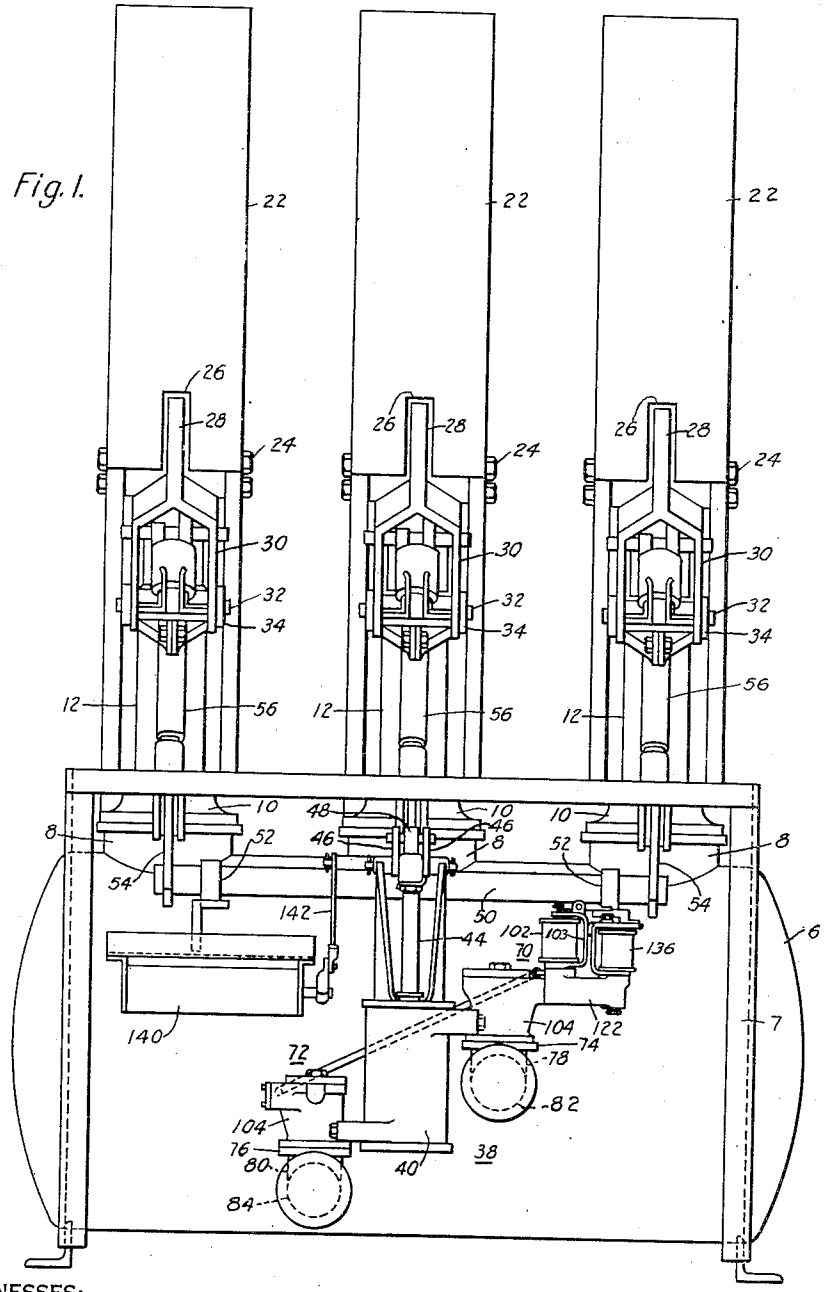
Oct. 17, 1944. F. B. JOHNSON 2,360,687

CIRCUIT INTERRUPTER

Filed July 29, 1942 3 Sheets-Sheet 1

Fig. 1.



