Sept. 4, 1951 H. MILLIKEN 2,567,022

AIR BLAST CIRCUIT BREAKER

Filed Dec. 3, 1948 2 Sheets-Sheet 1

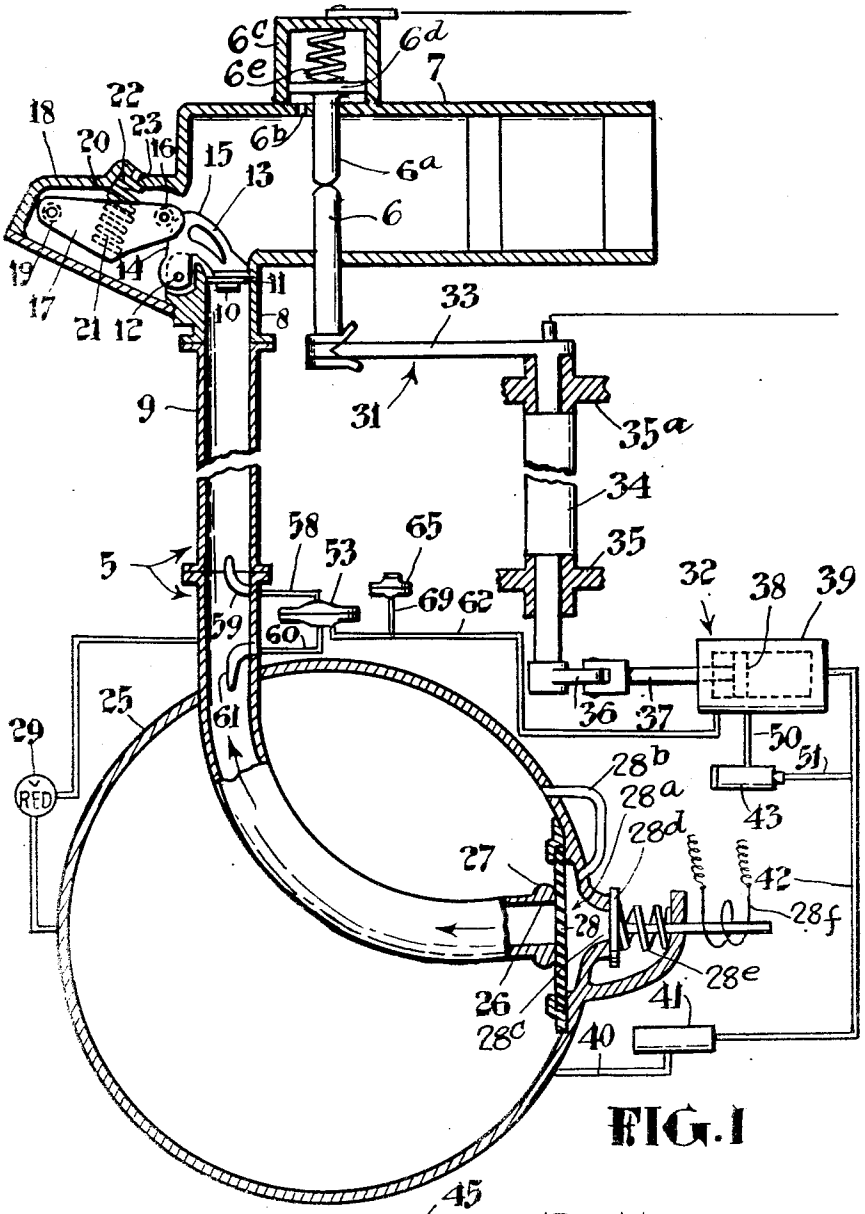


FIG. 1

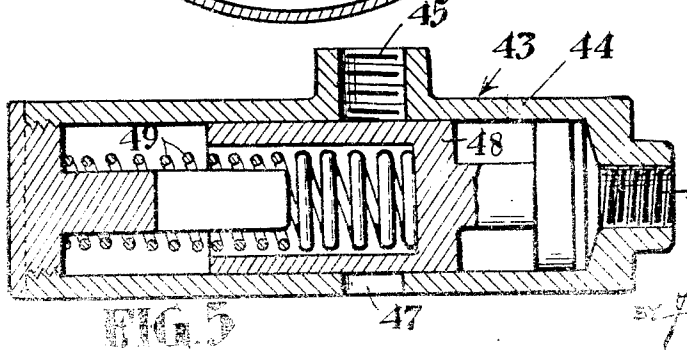


FIG. 5

INVENTOR
H. MILLIKEN
BY Fetherstonhaugh & Co.
ATTORNEYS

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AIR BLAST CIRCUIT BREAKER

