Nov. 20, 1962 T. R. COGGESHALL 3,065,322

GAS BLAST CIRCUIT BREAKER

Filed Dec. 20, 1960 2 Sheets-Sheet 1

Fig. 1.

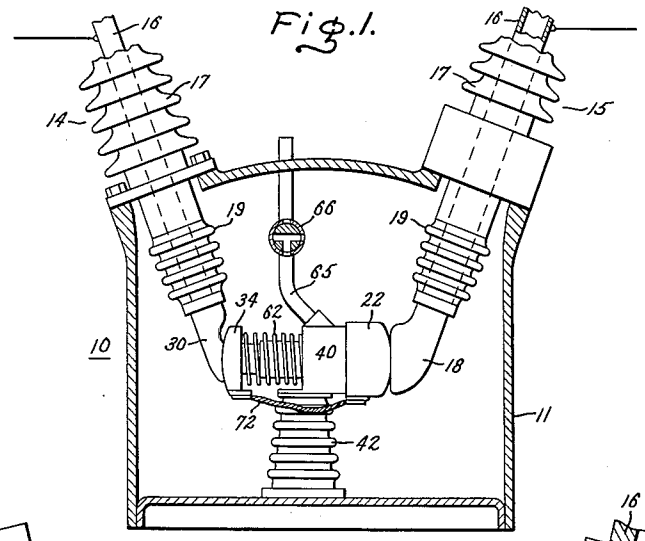
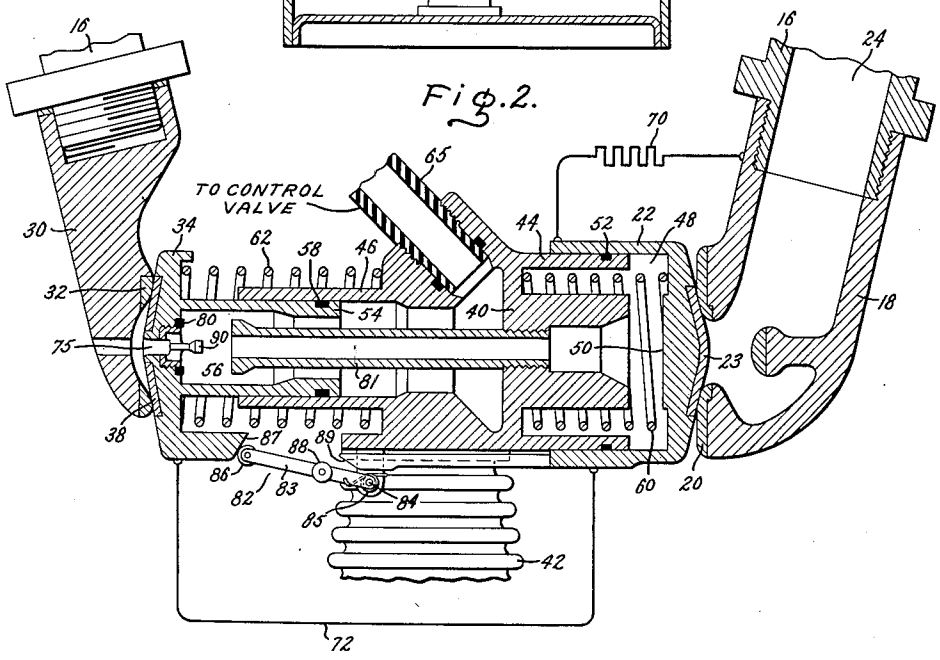


Fig. 2.



