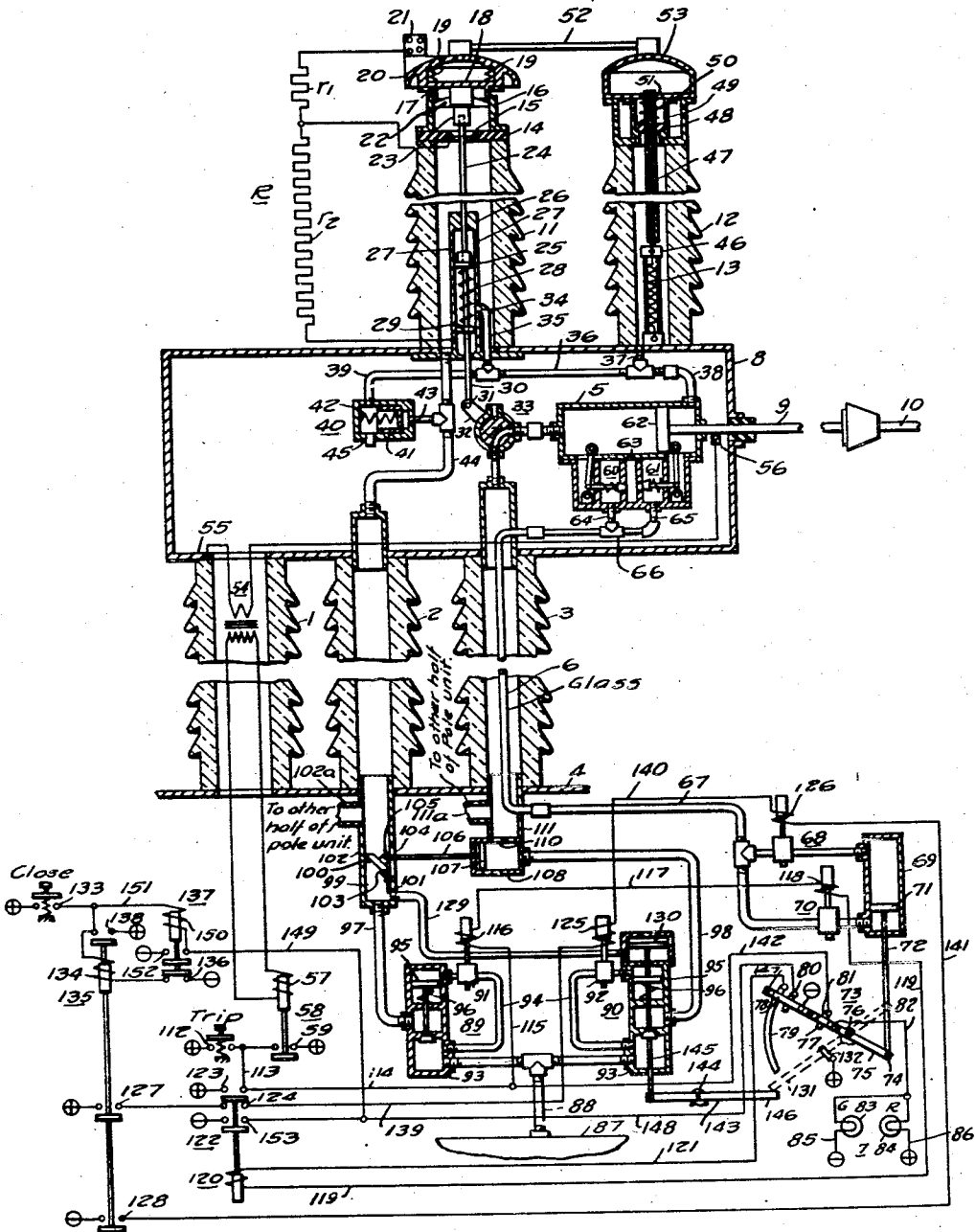


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COMPRESSED GAS-OPERATED CIRCUIT INTERRUPTER
WITH POSITION INDICATOR
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WITNESSES:

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COMPRESSED GAS-OPERATED CIRCUIT INTERRUPTER WITH POSITION INDICATOR

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This invention relates to circuit interrupters, and, in particular, to circuit interrupters of the fluid blast type. More particularly, our invention concerns an improved operating mechanism for a circuit interrupter of the gas blast type.

Certain features disclosed but not claimed in this application are fully disclosed and claimed in copending divisional application, Serial No. 1,546, filed January 10, 1948, by Leon R. Ludwig, Benjamin P. Baker, and James M. Cumming, and assigned to the assignee of the instant invention.

An object of our invention is to provide an improved pneumatically operated interlocking device which will ensure that the opening operation will take precedence over the closing operation.