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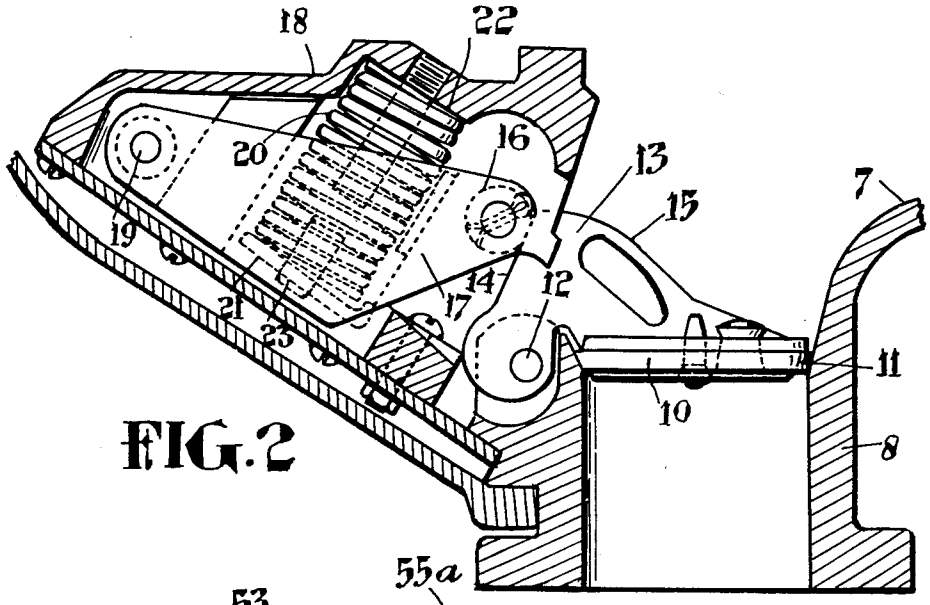


FIG. 2

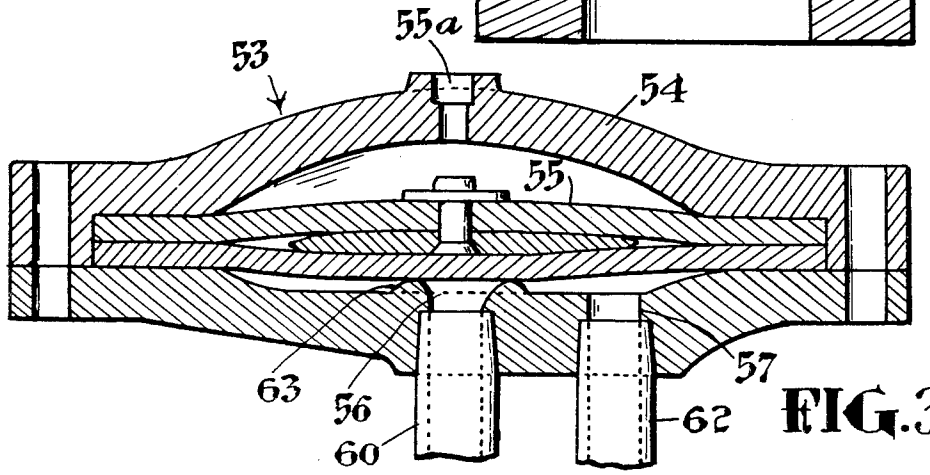


FIG. 3

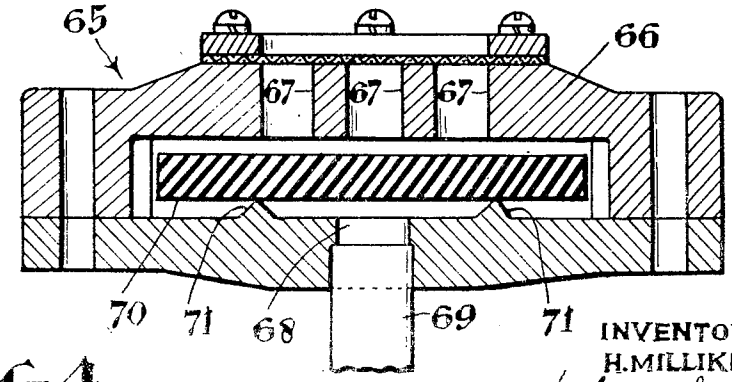


FIG. 4

INVENTOR
H. MILLIKEN
BY Fetherstonhaugh & Co.
ATTORNEYS.