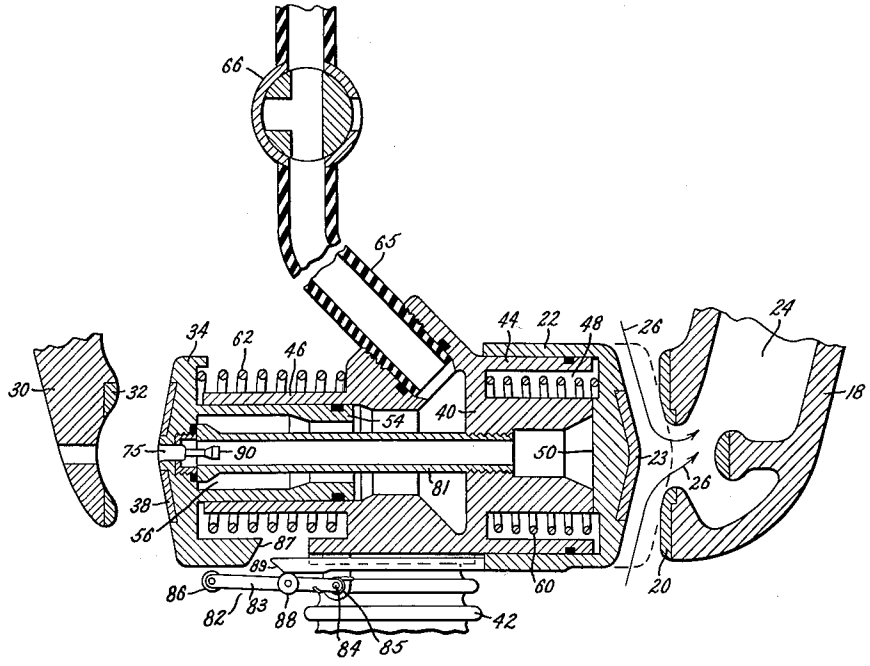
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Fig. 3.



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GAS BLAST CIRCUIT BREAKER

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This invention relates to an electric circuit breaker of the gas blast type and, more particularly, to fluid-controlled actuating means for operating the contacts of this type of circuit breaker.

The circuit breaker of this invention comprises a set of main contacts and a set of auxiliary contacts disposed in a container filled with pressurized gas. The main set of contacts is shunted by a resistor, and the other set is connected in series with the resistor for interrupting the resistor current after the main set of contacts has opened. Extending from the region of the main contacts is an exhaust passage, the flow through which is controlled by a moveable one of the main contacts. So long as this movable main contact is in its closed position, flow through the exhaust passage is blocked. But motion of the movable main contact in an opening direction effects opening of this passage to permit pressurized gas to flow from the container through this passage via the arcing region between the main contacts. This flow of pressurized gas aids in extinguishing the usual arc resulting from contact separation. After this arc has been extinguished, the auxiliary contacts are opened to interrupt the current that then flows through the resistor. After this resistor current has been interrupted, the main contacts are closed so as to terminate the flow of pressurized gas through the exhaust passage and thereby conserve the pressurized gas within the container for subsequent operations.

An object of this invention is to provide fluid-controlled actuating means, simple and compact in construction and reliable in operation, for operating the two sets of contacts in the sequence and manner set forth in the immediately preceding paragraph.

In carrying out my inventioin in one form, I provide a tank containing pressurized gas. Projecting into the tank is a pair of lead-in bushings respectively carrying at their inner ends movable and auxiliary contacts disposed in spaced-apart relationship. Located between the movable and auxiliary contacts and spaced therefrom is stationary supporting structure. The gap between the stationary supporting structure and the main contact is bridged by movable main contact means; and the gap between the supporting structure and the auxiliary contact is bridged by movable auxiliary contact means electrically connected to the movable main contact means. Each of the movable contact means has a first surface on which the pressurized gas within the tank acts in a direction to open the movable contact means and a second surface on which pressurized gas acts in a direction to close said movable contact means. The spaces adjacent the second surfaces contain pressurized gas when the movable contact means are in their respective closed positions. Means is provided for exhausting these spaces to a low pressure region to permit the pressurized gas acting on the first surfaces to open said movable contact means. Means responsive to opening of said movable contact means is provided for sealing off at least a portion of the second surface of said movable auxiliary contact means from the pressurized gas in the tank and for exposing the second surface of the movable main contact means to the pressurized gas within the tank to effect closing of the movable main contact means. Resistance means is connected in parallel with the gap that results from opening of said movable main contact means and in series with the auxiliary contact means.