Another object is to provide an improved structural arrangement for a circuit interrupter of the high voltage type in which the position of the disconnect contact is signalled by pneumatic means to suitable indicating equipment.

Another object is to provide an improved gas blast circuit interrupter in which suitable interlocking means are provided between the closing air for actuating the disconnect contact and the interrupting contacts.

Another object is to provide an improved operating arrangement for a gas blast circuit interrupter in which "pumping" is prevented.

Another object is to provide an improved gas blast circuit interrupter operating mechanism in which an interlocking means is provided so that when closing air is applied opening air will be dumped from the interrupters.

Another object is to provide an improved operating mechanism for a gas blast circuit interrupter in which an improved dumping means is provided for dumping air from the interrupters and also from the disconnect cylinder.

Further objects and advantages will readily become apparent upon a reading of the following specification taken in conjunction with the accompanying drawing, in which the figure shows schematically one-half of a single pole unit of a high voltage compressed air circuit interrupter embodying our invention and shown in the closed circuit position.

The complete circuit interrupter embodying our invention is shown in a patent application filed May 24, 1944, Serial No. 537,074, by Leon R. Ludwig, Herbert J. Webb and Benjamin P. Baker, and assigned to the same assignee as the instant application. The foregoing application not only shows a perspective view of the complete circuit interrupter, but also shows an enlarged

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view of the interrupting unit for one-half of the pole unit. The present application is concerned with the improved operating arrangement for actuating the aforesaid circuit interrupter.

Referring to the accompanying drawing, the reference numerals 1, 2, and 3 indicate hollow insulator columns supported on a grounded base structure 4. The column 1 encloses an overload current transformer. The column 2 serves to conduct the opening air to the interrupters and the column 3 not only serves to carry the closing air to the disconnect cylinder 5 but also has positioned concentrically therein an inner tube 6, preferably composed of an insulating material such as glass, to transmit the signalling air from the disconnect cylinder 5 down to suitable indicating equipment 7 contained in the base structure 4. The three insulator columns support a housing 8 which is preferably made of conducting material and which encloses the operating mechanism for actuating the disconnect contact 9. The disconnect contact 10 for the other one-half of the pole unit is fragmentarily shown.

Supported on the housing 8 are two insulator columns 11, 12. The column 11 encloses the main power interrupter. The column 12 encloses an auxiliary impedance interrupter for interrupting the residual current passing through the resistor 13. At the top of the column 11 is an insulating plate 14 having an aperture formed therein, the periphery of which is defined by a conducting ring-shaped orifice member 15 which serves as an orifice through which the main power interrupting arc is drawn and through which the blast air for extinguishing said arc is forced.

Supported on the insulating plate 14 is a conducting cylindrical member 16 having a plurality of exhaust apertures 17 provided therein which may be closed by a conservator 18 which is spring-biased downwardly by compression springs 19 having their upper seat formed by a conducting cap member 20 having a line terminal 21 rigidly affixed thereto.

A spider member 22 is supported by the inner wall of the conducting cylindrical member 16 and serves to maintain in position a stationary contact 23 which may be of the type having segmental conducting fingers biased radially inwardly by a garter spring and which serve to make contacting engagement, in the closed circuit position as shown in the drawing, with a movable main contact 24. The contact 24 is actuated by a piston 25 movable within a conducting cylindrical

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member 26 having apertures 27 formed therein. The piston 25 is biased upwardly by a compression spring 28; the lower end of which is seated on a ring-shaped plate member 29 rigidly affixed to the inner wall of the cylindrical member 26.

The movable contact 24 has an insulating rod-shaped extension 30 pivotally connected at 31 to a crankarm 32 which actuates a valve 33.

A resistor R has portions r_1 connected in parallel with the line terminal 21 and the conducting ring-shaped orifice member 15 and a portion r_2 connected in parallel between the ring-shaped orifice member 15 and the conducting cylindrical member 26, the purpose for which will appear more clearly hereinafter.

The cylindrical member 26 has an aperture 34 provided therein which communicates with a conduit 35. The conduit 35 connects to a conduit 36 having a connection at 37 with the interior of the insulating column 12. The conduit 36 also leads at 38 to the right-hand end of the disconnect cylinder 5. The conduit 36 also communicates by means of a conduit 39 to a dump valve generally designated by the reference numeral 40. The dump valve 40 may be closed by leftward motion of a slidable piston member 41 spring-biased to the right by a compression spring 42. The piston member 41 is in communication by means of a conduit 43 with the opening blast pipe 44 which communicates with the interior of the insulating column 11. The dump valve 40 has an exhaust opening at 45 to atmosphere.

The resistor 13 disposed within the insulating column 12 has an upper stationary contact 46 which electrically engages in the closed circuit position with a movable tubular contact 47 having affixed thereto at its upper end a piston 48 movable within a piston chamber 49 and biased downwardly by a compression spring 50. The piston chamber 49 has an aperture at 51 which communicates by way of a conduit 52 to the upper side of the conservator 18. A cap member 53 is disposed at the top of insulating column 12.