Patented Sept. 4, 1951

2,567,022

UNITED STATES PATENT OFFICE

2,567,022

AIR-BLAST CIRCUIT BREAKER

Humphreys Milliken, Mount Royal, Quebec, Canada

Application December 3, 1948, Serial No. 63,252

10 Claims. (Cl. 200—148)

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This invention relates to improvements in air-blast circuit breakers in which a blast of compressed air is delivered from a storage tank or other suitable source through a blast conduit to extinguish the arc drawn between the interrupter contacts when the latter are operated to open circuit position.

The primary purpose of the present invention is to provide means whereby the arc-extinguishing blast of air is more efficiently utilized to increase the interrupting capacity and decrease the opening time of the circuit breaker; to increase the dielectric strength of the blast conduit; and to ensure a more positive exclusion of moisture from said blast conduit.

In the usual air-blast circuit breaker the air in the blast conduit is normally at atmospheric pressure. When the blast valve is opened to place the blast conduit in communication with the tank or other source of compressed air the velocity of flow through the blast conduit becomes very high with excessive air friction and loss of pressure so that the delivery pressure of the blast at the interrupter contacts is commonly only about one-third the pressure of the air at the storage tank or other source of supply. When a storage tank is used, as is commonly the case, the pressure in the tank drops very rapidly during the blast since the volume of the tank is only sufficient to produce a wave of air pressure of very short duration in the interrupter unit containing the interrupter contacts. The duration of the arc across the interrupter contacts is usually much shorter than the duration of the air pressure wave. Since the interrupting capacity of an air blast circuit breaker is a function of the maximum pressure of the air wave at the interrupter contacts during the arcing period, it will be seen that an increase in such maximum pressure will produce a corresponding increase in the interrupting capacity of the circuit breaker.

According to the present invention an increase in the interrupting capacity of air blast circuit breakers is made possible by the provision of means for normally maintaining the air in the blast conduit at a superatmospheric pressure which is preferably equal to approximately one-half the pressure under which the air is normally maintained in the storage tank or other source of supply. The outlet through which the compressed air is delivered from the blast conduit to the interrupter contacts is normally closed by a suitably loaded valve which opens when the pressure of the superatmospheric air normally present in the blast conduit is increased beyond a predetermined

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value by the compressing effect of the higher pressure air admitted to the blast conduit from the storage tank or other source of supply by the opening of the normally closed blast valve controlling the air inlet of the blast conduit. This makes it possible to deliver to the interrupter contacts a pressure wave at a pressure per square inch which is approximately double the pressure of the wave delivered by a similar circuit breaker in which the air in the blast conduit is normally at atmospheric pressure.

A preferred embodiment of the invention is shown in the accompanying drawings, in which—

Fig. 1 is a diagrammatic view, partly in vertical section and partly in side elevation, of the component parts of an air blast circuit breaker embodying my invention.

Fig. 2 is an enlarged sectional view of the loaded valve assembly provided for normally closing the outlet end of the blast conduit shown in Fig. 1.

Fig. 3 is an enlarged sectional view of a relay valve forming part of the assembly shown in Fig. 1.

Fig. 4 is an enlarged sectional view of a leakage-relief and stop valve forming part of said assembly.

Fig. 5 is an enlarged sectional view of an air exhaust valve through which air is exhausted from the cylinder and piston device employed for operating the disconnecting switch shown in Fig. 1.

