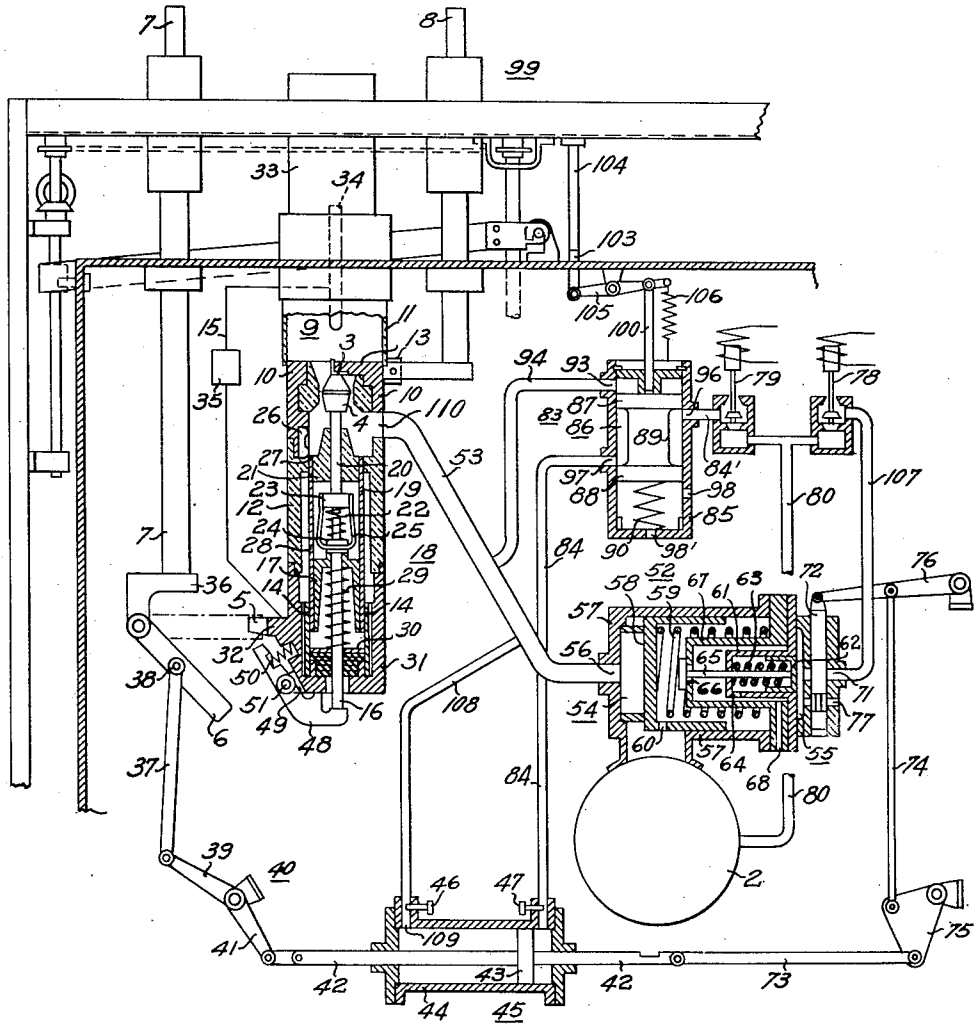
Dec. 12, 1950 J. F. CHIPMAN 2,533,559

PNEUMATIC INTERLOCKING DEVICE FOR PREVENTING IMPROPER CLOSING OF CIRCUIT BREAKERS

Filed Jan. 18, 1949



Inventor
John F. Chipman
By Warren F.B. Lindsley
Attorney

Patented Dec. 12, 1950

2,533,559

UNITED STATES PATENT OFFICE

2,533,559

PNEUMATIC INTERLOCKING DEVICE FOR PREVENTING IMPROPER CLOSING OF A CIRCUIT BREAKER

John F. Chipman, South Weymouth, Mass., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis., a corporation of Delaware

Application January 18, 1949, Serial No. 71,506

14 Claims. (Cl. 200—82)

1

This invention relates in general to switching devices such as electric circuit breakers of the fluid blast type and more particularly to pneumatic control systems therefor.

Heretofore, improper closing operations of circuit breakers have sometimes occurred when a tripping impulse was immediately preceded by a closing impulse. Such faulty operations may have been due to limited effectiveness of dumping or exhaust valves. Pneumatic motors are normally provided with valves for dumping compressed air from the closing side of the cylinder and the pipe system associated with it when a tripping impulse is being given. If the dumping valve of a pneumatic contact operating motor is not sufficiently effective, there may remain a considerable residue of air under pressure in the portions of the pneumatic system that are associated with the closing side of the cylinder. That residue of air under pressure may not be capable of accomplishing a normal closing operation, yet it may be sufficient to effect a slow and limited reverse movement of one of a pair of separated contacts, resulting in a decrease of the amount of contact separation below the requisite safe minimum distance. Such a decrease will be followed by a breakdown of the gap between the contacts. A breakdown occurring across a reduced gap between a pair of disconnect contacts of an air blast circuit breaker, the arcing contacts of which have been locked out by pressure responsive lockout means on account of a temporary reduction of pressure in the blast reservoir, may be of most serious consequences.

