Nov. 7, 1950 A. C. KELLE 2,528,694

CIRCUIT BREAKER CONTROL SYSTEM AND APPARATUS

Filed July 21, 1944 3 Sheets-Sheet 1

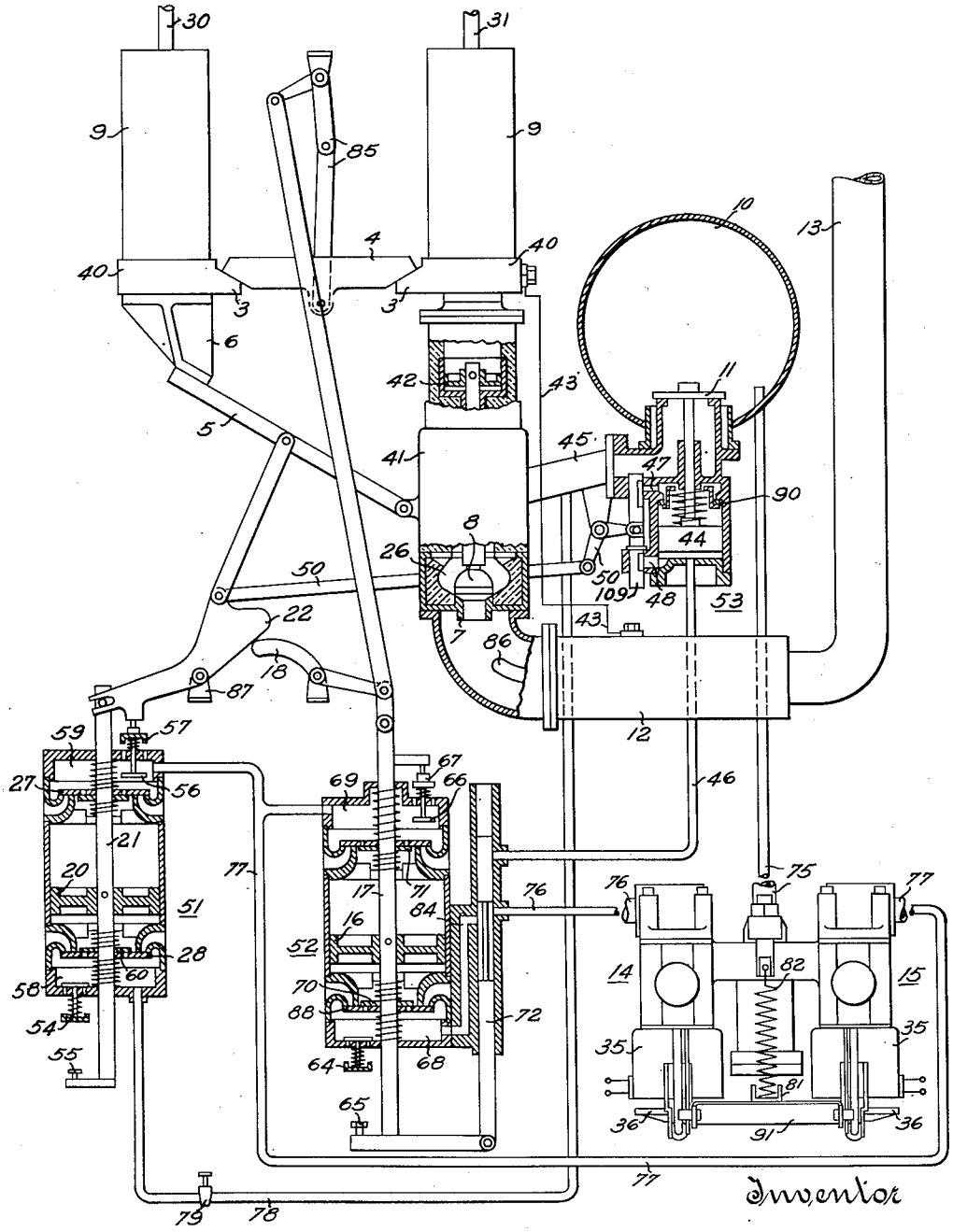


Fig. 1

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CIRCUIT BREAKER CONTROL SYSTEM AND APPARATUS

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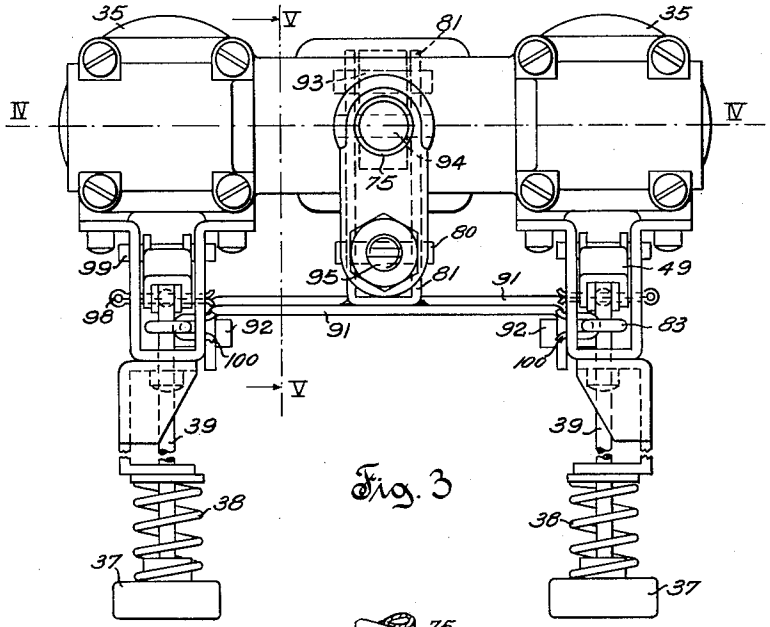