Referring more particularly to the drawings, 5 designates an air blast conduit through which an arc-extinguishing blast of compressed air is directed against the arc drawn between the stationary and movable interrupter contacts 6 and 6a when the latter contact is operated to open circuit position by the air blast as hereinafter described. The interrupter contacts are carried by an interrupter casing 7 provided with a neck extension 8 which is secured to and constitutes a continuation of the upper end of insulating section 9 of air blast conduit 5. Communication between the air blast conduit and the portion of the interrupter casing containing the interrupter contacts is controlled by a spring loaded valve 10 which is normally biased to close against a valve seat 11 at the upper end of the neck extension 8. The orifice controlled by valve 10 constitutes and is hereinafter referred to as the outlet through which the arc-extinguishing blast of air is delivered from the blast conduit to the interrupter casing. Valve 10 is mounted to swing about a pivotal axis 12 and is provided with a cam 13 presenting a straight edge portion 14 and a curved

edge portion 15. A spring-loaded valve closing roller 16, carried by one end of a valve closing lever 17, normally bears against the straight edge portion 14 of cam 13 to hold valve 10 closed against an opposing air pressure of approximately 75 lbs. per square inch normally maintained in the air blast conduit as hereinafter described.

Lever 17 operates in housing extension 18 of interrupter casing 7 and swings about a pivotal axis 19. This lever is urged to valve closing position by a spring 20 having one end bearing against a spring seat 21 carried by said lever and its other end bearing against a spring seat 22 afforded by the upper wall of the housing extension 18. Spring 20 is preferably held in position by positioning pins 23 projecting from the spring seats 21 and 22.

When the normal superatmospheric pressure in blast conduit 5 is increased to approximately 80 lbs. per square inch, the valve 10 is raised against the opposing pressure of valve closing roller 16 and the latter passes from the straight edge 14 on to the curved edge 15 of cam 13. In this latter position the valve closing roller exerts only a very slight restraining force on valve 10 so that the pressure in the air blast conduit becomes immediately effective to quickly blow the valve to a wide open position in which the valve remains until the pressure in the air blast conduit is diminished sufficiently to permit reclosing of the valve by virtue of its own weight and the relatively slight reclosing pressure exerted by roller 16 on the curved edge 15 of cam 13. As the valve 10 reaches its fully closed position the valve closing roller 16 passes onto the straight edge 14 of the cam 13 and becomes effective to hold the valve closed against the normal air pressure in the blast conduit.

In the open position of valve 10 a portion of the compressed air supplied to interrupter casing 7 passes through an opening 6*b* into the lower portion of a cylinder 6*c* and acts against the lower surface of a piston 6*d* operating in said cylinder and connected to the upper end of movable contact 6*a*. The pressure thus applied to piston 6*d* raises contact 6*a* to open-circuit position against the resistance of a biasing spring 6*e* acting against the upper surface of the piston. This method of operating a movable interrupter contact by the pressure of an air blast is conventional and, in itself, forms no part of the invention claimed herein.

The lower portion of air blast conduit 5 extends downwardly into a compressed air storage tank 25 and is provided with an inlet orifice 26 surrounded by a valve seat 27. Communication between the tank and the air blast conduit is controlled by a blast valve 28 which is normally closed against valve seat 27. Blast valve 28 is shown as a conventional diaphragm-type blast valve which is operated in the usual manner. In this connection it will be noted that valve 28 forms one wall of a pressure chamber 28*a* to which air is supplied from storage tank 25 by way of pipe 28*b* to normally hold valve 28 closed against its seat 27. Pressure chamber 28*a* is provided with an outlet 28*c* controlled by an electrically operated valve 28*d*. This valve 28*d* is closed by a spring 28*e* and is momentarily opened by energization of an operating coil 28*f* to exhaust air from pressure chamber 28*a* and thus permit opening of valve 28 by the air pressure in storage tank 25 acting directly against the side of valve 28 remote from the pressure chamber 28*a*. This method of opening and closing the blast valve is conventional and is disclosed, for example, in my prior United States Patent No. 2,260,188 granted October 21, 1941.

The air in storage tank 25 is normally compressed to a pressure of approximately 150 lbs. per square inch. In the closed position of the valves 10 and 28 compressed air is delivered from tank 25 through pressure reducing valve 29 to the air blast conduit 5 to establish and maintain in the latter the normal air pressure of approximately 75 lbs.