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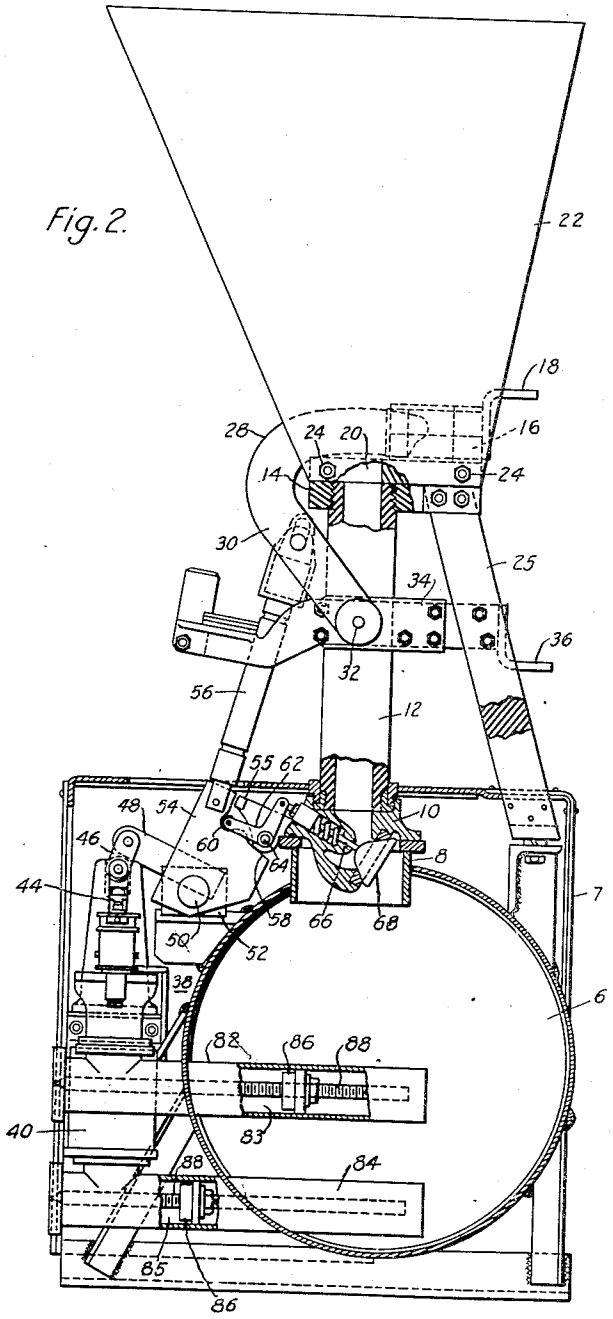
CIRCUIT INTERRUPTER

Filed July 29, 1942 3 Sheets-Sheet 2

Fig. 2.



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CIRCUIT INTERRUPTER

Filed July 29, 1942 3 Sheets-Sheet 3

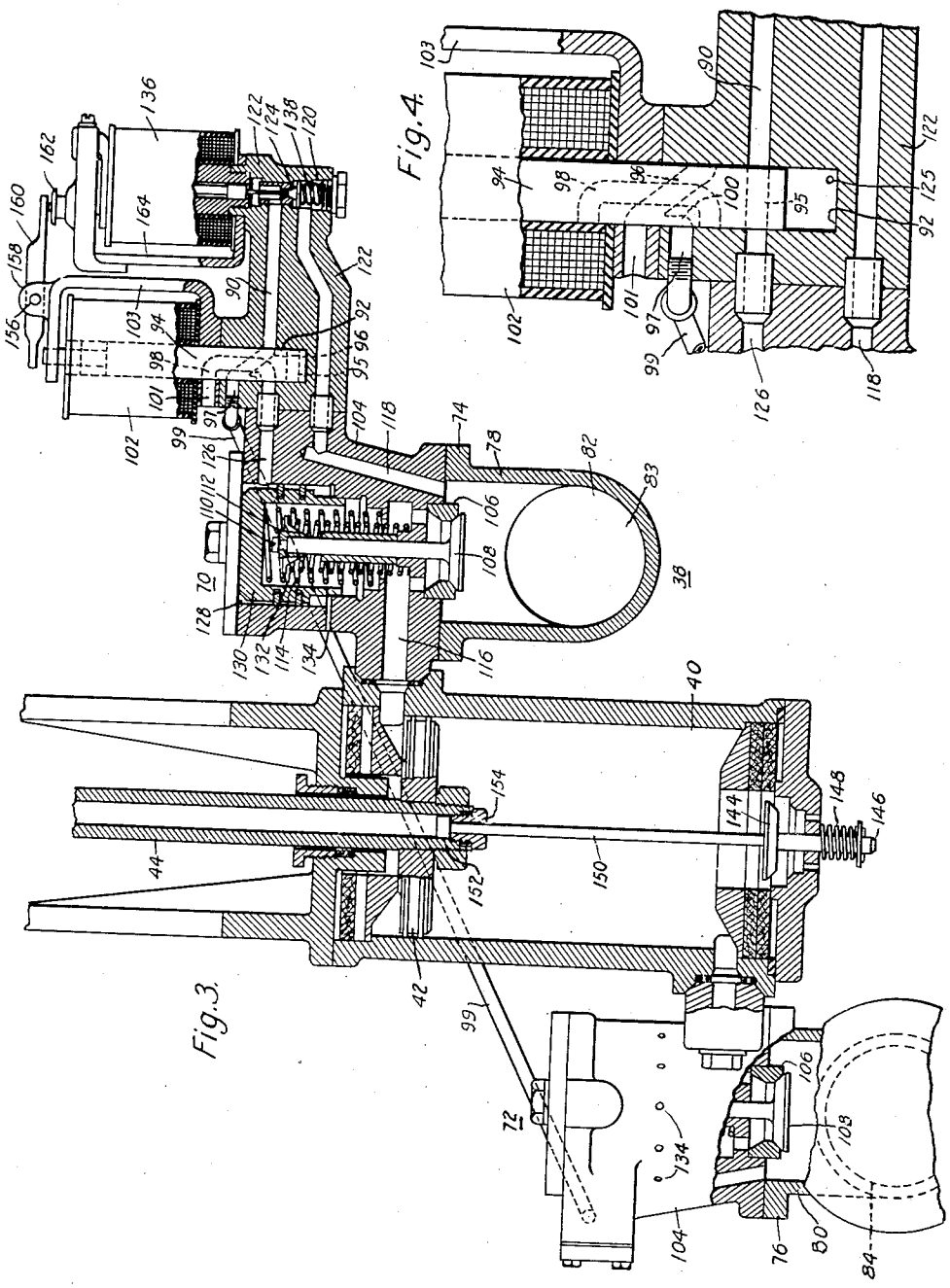

Fig. 3.

