Oct. 21, 1941. H. MILLIKEN 2,260,188

GAS-BLAST CIRCUIT BREAKER

Filed March 27, 1940 4 Sheets-Sheet 1

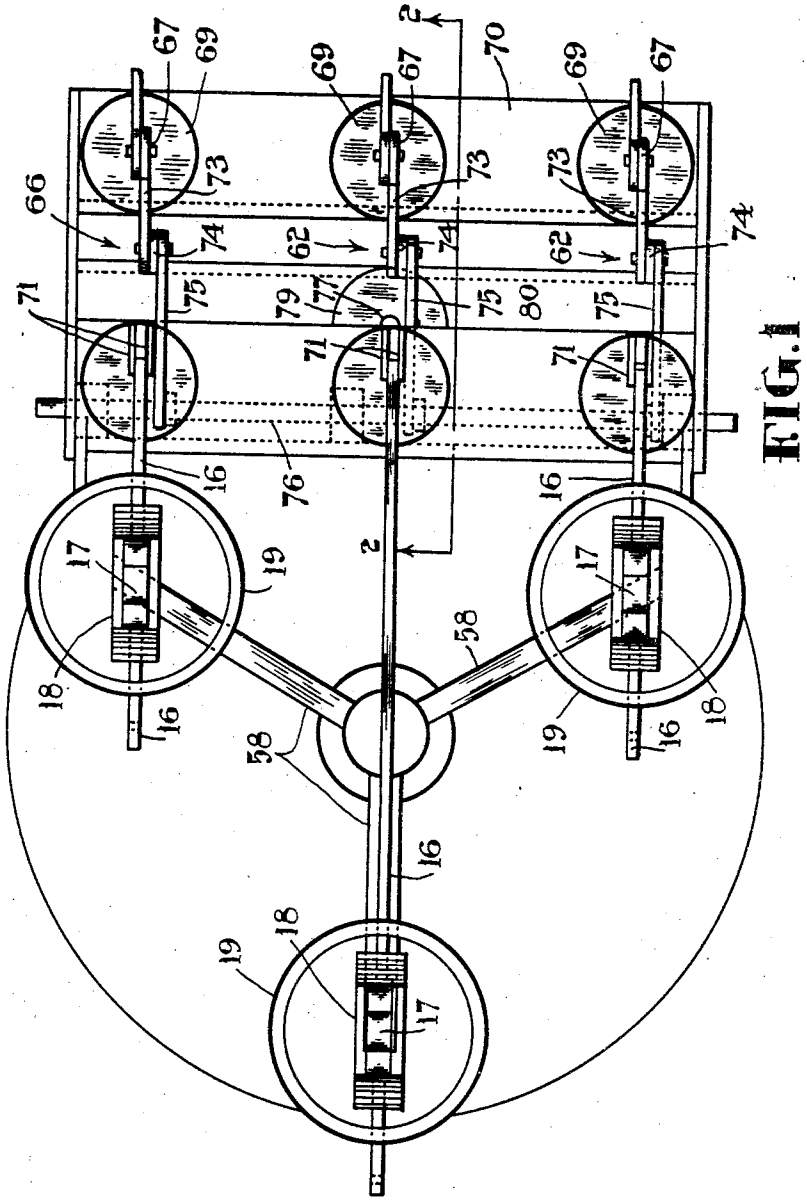


FIG. 1

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Filed March 27, 1940 4 Sheets-Sheet 2