When the air blast valve 28 is suddenly opened in the usual manner to admit air, at a pressure of 150 lbs. per square inch, the air pressure in the conduit which is normally at approximately 75 lbs., is raised to slightly less than 150 lbs. As the air pressure in the air blast conduit rises beyond about 80 lbs. per square inch, the valve 10 is suddenly blown to fully open position so that a pressure wave of compressed air at approximately 100 lbs. per square inch is delivered to the interrupter casing 7 to extinguish the arc drawn between the interrupter contacts 6. When blast valve 28 closes the pressure in interrupter casing 7 and blast conduit 5 drops to atmospheric pressure and valve 10 is quickly closed by the spring loaded valve closing roller 16. The pressure in the blast conduit is then quickly built up to the normal pressure of 75 lbs. per square inch by the opening of reducing valve 29.

The maintenance of a normal pressure of approximately 75 lbs. per square inch in the blast conduit greatly increases the dielectric strength of the interior of the insulating section 9 of blast conduit 5. It also provides an internal pressure which is effective to prevent rain water seeping into the insulating section of the blast conduit and causing a flash-over and destruction of the conduit. A further advantage arises from the fact that the velocity of the pressure wave is much greater in compressed air than in air at atmospheric pressure so that, in a circuit breaker designed in accordance with my invention, the pressure wave reaches the interrupter contacts in a shorter time and results in earlier extinction of the arc. This feature is of particular importance in circuit breakers of the higher voltages which require blast conduits of great length for insulating purposes.

An isolator, generally indicated at 31, is connected in series with the interrupter contacts 6 and is operated to open-circuit and closed-circuit position by a cylinder and piston device 32. In the present instance I have shown the movable contact 33 of the isolator carried by one end of an insulating member 34 rotatably mounted in suitable bearings 35 and 35*a*. The other end of member 34 carries a crank arm 36 which is secured to the piston rod 37 of a piston 38 operating in the cylinder 39 of said cylinder and piston device. The isolator is operated to closed position by air pressure supplied through line 40, switch closing valve 41, and line 42 to the right hand end of cylinder 39. Air trapped in cylinder 39, subsequent to the closure of the isolator, is exhausted to atmosphere through a suitable exhaust valve 43. In the present instance exhaust valve 43 is shown as comprising casing 44 (Fig. 5) provided with two pressure ports 45 and 46 and an exhaust port 47 and containing a plunger valve 48 which is normally urged by a biasing spring 49 to a position closing pressure port 45 and exhaust port 47. Pressure port 45 is connected by line 50 to cylinder 39 as shown in Fig. 1. Pressure port 46 is connected to a branch 51 of the

previously mentioned line 42. During closing of the isolator the air pressure supplied to line 42 acts against plunger valve 48 to move the latter to the left thereby uncovering the ports 45 and 47 and providing an escape path for any air trapped in the cylinder at the left hand side of piston 38.

When blast valve 28 is opened the isolator 31 is operated to open circuit position by compressed air supplied from the air blast conduit to the left hand end of cylinder 39. This is accomplished by the provision of a control valve generally indicated at 53. This control valve comprises a valve casing 54 containing a diaphragm valve 55 (Fig. 3) and provided with a plurality of ports including a top port 55a and bottom ports 56 and 57. The top port 55a is connected by line 58 to a streamlined elbow-shaped ejector nozzle 59 arranged in the air blast conduit with its tip directed in the downstream direction of the air flow through said conduit. The bottom casing port 56 is connected by line 60 to a streamlined elbow-shaped injector nozzle 61 arranged in the air blast conduit with its tip directed in the upstream direction of the air flow through said conduit. The remaining bottom port 57 is connected by line 62 to the left hand end of cylinder 39.

Under normal conditions the air in blast conduit 5 is stationary at a static pressure of approximately 75 lbs. per square inch. Diaphragm valve 55 is normally closed against a seat 63 surrounding the nozzle port 56 so that the bottom area of the diaphragm valve which is exposed to the static pressure in the blast conduit through line 60 is less than the top area which is exposed to the static pressure in said conduit through line 58. As a result the diaphragm 55 is pressed down against its seat 63 to seal the port 56 against leakage. When blast valve 28 opens, sending a blast of air up the blast conduit at high velocity, the static pressure in the conduit rises simultaneously at the two nozzles 59 and 61 but the pressure inside the ejector nozzle 59 and line 58 drops below the static pressure in the air blast conduit while the pressure inside the injector nozzle 61 and line 60 rises above said static pressure. As a result of this the pressure acting against the underside of the diaphragm valve 55 is increased above the pressure acting against the upper side of said valve and the latter is displaced upwardly to uncover the port 56 and permit compressed air to flow from the air blast conduit through line 60, valve ports 56 and 57 and line 62 to the left hand end of cylinder 39 to open the isolator 31.