For a better understanding of my invention, reference may be had to the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevational view partly in section of a circuit breaker embodying one form of my invention.

FIG. 2 is an enlarged view of a portion of FIG. 1. FIG. 2 depicts the parts of the circuit breaker when in the closed position.

FIG. 3 is a view similar to that of FIG. 2, but showing the parts of the circuit breaker in an open position.

Referring now to FIG. 1, there is shown a circuit breaker 10 comprising a metallic tank 11, preferably at ground potential, that is normally filled with a pressurized arc-extinguishing and insulating gas, such as air. Projecting into the tank is a pair of spaced-apart lead-in bushings 14 and 15 for conducting electric current between the exterior and interior of the tank.

These lead-in bushings can be of any suitable conventional design and will therefore be described only in sufficient detail to convey an understanding of the present invention. As will be apparent from FIG. 1, each of these bushings comprises a centrally-disposed conductive stud 16 extending longitudinally of the bushing and a pair of insulating shells 17 and 19 of conventional construction supporting the stud 16 on the top wall of the tank 11. For each bushing, these insulating shells electrically isolate the conductive stud 16, which is at high potential, from the tank 11, which preferably is at ground potential. The stud 16 of the right hand bushing is of a tubular construction, whereas the stud 16 of the left hand bushing is of a solid construction.

Suitably secured to the inner end of the conductive stud 16 of the right hand bushing 15 is stationary contact structure 18. This stationary contact structure 18 has annular contact making portion 20 of suitable arc-resistant metal that is adapted to be engaged by a movable contact member 22. The movable contact member 22 preferably has a conical portion 23 of arc-resistant material which is adapted to engage the contact-making portion 20 of the stationary contact structure when the contacts are closed. Both the stationary contact structure 18 and the stud 16 on which it is supported are of a tubular configuration so as to define internally thereof an exhaust passage 24 that extends from the inner end of the stationary contact structure 18 to the outer end of the stud 16. Normally, the flow of pressurized gas from the interior of the tank 11 through this exhaust passage 24 is blocked by the movable contact 22, which seals the inlet orifice to the passageway 24 when the contacts are in engagement. But when the contact 22 is withdrawn from the stationary contact 18, as is indicated in FIG. 3, the exhaust passage 24 is opened and pressurized gas is free to flow from the interior of tank 11 through the passage 24 to the surrounding atmosphere, as is indicated by the arrows 26 of FIG. 3. This flow of pressurized gas helps to extinguish the arc developed between the contacts 22 and 18 upon contact-separation, as will soon appear more clearly.

Suitably secured to the inner end of the other stud 16 is additional stationary contact structure 30. This stationary contact structure 30 has an annular contract-making portion 32 of suitable arc-resistant metal which is adapted to be engaged by additional movable contact structure 34. This movable contact structure 34 has an annular contact-making portion 38 of arc-resistant metal which is adapted to engage the contact-making portion 32 of the stationary contact structure when this set of contacts is closed.

As will soon appear more clearly, the first set of contacts 18, 22 is relied upon for the main portion of the current-interrupting duty, and these contacts will therefore be referred to hereinafter as the main contacts. The

other set of contacts 30, 34 is relied upon for auxiliary duties (soon to be explained), and these contacts 30, 34 will therefore be referred to hereinafter as the auxiliary contacts.

For supporting both the movable main contact 22 and the movable auxiliary contact 34, a stationary metallic support 40 is provided between the two contacts 22 and 34. This stationary support 40 is shown mounted atop a stationary insulating column 42 projecting from the bottom of the tank 11. The insulating column 42 serves to electrically isolate the support 40 from the ground and tank 11.