Fig. 3

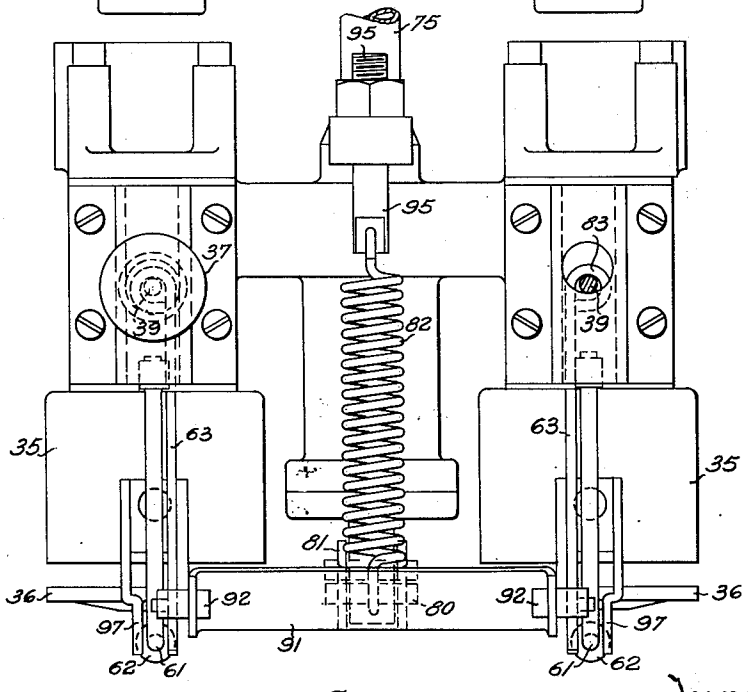


Fig. 2

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CIRCUIT BREAKER CONTROL SYSTEM AND APPARATUS

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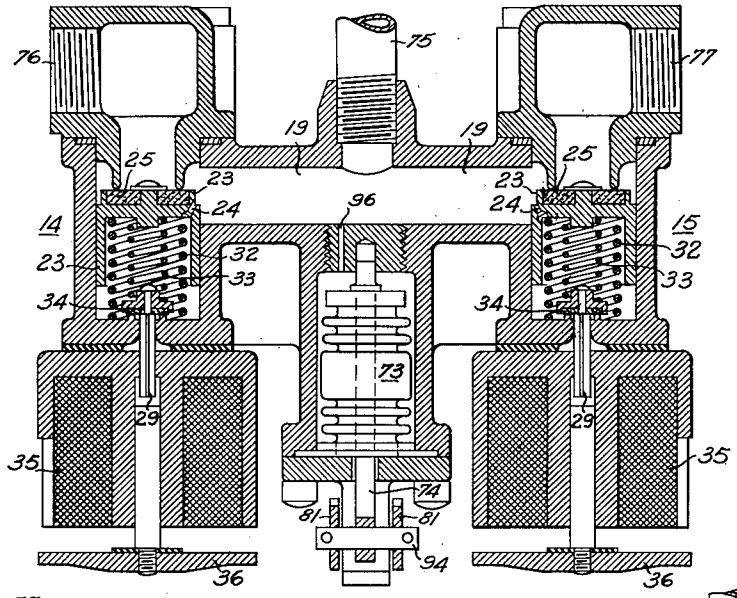


Fig. 4

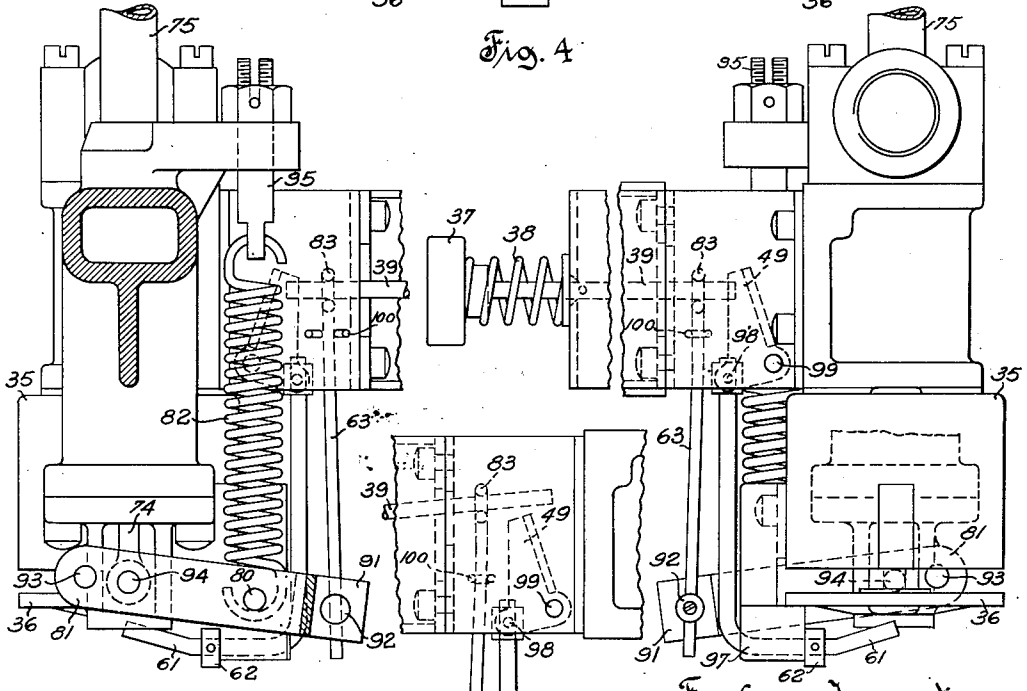


Fig. 5

Fig. 6

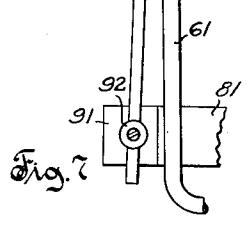


Fig. 7

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UNITED STATES PATENT OFFICE

2,528,694

CIRCUIT BREAKER CONTROL SYSTEM AND APPARATUS

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6 Claims. (Cl. 200—82)

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This invention relates in general to a pneumatic control system and particularly to an improved control system and parts thereof suitable for operating a gas blast circuit breaker.