An overload current transformer generally designated by the reference numeral 54 has its primary winding connected between a point 55 of the housing 8 and a slider connection at 56 making conducting sliding engagement with the disconnect contact 9. The secondary winding of the current transformer 54 is connected across a coil 57 actuating an overload contactor generally designated by the reference numeral 58. The contactor 58 has a pair of normally open contacts 59.

The disconnect cylinder 5 has a pair of valves, generally designated by the reference numerals 60 and 61, associated therewith which are opened mechanically by the piston member 62, the latter serving to actuate the disconnect contact 9. The valves 60 and 61 are only opened at the extreme ends of motion of the piston member 62. In other words, valve 60 is only opened when the disconnect contact 9 is at its fully open circuit position. In like manner the valve 61 is only opened when the disconnect contact 9 is at its fully closed position.

The valves 60, 61 serve, when opened, to permit communication between the interior of the disconnect cylinder 5 through an aperture 63 through the valves 60 or 61 to conduits 64, 65 which connect at 66 to lead by way of the insulating tube 6 to a conduit 67. The conduit 67 leads through a valve generally designated by the reference numeral 68 to the upper end of a piston

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chamber 69. The conduit 67 also leads by way of a valve generally designated by the reference numeral 70 to the lower end of the piston chamber 69. Movable within the piston chamber 69 is a piston 71 connected by means of a rod 72 to a rotatable switch generally designated by the reference numeral 73. In other words, the rod 72 is pivotally connected at 74 to a rotatable arm 75 pivotally supported at 76 on a fixed pivot.

The arm 75 has a conducting portion 77 and a conducting bridging portion 78. In the closed circuit position of the interrupter the conducting bridging portion 78 electrically connects a long segment 79 to a short segment 80. Also in the closed circuit position of the interrupter the conducting portion 77 makes electrical contact with a short segment 81. The conducting portion 77 is electrically connected by means of a conductor 82 to two indicating lamps 83, 84. The indicating lamp 83 is connected by means of the conductor 85 to the negative side of the D.-C. power supply for the operating mechanism. The indicating lamp 84 is connected by means of the line 86 to the positive side of the power supply. The conducting bridging portion 78 is electrically connected to the negative side of the power supply.

The reference numeral 87 indicates the source of compressed fluid, in this instance a tank of compressed air. A conduit 88 leads from the tank of compressed air to two electrically actuated valves generally designated by the reference numerals 89 and 90. The valve 89 is actuated by an electrically actuated valve 91. The valve 90 is actuated by an electrically actuated valve 92. It is apparent that upon actuation of either valve 91 or valve 92 compressed air will pass from the chamber 93 through a by-passing conduit 94 to the top side of pistons 95 spring-biased upwardly by compression springs 96. Thus, upon actuation of the valves 91, 92, the pistons 95 will be forced downwardly against the biasing action of the compression springs 96 to open the valves 89, 90 to permit compressed air to pass to either the conduit 97 or conduit 98.

The conduit 97 leads to a chamber 99 having associated therewith a dump valve 100, which is pivotally movable at 101 to a wall of the cylindrical member 102. The dump valve 100, when opened, serves to seat against a seat portion 103 integrally formed with the cylindrical member 102 thereby closing the chamber 99. The dump valve 100, when opened, opens an aperture 104 provided in the cylindrical member 102. The dump valve is pivotally connected at 105 to an actuating rod 106, the right-hand end of which is affixed to a piston 107 operable within a piston chamber 108. The piston chamber 108 communicates by way of the conduit 98 to the upper side of the valve 90. An aperture 110 is provided in the piston chamber 108 which thereby permits communication between the piston chamber 108 and a cylindrical member 111 which communicates with the interior of the insulating column 3. The members 111 and 102 communicate by conduits 111a and 102a to the columns (not shown) 2 and 3 of the other half of the pole unit.

The operation of the circuit interrupter will now be described. In the closed circuit position of the interrupter as shown in the drawing, the electrical circuit therethrough comprises line terminal 21, conducting cap member 20, conducting cylindrical member 16, conducting spider member 22, stationary contact 23, movable contact 24, conducting cylindrical member 26 to con-

ducting housing 8. It will be observed that the electrical circuit through the column 12 is in parallel with the aforesaid circuit. In other words, the electrical circuit through insulating column 12 comprises line terminal 21, conducting cap member 20, conducting conduit 52, conducting cap member 53, conducting piston chamber 49, conducting piston 48, movable tubular contact 47, upper stationary contact 46, resistor 13, to conducting housing 8.