As will be apparent from FIGS. 2 and 3, the support 40 is of a hollow construction and comprises cylindrical bosses 44 and 46 extending therefrom at opposite ends. The cylindrical boss 44 is slidably received within a cylindrical portion of the movable main contact 22 so that a contact-controlling chamber 48 is provided adjacent the inner surface 50 of the movable main contact 22. The movable main contact 22 is, in effect, a cylindrical piston telescopically mounted on the cylindrical boss 44. A suitable annular seal 52 is provided about the outer periphery of tubular boss 44 to prevent pressurized gas from leaking into or out of the chamber 48 along the outer surface of boss 44.

The auxiliary contact 34 is in the form of a piston having a centrally displosed cylindrical sleeve 54 integral with the piston and projecting laterally therefrom. This cylindrical sleeve 54 is telescopically received within the tubular boss 46. An auxiliary contact-controlling chamber 56 is located internally of the sleeve 54, and a suitable annular seal 58 is provided in the outer periphery of the sleeve 54 to prevent pressurized gas from leaking into or out of the chamber 56 along the outer surface of sleeve 54.

For providing a force tending to maintain each of the movable contacts 22 or 34 in its respective closed position, a pair of compression-type closing springs 60 and 62 are provided. Compression spring 60 acts between the stationary support 40 and the movable main contact 22 to exert a force on the movable contact 22 normally holding the contact 22 in its closed position of FIG. 2, whereas compression spring 62 acts between the stationary support 40 and the auxiliary contact 34 to exert a force on auxiliary contact 34 normally holding the auxiliary contact in its closed position of FIG. 2.

Contact-opening is effected by venting the contact-controlling chambers 48 and 56 through a controlling duct 65 of insulating material. A suitable control valve shown schematically at 66 is located in this duct 65 to control the flow of pressurized gas therethrough. The control valve 66 is preferably of the three-way type so that when closed, it establishes communication between the pressurized gas in the tank 11 and the contact-controlling chambers 56 and 48, as would be the case when the circuit breaker is in its closed position of FIGS. 1 and 2. When the control valve 66 is opened, as shown in FIG. 3, it vents the contact-controlling chambers 48 and 56 to atmosphere through the controlling duct 65, blocking communication between the contact-controlling chambers and the interior of the tank 11 through the controlling duct 65.

When the control valve 66 is in its position of FIG. 1, the pressurized gas in contact-controlling chambers 56 and 48 is at the same pressure as the gas in the tank 11 surrounding the contacts. Since the surface area (50) of contact 22 that is exposed to gas pressure acting in a direction to move the contact closed is greater than the area of contact 22 exposed to pressure acting to force the contact open, there is a net force from the pressurized gas acting in a direction to hold the contact 22 closed. This net force is supplemented by the spring 60, as has already been described. When the contact-controlling chamber 48 is vented to atmosphere by opening of the control valve 66, the pressure in contact-controlling chamber 48 quickly drops and permits the pressure acting on the right hand side of contact 22 to predominate. This predominating pressure forces the contact 22 to the left against its closing spring 60 to separate the movable main contact 22 from the stationary main contact 18.

Shortly after the main contacts 22, 18 have thus opened, the auxiliary contacts 34, 30 are also opened. The force for producing this auxiliary-contact opening action is made available by the venting of auxiliary contact-controlling chamber 56 that results from opening of the controlling valve 66. More specifically, when the auxiliary contact-controlling chamber 56 is vented through the controlling duct 65, the pressure in auxiliary contact-controlling chamber 56 drops, permitting the pressure acting on the left-hand side of piston 34 to predominate. This predominating pressure provides a force tending to drive the contact 34 to the right away from the stationary contact 30 against the bias of closing spring 62.