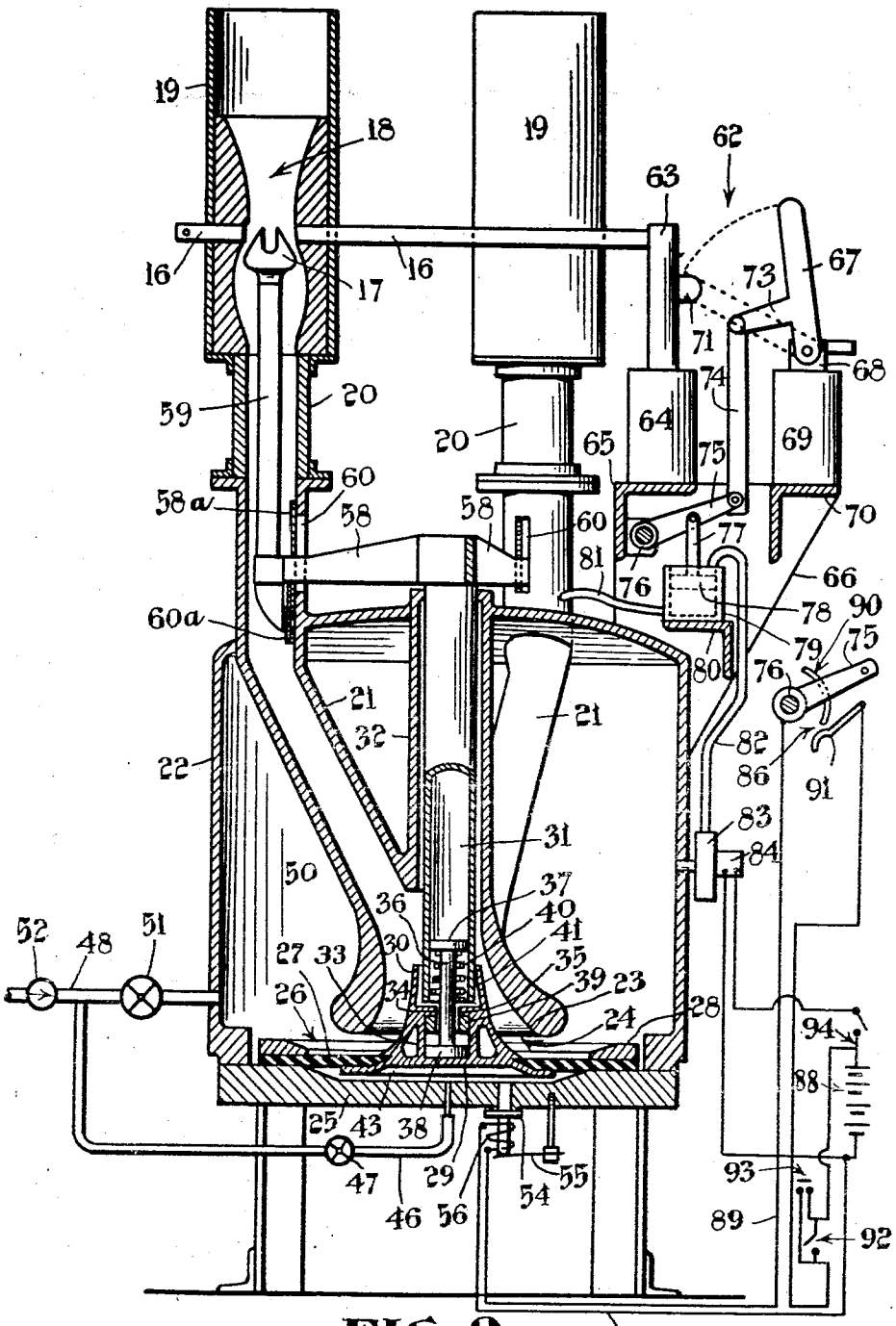


FIG. 2

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GAS-BLAST CIRCUIT BREAKER

Filed March 27, 1940 4 Sheets-Sheet 3

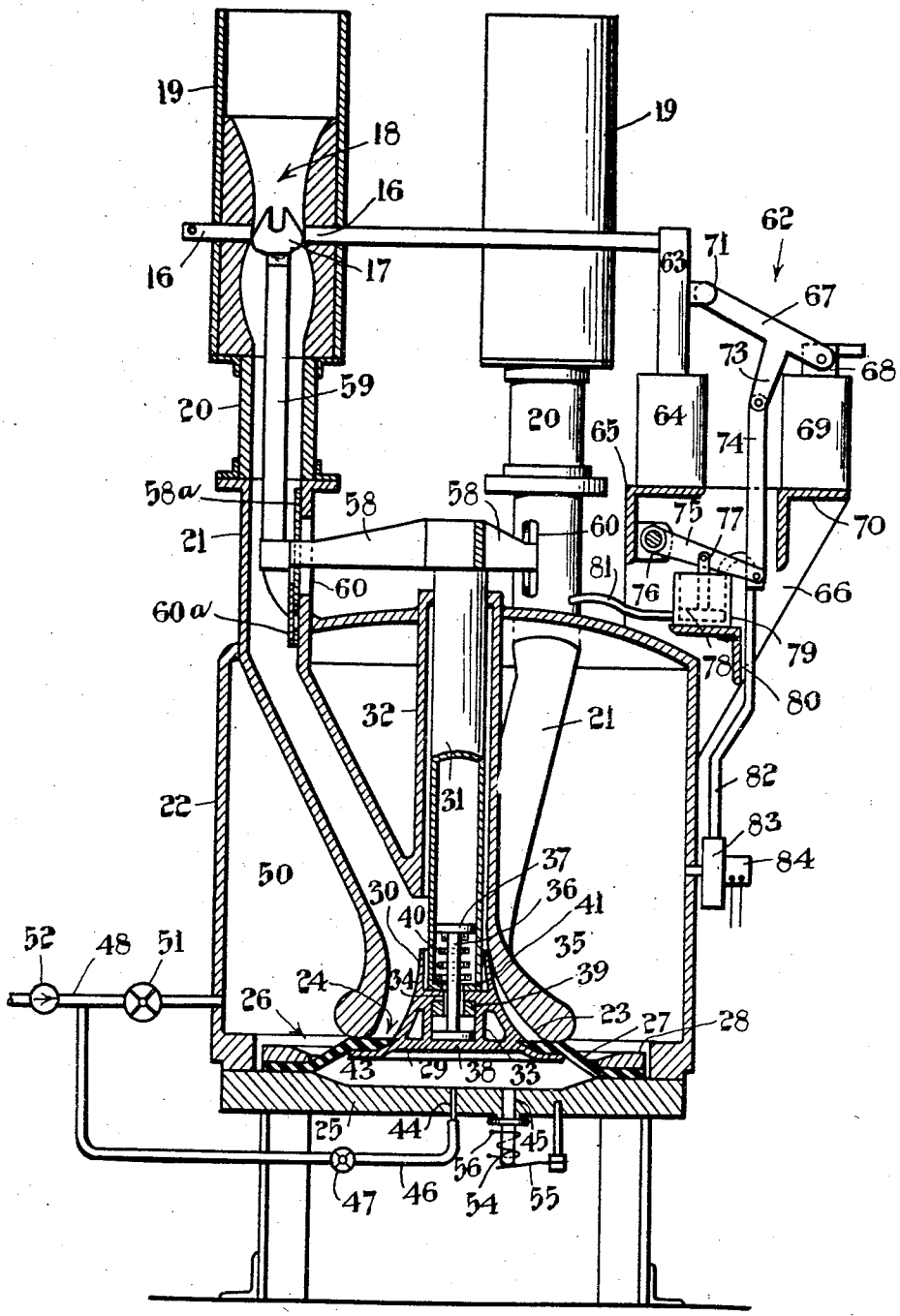


FIG. 3

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Oct. 21, 1941. H. MILLIKEN 2,260,188