Circuit breakers have been provided with trip predominance lockout valves which operated by trip or blast air and in so doing lock or close the conduit supplying fluid under pressure for closing the circuit breaker. When a trip impulse and a closing impulse are given substantially simultaneously, the trip impulse predominates since it results in locking the closing air conduit, thus precluding the occurrence of a closing operation. It is not sufficient, however, to provide a single trip predominance lockout valve, because, in case of contradictory operating impulses, improper closing might occur upon removal of the trip impulse if the closing impulse still prevails.

It is, therefore, one object of the present invention to provide a new and improved pneumatic control system for circuit breakers of the fluid blast type.

Another object of the invention is to provide a

2

new and improved pneumatic operated control system which precludes closing of the circuit breaker if closing and tripping impulses are being given substantially simultaneously.

Still another object of the invention is to provide a new and improved pneumatic circuit breaker control system which precludes closing of the circuit breaker following a tripping operation if closing and tripping impulses are being given substantially simultaneously, but which permits closing of the breaker upon removal of the original faulty closing impulse and upon an additional closing impulse being given which is not accompanied by a simultaneous tripping impulse.

A further object of the invention is to provide a new and improved pneumatic circuit breaker control system in which the fluid under pressure provided for closing the circuit breaker assists the fluid under pressure provided for tripping the circuit breaker to lock out the circuit breaker closing means when closing and tripping impulses are simultaneously received.

A still further object of the invention is to provide a new and improved dual purpose circuit breaker control system which precludes closing of the circuit breaker following a tripping operation if closing and tripping impulses are given substantially simultaneously and also precludes closing of the circuit breaker if the breaker is in the process of being removed from its cell wherein it is normally housed.

A still further object of the present invention is to provide a pneumatic circuit breaker control system in which the action of the pressure of closing air upon the movable valve element of a lockout valve is balanced during normal closing operation of the circuit breaker.

A still further object of the present invention is to provide a pneumatic circuit breaker operating system in which the action of the dumping valve for the closing conduit of the pneumatic motor is supplemented by venting the pneumatic system at a point remote from the dumping valve.

A still further object of the present invention is to provide a pneumatic circuit breaker operating system in which portions of the system that are associated with the closing side of the cylinder of a pneumatic contact operating motor may be vented by a lockout valve controlling the supply of closing air.

Objects and advantages other than those set forth will be apparent from the following description when read in connection with the accompanying drawing in which the single figure

is a diagrammatic showing of a circuit breaker and a pneumatic control system therefor embodying the present invention.

Referring more particularly to the drawing by characters of reference, the figure illustrates a circuit breaker including as a constructive element thereof a reservoir 2 constituting a source of supply of fluid under pressure, which will be assumed herein to be compressed air, supplied from a suitable compressor (not shown). Although in general, circuit breakers of the type herein considered are provided with a plurality of similar pole structures, one for each phase of a polyphase electric circuit, only one such pole structure or pole unit is shown in the figure and the circuit breaker will be described in detail as if it were of the single pole type.

The circuit breaker, for example, may comprise a fixed arcing contact 3 and a cooperating movable arcing contact 4 connected in series with a disconnecting switch comprising a fixed disconnect contact 5 and a cooperating movable disconnect contact 6 in an electric circuit through stud terminals 7 and 8. The arcing contacts 3 and 4 are housed in a tubular arcing chamber 9, having a metallic sleeve shaped wall 10 axially aligned with and supporting an insulating sleeve 11 and an insulating sleeve 12. The metallic sleeve 10 of chamber 9 constitutes a conductive connection between the fixed arcing contact 3 and an extension of terminal 8. Sleeve 11 constitutes a discharge passage for chamber 9.

Sleeve 10 is provided with an inwardly extending bracket 13 upon which is arranged a contact constituting the fixed arcing contact 3 of the circuit breaker. The cooperating movable arcing contact 4, which may be in the form of a streamlined solid of revolution, is actuated by a fluid motor 18 comprising a piston slidable in insulating sleeve 12 and secured to a stud 16. The piston of fluid motor 18 comprises a metallic sleeve member 26, an insulating hub 21 secured to member 26 at the upper end thereof, and a hub 17 secured to member 26 and stud 16 at the lower end thereof. Arcing contact 4 is suitably secured to a stud 20 which is slidably mounted in insulating hub 21 and biased to closed position by a spring 22 acting between a bushing 23 secured to stud 20 and an extension 24 of hub 17. The stud 20 is conductively connected to the stud 16 by means of flexible conductors 25.