Fig. 4.

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UNITED STATES PATENT OFFICE

2,360,687

CIRCUIT INTERRUPTER

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Application July 29, 1942, Serial No. 452,686

12 Claims. (Cl. 200—82)

This invention relates to circuit breakers, and more particularly to operating mechanisms for circuit breakers of the fluid operated type.

One object of the invention is to provide an improved operating mechanism of the fluid pressure operated type that is simple and rugged in construction and capable of efficient and reliable operation.

Another object of the invention is to provide a fluid pressure actuated operating mechanism for a circuit interrupter wherein compressed gas is admitted alternately to opposite sides of an operating piston by two control valves which are selectively operated by compressed gas admitted thereto by a single selector valve.

Another object of the invention is to provide an improved gas pressure actuated operating mechanism for circuit interrupters embodying a novel selector means for simultaneously shutting off the supply of gas pressure to one side of an operating piston and admitting compressed gas to the other side of the piston to effect a quick reversal of the movement of the piston.

Another object of the invention is the provision of a fluid pressure operated circuit breaker with an improved control valve mechanism which will always cause an opening operation of the circuit breaker to take precedence over a closing operation in the event of conflicting control impulses.

Another object of the invention is to provide an improved gas pressure actuated operating mechanism for circuit interrupters embodying electromagnetically operated valves for controlling the admission of compressed gas alternately to the opening and closing sides of an operating piston in which the opening valve is operable in response to overload currents to automatically shut off the supply of compressed gas to the closing side of the piston and to admit compressed gas to the opening side of the piston irrespective of the energized condition of the closing valve.

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

Fig. 1 is a front elevational view of a gas blast circuit interrupter embodying the principles of the invention;

Fig. 2 is a side elevational view, partly in section, showing the circuit interrupter illustrated in Fig. 1;

Fig. 3 is an elevational view, partly in section, of the operating cylinder of the operating mechanism and the control valves.

Fig. 4 is an enlarged detail view showing the selector valve in operated position.

Referring to Figs. 1 and 2 of the drawings, a storage tank 6 mounted within a metal frame 7 is provided for storing gas, such as air, under pressure. Extending from the top of the tank 6 are three flanged conduits 8 which, in turn, carry metallic valve casings 10. A tubular insulator 12 having a gas passage therethrough is mounted on the upper end of each valve casing 10 and an arc chute support 14 (Fig. 2) also of insulating material is secured to the upper end of the tubular insulator 12. The support 14 has mounted thereon a stationary contact 16 (Fig. 2) provided with an external terminal connector 18. A gas passage 20 extending through the support 14 coincides with the passage through the insulator 12. The passage 20 opens into the bottom of an arc chute 22 secured by means of bolts 24 to the support 14. Braces 25 of insulating material connect the frame 7 and the insulating brackets 14.

The forward side of the arc chute (Fig. 1) is provided with a rectangular opening 26 adjacent the lower end thereof through which a movable contact blade 28 is operated into and out of engagement with the stationary contact 16. One arm 30 of the movable contact is bifurcated and the two legs are pivoted at 32 to a conducting bracket 34 securely clamped about the tubular insulator 12. The pivotal connection 32 is of the high-pressure type in order to provide a good electrical connection at all times between the bifurcated contact arm 30 and the bracket 34. A terminal connector 36 extends from the right-hand side (Fig. 2) of the bracket 34, and serves, together with the terminal connector 18, to connect the interrupter in an electrical circuit. The circuit through the breaker extends from the terminal 18 through the stationary contact 16, the movable contact 28, the contact arms 30, the bracket 34 to the terminal 36.

An operating mechanism of the compressed gas type indicated generally at 38 (Figs. 1 and 2) is provided to actuate the three movable contact arms 30 about the pivots 32 to open and close the contacts. The operating mechanism 38 is mounted within the frame 7 and includes an

operating cylinder 40 (Figs. 1 and 3) a piston 42 (Fig. 3) reciprocably movable therein, and a connecting rod 44 attached to the piston and extending vertically through the upper end of the cylinder 40. The connecting rod 44 is connected by a pair of spaced links 46 to a crank arm 48 secured to a cross shaft 50 which is journaled in brackets 52 secured to the side of the pressure tank 6.