GAS-BLAST CIRCUIT BREAKER

Filed March 27, 1940 4 Sheets-Sheet 4

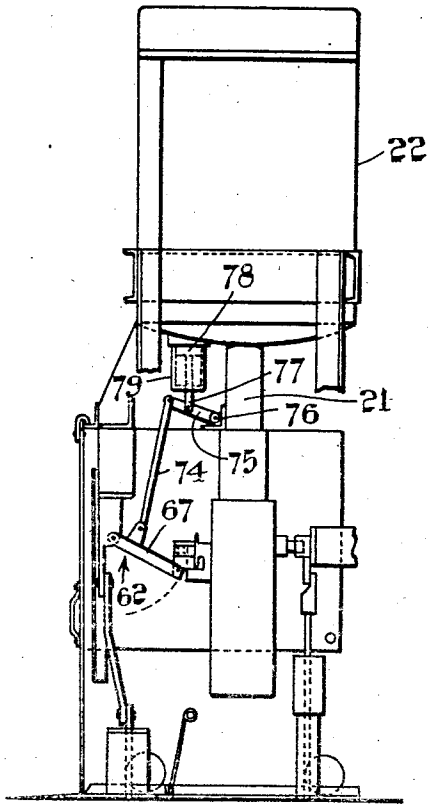


FIG. 5

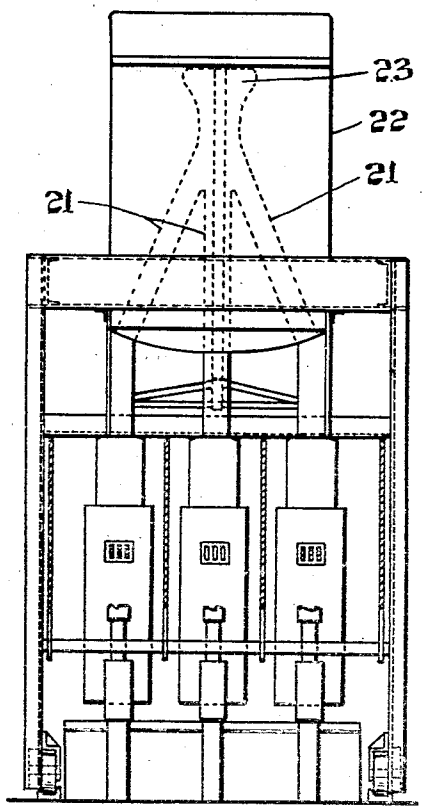


FIG. 6

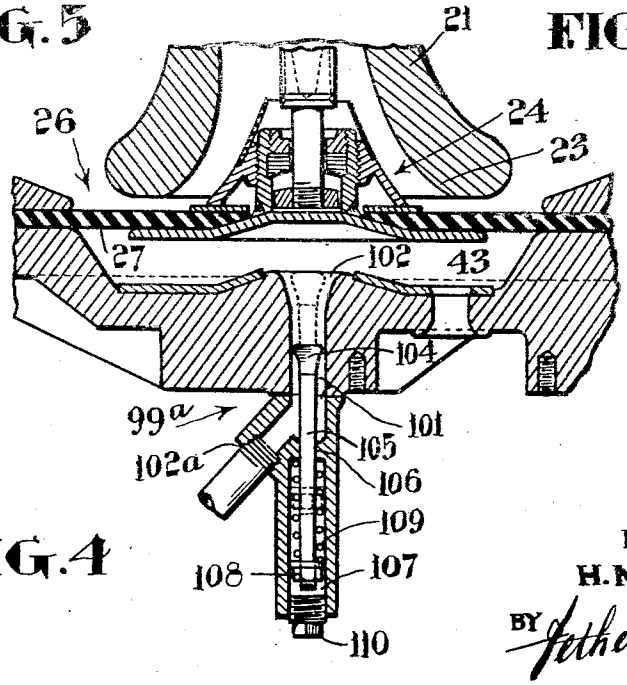


FIG. 4

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UNITED STATES PATENT OFFICE

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GAS-BLAST CIRCUIT BREAKER

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Application March 27, 1940, Serial No. 326,257

14 Claims. (Cl. 200—148)

This invention relates to gas-blast circuit breakers for electric power and lighting systems. More particularly, the invention consists in improvements in the design and relative arrangement of the component parts of such circuit breakers and in the provision of improved means for operating same.

One object of the invention is to provide a generally improved circuit breaker of the gas-blast type in which the component parts are so designed and relatively arranged as to effect a substantial reduction in the overall space occupied by the breaker.

Another object is to provide a gas-blast circuit breaker in which the valve controlling the conduits through which gas blasts are delivered to the interrupter contacts is mechanically connected to the movable interrupter contacts so that the opening and closing of the latter is directly controlled by the opening and closing of said valve.

Other objects of the invention will appear hereinafter.

In the drawings,

Fig. 1 is a plan view of the complete circuit breaker.

Fig. 2 is a vertical sectional view taken substantially along the line 2—2 of Fig. 1. In this view the component parts of the interrupter are shown in their open circuit position.

Fig. 3 is a view similar to Fig. 2 but showing the component parts of the interrupter in their closed circuit position.

Fig. 4 is a fragmentary vertical sectional view illustrating a slight modification.

Fig. 5 is a side elevation of a circuit breaker installed in an inverted position as compared with the circuit breaker shown in the preceding figures.

Fig. 6 is a rear elevation of the installation shown in Fig. 5.

In the present instance I have shown a 3-pole circuit breaker, each pole comprising an interrupter unit including a pair of stationary interrupter contacts 16 and a cooperating movable interrupter contact 17. The contacts 16 and 17 of each pole are located within an arc orifice 18 provided within a suitable casing 19. Casing 19 is carried by an insulator 20 which, in turn, is secured to the upper end