A pair of main or current carrying contacts 26 and 27 are in parallel with the arcing contacts 3 and 4. Contact 26 is preferably made in a series of segments resiliently mounted to form an annular stationary contact. The movable current carrying contact 27 is diagrammatically represented as a part of metallic sleeve member 28 which is secured to insulating hub 21 and hub 17 so as to move with the piston upon actuation thereof. Thus, current entering from terminal 8, flows through metallic sleeve 10, main or current carrying contacts 26 and 27, sliding contacts 14 and disconnect contacts 5 and 6 to the terminal 7. Although the arcing contacts when closed are in parallel with the main or current carrying contacts, the flow of current will generally pass almost entirely through the main contacts because of the relatively small area of the cooperating surfaces of the arcing contacts and because of the higher resistance thereof.

The movable current carrying contact 27 is urged into engagement with the fixed current carrying contact 26 by resilient means such as a spring 29 acting between hub 17 and a metallic washer 30 which is resiliently supported in a metallic sleeve portion 31. The metallic sleeve portion 31 is supported by insulating sleeve 12 at the free end thereof. Sleeve portion 31 is axially aligned with sleeves 10, 11 and 12. In addition sleeve portion 31 is provided with an extension arm 32 which supports the fixed disconnect contacts 5.

The insulating sleeve portion 11 communicates with a cooling chamber 33. The sleeve portion 11 may contain an auxiliary arcing electrode 34 which is usually affixed thereto and coaxially aligned therewith. The auxiliary arcing electrode 34 is connected in series relationship with the disconnect contacts 5 and 6 and a current limiting resistor 35 by means of conductor 15.

The movable disconnect contact 6 may be pivotally mounted on a bracket 36 which is secured to an extension of terminal 7. One end of a connecting rod 37 may be connected at a point 38 intermediate the ends of movable disconnect contact 6, and the other end of rod 37 may be connected to an arm 39 of a bell crank 40. A second arm 41 of bell crank 40 may be connected to the piston rod 42 of a fluid motor 45. The rod 42 protrudes through and beyond the ends of a cylinder 44 of motor 45. Motor 45 actuates the bell crank 40 which, in turn, actuates the connecting rod 42. A predetermined movement of connecting rod 37 actuates the movable disconnect contact 6 and moves it to its open and closed positions. A pair of regulating valves 46 and 47 may be utilized for regulating the supply of fluid from reservoir 2 to motor 45.

A mechanical interlocking device precludes improper sequence of operation of the disconnect contacts 5 and 6 with reference to the arcing contacts 3 and 4. The mechanical interlocking device comprises a means such as an abutment or bent lever 48 which is pivotally mounted at 51 on a bracket 49 and is arranged to lie within the path of movement of rod or stud 16 which is actuated with arcing contact 4. Lever 48 also lies in the path of movement of the disconnect contact 6 for preventing separation of the disconnect contacts 5 and 6 prior to opening of arcing contacts 3 and 4. A biasing means, such as a spring 50, pivots the lever 48 into the path of movement of the movable disconnect contact 6 and precludes separation thereof from the stationary or fixed disconnect contact 5 prior to separation of arcing contacts 3 and 4 which would occur in case of maladjustment of the pneumatic sequence control means for motor 45, i. e. needle valve 46.

As long as the disconnecting switch is closed there is no engagement between the lever 48 and the movable disconnect contact 6. If the circuit breaker opens, lever 48 will be pivoted out of the path of movement of the movable contact 6 of the disconnecting switch by the arcing contact operating fluid motor 18 and by stud 20. If arcing contacts 3, 4 are fully separated, the disconnecting switch can open without ever being engaged by the lever 48. If, however, the fluid motors 18 and 45 are not so adjusted as to result in proper sequential operation of the arcing contacts 3 and 4 and the disconnect contacts 5 and 6, lever 48 will stop the movable disconnect contact 6 and preclude its separation from the stationary disconnect contact 5 as long as the arcing contacts 3 and 4 have not fully parted.

The compressed air for operating the control system and the arcing contacts is derived from the reservoir 2. The air under pressure in res-

ervoir 2 also produces the arc extinguishing blast across the gap formed between the pair of cooperating arcing contacts 3, 4 upon separation thereof. The arc extinguishing blast from reservoir 2 to the arcing contacts 3, 4 is controlled by a blast valve 52 which provides a connection between the reservoir 2 and an insulated conduit 53 which is connected to the metallic sleeve portion 10 of chamber 9.