The crank arms 54, secured at spaced intervals to the cross shaft 50, are connected by insulating operating rods 56 to the movable contact arms 30 for the three poles of the interrupter. If gas under pressure is admitted to the cylinder 40 above the piston 42 the piston will move downwardly in the cylinder and the connecting rod 44 will actuate the crank arm 48 and the cross shaft 50 in a counterclockwise direction. This movement of the shaft 50 rotates the three crank arms 54 in the same direction and, through the connecting rods 56, rotates the movable contact arms 30 about the pivots 32 toward the open circuit position.

Referring to Fig. 2, each of the crank arms 54 is provided with a cam surface 58 which cooperates with a roller 60 carried by one arm of a bell crank 62. The bell crank 62 is pivoted at 64 on a suitable support and the other arm of the bell crank is pivotally connected to a valve stem 66 which carries a blast valve 68 at its lower end. The blast valve 68 is seated within the valve chamber 10 and normally closes the air blast passage in the insulator 12 from the pressure tank 6. As the three crank arms 54 start to rotate in a counterclockwise direction (Fig. 2), the cams 58 will cause the bell cranks 62 to be rotated in a clockwise direction, thereby operating the valve stems 66 to open the blast valves 68. Upon opening of the valves 68 a blast of compressed gas from the storage tank 6 is projected through the hollow insulators 12, through the passages 20 and between the contacts 16 and 28. The configuration of the cam 58 is such that the valve 68 is opened just prior to the separation of the contacts 16 and 28 to insure a blast of arc-extinguishing gas at the separating contacts when the arc is drawn. The arc drawn between the contacts is thus blown upwardly into the arc chute 22 and there extinguished by the blast of gas from the pressure tank 6. The cams 58 on the crank arms 54 are so shaped that the valves 68 are permitted to close when the moving contacts 28 have reached full open position so as to shut off the blast of compressed gas.

Upon admission of gas to the cylinder 40 below the piston 42, the piston will be moved upwardly in the cylinder reversing the above-described operation to operate the moving contacts 28 to closed position. As the mechanism arrives at the closed circuit position the crank arms 54 engage stops 55. In this position the crank arms 54 and their connecting rods 56 form a slightly overcenter toggle which maintains the movable contacts positively locked in the closed circuit position.

In order to effect opening and closing of the circuit interrupter, two control valves indicated generally at 70 and 72 (Figs. 1 and 3) are provided to control the flow of compressed gas from the storage tank 6 to the operating cylinder 40. The control valve assemblies 70 and 72 are secured to the operating cylinder 40 and rest upon and are secured respectively to flanges 74 and 76 of two short conduits 78 and 80. The conduits 78 and 80 communicate with relatively larger conduits 82 and 84 which extend through the side of the pressure tank 6 and terminate well within the interior thereof. Each of the conduits 82 and 84 is provided with a partition 86 (Fig. 2) for the purpose of forming auxiliary gas storage compartments 83 and 85, respectively, for supplying the compressed gas used in opening and closing the interrupter. The partitions 86 are mounted on threaded shafts 88 secured at their left-hand ends (Fig. 2) to the outer ends of the conduits 82 and 84. The volume of the auxiliary tanks 83 and 85 may be varied to meet certain conditions by changing the locations of the partitions 86 in their respective conduits.

Provision is made to control the replacement of gas from the tank 6 to the auxiliary tanks 83 and 85. The means for accomplishing this control is not shown herein but is fully disclosed in the copending application of Leon R. Ludwig and Benjamin P. Baker, Serial No. 323,214, filed March 9, 1940, and assigned to the assignee of the present invention. Generally, the means for controlling the rate of replacement of gas to the auxiliary tanks 83 and 85 comprises a plurality of passages (not shown) through the partitions 86. These passages may be opened or closed by removing or inserting suitable plugs (not shown) in the openings as a greater or lesser flow of gas is desired.

The valves 70 and 72, which respectively control the flow of gas from the auxiliary tanks 83 and 85, are similar in construction. The opening valve 70, shown in section in Fig. 3, comprises a valve casing 104, the lower face of which rests on the flange 74 of the conduit 78. The valve casing 104 is provided with a valve seat 106 with which a valve 108 of the poppet type cooperates to open and close the air passage leading from the auxiliary tank 83 to the cylinder 40 above the piston 42. The valve 108 is provided with a valve stem 110 having a washer 112 secured to its upper end with which a spring 114 coacts to normally hold the valve closed. The inner chamber of the valve casing 104 communicates, by means of a passage 116, to the upper end of the cylinder 40. The valve casing 104 is also provided with a passage 118 which communicates with the auxiliary chamber 83 and a valve chamber 120 in an auxiliary valve casing 122.

An electromagnetically operated valve 124 in the casing 122 communicates, by means of a passage 90, with a selector chamber 92 (Fig. 4) having an electromagnetically operated selector valve 94 reciprocably movable therein. The selector chamber communicates by means of a passage 126 with a piston chamber 128 at the upper end of the opening valve casing 104. A piston 130 operable in the chamber 128 is normally held in raised position by a spring 132. The lower end or skirt of the piston 130 extends to a plurality of ports 134 passing radially through the side of the valve casing 104. When the piston 130 is in the raised position (Fig. 3) the ports 134 are open, thereby connecting the space in the operating cylinder 40 above the piston 42 to the atmosphere. Downward movement of the piston 130 closes the ports 134 and thereby seals the passage 116 and the cylinder 40 from the atmosphere and moves the main valve 108 to open position.