of a gas blast conduit 21. The conduits 21 extend downwardly within a casing 22 and converge at their lower ends to form a valve seat 23 surrounding an orifice 24 common to all of said conduits. A head 25 is bolted to and forms the bottom wall of casing 22. Head 25 carries a diaphragm valve generally indicated at 26. Said valve comprises a rubber ring 27 having its outer marginal portion clamped or otherwise fastened to the upper surface of head 25 as indicated at 28. The central portion of the valve 26 is formed by a metal disc 29 suitably secured to the inner periphery of the rubber ring 27. Disc 29 is provided with an upwardly extending sleeve portion 30 which telescopes the lower end of a tubular member 31 working in a tubular guide 32 formed integral with the blast conduits 21. Located within the sleeve 30 is a cylinder 33 having a top wall 34 provided with a central aperture 35 through which extends an axially movable rod 36 enlarged at its ends to provide the upper and lower heads 37 and 38. A resilient ring or washer 39 is arranged in the upper portion of cylinder 33 and is sometimes engaged with the lower head 38 of rod 36 as hereinafter explained. The rod 36 extends upwardly within the tubular member 31 and a spring 40 is confined between the head 37 and an inwardly directed flange 41 provided at the lower end of member 31. The casing head 25 is recessed to provide the bottom and side walls of a pressure chamber 43 the top wall of which is formed by the diaphragm valve 26.

Chamber 43 is provided with an inlet 44 and an outlet 45. Inlet 41 is connected through pipe 46 and hand operated valve 47 to the main supply pipe 48 through which gas is supplied to the pressure chamber 50 above the diaphragm valve 26. Pipe 48 is equipped with a hand valve 51 and a non-return valve 52. The gas supplied under pressure through pipe 48 may be drawn from a storage tank or other suitable source. The outlet 45 of chamber 43 is controlled by an electrically operated valve 54. This valve is closed by the pressure of a spring 55 and is momentarily opened by the energization of an operating coil 56.

Three contact operating arms 58 are rigidly fastened at their inner ends to the upper extremity of the tubular member 31. Each of the movable circuit breaker contacts 17 is rigidly fastened to the upper end of an insulating rod 59 having its lower end rigidly fastened to the outer extremity of one of the contact operating arms 58. It will be noted that the arms 58 work in slots 60 provided in the conduits 21.