Differential type blast valve 52 employing a pilot valve therefor comprises fluid motors 54 and 55 for controlling a blast inlet port 56. Motor 54 comprises a cylinder 57, a piston 58, a spring 59, and an inlet port 60. Motor 55 comprises a cylinder 61, a piston 62, a return spring 63, for piston 62, an exhaust port 64. Valve 65 for closing exhaust port 66 is adapted to be operated by motor 55. A cylinder 67 surrounds cylinder 61 of motor 55 coaxially therewith. Cylinder 67 is provided with an exhaust port 68. Piston 62, when actuated by air under pressure, actuates valve 65 and opens exhaust port 66 against the action of spring 63. As long as exhaust port 66 remains closed, air under pressure supplied from reservoir 2 through inlet port 60 cooperates with spring 63 to maintain the valve 65 in the position shown.

Inlet port 71 of blast valve 52 supplies fluid motor 55 with operating fluid under pressure for actuating piston 62. Inlet port 71, however, is controlled by a slide valve 72 which opens and closes port 71 upon a predetermined movement of piston 43 of fluid motor 45. Connecting rods 73 and 74, interconnected by link 75 and of which the former is connected to slide valve 72 by means of link 76, form a mechanical connection between rod 42 of piston 43 to slide valve 72. The movement of slide valve 72 also opens and closes an exhaust port 77 for dumping fluid under pressure from the right side of piston 62 of fluid motor 55.

A pair of opening and closing means such as solenoid type control valves 78 and 79, respectively, control the actuating means for the circuit breaker. Both control valves 78 and 79 are connected to reservoir 2 by a common conduit 80.

In accordance with the present invention a means which, for example, may be a slide or piston type interlocking valve 83 is provided and arranged in a conduit 84, 84' for connecting the closing valve 79 and the fluid operated motor 45. Valve 83 comprises a cylindrical valve housing 85 defining a passage inter-connecting conduit portions 84, 84', a valve element 86, and biasing means such as a spring 90 acting upon valve element 86 in a direction longitudinally thereof and tending to maintain valve element 86 in its open position. Element 86 is adapted to be moved selectively to the open position shown and to a closed position and may comprise axially aligned pistons 87 and 88 which are slidable into valve housing 85 and are joined by a stem portion 89. Fluid under pressure is enabled to flow through valve housing 85 when valve element 86 is in open position.

Valve housing 85 defines means such as a first port 93 for admitting therein fluid under pressure from a conduit 94 which is connected to conduit 53. Valve housing 85, in addition, comprises means such as a second port 96 for admitting fluid under pressure from conduit section 84', means defining a third port 97 for interconnecting housing 85 and motor means 45, and means defining a fourth port 98 and fifth port 98'. Port 98 serves the purpose of exhausting residual air trapped in cylinder 44 on the right side of piston 43 and in conduit 84, while port 98' serves the purpose of venting compressed air that may leak between the pistons 87, 88 and the walls of valve 83 to the lower end of valve housing 85. In its open position shown, piston 87 is situated between the first port 93 and the second port 96. When valve element 86 is in its closed position, piston 87 is situated between the second port 96 and the third port 97. Port 97 is always situated between pistons 87 and 88.

The piston type interlocking valve 83 may be mechanically operated to lockout position if the circuit breaker is removed from its cell 99. Rod 100, which may press on piston 87 of valve element 86, is actuated in an upward direction when the circuit breaker, which forms part of a vertical lift arrangement, is in position in cell 99. This actuation of rod 100, upward, frees valve element 86 and permits it to assume its open position. Rod 100 is actuated upward when the circuit breaker is raised into position in cell 99 by abutment of a connecting rod 103 against a structural member 104. The abutment of rod 103 against member 104 results in rotation of a link 105 in a counterclockwise direction and thus applies tension to a helical spring 106. Lowering of the circuit breaker to permit removal thereof from cell 99 permits spring 106 to contract. Spring 106 is stronger than spring 90 located within valve 83 and hence when the breaker is lowered from its cell 99, spring 106 actuates valve element 86 to its closed position.

The circuit breaker illustrated in the drawing is shown with the disconnect contacts in the open circuit position and the pneumatic control system in the corresponding position. A closing operation is initiated by energization of the closing solenoid valve 79, thereby causing air under pressure from reservoir 2 to pass through conduit 80, valve 79, conduit 84', valve 83, conduit 84 to fluid motor 45. Operation of solenoid valve 79 results in piston 43 of motor 45 moving from right to left to actuate rod 42, bell crank 40, and connecting rod 37, thus closing the disconnect contacts 5 and 6. The movement of piston 43 of motor 45 from right to left rotates link 75 clockwise, and this results in an upward movement of connecting rod 74 which in turn rotates link 76 in a clockwise direction. The clockwise rotation of link 76 actuates slide valve 72 in an upward direction, thus opening port 71 and closing exhaust ports 77.

The passage of air through ports 96 and 97 of valve 83 during a closing operation of the circuit breaker does not actuate valve element 86, because the pressures applied thereby to pistons 87 and 88 are equal.