Thus these two parallel circuits through the columns 11, 12 meet at the conducting housing 8 to pass at the point 55 through the primary winding of the overload current transformer 54 to the slider connector 56 to the left-hand movable disconnect contact 9. The circuit then extends through the right-hand disconnect contact 10 through an identical circuit through the other half of the pole unit (not shown) to the other line terminal of the interrupter.

The following discussion assumes a manual tripping of the circuit interrupter by momentarily pressing the trip button 112. The momentary pressing of the trip button 112 puts the following circuit across the supply system; trip button 112, line 113, line 114, line 115, coil 116, line 117, coil 118, line 119, coil 120, line 121, long segment 79, conducting bridging portion 78 to the negative side of the supply voltage. This energizes the aforesaid coils. The energization of the coil 120 closes the contactor, generally designated by the reference numeral 122 to thereby cause a circuit to pass through the normally open contacts 123 of the contactor 122 to shunt the trip button 112, thus maintaining the aforesaid coils in an energized state following release of the trip button 112. The closing of the contactor 122 opens the normally closed contacts 124 to thereby break the circuit through the coils 125 and 126 assuming that the normally open contacts 127, 128 were closed by energization of contactor 135. Thus the opening operation takes electrical precedence over the closing operation by virtue of the fact that the normally closed contacts 124 are serially connected in the circuit for energizing the closing coil 125.

The energization of the coil 116 causes an actuation of the electrically actuated valve 91 to thereby cause an opening of the opening valve 89. Compressed air consequently passes from the tank 87 through conduit 88, chamber 93, through opening valve 89, through conduit 97 to chamber 99 to seat the dump valve 100 against the aperture 104 of the cylindrical member 102. The compressed air passing into the cylindrical member 102 acts through conduit 129 to maintain the piston 130 in its upper position, thereby mechanically maintaining the closing valve 90 closed. Thus the piston 130 provides a pneumatic interlock between the opening and closing valves 89, 90 whereby the opening blast of air will always take pneumatic precedence over the closing air. This results since the area of the piston 130 is greater than the area of the piston 95.

The opening blast air passes upwardly through the insulating column 2 through opening blast pipe 44 to act through conduit 43 to close the dump valve 40. Also the opening blast air passes upwardly into the interior of the insulating column 11 to act through the apertures 27 and force the piston 25 downwardly thereby separating the movable contact 24 from the stationary contact 23 drawing an arc therebetween. The opening blast air passes upwardly through the orifice member 15, raising the conservator 18 against the

biasing action of the springs 19 to permit the blast air to exhaust through the apertures 17 provided in the conducting cylindrical member 16. The compression springs 19 exert only a few pounds pressure on the conservator 18 and since the opening blast air is at a considerably higher pressure, say 250 pounds per square inch, the pressure is sufficient to force the conservator 18 upwardly to thereby uncover the exhaust apertures 17.

The passage of the blast air upwardly through the orifice member 15 and outwardly through the apertures 17 serves to quickly extinguish the arc drawn between the movable contact 24 and the stationary contact 23. The breaking of this arc causes the electrical circuit to pass through the insulator column 12 by way of the movable contact 47, stationary contact 46 and resistor 13. The providing of a parallel resistance path lowers the rate of rise of the recovery voltage across the contacts 23, 24 and lowers the overshoot of the recovery voltage transient.

Since the pressure below the insulating plate member 14 is relatively high and consequently of high dielectric strength, and since the pressure above the plate member 14 is relatively low and consequently of poor dielectric strength, it is desirable to impress a major portion of the voltage between the contacts 23, 24 across the gap between the orifice 15 and the movable contact 24 during the interrupting operation because of the high pressure within the column 11. This is accomplished by the resistor R having a small portion thereof r_1 connected in parallel between the line terminal 21 and the conducting orifice member 15, and having a larger portion r_2 thereof in parallel between the conducting orifice member 15 and the conducting cylindrical member 26. By the foregoing we have divided the voltage properly through the orifice by causing a greater portion of the voltage to be impressed below the orifice and by having the smaller portion of the voltage impressed on the low pressure side of the orifice.

The low impedance part of the electrical circuit now through the interrupter comprises the line terminal 21, contact cap 20, conducting conduit 52, cap member 53, piston chamber 49, piston member 48, movable tubular contact 47, stationary contact 46, resistor 13, housing 8, primary winding of current transformer 54, disconnect contact 9 to the right-hand half of the pole unit not shown.