Each pole or phase of the circuit breaker is connected in series with a disconnecting switch generally indicated at 62. In the present instance this is accomplished by connecting one

contact 16 of each pole or phase to a conductor 63 rising from an insulator 64 mounted on an angle bracket 65 which, in turn, is supported on the casing 22 by means of suitable supporting brackets 66. In the present instance each disconnecting switch is shown as comprising a movable blade 67 having one end pivoted to a conductor 68 mounted on an insulator 69. Insulator 69 is shown mounted on an angle bracket 70 carried by the supporting brackets 66. In the closed position of the disconnecting switch the free end of blade 67 is received between a pair of stationary jaws 71 carried by or forming part of conductor 63. The movable blade 67 of each switch 62 is provided with a crank 73 which is connected by insulating link 74 and crank arm 75 to an operating shaft 76 journalled in bearings carried by the angle bracket 65. One of the cranks 75 is connected to the upper end of a piston rod 77 equipped with a piston 78 operating in a cylinder 79, said cylinder being mounted on an angle bracket 80 extending between the supporting brackets 66. The lower portion of cylinder 79 is connected to one of the blast conduits 21 through pipe 81. The upper end of cylinder 79 is connected to the pressure chamber 50 through pipe 82 and solenoid operated valve 83.

In Fig. 2 the diaphragm valve 26, movable interrupter contacts 17 and disconnecting switches 62 are shown in what may be termed the open position, which would be the condition obtaining before the circuit breaker has been put in service. Assuming that hand valves 47 and 51 are closed and that there is gas pressure in pipe 46, the circuit breaker is put in service in the following manner: Hand valve 47 is first opened to admit gas to the chamber 43 provided beneath the diaphragm valve 26. The pressure thus established in chamber 43 causes the diaphragm 27 to move upwardly against the valve seat 28, thus closing off communication between the lower ends of the blast conduits 21 and the pressure chamber 50 located above the diaphragm valve. Hand valve 51 is now opened to admit gas to chamber 50. When the diaphragm valve is closed the area of diaphragm 27, which is exposed to the gas pressure supplied to chamber 50 through pipe 46, is less than the area of the diaphragm exposed to the pressure established in chamber 43, assuming the outlet valve 54 of chamber 43 to be in closed position. As the diaphragm valve 26 moves upwardly from the position shown in Fig. 2 to the position shown in Fig. 3 the top wall of cylinder 33 engages the lower end of tube 31 and moves the latter upwardly so that the movable interrupter contacts 17 are shifted to the closed circuit position shown in Fig. 3. Valve 83 which is normally biased to closed position is now opened by energizing its operating coil 84. This opening of valve 83 permits gas to flow from chamber 50 through pipe 82 to the upper end of cylinder 79, thus forcing piston 78 downwardly from the raised position shown in Fig. 2. This downward movement of piston 78 acts through piston rod 77 to rotate the shaft 76 in a switch closing direction so that the movable blades 67 of the disconnecting switches 62 are swung downwardly from the open-circuit position shown in Fig. 2 to the closed circuit position shown in Fig. 3.

When it is desired to open the circuit breaker, current is supplied to the operating coil 58 of valve 54, thus opening said valve and exhausting the gas from beneath the diaphragm valve 26. When this occurs diaphragm valve 26 is forced downwardly to the open position shown in Fig. 2 by the gas pressure in chamber 50. When the diaphragm valve 26 is thus opened a blast of gas is delivered from chamber 50 through each of the blast conduits 21 and serves to extinguish the arcs drawn by the separation of the movable interrupter contacts 17 from the cooperating stationary contacts 16. In order to minimize burning of the contacts 16 and 17 it is desirable that the gas blasts reach these contacts before the contact 17 is shifted to its open circuit position by the downward movement of the diaphragm valve 26. In the present instance this is taken care of by reason of the fact that there is a certain amount of lost motion in the mechanical connections provided between said valve and the contacts 17. In this connection it may be explained that during the early part of the downward or opening movement of diaphragm valve 26 there is no corresponding movement of the tubular contact actuating member 31 since the cylinder 33 of the valve moves downwardly independently of the rod 36 until the cushioning member 38 located in the upper portion of said cylinder contacts the head 39 at the lower end of said rod. When this occurs the rod 36 is pulled downwardly and acts to compress the spring 40, thus exerting downward pressure on the tubular member 31 to initiate downward movement of the latter to the position shown in Fig. 2, thus separating the contacts 17 from the contacts 16. Shortly after the parting of the contacts 17 from the cooperating contacts 16 the disconnecting switches 62 are opened by the gas pressure transmitted to the lower end of cylinder 79 through pipe 81. The pressure thus supplied to cylinder 79 raises piston 78 to rotate shaft 76 in the direction necessary to swing the movable blades 67 of the disconnecting switches to the open circuit position shown in Fig. 2.