When the solenoid trip valve 78 is energized, compressed air flows from reservoir 2, through conduit 80, trip valve 78, a conduit 107, and inlet port 71 of slide valve 72. This causes air from reservoir 2 to move piston 62 of motor 55 against the action of spring 63. The movement of piston 62 under the action of air pressure from reservoir 2 moves valve 65 and opens port 66 in cylinder 67. Upon opening of port 66, air under pressure trapped in cylinder 67 exhausts to the atmosphere through port 68. This exhausting action reduces the pressure behind piston 58 of motor 54 and enables the air under pressure in reservoir 2 acting on the portion of the left side of piston 58 surrounding the seat of the blast valve to overcome the action of spring

59. A blast of air under pressure then flows through cylinder 57 of motor 54 left of piston 53, inlet port 56, conduit 53, and an inlet port 110 in sleeve portion 10 of chamber 9. Air under pressure in chamber 9 acting on insulating hub 21 actuates the piston of motor 18 and the piston sequentially opens the current carrying contacts 26 and 27 and the arcing contacts 3 and 4. Insulating hub 21, being secured to sleeve member 28, moves sleeve member 28, hub 17, and stud 16 in contact opening direction, thereby separating first the current carrying contacts 26 and 27 and shortly thereafter (upon the engagement of hub 21 and bushing 23) the arcing contacts 3 and 4. The air blast extinguishes the arc that occurs upon separation of the arcing contacts 3 and 4.

Upon a predetermined travel of stud 16, which is actuated by the piston of motor 18, a portion thereof abuts against lever 48. The movement of lever 48 moves one arm thereof out of the path of movement of the movable disconnect contact 6. The proper sequence is assured by interlock lever 48 but timing is governed by rate of flow of air controlled by valve 46.

Upon the flow of the air blast through conduit 53, air under pressure therefrom is transmitted through a conduit 108 connected thereto and to an inlet port 109 in motor 45. This pressure impulse moves piston 43 of motor 45 from left to right, thus resulting in the separation of the disconnect contacts 5 and 6. If the desired predetermined sequence of operation of fluid motor 18 resulting in separation of the arcing contacts 3 and 4, and of fluid motor 45 resulting in separation of the disconnect contacts 5 and 6, does not occur, the lever 48 will prevent disconnect contacts 5 and 6 from separating as long as arcing contacts 3, 4 are not fully separated. However, if fluid motors 18 and 45 operate in the proper sequence, lever 48 will be moved out of the path of movement of disconnect contact 5 without physical engagement thereof before fluid motor 45 actuates disconnect contact 5.

Upon the flow of an air blast through conduit 53, air under pressure therefrom is transmitted through conduit 94, through inlet port 93, to valve 83. This pressure impulse moves valve element 86 into the closed position thereof against the action of spring 89. Such movement of valve element 86 brings piston 87 below port 96, whereby the connection between port 96 and port 97 is interrupted. The closing of the connection precludes the possibility of air under pressure being supplied through port 97 to motor 45, which might result in closing the disconnect contacts prematurely.

Opening of disconnect contacts 5, 6 effects resetting of blast valve 52 by cutting off of air feed through port 71 by positioning of slide valve 72 and simultaneous venting of the actuating air from chamber of piston 62 through port 77. Blast valve 52 closes and stops the flow of fluid through conduit 53 and adjacent the arcing contacts 3 and 4. The action of springs 22 and 29 then closes the arcing contacts 3 and 4 and the main current carrying contacts 26, 27. The reduction of pressure in conduit 94 enables spring 90 to return valve element 86 to its open position.

If opening and closing impulses are substantially simultaneously initiated by valves 78 and 79, respectively, air under pressure from conduit 53 again moves valve element 86, against the action of spring 90. This prevents the closing impulse from flowing through valve 79, valve 83, conduit 84 to fluid motor 45. Disconnect contacts 5 and 6 cannot be closed during the period of time a tripping impulse prevails. The lockout feature of valve 83 is aided by the action of the closing impulse which flows through valve 79 and port 96 into the space in valve 83, above piston 87. This closing impulse thus aids the blast air from conduit 53 in locking valve 83 in its closed position. Once actuated to closed position, no closing impulse can be passed through valve 83 as long as either closing valve 79 or blast valve 53 remain open since either or both will feed air to chamber above piston 87, thereby holding valve 83 in closed position. In the lockout position of valve element 86, ports 97 and 98 are in communication, resulting in venting of the conduit 84 which connects valve 83 and fluid motor 45. Port 98' is provided to vent air which might leak by piston 88, thereby preventing resetting of valve 83 due to build-up of pressure behind piston 88.

In the lockout position of valve element 86 fluid under pressure from conduit 84' maintains valve element 86 in its lockout position even though admission of fluid under pressure through port 93 has ceased.