As pneumatically operated gas blast circuit breakers have been utilized to interrupt increasingly greater currents, the size of the contacts and operating elements of such circuit breakers has increased. This increase in size involves the use of a greater volume of air for operating the circuit breaker and for extinguishing the arc. In prior art circuit breakers, the time necessary to operate a solenoid valve for initiating a circuit breaker operation has become a bottleneck in reducing the circuit breaker operating time to the desired minimum. This disadvantage has become greater as the sizes of such solenoid valves have increased.

It is therefore an object of the present invention to provide an improved operating system and apparatus for a gas blast circuit breaker that will provide circuit breaker opening and closing operations in a minimum of time.

It is also an object of the present invention to provide an improved operating system and apparatus for a gas blast circuit breaker that will provide for very rapid operation of the circuit breaker and which will also prevent undesired operation of the circuit breaker.

It is also an object of the present invention to provide an improved pneumatic control system and apparatus for a circuit breaker, in which there is a provision for manual operation and in which manual operation is prevented if the operating pressure is below a predetermined minimum.

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

Fig. 1 is a diagrammatic representation of a gas blast circuit breaker and an operating system and apparatus therefor embodying the present invention;

Fig. 2 is an enlarged front view (with some parts removed to more clearly show the structure) of the solenoid valve and low pressure lockout structure shown in Fig. 1;

Fig. 3 is a top view of the structure shown in Fig. 2;

Fig. 4 is a section view taken on the line IV—IV of Fig. 3;

Fig. 5 is a section view taken on the line V—V of Fig. 3;

Fig. 6 is an end view of the structure shown in Fig. 2; and

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Fig. 7 is a partial end view similar to Fig. 6 showing the parts in different positions.

In the drawing, an electric circuit (not shown) connected to conductors 30 and 31 is shown as controlled by a circuit breaker of the gas blast type. The conductors 30 and 31 extend through studs 9 to contact blocks 40 which have thereon fixed contacts 3 shown as bridged by a conducting movable main or bridging contact 4.

In parallel with the bridging contacts 3, 4 are arcing contacts 7, 8 and disconnect contacts 5, 6 connected in series. A reservoir containing gas suitable for arc extinguishing is shown at 10, and for purposes of illustration the gas therein will be considered to be air maintained under pressure of the order of 100 to 500 pounds per square inch. In general, the flow of air is from the tank 10 through a blast valve 11 and a manifold 45 through the arcing contact chamber 26. Air travel continues from the arcing contact chamber 26 through the fixed arcing contact 7 into a gas cooling device or muffler 12 and through an exhaust pipe 13 to atmosphere.

Separate fluid motors 42, 51, 52 and 53 are utilized to operate the arcing contact, disconnect contact, the bridging contact and the blast valve, respectively. Motor 51 is provided with a piston 20 having a rod 21 movable therewith and connected through linkage including a cam member 22 to the movable disconnect contact 5. Motor 52 has a piston 16 having a rod 17 connected through linkage to the movable bridging member 4. The cam member 18, operably connected to the rod 17, cooperates with cam 22 to prevent opening of the disconnect contact 5 unless the bridging contact 4 is in open position. Also, a camming action of cam 18 closes the disconnect contact 5, if open, upon movement of the bridging contact 4 to closed position.

In the circuit breaker as shown in the drawing, the contacts are all shown in the closed position and current flow is from conductor 30 through contacts 3, 4 to conductor 31. Operation of solenoid valve 14 initiates the opening operation of the circuit breaker. Air under pressure from tank 10 is supplied through pipe 75, through the solenoid valve 14, through the pipe 76 to slide valve 72. With the slide valve 72 in the position shown, air passes through the slide valve, through pipe 84 to the chamber 68 of the fluid motor 52.