Under normal conditions any air leaking past diaphragm valve 55 into line 62 is discharged to atmosphere through a leakage-relief and stop valve 65 to prevent accidental opening of the isolator 31. As here shown, the valve 65 comprises a valve casing 66 (Fig. 4) provided with top ports 67 open to the atmosphere and with a bottom port 68 which is connected to line 62 by a branch connection 69. A floating valve-disk or diaphragm 70, preferably made of soft rubber, is loosely arranged in valve casing 66 so that it normally rests by gravity on small bosses 71 projecting upwardly from the bottom of said valve casing. Under normal conditions the leakage air entering valve casing 66 through line connection 69 and port 68 flows around valve 70 and out through the ports 67 to atmosphere. When the inflow of air through valve port 68 is suddenly increased, as by the opening of blast valve 28, the disk or diaphragm 70 is blown upwardly to a position closing the exhaust ports 67 and preventing further escape of air from valve casing 66. In its open position the valve 70 also provides for slow exhaust of air from the left hand end of cylinder 39 after an opening operation. In the case where the isolator switch 31 is reclosed before such leakage is complete the air in the left hand end of cylinder 39 is exhausted by valve 43 as previously described. When valve 43 opens to discharge residual compressed air from the left hand end of cylinder 39, the valve 65 also opens and remains open.

Having thus described the nature of my invention and a preferred embodiment thereof, it will be understood that various modifications may be resorted to within the scope and spirit of the invention as defined by the appended claims.

I claim:

1. An air-blast circuit breaker comprising an interrupter, a storage tank containing air under pressure, a blast conduit for conveying a blast of air from said tank to said interrupter, a normally closed blast valve controlling communication between said tank and said conduit, air flow control means normally preventing the flow of air from said conduit to said interrupter and operable to permit flow of air from said conduit to said interrupter in response to an increase in air pressure in said conduit resulting from the opening of the blast valve, means for conducting air from said storage tank to said conduit in the closed position of the blast valve, a switch connected in series with said interrupter, pressure-responsive switch-operating means for operating said switch to open-circuit position, a pipe through which air under pressure is conveyed from said blast conduit to said pressure-responsive switch-operating means to operate said switch to open-circuit position, a normally closed valve in said pipe adapted to open automatically in response to velocity of air in the blast conduit resulting from the opening of said blast valve and means functioning in the closed position of the blast valve to prevent a gradual increase of pressure in said pipe.

2. An air-blast circuit breaker comprising interrupter contacts, a source of air under pressure, a blast conduit through which a blast of air is directed against the arc drawn between the interrupter contacts when the latter are operated to open-circuit position, a normally closed blast valve controlling communication between said source and said conduit and means functioning in the closed position of the blast valve to establish and maintain in said conduit a superatmospheric air pressure, said means comprising a normally closed valve controlling a delivery opening in the blast conduit through which the blast of air is directed against the said arc and means for supplying air under pressure to said conduit in the closed position of said valves.

3. An air-blast circuit breaker comprising interrupter contacts, a source of air under pressure, a blast conduit through which a blast of air is directed against the arc drawn between the interrupter contacts when the latter are operated to open-circuit position, a normally closed blast valve controlling communication between said source and said conduit and means functioning in the closed position of the blast valve to establish and maintain in said conduit air at a superatmospheric pressure below the air pressure at said source, said means comprising a normally closed valve controlling a delivery opening in the blast conduit through which the blast of air is directed against the said arc and means for

supplying air under pressure to said conduit in the closed position of said valves.

4. An air-blast circuit breaker comprising an interrupter, a storage tank containing air under pressure, a blast conduit having an inlet orifice and an outlet orifice, a normally closed blast valve controlling communication between the storage tank and the inlet orifice of the blast conduit, a normally closed valve controlling communication between the outlet orifice of the blast conduit and the interrupter, a pressure reducing valve through which air is supplied from the storage tank to the blast conduit in the closed position of said valves to normally maintain in said conduit air at a predetermined superatmospheric pressure.

5. An air-blast circuit breaker as set forth in claim 4, in which the valve controlling the outlet orifice of the blast conduit is biased to closed position by loading means which is effective to maintain said valve closed against the normal pressure in said blast conduit but permits automatic opening of said valve when the pressure in the blast conduit is increased beyond the normal pressure by the opening of said blast valve.