When the piston 25 passes below the aperture 34, opening blast air will pass downwardly through the conduit 35, and since dump valve 40 is closed at this time will pass to the right through conduit 36 and upwardly into the interior of the column 12 and also to the right-hand end of disconnect cylinder 5. The passage of the opening blast air upwardly within the column 12 will act upwardly on the piston 48 causing the movable tubular contact 47 to move upwardly separating from the stationary contact 46 to establish a residual current arc. The opening blast air will pass through the arc and upwardly through the tubular contact 47, upwardly through the aperture 51, through the conducting conduit 52 to act downwardly on the conservator 18, thus closing the apertures 17. This occurs because the area of the conservator 18 acted upon by the blast air passing through the conduit 52 is greater than the area of the conservator 18 acted upon by the blast air below the conservator 18. The arc is extinguished between the contacts 46, 47

and thereby the residual current passing through the resistor 13 is interrupted.

It will be observed that downward motion of the piston 25 through extension 30 causes an actuation of the valve 33 to dump the air within the disconnect cylinder 5 to the left of the piston 62. Consequently the opening blast air which passes through conduit 38 into the right-hand end of disconnect cylinder 5 causes a leftward movement of piston member 62 and a consequent opening movement of the disconnect contact 9.

The current passing through the resistor 13 is of a relatively low magnitude, say 100 amperes, and is thus very easily interrupted with small time delay. As a result the disconnect contact 9 is not moved to the left until after the arc is extinguished within the column 12.

At the end of the leftward motion of the piston member 62, the valve 60 is mechanically actuated and opening air within the disconnect cylinder 5 acts downwardly through aperture 63, through valve 60, conduit 64, tube 6, conduit 67 through electrically actuated valve 70 (coil 118 now being energized) to act upwardly on the piston 71 within the piston chamber 69. This causes the rotatable switch 73 to be actuated thereby rotating arm 75 in a counterclockwise direction about pivot point 76.

The rotation of the arm 75 causes a separation between the long segment 79 and the conducting bridging portion 78 of arm 75 to thereby break the circuit through the opening coils 116, 118 and 120.

The rotation of the arm 75 to the dotted position indicated by the reference numeral 131 causes contact between the segment 132 and the conducting portion 77 of the arm 75. Thus the indicating light 83 is energized, and the circuit through the indicating light 84 is shorted out, thus darkening the indicating light 84.

The de-energization of coil 116 permits compression spring 96 to raise piston 95 thus closing the opening valve 89. Gradual leakage of air past the conservator 13 will serve to bring about a reduction in pressure of the air within the column 11. This will permit the compression spring 42 to force the piston member 41 to the right thus opening dump valve 40. The opening of dump valve 40 permits air within the column 12 and air to the right of piston member 62 to be dumped. Also the reduction in pressure of the air within column 11 will permit the compression spring 28 to raise the piston 25 and thus cause a re-engagement of contacts 23 and 24. Also the reduction of pressure within the column 12 will permit the compression spring 50 to lower the piston 48 and hence effect a re-engagement of the contacts 46, 47.

Thus the two pairs of contacts within the columns 11, 12 reclose following an opening operation and the entire voltage across the circuit interrupter is impressed between the disconnect gap caused by separation of the disconnect contacts 9 and 10.

The following discussion assumes a normal closing operation with a momentary pressing of the closing button 133. The momentary closing of closing button 133 causes an energization of the circuit comprising closing button 133, coil 134 and normally closed contacts 136 of contactor 137 to the negative side of the supply voltage. This will close the contactor 135 and thereby effect a closure of normally open contacts 138 of contactor 135. The closure of contacts 138

causes a by-passing circuit around the closing button 133 to the positive side of the supply voltage. The closing of contactor 135 effects a closure of normally open contacts 127, 128. The closure of these latter contacts causes an energization of the circuit which includes contacts 127, normally closed contacts 124 of contactor 122, line 139, closing coil 125, line 140, coil 126, line 141 through closed contacts 123 of contactor 135 to the negative side of the line. The result is an opening of closing valve 90 and also an opening of valve 68.

The opening of closing valve 90 permits compressed air to flow from the tank 87 upwardly through conduit 88, through valve 90, through conduit 98 into piston chamber 108 to force piston 107 to the left thereby seating the dump valve 100 against the seat portion 103 of cylindrical member 102. Also the closing air passes upwardly out of piston chamber 108 through aperture 110 and upwardly through column 3, through valve 33 (movable contact 24 being in its raised position) to the left-hand side of piston member 62. This closing air forces piston member 62 to the right, the air to the right of the piston member 62 dumping through the dumping valve 40. Disconnect contacts 9 and 10 thus approach each other, engage and thereby effect a closing of the circuit through the interrupter. When the piston member 62 is at its fully closed position, it manually opens valve 61 to permit closing air to pass out of the disconnect cylinder 5 downwardly through aperture 63, through valve 61, conduit 65, conduit 6, conduit 67, through valve 68 to the top side of the piston 71 within the piston chamber 69. This moves the piston member 71 downwardly effecting a clockwise rotation of arm 75 about the pivotal point 76 to the position indicated by the full lines in the drawing.