As pressure rises in chamber 68, valve 70 is operated admitting air to the underside of piston 16. Movement of piston 16 upward causes piston rod 17 to move the linkage to break toggle 85 to the left as viewed in the drawing, thereby

opening bridging contact 4. This movement of rod 17 upward rotates the cam 18 in a counterclockwise direction as viewed in the drawing and clears the path of movement of the cam 22.

Upon movement of the piston 16 upward a predetermined distance, slide valve 72, connected to move with rod 17, closes off pipe 84 from supply pipe 76 and opens pipe 76 to pipe 46. With pipe 46 supplied with air under pressure, the blast valve motor 53 is operated. Air is supplied under piston 44 and, as outlet port 48 is covered by slide valve 109, the piston 44 is moved upward, thereby opening blast valve 11. Movement of piston 44 at the top of the stroke is arrested and the shock absorbed by resilient material 90.

Opening of the blast valve 11 admits air to manifold 45 and thereby to the arcing contact chamber 26 and to the cylinder containing arcing contact operating piston 42. Movement of the piston 42 upward separates the arcing contacts 7 and 8 drawing an arc therebetween. The air under pressure in chamber 26 blasts the arc through orifice contact 7 and extinguishes it. An auxiliary electrode 86 may be provided and connected to a resistance (not shown) which may be wound on the cooling chamber 12, which resistance is connected to contact block 40 by conductor 43. The electrode 86 is connected in the circuit by movement of the arc through contact 7. The arc gases are cooled in the muffler 12 and exhausted through pipe 13 to atmosphere.

When air is supplied to the manifold 45 by opening of the main blast valve 11, pressure air is supplied through pipe 78 to the chamber 58 of fluid motor 51. In order to assure a proper sequence of operation of arcing contact 8 and disconnecting contact 5, a needle valve 79 in the line 78 is provided for adjustment of the air flow therein. As pressure builds up in chamber 58, the valve 60 is opened admitting air under pressure to the bottom of piston 20. Movement of piston 20 and piston rod 21 upward rotates the cam member 22 in a clockwise direction about its pivot 87, thereby opening the movable disconnect contact 5.

At a predetermined amount of opening of the disconnect contact 5, links 50 move a slide valve 109 to uncover an exhaust port 48 and open an inlet port 47 of the blast valve 11. This releases pressure beneath piston 44 and allows tank pressure to be applied on the top of the piston, thus rapidly reclosing valve 11. Upon closing of valve 11, pressure air is shut off from chamber 26, permitting arcing contact 8 to reclose under bias of a spring (not shown). Rapid reclosing of blast valve 11 and arcing contact 8 is very necessary from the standpoints of time of circuit breaker reclosing and of air conservation.

Fluid motors 51, 52 and 53 are designed to permit a fast reclosing of the circuit breaker. Motor 51 is provided with valve 28 providing for release of pressure underneath piston 20 at or near the end of the upward stroke. An operating member 55 on rod 21 operates poppet valve 54 permitting pressure in the chamber 58 to leak off to atmosphere. The difference of pressures under the piston 20 and in chamber 58 forces the valve 28 downward against the pressure of its biasing spring, thereby opening the space underneath the piston 20 to atmosphere and immediately relieving the pressure therein.

In the motor 52 a similar action takes place, poppet valve 64 is operated by operating member 65 movable with the piston rod 17. Operation of valve 64 lowers the pressure in chamber 68 thereby operating valve 88 to permit a rapid release of pressure under piston 16. Motors 51 and 52 are therefore ready for immediate reversal.