The selector valve element 94 is provided with three passages 95, 96 and 98 and an auxiliary

passage 100 and is adapted to be operated from the position in which it is shown in Fig. 3 to the position shown in Fig. 4 by means of a tripping electromagnet 102. With the magnet 102 unenergized, the selector valve 94 rests in the bottom of the selector chamber 92. In this position the passage 96 in the selector valve 94 connects the passage 90 to a passage 97 in the casing 122 above the valve casing 104. The passage 97 communicates by means of a conduit 99 to the piston chamber (not shown) in the closing control valve 72.

When the selector valve 94 is in the lower position (Fig. 3) the lower end of the passage 98 is aligned with the passage 126 and the upper end of the passage 98 is aligned with an exhaust port 101 extending through the bottom leg of a U-shaped bracket 103 which supports the electromagnet 102, thus connecting the piston chamber 128 of the opening valve 70 with the atmosphere.

Pivotally mounted at 156 (Fig. 3) in projections 158 of the bracket 103 is a lever 160 having one end disposed above and adjacent to the upper end of the selector valve element 94. The other end of the lever 160 normally rests on a manual closing button 162 depressibly supported on a magnet frame 164. The magnet frame is securely mounted on the outer end of the valve casing 122 and rigidly supports a closing electromagnet 136. The valve 124 is actuated downwardly to open position by the electromagnet 136 which may be energized by a suitable source of electrical energy (not shown), and is moved upwardly to the closed position by a spring 138.

When the interrupter is in the closed circuit position, the operating mechanism, including the piston 42 is in the position shown in Fig. 3. With the mechanism in this position, if an overload occurs, or if it is desired to open the interrupter for any other reason, the trip magnet 102 is energized. The energizing circuit of the electromagnet 102 may be controlled by an opening relay and by an auxiliary switch 140 (Fig. 1) of any suitable construction mounted on the tank 6.

Upon energization of the trip magnet 102, the selector valve 94 is shifted upwardly in the chamber 92 to the position shown in Fig. 4 in which the passage 95 of the valve is in alignment with the passages 90 and 126, thus forming a clear passage from the valve chamber 120 to the piston chamber 128 of the opening valve. When the valve 94 is moved to its upper position the passage 100 forms a connection between the passage 97 and the exhaust port 101, as shown in Fig. 4, thus connecting the piston chamber (not shown) for the closing valve 72 to the atmosphere through the conduit 99, passages 97, 100 and 101. When the valve 94 moves upwardly, upon energization of the magnet 102, the upper end thereof engages and rocks the lever 160 clockwise about its pivot 156. The lever 160 engages and operates the button 162 to open the valve 124 and permit air under pressure within the auxiliary tank 83 to flow through the passage 118, through the valve 124, passages 90, 95 and 126 into the piston chamber 128 of the opening valve. The piston 130 is thereupon moved downwardly against the force of the spring 132, thereby closing the ports 134 and opening the valve 108. The piston 130 is so disposed with respect to the upper end of the valve stem 110 that the ports 134 are substantially closed by the time the piston engages the valve stem. Opening of the valve 108 permits compressed gas from the auxiliary tank 83 to flow through the passage 116 to the space in the cylinder 40 above the operating piston 42, moving the piston downwardly to actuate the breaker contacts 28 to the open circuit position in the manner previously described.

When the breaker reaches full open position, the auxiliary switch 140, which is connected by a linkage 142 to the connecting rod 44, is actuated to open the energizing circuit of the trip magnet 102 allowing the valve 124 to close. Deenergization of the magnet 102 also permits the selector valve 94 to move to its normal position as shown in Fig. 3, thus connecting the chamber 128 with the atmosphere. A small exhaust port 125 connects the chamber 92 below the selector valve 94 to the atmosphere to exhaust the air pressure below the valve as it moves downwardly in the chamber 92. When the pressure has been reduced in the chamber 128, the springs 114 and 132 expand and cause the piston 130 to move upwardly and at the same time cause the valve 108 to close. In order that the main piston 42 may move downwardly at a very high rate of speed so as to effect opening of the contacts as quickly as possible, a relatively high gas pressure is essential at the beginning of the opening stroke. This has been accomplished by providing the auxiliary tank 83 of such volume as to produce the desired result. To reduce shock at the end of the opening stroke, but without sacrificing speed of operation, the force acting on the main piston 42 decreases as the movement of the piston increases. As the piston 42 is moved to the open circuit position, the air pressure within the auxiliary tank 83 decreases during the short interval of time required for the mechanism to reach full open position. This decrease of pressure in the auxiliary tank 83 is effected by making the passage through the partition 86 (Fig. 2) relatively small to avoid substantial replacement of the air pressure within the auxiliary tank 83 from the main tank 6 during the opening operation. By providing the proper number of passages, the proper rate of flow of air from the main tank 6 into the auxiliary tank 83 may be obtained.