The separation of segment 132 from conducting portion 77 of arm 75 breaks the circuit which passed through the indicating light 83 and shunted the indicating light 84. Also the engagement of long segment 79 with conducting bridging portion 78 of arm 75 causes a circuit to be established through indicating light 84 which comprises the following: negative side of the supply voltage, conducting portion 78, long segment 79, coil 120, coil 118, coil 116, line 115, line 142, segment 81, conducting portion 77, line 82, indicating light 84 to the positive side of the supply voltage. Thus the indicating light 84 lights, but the current passing therethrough is not sufficient to energize the opening coil 116 or coils 118 and 120. The result is that indicating light 83 darkens and indicating light 84 is lighted upon the completion of the closing operation of the interrupter.

Upon the completion of the closing operation the energizing circuit through the closing coils 125, 126 is broken as follows. The engagement of the conducting bridging portion 78 with short segment 80 causes the following circuit to be established: negative side of supply voltage, conducting bridging portion 78, short segment 80, line 148, line 149, coil 150 of contactor 137, line 151 through closed contacts 138 of contactor 135 to the positive side of the supply voltage. Thus contactor 137 closes and contacts 136 thereof open to break the circuit through coil 134 of contactor 135. Contactor 135 then opens and causes opening of contacts 127 and 128. The opening of the latter contacts breaks the circuit through the closing coils 125 and 126. Also the

opening of contactor 135 causes contacts 138 thereof to open thereby opening the circuit through the coil 150 of contactor 137. In this state of affairs all of the coils are de-energized and all of the contactors are in their normally open circuit position.

It will be observed that during the initial portion of the closing operation, that is during actuation of the closing valve 90, that there is thereby caused a counterclockwise rotation of a lever 143 pivotally mounted at a fixed pivot 144 and mechanically connected by a rod 145 to the closing valve 90. The right-hand end 146 of the lever 143 moves the end 147 of the rotatable arm 75 to thereby effect an engagement between the long segment 79 and the conducting portion 78 of the arm 75. Thus during the initial portion of the closing operation there is provided a possibility of a circuit through the opening coil 116 which may be effected upon a closing of overload contactor 58 following overload conditions existing in the circuit controlled by the interrupter. In other words, if one is manually closing the breaker during fault conditions, the current transformer 54 will cause a closure of contactor 58 to effect closure of contacts 59. The closure of contacts 59 effects a circuit from the positive side of the supply voltage through contacts 59, line 113, line 114, line 115, opening coil 116, line 117, coil 118, line 119, coil 120, long segment 79, conducting portion 78, to the negative side of the supply voltage.

Thus by the arm 75 engaging long segment 79 during the initial portion of the closing operation, it is possible to obtain an energization of the opening coil 116 even before the disconnect contacts 9, 10 have effected a complete engagement. Consequently, if one is closing the breaker manually on a fault, the opening coil 116 will be energized even before the breaker is fully closed. Also the coil 120 will be energized at the same time as the energization of the coil 116 and this will cause a closure of contactor 122 which will open the normally closed contacts 124 to break the circuit through the closing coil 125. The result is that when closing the breaker on a fault the opening coil 116 will take electrical precedence over the closing coil 125 and the breaker will be returned to the fully open circuit position. Naturally the opening sequence of the various parts is as previously described.

Furthermore, when attempting manually to close the breaker on a fault, the passage of compressed air through valve 89 will act through conduit 129 to force piston 130 upward to seal the closing valve 90 closed. This ensures in a pneumatic manner that all the parts of the breaker will move to the open circuit position promptly. The lowering of movable contact 24 will cause rotation of valve 33 to dump closing air out of the disconnect cylinder 5 so that leftward movement of the disconnect piston 62 will not be impeded.

The action of the breaker during high speed reclosing will now be described. Assume the breaker has just been opened during a normal opening operation as explained above, and that it is desired to immediately reclose the breaker. In this condition, however, the air within columns 2, 11 and 12 will still be at a high pressure, and movable contact 24 lowered. When closing valve 90 is actuated the air pressure passing therethrough will move piston 107 to the left thereby opening dump valve 100. The opening

of dump valve 100 will dump the air out of columns 2 and 11 and thereby permit opening of dump valve 40. The opening of dump valve 40 will dump the air out of column 12 and the right end of disconnect cylinder 5. Also the raising of contact 24 will actuate valve 33 to permit communication between column 3 and the left-hand end of disconnect cylinder 5. Consequently, the disconnect contact 9 will be moved to the right to effect a closing of the electrical circuit through the interrupter, the contacts 23, 24 having previously effected engagement. Thus the circuit is closed on the disconnect contacts 9 and 10 and not on the contacts 23, 24. From the above it is apparent that the interrupter is operable to always break the circuit on the arcing contacts 23, 24 and 46, 47 and always to close the circuit on the disconnect contacts 9, 10. In the open circuit position of the interrupter the re-engagement of the contacts removes the voltage from the columns 11, 12 and impresses it across the isolating gap created by separation of the disconnect contacts 9, 10.

