetermined pressure and control means operable upon actuation of one of said first and second means by fluid under pressure supplied by one of said accumulators for shifting, by said selectively operable means, the supply of fluid under pressure to said second means from said one to another accumulator within a given cycle of operation,

said control means being operable to supply fluid under pressure to said first means from the same accumulator which supplied fluid under pressure to the second means for an opening operation directly preceding the closing operation to be realized by actuation of said first means.

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15. A control system for controlling the closing and opening operations of a circuit breaker by means of a fluid under pressure, comprising:

first actuator means operable by the application thereto of the fluid under pressure for closing the circuit breaker,

second actuator means operable by the application thereto of the fluid under pressure for opening the circuit breaker,

at least two accumulators for storing therein the fluid under pressure,

first connecting means to enable an operative connection of said first actuator means only with one of said accumulators,

and second connecting means to enable an operative connection of said second actuator means with any one of said accumulators including selectively operable means for selectively connecting said second actuator means only with an accumulator containing fluid at at predetermined pressure at the time an opening operation can be expected in a given cycle.

16. In an electric circuit breaker control system having a first actuator for controlling the closing of a circuit breaker under the action of a fluid under pressure and a second actuator for controlling the opening thereof under the action of a fluid under pressure,

the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and means operatively connecting said accumulators with said first and second actuators including first connecting means to enable a connection of said first actuator with only one of said accumulators, second connecting means including switching means for selectively connecting said second actuator with either one of said accumulators, and control means operatively connected with said switching means to provide an operative connection between said second actuator and an accumulator different from the accumulator having supplied, within the same cycle of operation, fluid under pres-

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sure to said first actuator for a preceding closing operation within said cycle.

17. In an electric circuit breaker control system having a first actuator for controlling the closing of a circuit breaker under the action of a fluid under pressure and a second actuator for controlling the opening thereof under the action of a fluid under pressure.

the improvement essentially consisting of at least two accumulators for storing and maintaining therein fluid under pressure, and means operatively connecting said accumulators with said first and second actuators including first connecting means to enable a connection of said first actuator with only one of said accumulators, second connecting means including switching means for selectively connecting said second actuator with either one of said accumulators, and control means operatively connected with said switching means to provide an operative connection between said second actuator and an accumulator different from the accumulator having supplied, within the same cycle of operation, fluid under pressure to said first actuator for a preceding closing operation within said cycle,

said control means including means for supplying, with an opening-closing-opening cycle, fluid under pressure to said second actuator from one of said accumulators for the first opening operation, to said first actuator from said one accumulator for the next closing operation, and to said second actuator from the other accumulator for the second opening operation.

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