It is important that the movable auxiliary contact 34 remain in its closed position until after the movable main contact 22 has moved open a substantial distance. In some cases, this sequence of opening operations can be attained by suitably controlling the relative masses of and the relative net opening forces on the two movable contacts. But in a preferred form of my invention, I provide a more positive control over this opening sequence by including restraining means 82 that is effective to latch the movable auxiliary contact 34 in its closed position of FIG. 2 until the movable main contact 22 has moved through substantially its entire opening stroke. This restraining means 82 comprises a latching lever 83 pivotally mounted on a stationary pivot 84 and biased in a clockwise direction about pivot 84 by a suitable spring, such as 85. The latching lever 83 carries a roller 86 at its free end that engages a cam surface 87 on the auxiliary contact 34. When the latching lever 83 is in its restraining position of FIG. 2, this roller 86 acts through the cam surface 87 to hold the movable auxiliary contact 34 closed.

For releasing the latching lever 83 in response to opening movement of the main movable contact 22, an actuating cam 89 suitably coupled to the main movable contact 22 is provided. When the main movable contact 22 moves into its fully opened position of FIG. 3, this actuating cam 89 engages a follower 88 carried by the latching lever 83 and forces the latching lever 83 counterclockwise about its pivot 84, thereby freeing the movable auxiliary contact for opening. Since there is then an opening force acting on the movable auxiliary contact 34, as was explained hereinabove, the movable auxiliary contact 34 responds by moving to the right from its position of FIG. 2 to that of FIG. 3.

When the main contacts 22, 18 are separated, the arc that is established therebetween is subjected to a blast of pressurized fluid that flows through the arcing region in the direction of the arrows 26 of FIG. 3. In a known manner, this blast of gas quickly extinguishes the arc by building up sufficient dielectric strength across the arcing gap to prevent arc-reignition after an early current zero.

This interrupting process is made less severe by the presence across the arcing gap of a resistor 70 that acts in a known manner to reduce the rate at which the usual recovery voltage transient builds up across the arcing gap after each current zero during the interrupting process. After the arc has been interrupted at the main contacts, current flows through the series combination of resistor 70 and the auxiliary contacts 30, 34 via a flexible conductor 72 suitably connected between the two sets of movable contacts. This resistor current is interrupted by separating the auxiliary contacts 34 and 30 in the manner described hereinabove. This current, being limited by the resistor 70, is much lower than the current interrupted at the main gap, and the arc established across the auxiliary contacts can be extinguished in the pressurized gas with no appreciable gas flow.

A relatively large amount of pressurized gas is exhausted through the exhaust passage 24 associated with the main contacts 18, 22, and it is therefore important to terminate this flow of gas as soon as the resistor current is interrupted in order to avoid an excessive pressure drop in the tank 11 and an excessive loss of gas. To this end, I return the movable main contact 22 to its closed position in which it seals off exhaust passage 24 within a predetermined short period of time after the auxiliary contacts are opened. This return motion of the movable main contact 22 is produced by supplying pressurized gas to its contact-controlling chamber 48 through an opening 75 provided in the auxiliary contact 34 centrally thereof. More particularly, when the movable contact 34 reaches its fully opened position of FIG. 3, an annular seal 80 carried by the movable auxiliary contact 34 engages the left-hand end of a rigid tube 81 projecting from the movable main contact chamber 48. This not only interrupts communication between the main contact chamber 48 and the vented duct 65, but also establishes direct communication between the pressurized gas in the tank 11 and the main contact-controlling chamber 48 via the opening 75 and the tube 82. The result is that pressure in the contact-controlling chamber 48 soon builds up and produces a predominating force that drives the movable contact 22 to the right into its closed position, sealing off the exhaust passage 24 and thus terminating the flow of pressurized gas therethrough.

The period of time required for pressure to build up in the contact-controlling chamber 48 sufficiently to drive the movable main contact 22 closed is governed by a metering pin 90 carried by the movable auxiliary contact 34. This metering pin 90 slides into the bore of tube 82 as the movable auxiliary 34 moves into its fully-open position, thus providing a restricted orifice that controls the rate at which pressurized gas flows to the right through tube 82 to build up pressure for closing. The metering pin 90 is so designed that sufficient time elapses between the time the movable auxiliary contact reaches fully-open position and the time main movable contact 22 closes to assure that the resistor current has been interrupted at the auxiliary contacts 30, 34 before the main contacts are reclosed.