While the embodiment shows how the present invention may be applied to a circuit breaker having separate arcing contacts and disconnect contacts, it will be apparent that the invention is not limited to circuit breakers of this particular type. It is equally applicable to circuit breakers which have but one single set of contacts serving the purpose of forming an arc gap for initial circuit interruption as well as the purpose of increasing the amount of circuit insulation upon interruption of the circuit at that arc gap. It is also apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In a switching arrangement, the combination of a switching means for opening and closing an electric circuit, pressure operated means for actuating said switching means, a source of fluid under pressure, a conduit for supplying fluid under pressure from said source to said pressure operated means, a first valve for controlling the admission of fluid under pressure from said source to said conduit, a second valve arranged in said conduit between said first valve and said pressure operated means, means for biasing said second valve to the open position thereof, means for initiating closing of said second valve, closing means distinct from said initiating means and operative upon operation of said initiating means for maintaining said second valve closed, said closing means being actuated by the fluid under pressure in the section of said conduit situated between said first and second valves for maintaining said second valve in the closed position thereof, said second valve preventing fluid under pressure from said conduit from acting upon said closing means of said second valve prior to operation of said initiating means.

2. In a switching arrangement, the combination of relatively movable contact means for opening and closing a circuit, a motor operated by fluid under pressure for actuating said contact means, a source of fluid under pressure, a conduit for supplying fluid under pressure from

said source to said fluid operated motor, a first valve for controlling the admission of fluid under pressure from said source to said conduit, a second valve arranged in said conduit between said first valve and said fluid operated motor, resilient means for biasing said second valve to the open position thereof, motor means for closing said second valve against the action of said resilient means, means connecting said motor means with said source to cause closure of said second valve, and means responsive to operation of said motor means for connecting said motor means with the section of said conduit situated between said first and second valves for maintaining said second valve in closed position thereof.

3. In a switching arrangement, the combination of a pair of relatively movable contacts for opening and closing a circuit, a contact operating motor to be operated by fluid under pressure for relatively moving said pair of contacts, a source of fluid under pressure, a conduit for supplying fluid under pressure from said source to said contact operating motor for closing said pair of contacts, a first valve for controlling the passage of fluid under pressure from said source to said conduit, a second valve arranged in said conduit between said first valve and said contact operating motor, spring means for biasing said second valve to the open position thereof, a fluid operated motor for closing said second valve against the action of said spring means and for maintaining said second valve in the closed position thereof, and means for controlling the operation of said valve closing motor including means for controlling admission of fluid under pressure from the section of said conduit situated between said first valve and said second valve to said valve closing motor, said last mentioned means including means for causing admission of fluid under pressure to said valve closing motor upon closing of said second valve and for preventing the admission of fluid under pressure to said valve closing motor prior to closing of said second valve.

4. In a switching arrangement, the combination of a pair of cooperating contacts for opening and closing an electric circuit, fluid operated motor means for actuating said contacts, tripping means for causing actuation of said motor means to separate said contacts, a first conduit supplied with fluid under pressure upon operation of said tripping means, a closing valve, a second conduit controlled by said closing valve to supply fluid under pressure to said motor means for closing said contacts, an interlocking valve arranged in said second conduit, resilient means for biasing said interlocking valve to the open position thereof, motor means of the cylinder piston type for closing said interlocking valve, said motor means being supplied with fluid under pressure from said first conduit, means providing for the admission of fluid under pressure from said second conduit to said motor means upon closing of said interlocking valve, and means under the control of said interlocking valve for preventing the admission of fluid under pressure from said second conduit to said motor means as long as said interlocking valve remains in the open position thereof.

5. In a switching arrangement, the combination of a pair of cooperating contacts for opening and closing an electric circuit, fluid operated motor means for actuating said contacts, tripping means for causing actuation of said motor means to separate said contacts, a first conduit supplied with fluid under pressure upon operation of said tripping means, a closing valve, a second conduit controlled by said closing valve to supply fluid under pressure to said motor means for closing said contact means, an interlocking valve arranged in said second conduit and comprising a balanced valve element to be moved selectively to an open position and to a closed position, spring means for biasing said valve element to the open position thereof, a reciprocatory fluid operated motor comprising a piston connected to said first conduit for moving said valve element to the closed position thereof, means defining a port for admitting fluid under pressure from said first conduit to said reciprocatory motor means in valve closing direction, means for preventing fluid under pressure in said second conduit from actuating said reciprocatory motor in either valve opening direction or valve closing direction, and means operative upon movement of said valve element to the closed position thereof for rendering said preventing means ineffective and for causing fluid under pressure in said second conduit to act upon said piston of the reciprocatory motor in valve closing direction.