An improvement in the solenoid valves 14 and 15 is of peculiar benefit in the rapid reclosing of the blast valve 11 and the reclosing of the circuit breaker. The valves 14 and 15 are similar structures and therefore the description of one of these valves will also describe the other. The manifold 19 is supplied with air under pressure from the reservoir 10 by a pipe 75. Air pressure from the header 19 is prevented from flowing into the pipe 76 by a piston operated valve 23. The valve 23 is biased to the closed position shown in Fig. 4 by a spring 32 and in this position the resilient material 25, set into the valve 23, is pressed against the valve seat. An opening 24 is provided in the valve piston 23 permitting air under pressure from the manifold 19 to normally be supplied, at a predetermined relatively slow rate, to the bottom of the piston 23. This air under pressure aids in maintaining a tight closure of the valve 23.

A small lightweight pilot valve 34 is provided in the bottom of the valve cylinder and is biased to the closed position shown in Fig. 4 by a spring 33. This valve has a fluted stem 29 which permits the air underneath the piston to be exhausted to atmosphere when the pilot valve 34 is raised from its seat by attraction of armature 36 when the coil 35 is energized. The pilot valve 34 being light in weight can be quickly moved with little energy, independently of the size and weight of valve 23.

Upon energization of the coil 35, the armature 36 is attracted to open the valve 34, thereby providing a drop in pressure underneath the piston 23. As there is full air pressure on the outer annular top surface of the piston 23, the valve is quickly opened. The area of the valve opening of the valve 34 is several times the area of the opening 24, so that the flow of air through the valve 34 is rapid relative to the flow of air through opening 24.

It is desirable to provide manual operation of the solenoid valves 14 and 15 such as will function independently of the electric circuit. As more clearly shown in Figs. 3 and 6, the push buttons 37 are provided with actuating stems 39 and are biased by springs 38 to the non-operative position shown in Fig. 6. When one of the push buttons 37 is moved against the bias of its spring 38, the stem 39 moves a crank member 49 about its pivot 99 in a clockwise direction as viewed in Fig. 6. The crank member 49 pivotally supports an actuating member 61 by means of a cotter key 98. Movement of the actuating member 61 is guided by the members 97 and 62 so that upon movement of the crank member 49 in a clockwise direction, the member 61 is raised, thereby raising the armature 36 of the electromagnet.

A reduced pressure lockout device is provided whereby manual operation of the armature 36 to operate valve 34 is prevented, independently of whether or not the push button 37 is operated, upon a predetermined pressure drop in the manifold 19. A bellows 73 is supported in a chamber adjacent the manifold 19. The bottom of the bellows is supported by the chamber in pressure tight relation. The upper end of the bellows is connected mechanically to an actuating rod 74 so that air pressure being supplied from the manifold 19 through the opening 96 tends to collapse the bellows 73 pushing downwardly on the rod 74.

A long narrow U-shaped bracket 81 is pivotally supported at 93 on the housing for the bel-

lows 73. The rod 74 is pivotally connected to the bracket 81 by a pin 94 so that pressure from the bellows is transmitted through rod 74 tending to provide movement of the bracket 81 about its pivot 93 in a clockwise direction as viewed in Fig. 5. The long narrow U-shaped bracket 81 has welded thereto a short wide bracket 91, the closed ends of the U-shaped brackets being welded together back to back as more clearly shown in Fig. 3. The arms of the bracket 91 each have a lift rod 63 pivotally attached thereto by a pin 92 having a set screw therein. The lift rod 63 is guided for vertical movement by a bent wire guide 100 and at its upper end is bent to form an eye 83 providing a guide through which the stem 39 of the push button 37 extends.

A spring 82 is connected between a pin 80 in the U-shaped bracket 81 and an adjustably threaded member 95 supported by the valve housing. The spring 82 provides the bias against which the air pressure on the bellows 73 is balanced.