By using a limited quantity of air to effect the opening operation, the piston and operating mechanism may be brought to rest without too much impact or shock. It is desirable, however, to provide shock absorbing means in order to absorb the kinetic energy of the moving parts. The kinetic energy at the end of the opening stroke is absorbed by controlling the discharge of air ahead of the piston 42. The degree of compression, particularly at the end of the stroke, may be controlled and utilized to provide a shock-absorbing cushion for arresting the movement of the piston and the connected moving parts. The escape of air ahead of the piston is controlled by the ports 134 through the side of the valve casing 104 of the closing central valve 72. The construction of the control valve 72 is similar to the control valve 70. When the valve 70 is opened for admitting air to the operating cylinder 40 to effect opening of interrupter, the valve 72 is closed. The ports 134 of the control valve 72 both as to number and size are arranged so that the air ahead of the piston during the opening operation reaches a predetermined compression at the end of the opening stroke. This condition of compression ahead of the piston 42 persists but only for a short time as the air is quickly exhausted from the cylinder 40 through the ports 134. When the piston 42 reaches full open-cir-

cuit position and control valve 70 is closed due to the deenergization of the electromagnet 102, the air above the piston 42 is quickly exhausted through the passage 116 and the ports 134 in the control valve 70 so as to permit a reclosing operation of the interrupter by admission of air to the lower side of the piston 42 through the valve 72.

When it is desired to close the interrupter, the electromagnet 136 is energized through the auxiliary switch 140. Energization of the magnet 136 opens the valve 124 and, since at this time the magnet 102 is not energized, the selector valve 94 remains in its lower position (Fig. 3) wherein the passage 96 connects the passage 90 with the passage 97 and the conduit 99 to admit air from the auxiliary tank 83, through the passage 118, valve 124, passages 90, 96 and 97 and through the conduit 99 to the valve 72. This opens the valve 72 so as to admit air from the auxiliary tank 85 to the lower side of the operating piston 42. The valves 70 and 72 are identical in construction for which reason it is not deemed necessary to further describe the valve 72. During the closing operation, the air above the piston 42 is compressed by the moving piston 42 to provide a pneumatic cushion for arresting the movement of the piston 42. The proper degree of compression is obtained by the selection of the size and number of exhaust ports 134 provided in the casing of the opening control valve 70. Upon reaching the closed circuit position, or at a predetermined time during the closing operation, the auxiliary switch 140 interrupts the circuit to the electromagnet 136 permitting the valve 124 to close which, in turn, permits the valve 72 to close in the manner described in connection with the description of the valve 70.

The interrupter may be closed manually by depressing the manual closing button 162. Depression of the button 162 opens the pivot valve 124 and admits compressed air through the previously described passages including the conduit 99 to operate the closing control valve 72. This admits compressed air into the cylinder 40 below the operating piston 42 to actuate the piston and the connected operating mechanism to closed position.

If the interrupter is closed while an overload exists on the circuit controlled by the interrupter, it is necessary that the direction of motion of the piston 42 be quickly reversed in order to actuate the interrupter to open circuit position. To accomplish this quick reversal it is necessary to quickly exhaust the pressure under the piston 42. For this purpose a quick release valve 144 (Fig. 3) is provided at the bottom of the cylinder 40. The valve 144 is carried on a stem 146 slidable vertically through a suitable opening in the bottom of the cylinder 40 and is biased to closed position by a spring 148. The valve 144 is adapted to be moved to open position by means of an operating rod 150 secured at its lower end to the valve 144 and having at its upper end a slidable connection with the connecting rod 44. The slidable connection comprises a head 152 on the upper end of the rod, which is slidable in the bore of the connecting rod 44. The head 152 is adapted to be engaged by a packing and guide sleeve 154 threadedly engaging the lower end of the connecting rod 44. The operating rod 150 is of a length such that when the piston 42 reaches the upper limit of its travel, the valve 144 will be fully opened, thereby quickly exhausting the air below the piston 42 to the atmosphere. Thus it can be seen that the piston 42 is free to move downwardly under normal conditions of operation. Only a short travel in a downward direction is required of the piston 42 before the valve 144 is closed, thereby permitting the air under the piston to be compressed for the purpose of cushioning the piston at the end of its opening stroke.

Heretofore in compressed air operating mechanisms of the type disclosed, the movement of the operating piston was controlled for opening and closing movements by electromagnetically operated valves, one for admitting air to the opening side of the piston, and the other for admitting compressed air to the closing side of the piston. Since these valves were electrically operated, a condition was possible in which both electromagnets might be energized at the same time, thus admitting compressed air simultaneously to both sides of the operating piston. If pressure were admitted on both sides of the piston 42, the operating mechanism would become inoperative and no movement either in opening or closing direction would occur, and the moving contacts may become stationary at any point of their travel. The purpose of the interrupter is to provide protection for the circuit controlled thereby, and it is necessary to insure high speed opening movement of the operating mechanism under the adverse condition of conflicting control impulses. This quick reversal of the movement of the operating mechanism and high speed movement thereof in opening direction is accomplished by the provision of the novel selector valve 94.