To prevent discharge of more gas than is necessary from chamber 50 through blast conduits 21 it is desirable that diaphragm valve 26 be closed as quickly as possible. Accordingly, provision is made for deenergizing coil 58 of valve 54 in response to the aforesaid opening of the disconnecting switches 62. To this end one of the crank arms 75 is utilized to operate a switch 86 (Fig. 2) so that coil 58 of valve 54 will be deenergized to permit closing of the valve 54 by the spring 55 when the shaft 76 is rotated to open the disconnecting switches.

In the unusual event that it should become necessary to keep the contacts 17 in closed circuit position while the diaphragm valve 26 is open, suitable blocks may be placed beneath the contact operating arms 68 to hold the latter upwardly in their contact closing position. The valve 54 may then be opened to exhaust the gas from chamber 43 and permit the diaphragm valve 26 to move to its open position. In this case the downward movement of valve 26 compresses the spring 40 without causing downward movement of the tubular contact operating member 31. This procedure is sometimes resorted to for the purpose of inspecting the valve and making repairs and when this work is finished the diaphragm valve 26 is reclosed and the blocks removed from beneath the arms 68 to permit the breaker to function in the normal manner.

Referring to the wiring diagram shown in Fig. 2, it will be noted that one terminal of coil 58 is connected by conductor 87 to one terminal of

a battery 88. The remaining terminal of coil 56 is connected, through conductor 89 and crank arm 75, to the movable arcuate contact 90 of switch 86. The stationary contact 91 of switch 86 is connected to the remaining terminal of battery 88 by closure of a manually operable switch 92 or by closure of an automatic relay contact 93, the latter being of a type which operates automatically in response to a fault in the system. Assuming that switches 92 or 93 are closed, it will be seen that coil 56 is deenergized to permit closing of the valve 54 by the spring 40 when the disconnecting switches 62 are moved to open-circuit position since, in this position of the disconnecting switches, movable contact 90 of switch 86 is in the open-circuit position shown in Fig. 2. When the disconnecting switches are closed the contact 90 moves into engagement with contact 91, thus closing switch 86. Relay contact 93 closes automatically in response to a fault in the system to energize coil 56 and thus open valve 54 to cause the circuit breaker to open. The operating coil 84 of valve 83 is connected across the battery 88 by closing switch 94 to close disconnecting switch 62.

In gas blast circuit breakers heretofore used the contacts are operated by cylinders, pistons and linkages separate from the blast valve. It is evident that my invention eliminates such cylinders and pistons and simplifies the construction of the circuit breaker. The time of opening is also minimized by connecting the contacts mechanically to the diaphragm blast valve; furthermore there is no possibility of the interrupter contacts drifting open without the blast valve also opening and applying a blast of gas to extinguish the arcs.

Another novel feature of my invention is that the casing 22, blast conduits 21, seat member 23 and diaphragm valve 26 are relatively arranged so as to conjointly provide a compact blast valve assembly, the body of which is formed by the casing 22, the inlet to said body being constituted by the supply pipe 48 and the outlet from said body being constituted by the orifice 24 which is common to the three blast conduits.

A further advantage of the construction described herein is that it lends itself to a compact triangular arrangement of the three poles or phases of the circuit breaker so that considerable space is saved as compared with conventional multi-pole circuit breakers in which the poles or phases are arranged in a row. In this connection, it will be noted that the interrupter units comprising the three poles or phases of the circuit breaker are arranged in triangular formation on top of the casing 22 so that they lie substantially within the area of the circle defined by the circumferential wall of the casing.

The drawings show a circuit breaker having single movable interrupting contact in each pole but it is apparent that the same method of operation could be applied to interrupters having several movable contacts in series for higher voltages, or the invention may be applied to interrupters having several movable contacts in multiple for carrying and interrupting higher currents.

As shown in Fig. 2, the contact operating arms 58 carry movable baffles 58a which cooperate with stationary baffles 60a to prevent excessive leakage of the blast through slots 60.

When the blast valve 26 is in open position, as shown in Fig. 2, the area of the movable valve member subjected to downward air pressure is substantially equal to the area subjected to upward pressure but the velocity of the upward blast through orifice 24 creates a counter-suction effect reducing the net pressure on the central portion of the movable valve member so that said member moves upward and closes the valve. This valve closing effect of the suction created by the upward flow through orifice 24 has been demonstrated by the fact that the valve fails to close when the blast velocity in conduits 21 is eliminated by closing off the outlets of said conduits. There is a structural advantage in this arrangement of equal areas.