6. In a switching arrangement, the combination of a plurality of cooperating arcing contacts in series with a plurality of cooperating disconnect contacts, a first motor means actuated by fluid under pressure for separating said arcing contacts, a second motor means actuated by fluid under pressure for disengaging said disconnect contacts, a source of fluid under pressure, tripping means for initiating separation of said arcing contacts and of said disconnect contacts by said first and second motor means respectively and for initiating establishment of an arc extinguishing blast of fluid under pressure from said source adjacent said arcing contacts, a first conduit supplied with fluid under pressure upon operation of said tripping means, a closing valve, a second conduit controlled by said closing valve for supplying fluid under pressure from said source to said second motor means for closing said disconnect contacts, an interlocking valve arranged in said second conduit and comprising a balanced valve element to be moved selectively to an open position and to a closed position, spring means for biasing said valve element to the open position thereof, a fluid operated reciprocatory motor for moving said valve element to the closed position thereof, means defining a port for admitting fluid under pressure from said first conduit to said reciprocatory motor in valve closing direction, means for preventing fluid under pressure in said second conduit from acting upon said reciprocatory motor in either valve opening direction or valve closing direction, and means operative upon moving of said valve element to the closed position thereof for rendering said preventing means ineffective and for causing fluid under pressure in said second conduit to act upon said reciprocatory motor in valve closing direction.

7. In a switching arrangement, the combination of a plurality of cooperating arcing contacts in series with a plurality of cooperating disconnect contacts, a first motor means actuated by fluid under pressure for separating said arcing contacts, a second motor means actuated by fluid under pressure for disengaging said disconnect contacts, a source of fluid under pressure, tripping means for initiating separation of said arcing contacts and of said disconnect contacts by said

first and second motor means respectively and for initiating establishment of an arc extinguishing blast of fluid under pressure from said source adjacent said arcing contacts, a valve, a conduit controlled by said valve for supplying fluid under pressure from said source to said second motor means for closing said disconnect contacts, an interlocking valve arranged in said conduit, means for biasing said interlocking valve to the open position thereof, a fluid operated reciprocatory motor for closing said interlocking valve, means for supplying said reciprocatory motor with fluid under pressure derived from said arc extinguishing blast, means admitting fluid under pressure from said conduit to said reciprocatory motor upon closing of said interlocking valve, and means under the control of said interlocking valve for preventing said admission of fluid from said conduit to said reciprocatory motor as long as said interlocking valve remains in the open position thereof.

8. In a switching arrangement, the combination of relatively movable contact means for opening and closing an electric circuit, motor means operated by fluid under pressure for actuating said contact means, tripping means for initiating opening of said contact means by said motor means, a first conduit to be supplied with fluid under pressure upon operation of said tripping means, a valve, a second conduit controlled by said valve for supplying fluid under pressure to said motor means for closing said contact means, a slide valve arranged in said second conduit and comprising a valve housing and a valve element adapted to be moved selectively to an open position and to a closed position, means in said housing defining a first port for admitting into said housing fluid under pressure from said first conduit, means in said housing defining a second port for admitting into said housing fluid under pressure from said second conduit, and means in said housing defining a third port for interconnecting said housing and said motor means, said valve element comprising a pair of pistons slidable in said valve housing and a stem joining said pistons, one of said pistons being situated in the open position of said valve element between said first port and said second port and in the closed position of said valve element between said second port and said third port, said third port being situated between said pistons in both positions of said valve element.

9. In a switching arrangement, the combination of a plurality of cooperating arcing contacts in series with a plurality of cooperating disconnect contacts, a first motor means actuated by fluid under pressure for separating said arcing contacts, a second motor means actuated by fluid under pressure for engaging and disengaging said disconnect contacts, a source of fluid under pressure, tripping means for initiating separation of said arcing contacts and of said disconnect contacts respectively by said first and second motor means and for initiating establishment of an arc extinguishing blast of fluid under pressure from said source adjacent said arcing contacts, a first conduit to be supplied with fluid under pressure upon operation of said tripping means, a valve, a second conduit controlled by said valve for supplying fluid under pressure to said second motor means for closing said disconnect contacts, a slide valve arranged in said second conduit and comprising a valve housing and a valve element adapted to be moved selectively to an open position and to a closed position, means in said housing defining a first port for admitting into said housing fluid under pressure from said first conduit, means in said housing defining a second port for admitting into said housing fluid under pressure from said second conduit, and means in said housing defining a third port for interconnecting said housing and said second motor means, said valve element comprising a pair of pistons slidable in said valve housing and a stem joining said pistons, one of said pistons being situated in the open position of said valve element between said first port and said second port, and in the closed position of said valve element between said second port and said third port, said third port being situated between said pistons in both positions of said valve element.