The question of "pumping" will now be considered. Pumping may be defined as repeated rapid opening and closing operations as a result of maintaining the closing button closed during the existence of overload conditions on the circuit controlled by the interrupter. Each time the interrupter is closed, the overload current passing therethrough will actuate the tripping mechanism to return the interrupter to the open circuit position. The maintaining of the closing button closed will then again cause the interrupter to begin to close. This repeated opening and closing of the interrupter is called "pumping."

In the interrupter of our construction this pumping is prevented in a novel manner. To explain how this is done certain assumptions will be made. First, assume that contacts 152 of contactor 137 and contacts 153 of contactor 122 are omitted. What is the result? It is apparent that if one maintains the closing button 133 constantly closed, the breaker will be repeatedly moved toward the closed position as long as the contactor 137 is not energized when the breaker is in the open circuit position. For, if the contactor 137 is energized in the open circuit position, the contacts 136 thereof will break the circuit through the coil 134 of contactor 135. This will open contacts 127 and 128 to break the circuit through the closing coils 125, 126. Consequently, if contacts 152 of contactor 137 and contacts 153 of contactor 122 are omitted there will result pumping, since contactor 137 is not energized in the open circuit position.

Secondly, assume that only the contacts 153 of contactor 122 are omitted. What is the result now? If the breaker moves far enough toward the closed circuit position before tripping takes precedence so that conducting bridging portion 78 of arm 75 engages segment 80, then contactor 137 will be energized. In this event contactor 137 will be maintained in an energized state through contacts 152 thereof and there will result no pumping, contacts 136 opening the circuit through coil 134 of contactor 135. But if the breaker does not move far enough toward the closed position so that contact is once made between segments 78, 80 to pick up contactor 137, there will result pumping, since contactor 137 will never be energized and coil 134 of contactor 135 will remain energized in the open circuit position of the interrupter.

Now assume that contacts 153 of contactor 122 are present as shown in the drawings. What is the result now? Regardless of the closing travel of the interrupter, and whether or not segments 78, 80 make engagement, once the tripping operation takes place contacts 153 of contactor 122 will energize the contactor 137, and once this contactor is energized it will be maintained in an energized state through its own contacts 152. Since in this state of affairs contactor 137 is energized and maintained energized in the open circuit position of the interrupter, the contacts 136 thereof will maintain the contactor 135 in a de-energized state so that closing movement of the interrupter will not take place. Pumping will, therefore, be prevented. Consequently, by the construction which we show in the drawing, pumping is entirely eliminated.

Although we have shown and described a specific construction, it is to be clearly understood that the same was merely for the purpose of illustration, and that changes and modifications may readily be made by those skilled in the art without departing from the spirit and scope of the appended claims.

We claim as our invention:

1. In a gas blast circuit interrupter, a disconnect contact, a piston operated in a disconnect cylinder for actuating the disconnect contact, signal means indicating the full open and full closed positions of the disconnect contact, pneumatic means interconnecting the signal means and the disconnect cylinder, valve means for controlling the energization of said pneumatic means to actuate said signal means, and means disposed in said disconnect cylinder engageable by said piston for actuating said valve means.

2. In a gas blast circuit interrupter, a disconnect contact, a piston operated in a disconnect cylinder for actuating the disconnect contact, a first valve means disposed at one end of the disconnect cylinder, a second valve means disposed at the other end of the disconnect cylinder, said piston engaging and operating said first and second valve means at its fully open and fully closed positions, and signal means responsive to operation of the first and second valve means to indicate the full open and full closed positions of the disconnect contact.

3. In a gas blast circuit interrupter, disconnect means, operating means for moving said disconnect means to open and closed positions, signalling means comprising a piston chamber and a switch operable to effect indication of the position of the disconnect means, a piston operable within the piston chamber to actuate said switch, and valve means operated by said operating means only when said disconnect means is in the fully open or fully closed position for admitting compressed gas to said piston chamber to operate said piston.

4. In a gas blast circuit interrupter, disconnect means, pneumatic means for operating said disconnect means, signalling means comprising a mounted switch operable to indicate the position of the disconnect means, a conduit for transmitting compressed gas to the pneumatic operating means to effect the closing operation of the disconnect means, valve means operable to admit compressed gas to the conduit, an electrical tripping circuit for causing the opening operation of the interrupter comprising a pair of contacts associated with said switch, and means operable by the valve means for actuating the switch to effect

closure of the pair of contacts to prepare said tripping circuit.