It is desirable to close blast valve 26 as quickly as possible after the disconnecting switch has opened. This requires a relatively large diameter of inlet pipe 46 and its connection to space 43 but such a large inlet would cause slow opening of the blast valve which would be undesirable. In order to overcome these conflicting requirements an automatic throttle valve 99a may be provided as shown in Fig. 4. This valve comprises an upper cylinder 101 formed at its upper end to provide a discharge nozzle 102 opening into pressure chamber 43 and having its lower end connected to pipe 46 by connection 102a. A piston 104, working in cylinder 101, is carried by the upper end of a piston rod 105. Piston rod 105 works loosely in a partition 106 which forms the upper wall of a lower cylinder 107. A piston 108 is carried by the lower end of piston rod 105 and is normally urged downwardly by a spring 109 confined between said piston and the partition 106. The lower end of cylinder 107 is closed by a removable plug 110. Piston 104, piston rod 105, piston 108, and spring 109 are normally positioned as indicated by full lines in Fig. 4, with piston 104 closing cylinder 101 except for a slight leakage clearance between piston 104 and the wall of cylinder 101 which admits gas from pipe 46 into pressure chamber 43 at a rate sufficient to overcome leakage out of pressure chamber 43 and maintains pressure in 43. When valve 54 opens suddenly discharging gas from pressure chamber 43 to atmosphere, the unbalance of pressure above and below piston 104 causes this piston and the piston rod 105 to move upwardly; the inertia of these moving parts and the dashpot action of piston 108 serving to introduce a certain interval of time before piston 104 reaches nozzle 102 and this time interval is adjusted so that the diaphragm 27 reaches the bottom of its travel at the same instant piston 104 reaches the top of its travel; thus the inlet of gas to pressure chamber 43 is cut off until it is required and then it is opened wide to reclose the movable diaphragm 27. After blast valve 54 closes, the pressure at both sides of piston 104 is equal and said piston is moved downwardly to its closed position by the action of spring 109.

In Figs. 1 to 4 inclusive the circuit breaker is shown in an upright position but it will be understood that the circuit breaker may be installed and operated in a horizontal or a vertical position, or in any other desired position. For example, Figs. 5 and 6 show the invention embodied in a circuit breaker installed in an inverted position as compared with the circuit breakers shown in the preceding figures. In Figs. 5 and 6 the three conduits 21 are arranged in a line instead of being arranged in triangular formation and are inverted so that the valve seat 23 faces upwardly instead of downwardly. In Figs. 5 and 6 the disconnecting switches 62 and their operating connections, including the piston 76 and the

cylinder 79, are also shown in an inverted position as compared with the corresponding elements appearing in Figs. 1 to 4 inclusive.

Having thus described what I now consider to be the preferred embodiment of this invention, it will be understood that various modifications in the construction and arrangement of parts may be resorted to within the scope and spirit of the invention as defined by the appended claims.

Having thus described my invention, what I claim is:

1. A gas-blast circuit breaker comprising stationary and movable interrupting contacts, a source of gas under pressure, a conduit through which a blast of gas is delivered from said source to said contacts, a valve controlling communication between said source and said conduit, means connecting said valve to at least one of the interrupting contacts whereby said contacts are moved to the open-circuit position by the opening of said valve and to the closed-circuit position by the closing of said valve, said means permitting the valve to have a limited movement independently of the connected interrupting contact whereby the valve may be opened to a certain extent prior to the movement of the interrupting contacts to open-circuit position.

2. A circuit breaker as set forth in claim 1 in which the said means also serves to hold the interrupting contacts against drifting to open-circuit position as long as the valve is in its closed position.

3. A gas-blast circuit breaker comprising a pair of stationary contacts, a movable contact cooperating with said stationary contacts, a source of gas under pressure, a conduit through which a blast of gas is conveyed from said source to said contacts, a valve controlling communication between said source and said conduit and a lost motion connection between the valve and the movable interrupting contact adapted to operate the latter to open-circuit position in response to movement of the valve to its open position.

4. A gas-blast circuit breaker comprising a pair of stationary contacts, a movable contact cooperating with said stationary contacts, a source of gas under pressure, a conduit through which the blast of gas is conveyed from said source to said contacts, a valve controlling communication between said source and said conduit, and a resilient connection between the valve and the movable interrupting contact adapted to operate the latter to open-circuit position in response to movement of the valve to its open position, said resilient connection permitting the valve to have a limited movement independently of the connected interrupting contact whereby the valve may be opened to a certain extent prior to movement of the interrupting contacts to open-circuit position.

5. A multi-pole circuit breaker comprising a plurality of interrupters each including a movable interrupting contact and one or more cooperating stationary contacts, a source of gas under pressure, a plurality of conduits, each serving to deliver a blast of gas from said source to one of said interrupters to extinguish the arcs drawn between the interrupting contacts when the movable contact is moved to open-circuit position, a single valve controlling communication between said source and all of said conduits and means affording a lost motion connection between said valve and the movable interrupter contact of each interrupter whereby the opening and closing of the contacts of each unit is controlled directly by the opening and closing movements of said valve.