When the pressure in the manifold 19 drops below a predetermined value, the bellows 73 will extend by reason of the pull of the spring 82 on the rod 74. Extension of the bellows 73 will raise the rod 74 thereby moving the bracket 81 about its pivot 93 in a counterclockwise direction as viewed in Fig. 5. Movement of the bracket 81 moves the bracket 91, which is movable therewith, thereby lifting the rod 63 to the position shown in Fig. 7. In this position the eye 83 raises the stem 39 to a position above the crank member 49, whereby operation of the push button 37 can not rotate the crank member 49.

The control above effected has a great advantage in providing for manual operation entirely independent of the electrical control and in providing against operation of the circuit breaker by such manual control unless air pressure of at least a desired minimum value is available in the manifold 19. This permits manual control of the circuit breaker in the event the electrical control does not function, but prevents part operation if insufficient air pressure is available. The conventional electrical control of coils 35, with low pressure lockout of the electrical system, may also be utilized in conjunction with the manual control above described, to operate the circuit breaker.

Due to the improved fluid motors, the improved blast and solenoid valves and to the rapid interruption of the circuit, the opening operation can be completed in a few cycles. Upon completion of the opening operation, the circuit breaker is ready for reclosing which may be effected by energization of the solenoid valve 15. With solenoid valve 14 closed, pressure air from the pipe 75 is rapidly supplied through solenoid valve 15 and pipe 77 to chambers 59 and 69 of motors 51 and 52. The operation of valve 15 is similar to the above described operation of valve 14. With downward movement of pistons 20 and 16 the bridging contacts 4, 5 and the disconnect contacts 5, 6 are reclosed, with the limitation provided by cams 18 and 22 that the bridging contacts 3, 4 must be reclosed subsequent to closure of disconnect contacts 5, 6. If movement of contacts 3, 4 tends to be faster than movement of contacts 5, 6, movement of cam 18 in a clockwise direction forces cam 22 to close contact 5. This prevents arcing at the bridging contacts 3, 4 and provides for closing of the circiut at the disconnect contacts 5, 6 especially designed for closing against heavy currents.

Upon movement of pistons 20 and 16 downward, operating members 57 and 67 operate poppet valves 56 and 66 to provide release of pressure above the pistons 20 and 16 in a manner similar to the pressure release afforded by valves 54 and 64. Movement of piston rod 17 downward moves slide valve 72 to the position shown in the drawing and the blast valve having been closed, the circuit breaker is immediately ready for a subseqent opening operation. Considerable saving in reclosing time is effected by the simultaneous energization of motors 51 and 52 for closing and by insuring of the proper closing sequence by the abutting cam members 18 and 22. The interlock afforded by cams 18 and 22 involves no loss of time.

Although the various elements of the circuit breaker system have been described as operating in conjunction with each other, the improvements disclosed have utility other than with all of the elements shown and described. For example, the fluid motors 51 and 52 may be utilized for any purpose where quick reversal of a fluid motor is desirable. While the disclosed arrangement of bridging contacts 3, 4 is desirable for circuit breakers of high current rating, these contacts may be omitted in the lower current ratings.

The improvements utilized in effecting a quick reclosure of the blast valve 11, although shown as initiated by movement of the disconnect contact 5, may as well be effected by an isolating movement of the arcing contacts 7, 8 in cases where no separate disconnect is utilized. The present disclosure of an interrupting operation utilizing an auxiliary electrode 86 and associated resistor is by way of illustration, for in the lower current ratings, these elements may be omitted. The rapidly acting pneumatic operating system and apparatus above described may be utilized with circuit breakers having no gas blast across the arcing contacts.

For simplicity and clarity of disclosure, a single pole circuit breaker has been described and shown, although usually a multipole circuit breaker is operated. In such cases, the manifold 45 extends to the interrupting chambers of the additional poles, and the linkages operated by motors 51 and 52 operate shafts for additionally operating the disconnect and bridging contacts of the other poles.

The improved solenoid valves 14 and 15 permit the use of the escape valve 34 that has only light weight moving parts. The valve 34 needs only a small movement to provide its pressure escape function. This permits the use of a short stroke electromagnet having light weight moving parts and provides for extremely rapid operation of the valve 23.