The auxiliary movable contact 34 remains in its open position of FIG. 3 during this interval when the main movable contact is closing, since most of the auxiliary contact-controlling chamber 56 is still vented to atmosphere through the controlling duct 65. As a result, there is sufficient net area of auxiliary contact 34 exposed to pressure from the tank 11 to hold the auxiliary contact 34 in its open position against the opposing bias of spring 62. By maintaining the contacts 34, 30 open in this manner, the circuit is maintained in the desired open condition. Since the gap between auxiliary contacts 30 and 34 is located in the pressurized gas of the tank 11, this gap has sufficient dielectric strength to maintain a relatively high-voltage circuit open.

No significant amount of gas is being lost through the controlling duct 65 during this period when the contacts are maintained in their position of FIG. 3 inasmuch as the seal 80 is preventing any leakage from occurring between the then-pressurized regions of the actuating mechanism and the controlling duct 65. The seal 80 also acts during this interval to sead off the auxiliary contact controlling chamber 56 from the adjacent pressurized gas, thus cooperating with the vented duct 65 to assure that the pressure in auxiliary contact-controlling chamber 56 remains low and the movable auxiliary contact 34 therefore remains open.

To return the movable auxiliary contact 34 from its open position of FIG. 2 to its closed position of FIG. 1, the controlling valve 66 is returned to its closed position of FIG. 1. This allows pressurized gas to flow from the tank 11 through the controlling duct 65 into the auxiliary contact-controlling chamber 56. The buildup of

pressure in auxiliary contact-controlling chamber 56 forces the movable auxiliary contact 34 to the left, finally returning the movable auxiliary contact to its closed position of FIG. 1 with the assistance of closing spring 62.

With respect to initiating opening of the movable main contact 22 by venting of the contact-controlling chamber 48, it will be apparent that the metering pin 90 will not interfere with the venting of this contact controlling chamber 48 at the desired high rate inasmuch as the metering pin 90 is located outside of the tube during venting of the movable contact-controlling chamber 48, as will be apparent from FIG. 2. With further reference to a contact-opening operation, it is to be understood that the central opening 75 in the auxiliary contact 34 does not significantly interfere with venting of the auxiliary contact controlling chamber 56 since this opening 75 is very small compared to the most restricted area through which venting takes place, e.g., the area between the fixed tube 82 and the sleeve 54 on the movable auxiliary contact 34. Thus, any pressurized gas that flows in through opening 75 during venting is exhausted through the controlling duct 65 before any significant pressure can be built up in the contact-controlling chamber 56 during venting of this chamber 56.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric circuit breaker of the gas blast type comprising a tank adapted to contain pressurized gas, a pair of lead-in bushings projecting into said tank, a main and an auxiliary contact respectively mounted on the inner ends of said bushings in spaced-apart relationship to each other, stationary supporting structure located between said contacts and spaced therefrom, movable main contact means bridging the gap between said stationary supporting structure and said main contact, movable auxiliary contact means bridging the gap between said stationary supporting structure and said auxiliary contact, means for electrically interconnecting said movable main and movable auxiliary contact means, each of said movable contact means having a first surface on which the pressurized gas within said tank acts in a direction to open said movable contact means and a second surface on which pressurized gas acts in a direction to close said movable contact means, the spaces adjacent said second surfaces containing pressurized gas when said movable contact means are in their respective closed positions, means for exhausting said spaces to a low pressure region to permit the pressurized gas acting on said first surfaces to open said movable contact means, means responsive to opening of said movable auxiliary contact means for sealing off at least a portion of the second surface of said movable auxiliary contact means from the pressurized gas in said tank and for exposing the second surface of said movable main contact means to the pressurized gas within said tank to effect closing of said movable main contact means, resistance means connected in parallel with the gap resulting from opening of said movable main contact means and in series with said movable auxiliary contact means, restraining means for holding said movable auxiliary contact means in its closed position until opening motion of said movable main contact means is initiated, and means controlled by opening motion of said movable main contact means for rendering said restraining means inoperable to hold said movable auxiliary contact means closed after a predetermined amount of opening motion of said movable main contact means.