10. In a switching arrangement means for interrupting a circuit including a source of fluid under pressure and pneumatic tripping means for initiating a circuit interruption causing flow of fluid under pressure, circuit closing means including a pair of relatively movable contacts, a fluid operated motor for causing engagement of said contacts, a conduit for supplying fluid under pressure from said source to said motor, a control valve arranged in said conduit, a piston type interlocking valve arranged in said conduit between said control valve and said motor and comprising a cylindrical valve housing defining a passage forming an integral part of said conduit, a valve element having axially aligned pistons slidable in said housing and joined by a stem portion enabling fluid to flow through said conduit and said housing when said valve element is in open position, and biasing means acting upon said valve element in a direction longitudinally thereof and tending to maintain said valve element in open position, passage means for diverting to said interlocking valve a portion of said flow of fluid under pressure, and means for causing said diverted portion of said flow of fluid under pressure to act upon one of said pistons of said valve element to move said valve element in closing direction to admit fluid under pressure from said control valve to said one of said pistons of said valve element to cooperate with said diverted portion of said flow of fluid under pressure.

11. In a switching arrangement, means for interrupting a circuit including a source of fluid under pressure and pneumatic tripping means for initiating a circuit interruption causing flow of fluid under pressure from said source, closing means including a pair of relatively movable contacts, a fluid operated motor for causing engagement of said contacts, a conduit for supplying fluid under pressure from said source to said motor, a control valve arranged in said conduit, a piston type interlocking valve in said conduit arranged between said control valve and said motor and comprising a cylindrical valve housing defining a passage forming an integral part of said conduit, a valve element having axially aligned pistons slidable in said housing and a stem portion joining said pistons for enabling fluid to flow through said housing when said valve element is in the open position, and biasing means acting upon said valve element in a direction longitudinally thereof and tending to maintain said valve element in open position, and means responsive to operation of said tripping means for moving said valve element in closing direction against the action of said biasing means to admit fluid under pressure from said control valve to an axially outer surface of said valve element to maintain said valve element in closed position

by the action of fluid under pressure flowing through said control valve in the event of said control valve being opened at the time said tripping means are operated.

12. In a switching arrangement, the combination of a plurality of cooperating contacts, motor means actuated by fluid under pressure for separating said contacts, a source of fluid under pressure, tripping means for initiating separation of said contacts by said motor means and for initiating establishment of an arc extinguishing blast of fluid under pressure from said source adjacent said contacts, a valve, a conduit controlled by said valve for supplying fluid under pressure from said source to said motor means for closing said contacts, a dual purpose interlocking valve arranged in said conduit, means for biasing said interlocking valve to the open position thereof, a fluid operated reciprocatory motor for closing said interlocking valve, means for supplying said reciprocatory motor with fluid under pressure derived from said arc extinguishing blast, said interlocking valve admitting fluid under pressure from said conduit to said reciprocatory motor and venting said motor means to atmosphere upon closing of said interlocking valve, said interlocking valve preventing said admission of fluid from said conduit to said reciprocatory motor as long as said interlocking valve remains in the open position thereof.

13. In a switching arrangement, the combination of a housing, an electric switch comprising relatively movable contact means for opening and closing a circuit, a motor operated by fluid under pressure for actuating said contact means, a source of fluid under pressure, a conduit for supplying fluid under pressure from said source to said fluid operated motor, a first valve for controlling the admission of fluid under pressure from said source to said conduit, a second valve arranged in said conduit between said first valve and said fluid operated motor, resilient means for biasing said second valve to the open position thereof, motor means for closing said second valve against the action of said resilient means, means connecting said motor means with said source to cause closure of said second valve, means responsive to operation of said motor means for connecting said motor means with the section of said conduit situated between said first and second valves for maintaining said second valve in closing position thereof, and linkage means causing closure of said second valve upon removal of said switch from said housing.

14. In a switching arrangement, the combination of a housing, an electric switch comprising a plurality of cooperating arcing contacts in series with a plurality of cooperating disconnect contacts, a first motor means actuated by fluid under pressure for separating said arcing contacts, a second motor means actuated by fluid under pressure for disengaging said disconnect contacts, a source of fluid under pressure, tripping means for initiating separation of said arcing contacts and of said disconnect contacts by said first and second motor means respectively and for initiating establishment of an arc extinguishing blast of fluid under pressure from said source adjacent said arcing contacts, a valve, a conduit controlled by said valve for supplying fluid under pressure from said source to said second motor means for closing said disconnect contacts, an interlocking valve arranged in said conduit, means for biasing said interlocking valve to the open position thereof, a fluid operated reciprocatory motor for closing said interlocking valve, means for supplying said reciprocatory motor with fluid under pressure derived from said arc extinguishing blast, said interlocking valve admitting fluid under pressure from said conduit to said reciprocatory motor upon closing of said interlocking valve, said interlocking valve preventing said admission of fluid from said conduit to said reciprocatory motor as long as said interlocking valve remains in the open position thereof, and linkage means causing closure of said interlocking valve upon removal of said switch from said housing, said linkage means preventing engagement of said disconnect contacts until said switch is back in position in said housing.

JOHN F. CHIPMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,363,283	Baker et al.	Nov. 21, 1944
2,394,086	Ludwig et al.	Feb. 5, 1946