Although a single embodiment has been illustrated and described, it will be 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 combination, a circuit breaker provided with fixed and movable contacts cooperable to make and break an electric circuit, a source of gas under pressure, means comprising a valve for controlling the supply of gas under pressure from said source to operate said movable contact to open position, means responsive to said electric circuit for operating said valve, means for manually operating said valve independently

of said electric circuit, and means operably responsive to a predetermined minimum gas pressure at said source for preventing operation of said valve by said manually operable means.

2. In combination, a circuit breaker provided with cooperating fixed and movable contacts, a source of gas under pressure, means comprising a pneumatically operated main valve for supplying gas under pressure from said source to operate said movable contact to open position, an electrically operable auxiliary valve for controlling the supply of gas under pressure from said source to operate said main valve, means for manually operating said auxiliary valve independently of the electrical operation thereof, and means operably responsive to a predetermined minimum gas pressure at said source for preventing operation of said auxiliary valve by said manually operable means.

3. In combination, a circuit breaker provided with cooperating fixed and movable contacts, a source of gas under pressure, means comprising a valve for controlling the supply of gas under pressure from said source to operate said movable contact to open position, said valve comprising a piston normally subjected to pressure gas from said source on both sides of said piston to maintain said valve closed, means comprising an electromagnet and armature for relieving the pressure on one side of said piston to rapidly open said valve, means independent of said electromagnet for manually operating said pressure relieving means, and means responsive to a predetermined minimum gas pressure at said source for preventing operation of manually operable pressure relieving means.

4. In combination, a circuit breaker provided with cooperating fixed and movable contacts, a source of gas under pressure, motor means connected with said movable contact, said motor means energizable by said gas under pressure to force said movable contact to an open position, a first valve means comprising a cylinder and piston controliing the supply of gas under pressure from said source to said motor means for the operation thereof, said piston normally subjected on both sides to gas under pressure from said source, a second valve means for exhausting to atmosphere the pressure in said cylinder on one side of said piston, and a common spring for biasing said first and second valve means in valve closing directions, said spring cooperating with said gas under pressure from said source maintaining said first and second valve means closed, and means for opening said second valve means for relieving the pressure on said one side of said piston to rapidly open said first valve means.

5. In combination, a circuit breaker provided with cooperating fixed and movable contacts, a source of gas under pressure, motor means connected with said movable contact, said motor means energizable by said gas under pressure to force said movable contact to an open position, a first valve means comprising a cylinder and piston controlling the supply of gas under pressure from said source to said motor means for the operation thereof, said piston normally subjected on both sides to gas under pressure from said source, a second valve means for exhausting to atmosphere the pressure in said cylinder on one side of said piston, and a spring having one end thereof seated against said first valve means and the other end thereof seated against said second valve means for biasing each of said valve means in valve closing directions, said spring cooperating with said gas under pressure from said source maintaining said first and second valve means closed, and means for opening said second valve means for relieving the pressure on said one side of said piston to rapidly open said first valve means.

6. In combination, a circuit breaker provided with cooperating fixed and movable contacts, a source of gas under pressure, motor means connected with said movable contact, said motor means energizable by said gas under pressure to force said movable contact to an open position, a first valve means comprising a cylinder and piston controlling the supply of gas under pressure from said source to said motor means for the operation thereof, said piston normally subjected on both sides to gas under pressure from said source, a second valve means for exhausting to atmosphere the pressure in said cylinder on one side of said piston, a spring extending between and seated against said first and second valve means for biasing said first and second valve means in valve closing directions, a second spring coaxially aligned and surrounding said first spring for biasing only said first valve in valve closing directions, said springs and said gas under pressure from said source maintaining said first and second valve means closed, and means for opening said second valve means for relieving the pressure on one side of said piston to rapidly open said first valve means.

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