Assuming that the interrupter has been opened and that the closing magnet 136 is energized to operate the closing control valve 72. If, during the upward movement of the operating piston 42, the trip magnet 102 is energized, the selector valve 94 will be immediately moved to its upper position. This movement of the selector valve simultaneously connects the passages 90 and 126 by means of the passage 95 to admit air pressure to the piston chamber 128 of the opening valve 70 and closes the passage 90—97 for energizing the closing control valve 72. At the same time the passage 100 (Fig. 4) in the selector valve connects the closing valve 72 to atmosphere permitting quick retrieving of the piston 130 for the valve 72 thereby quickly shutting off the supply of compressed air to the under side of the contact operating piston 42 and opening the ports 134 for the closing valve 72 to permit bleeding of the pressure below the contact operating piston. It will be obvious that under such abnormal condition of simultaneous energization of both control valves, the direction of movement of the operating piston 42 and the connected operating mechanism will be quickly reversed and the movable contacts driven to full open position at high speed. It will be further obvious that the above described mechanism is, in effect, trip-free when the interrupter is closed with an overload condition on the circuit controlled thereby.

Some circuit interrupter operating mechanisms of the compressed fluid type employ manually operable means to initiate both opening and closing operations of the interrupter. In such devices it is possible, by inadvertently operating both the closing and the opening control devices at the same time, to admit air pressure to both sides of the operating piston which may result in immobilizing the movable contact in a dangerous partially opened position. The provision

of the selector valve **94** obviates this condition. If the closing button **162** is manually operated and held in its operated position to effect closing of the interrupter and the magnet **102** is energized either under manual control or automatically the selector valve **94** is immediately operated to deenergize the closing control valve **72** and energize the opening control valve **70** in the previously described manner. This quickly reverses the direction of movement of the operating piston **42** and the connected operating mechanism and moves the movable contact to full open position.

Having described a preferred embodiment of the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made in the structural details thereof without departing from some of the essential features of the invention. It is, therefore, desired that the language of the appended claims be given as reasonably broad interpretation as the prior art permits.

I claim as my invention:

1. In a circuit interrupter, separable contacts, operating mechanism including a cylinder and a piston operable therein for moving said contacts to open and closed positions, a source of gas under pressure, opening and closing control valves operable by compressed gas to admit gas under pressure to said cylinder to cause the piston to move to open or closed position, a pilot valve operable to admit compressed gas to the control valves to operate said control valves, and means comprising a selector valve operable to selectively determine which one of said control valves is to be operated and also operable at times to operate the pilot valve.

2. In a circuit interrupter, separable contacts, operating means including a cylinder and a piston operable therein for moving said contacts to open and closed positions, a source of gas under pressure, opening and closing control valves for alternately admitting gas under pressure from said source to opposite sides of said piston to cause said piston to move to open and closed positions, an electromagnetically operated pilot valve operable to admit compressed gas for energizing said opening and closing control valves, means comprising a selector valve operable to determine which one of said control valves is to be energized, and means relating said selector valve to said pilot valve to effect opening of said pilot valve upon operation of said selector valve.

3. In a circuit interrupter, separable contacts, operating means including a cylinder and a piston operable therein for moving said contacts to open and closed positions, a source of compressed gas, opening and closing control valves operable by compressed gas to admit compressed gas to said cylinder to cause the piston to move to open or closed position, an electromagnetically operated pilot valve operable to admit compressed gas to the control valves to operate said control valves, and means normally directing the compressed gas to operate the closing control valve, said means being operable in response to predetermined abnormal circuit conditions to direct the compressed gas to operate the opening control valve and to shut off the compressed gas from the closing control valve.

4. In a circuit interrupter, separable contacts, operating means including a cylinder and a piston movable therein to open and closed positions, a source of gas under pressure, opening and closing valves for alternately admitting gas under pressure to opposite sides of said piston for moving said piston to open and closed position, a selector valve, a pilot valve operable to admit gas under pressure from said source to the selector valve, said selector valve being operable to direct the gas under pressure from the source alternately to the opening and closing valves, and means operated by the selector valve to operate the pilot valve.

5. In a circuit interrupter, contact means, operating means including a cylinder and a piston movable therein to open and closed positions, a source of gas under pressure, opening and closing control valves for alternately admitting gas under pressure to opposite sides of the piston for moving said piston to open and closed positions, a selector valve for directing gas under pressure to alternately energize the control valves, an electromagnet for operating said selector valve, a pilot valve between the source and the selector valve, said pilot valve being operable by said selector valve to admit gas under pressure to said selector valve, and an electromagnet for operating the pilot valve independently of the selector valve to admit gas under pressure to the selector valve.