6. A circuit breaker as set forth in claim 5 in which the source of gas under pressure comprises a tank into which the blast conduits extend, the valve controlling the delivery of the air blasts through the conduits being also located in said tank.

7. In a gas-blast circuit breaker, a casing, a diaphragm valve dividing the interior of the casing into non-communicating pressure chambers, air blast conduits extending into one of said chambers and having their inner ends joined together to form a valve seat defining a gas-blast inlet common to all of said conduits, means for supplying gas under pressure to the chamber containing said valve seat, means for supplying gas under pressure to the remaining chamber to move said valve to a closed position against said seat and means for exhausting the gas from said last mentioned chamber to effect opening of said valve.

8. The combination with the construction set forth in claim 7 of a plurality of interrupters each including an arc orifice to which a blast of gas is delivered through one of said conduits and relatively movable interrupting contacts arranged in said orifice so that the arc drawn between the interrupter contacts when the latter are operated to open-circuit position is extinguished by the gas-blast delivered to the arc orifice in which said contacts are arranged.

9. A gas blast circuit breaker comprising a casing, a plurality of interrupters arranged above the top wall of the casing in triangular formation, each interrupter including an arc orifice and interrupter contacts arranged in said orifice, a diaphragm valve dividing the interior of the casing into upper and lower non-communicating pressure chambers, air blast conduits extending downwardly through the top wall of said casing and having their inner ends joined together within the upper pressure chamber to form a downwardly facing valve seat defining a gas-blast inlet common to all of said conduits, the upper end of each blast conduit serving to support one of said interrupters and having its gas passage aligned with the arc orifice of said interrupter, means for supplying gas under pressure to said upper chamber for delivery through said conduits in the open position of said valve, means for supplying gas under pressure to the lower pressure chamber to close said valve against said seat and means for exhausting gas from said lower chamber to effect opening of said valve when it is desired to deliver a blast of gas through each of said conduits.

10. In a gas-blast circuit interrupter, a casing, a diaphragm dividing the interior of the casing into two pressure chambers of unequal size, a gas-blast conduit extending into the larger of said chambers and having a valve seat at its inner end, means for supplying compressed gas to both of said chambers from a common source, said smaller chamber being provided with an outlet through which compressed gas supplied to said chamber is relieved to atmosphere, a normally closed valve controlling the flow through said outlet and electro-magnetic means for opening said valve, said diaphragm being closed against said seat by the gas pressure in said smaller chamber when the valve controlling the outlet from said smaller chamber is in its closed

position, said diaphragm being moved away from said seat by gas pressure in the larger chamber when the pressure in the smaller chamber is reduced by the opening of the valve controlling the outlet from said smaller chamber, said circuit breaker being also characterized in that substantially equal areas of the diaphragm are exposed to the gas pressure established in said chambers when said diaphragm is in its open position away from said seat so that the velocity of the blast of air which is delivered from the larger chamber through the gas-blast conduit in the open position of the diaphragm serves to unbalance the forces acting against opposite sides of the diaphragm and to thereby assist in moving the diaphragm to a closed position against said seat.

11. A gas-blast circuit breaker comprising interrupter contacts, a source of gas under pressure, a conduit through which a blast of gas is delivered to extinguish the arcs drawn between the interrupter contacts when the latter are operated to open-circuit position, a valve controlling communication between said source and said conduit and movable mechanical connections between the valve and the interrupter contacts whereby said contacts are moved to open-circuit position by the valve when the latter is moved to open position to provide communication between the conduit and the source of gas under pressure.

12. A gas-blast circuit breaker as set forth in claim 11 in which the connections between the valve and the interrupter contacts serve to move said contacts to the closed-circuit position in response to closing movement of the valve.

13. A gas-blast circuit breaker comprising stationary and movable interrupter contacts, a source of gas under pressure, a conduit through which a blast of gas is delivered from said source to said contacts, a movable valve member controlling communication between said conduit and said source, said valve member and at least one of the interrupter contacts being interconnected so that said interrupter contacts are moved to open-circuit position in response to opening motion of the valve and to closed-circuit position in response to closing movement of the valve, said circuit breaker being further characterized in that the means interconnecting the valve and the interrupter contacts serves to retain the interrupter contacts in the closed-circuit position when said valve is in its closed position.

14. A gas-blast circuit breaker comprising interrupter contacts normally exposed to or surrounded by air at atmospheric pressure, a source of gas under pressure, a conduit through which a blast of gas is delivered to extinguish the arcs drawn between the interrupter contacts when the latter are operated to open-circuit position, the air in said conduit being normally at atmospheric pressure, a valve controlling communication between said source and said conduit and connections between the valve and the interrupter contacts whereby said contacts are moved to open-circuit position by the valve when the latter is moved to open position to provide communication between the conduit and the source of gas under pressure.

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