5. In a gas blast circuit interrupter, disconnect means, operating means comprising a cylinder and a piston operable therein for operating said disconnect means to open and closed positions, signalling means comprising a switch movable to two positions to effect indication of the position of said disconnect means, pneumatic operating means for said signal switch, valve means operable to permit selectively energization of said pneumatic operating means to effect movement of said switch to one position or the other, and valve means operated by said piston only when the disconnect means is in its fully closed and fully open positions to effect energization of said pneumatic operating means.

6. In a gas blast circuit interrupter, disconnect means, compressed gas operated means for moving said disconnect means to open and closed positions, control valve means comprising an opening control valve operable to admit compressed gas to said interrupter and to said compressed gas operated means to operate said interrupter to the open position and for moving said disconnect means to the open position, a closing control valve operable to admit compressed gas to said compressed gas operated means to move said disconnect means to the closed position, indicating means comprising a switch movable to two positions to indicate the open and closed positions of said disconnect means, pneumatic operating means for said switch, a first valve operable to admit compressed gas to said pneumatic operating means to effect movement of said switch to the "open" indicating position, a second valve operable to admit compressed gas to said pneumatic operating means to effect movement of said switch to the "closed" indicating position, means for actuating said opening control valve and said first valve simultaneously, and means for operating said closing control valve and said second valve simultaneously.

7. In a gas blast circuit interrupter, disconnect means, pneumatic means for operating said interrupter, signalling means comprising a switch operable to indicate the position of said disconnect means, a conduit for transmitting compressed gas to said pneumatic operating means to operate said disconnect means to closed position, valve means operable to admit compressed gas to said conduit, trip means operable when energized to cause opening operation of said interrupter and said disconnect means, a tripping electrical circuit for energizing said trip means, and mechanical interlocking means operatively relating said valve means to said switch to automatically actuate said switch upon operation of said valve means to prepare said tripping circuit for energizing said trip means.

8. In a pneumatic operating mechanism, a main cylinder and a main operating piston movable therein between two extreme positions, control valve means comprising a first inlet valve operable to admit compressed gas to said cylinder to move said piston to one of said extreme positions, a second inlet valve operable to admit compressed gas to said cylinder to move said piston to a second extreme position, indicating means for indicating the extreme positions of said piston, switch means movable to two positions for energizing said indicating means, operating means for said switch comprising a secondary cylinder and a piston operable therein for actuating said switch, and valve means operable by said main

piston only when said main piston is moved to its extreme positions for admitting compressed gas to said secondary cylinder to actuate said switch.

9. In a pneumatic operating mechanism, a main operating cylinder and a main operating piston movable therein between two extreme positions, control valve means comprising a first inlet valve operable to admit compressed gas to said main cylinder to move said main piston to one extreme position, a second inlet valve operable to admit compressed gas to said main cylinder to move said main piston to a second extreme position, indicating means for indicating the extreme positions of said main piston, switch means movable to two positions for energizing said indicating means, operating means for said switch comprising a secondary cylinder and a piston movable therein for actuating said switch, valve means for selectively admitting compressed gas to said secondary cylinder to actuate said switch, means for actuating said valve means in accordance with the operation of said first and second inlet valves, and valve means operable by said main piston only when said main piston is in said extreme positions to admit compressed gas to said secondary cylinder.

10. In a pneumatic operating mechanism, a main operating cylinder and a main operating piston movable therein between two extreme positions, control valve means comprising a first inlet valve operable to admit compressed gas to said main cylinder to move said main piston to one extreme position, a second inlet valve operable to admit compressed gas to said main cylinder to move said main piston to a second extreme position, indicating means for indicating the extreme position of said main piston, switch means movable to two positions for energizing said indicating means, operating means for said switch comprising a secondary cylinder and a piston movable therein for actuating said switch, valve means disposed at opposite ends of said secondary cylinder and operable to admit compressed gas to said secondary cylinder to actuate said switch to its two positions, means for simultaneously actuating said first inlet valve and the valve at one end of said secondary cylinder, means for simultaneously actuating said second inlet valve and the valve at the other end of said secondary cylinder, and

valve means disposed in said main cylinder to be engaged and operated by said main piston only when said main piston nears its extreme positions to admit compressed gas to said secondary cylinder.

11. A gas blast circuit interrupter comprising disconnect means, a cylinder and a piston operable therein for operating said disconnect means, signalling means, pneumatic means for operating said signalling means, a first conduit for transmitting compressed gas to said cylinder to effect an opening operation of said disconnect means, a second conduit means for transmitting compressed gas to said cylinder to effect a closing operation of said disconnect means, a first valve means for admitting compressed gas to said first conduit, a second valve means for admitting compressed gas to said second conduit, and valve means operable simultaneously with said first and second valve means for admitting compressed gas to said pneumatic means according to the operation of said first or second valve means to actuate said signalling means to indicate the position of said disconnect means.

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