6. In a circuit interrupter, contact means, operating means including a fluid motor operable in opening and closing directions to move said contacts to open and closed positions, a source of fluid under pressure, opening and closing control valves for admitting fluid under pressure to operate the motor in opening and closing directions, a selector valve normally in a position to direct fluid under pressure to energize the closing valve and operable to a position to direct the fluid under pressure to energize the opening valve and simultaneously to connect the closing valve to the atmosphere, a pilot valve for controlling the admission of fluid under pressure to the selector valve, and means operated by the selector valve for operating said pilot valve.

7. In a circuit interrupter, contact means, operating means comprising a fluid motor operable in opening and closing directions for actuating said contact means to open and closed positions, a source of fluid under pressure, fluid pressure actuated opening and closing valves for alternately admitting fluid under pressure to the motor for causing operation of the motor in opening and closing directions, a selector valve having a passage normally connecting the closing valve to the source for energizing said closing valve, said selector valve normally deenergizing the opening valve, a pilot valve intermediate the source and the selector valve, electroresponsive means for opening the pilot valve to thereby energize the closing valve and cause movement of the motor in closing direction, and a tripping electromagnet operable in response to overload currents in the circuit for operating the selector valve and the pilot valve to simultaneously energize the opening valve and deenergize the closing valve to thereby cause movement of the motor in opening direction.

8. In a circuit interrupter, contact means, operating means comprising a fluid motor operable in opening and closing directions to move the contact means to open and closed positions, a source of fluid under pressure, opening and closing valves for alternately admitting fluid under pressure to the motor for causing operation of the motor in opening and closing directions, a selector valve having a passage normally con-

necting the closing valve to the source for energizing said closing valve, said selector valve normally deenergizing the opening valve, a pilot valve intermediate the source and the selector valve, a closing electromagnet operable when energized to open the pilot valve to thereby energize the closing valve and cause movement of the motor in closing direction, and a trip device including electroresponsive means operable in response to overload currents for operating the selector valve to cause energization of the opening valve to thereby cause movement of the motor in opening direction irrespective of the energized condition of the closing magnet.

9. In a circuit interrupter, contact means, operating means including a fluid motor operable to actuate the contact means to open and closed positions, a source of fluid under pressure, opening and closing control valves for admitting fluid under pressure directly from said source to said motor to operate the motor in opening and closing directions, independently operable means for each control valve including a cylinder and a piston movable therein for operating the opening and closing valves, a selector valve operable to simultaneously direct fluid under pressure to one of said cylinders and to exhaust the pressure from the other of said cylinder to atmosphere to thereby quickly reverse the direction of operation of the fluid motor, and a pilot valve operable by said selector valve and also operable independently of said selector valve to admit fluid pressure to said selector valve.

10. In a circuit interrupter, contact means, operating means including a fluid motor operable to actuate the contact means to open and closed positions, a source of fluid under pressure, opening and closing control valves disposed in passages directly communicating said source to opposite ends of said motor, said valves being operable to admit fluid under pressure to said motor to operate the motor in opening and closing directions, independently operable means for each control valve including a cylinder and a piston movable therein for operating the opening and closing control valves, a pilot valve between said source and said valve cylinders and operable to admit fluid pressure to said valve cylinders, a selector valve normally establishing communication between the pilot valve and the cylinder of the closing valve and operable to quickly interrupt the communication between the pilot valve and the closing valve cylinder and to establish communication between the pilot valve and the opening valve cylinder to operate the opening valve, and an electromagnet for operating the selector valve.

11. In a circuit breaker, contact means, operating means including a fluid motor operable to actuate the contact means to open and closed position, a source of fluid under pressure, opening and closing control valves for admitting fluid under pressure to said motor to operate said motor in opening and closing directions, independently operable means for each control valve including a cylinder and a piston movable therein for operating the opening and closing control valves, a pilot valve between said source and said valve cylinders for controlling the admission of fluid pressure to said cylinders, a selector valve normally establishing communication between the pilot valve and the cylinder of the closing valve and operable to interrupt said communication and to establish a communication between the pilot valve and the opening valve cylinder, said selector valve also being operable to exhaust the pressure from the closing valve cylinder to atmosphere, and an electromagnet for simultaneously operating the selector valve and said pilot valve to admit fluid pressure to the opening control valve cylinder.

12. In a circuit breaker, contact means, operating mechanism including a fluid motor operable to actuate the contact means to open and closed positions, a source of fluid under pressure, opening and closing control valves for admitting fluid under pressure to said motor to operate the motor in opening and closing directions, independently operable means for each control valve including a cylinder and a piston movable therein for operating the opening and closing control valves, a pilot valve between said source and the valve cylinders, a selector valve normally establishing communication between said pilot valve and the closing valve cylinder, an electromagnet operable when energized to interrupt said communication between said pilot valve and the closing valve cylinder and to establish communication between the pilot valve and the opening valve cylinder to operate the opening valve, and means operable by said electromagnet to operate the pilot valve.

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