6. An air-blast circuit breaker comprising an interrupter, a storage tank containing air under pressure, a blast conduit having an outlet orifice and an outlet orifice, a normally closed blast valve controlling communication between the blast conduit and the storage tank, a normally closed valve controlling communication between the blast conduit and the interrupter, a pressure reducing valve through which air is supplied from said tank to said conduit in the closed position of said valves to normally maintain in said blast conduit air at a superatmospheric pressure less than the normal pressure of the air in said tank, the valve controlling the outlet orifice of the blast conduit being biased to closed position by loading means which hold said valve closed against the normal pressure in the blast conduit but permits opening of said valve when the normal pressure in the blast conduit is increased as a result of opening of the blast valve.

7. An air-blast circuit breaker as set forth in claim 6, including a normally closed switch connected in series with the interrupter contacts of said interrupter, a pressure-responsive device for operating said switch to open-circuit position, injector and ejector nozzles arranged in the blast conduit between the valves controlling the inlet and outlet orifices of said conduit, the injector nozzle being arranged with its tip directed in the upstream direction of air flowing through said conduit and the ejector nozzle being arranged with its tip directed in the downstream direction of air flowing through said conduit, a valve casing containing a diaphragm valve and provided with a plurality of ports including a top port located above the diaphragm valve and two bottom ports located below the diaphragm valve, the top port being connected to the ejector nozzle and one of the bottom ports which is normally closed by the diaphragm being connected to the injector nozzle, the remaining bottom port being connected to said pressure-responsive device so that when the pressure in the blast conduit is increased beyond the normal pressure, the diaphragm valve is raised to permit flow of compressed air from the blast conduit to the pressure-responsive device to operate said switch to open-circuit position.

8. An air-blast circuit breaker comprising an interrupter, a storage tank containing air under pressure, a blast conduit having an inlet orifice and an outlet orifice, a normally closed blast valve controlling communication between the storage tank and the inlet orifice of the blast conduit, a normally closed valve controlling communication between the outlet orifice of the blast conduit and the interrupter, a cam carried by the last mentioned valve, a spring loaded valve-closing lever cooperating with said cam to hold said valve closed against the normal pressure in the blast conduit and a pressure-reducing connection through which air is supplied from the storage tank to the blast conduit in the closed position of said valves to normally maintain in said conduit a body of air at a predetermined superatmospheric pressure.

9. An air-blast circuit breaker comprising an interrupter, a storage tank containing air under pressure, a blast conduit for conveying a blast of air from said tank to said interrupter, a normally closed blast valve controlling communication between said tank and said conduit, air flow control means normally preventing the flow of air from said conduit to said interrupter and operable to permit flow of air from said conduit to said interrupter in response to an increase in air pressure in said conduit resulting from the opening of the blast valve, means for conducting air from said storage tank to said conduit in the closed position of the blast valve, a switch in series with said interrupter, pneumatic means for opening said switch, said pneumatic means being responsive to air velocity in said blast conduit and comprising two orifices in said blast conduit, one of said orifices being directed against the motion of the air blast, the other orifice being directed in the same direction as the motion of said air blast, a differential valve having two chambers, one chamber being pneumatically connected to said first-named orifice, the other chamber being connected to the second-named orifice, said two chambers being separated by a relatively movable partition, said first named chamber having an inlet orifice pneumatically connected as aforesaid to said first named orifice, said inlet orifice in said chamber being normally closed by said movable partition; pneumatic mechanism for opening said switch, a pneumatic tube connecting said mechanism to said last-named chamber in said differential valve; a second valve pneumatically connected to said last named tube, said second valve having an outlet to atmosphere normally in communication with said inlet of said second valve, a movable member adapted to move and close said atmospheric outlet when abnormal air pressure is applied to said tube between said differential valve and said switch opening mechanism.

10. An air-blast circuit breaker as set forth in claim 2, in which the means for supplying air under pressure to said conduit in the closed position of said valves includes a pressure reducing valve.

HUMPHREYS MILLIKEN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,248,593	Thumim	July 8, 1941
2,279,536	Thommen	Apr. 14, 1942
2,491,112	Jansson	Dec. 13, 1949