2. An electric circuit breaker of the gas blast type com-

prising a tank adapted to contain pressurized gas, a pair of lead-in bushings projecting into said tank, a main and an auxiliary contact respectively mounted on the inner ends of said bushings in spaced-apart relationship to each other, stationary supporting structure located between said contacts and spaced therefrom, movable main contact means bridging the gap between said stationary supporting structure and said main contact, movable auxiliary contact means bridging the gap between said stationary supporting structure and said auxiliary contact, means for electrically interconnecting said movable main and movable auxiliary contact means, each of said movable contact means having a first surface on which the pressurized gas within said tank acts in a direction to open said movable contact means and a second surface on which pressurized gas acts in a direction to close said movable contact means, the spaces adjacent said second surfaces containing pressurized gas when said movable contact means are in their respective closed positions, means for exhausting said spaces to a low pressure region to permit the pressurized gas acting on said first surfaces to open said movable contact means, means responsive to opening of said movable auxiliary contact means for sealing off at least a portion of the second surface of said movable auxiliary contact means from the pressurized gas in said tank and for exposing the second surface of said movable main contact means to the pressurized gas within said tank to effect closing of said movable main contact means, resistance means connected in parallel with the gap resulting from opening of said movable main contact means and in series with said movable auxiliary contact means, opening of said movable auxiliary contact means being delayed until opening of said movable main contact means has occurred, the means for exposing the second surface of said movable main contact means to pressurized gas comprises an opening in said movable auxiliary contact means affording communication between the pressurized gas within said tank and the second surface of said movable main contact means when said movable auxiliary contact means has opened, and a metering pin carried by said movable auxiliary contact means for controlling the rate at which pressurized gas flows toward the second surface of said main movable contact means, the opposition presented by said metering pin to flow to and from said second surface of said movable main contact means increasing in response to opening movement of said movable auxiliary contact means.

3. An electric circuit breaker of the gas blast type comprising a tank adapted to contain pressurized gas, a pair of lead-in bushings projecting into said tank, a main and an auxiliary contact respectively mounted on the inner ends of said bushings in spaced-apart relationship to each other, stationary supporting structure located between said contact and spaced therefrom, movable main contact means bridging the gap between said stationary supporting structure and said main contact, movable auxiliary contact means bridging the gap between said stationary supporting structure and said auxiliary contact, means for electrically interconnecting said movable main and movable auxiliary contact means, each of said movable contact means including a piston containing a hollow portion constituting a contact-controlling chamber in which pressurized gas acts on said piston in a direction to close said movable contact means, each of said movable contact means having another surface on which pressurized gas within said tank acts in a direction to open said movable contact means, said contact-controlling chambers containing pressurized gas when said movable contact means are in closed position, means for exhausting said contact-controlling chambers to a low pressure region to permit the pressurized gas acting on said other surface to open said contact means, means responsive to opening of said auxiliary contact means for establishing communication between the contact-controlling chamber of said movable main contact means and the pressurized gas within said tank so as to effect closing of said movable main contact means, said means responsive to opening of said auxiliary contact means acting to seal off at least a portion of the contact-controlling chambers of said auxiliary contact means from the pressurized gas in said tank so that the latter contact-controlling chamber remains vented to said low pressure region when said movable main contact means closes, resistance means connected in parallel with the gap resulting from opening of said movable main contact means and in series with said movable auxiliary contact means, and restraining means for holding said movable auxiliary contact means in its closed position until opening motion of said movable main contact means is initiated, and means controlled by opening motion of said movable main contact means for rendering said restraining means inoperable to hold said movable auxiliary contact means closed after a predetermined amount of opening motion of said movable main contact means.

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