Dec. 13, 1949 G. E. JANSSON 2,491,112

GAS BLAST BREAKER HAVING TWO TANKS AND A TANK INTERCONNECTING VALVE

Filed July 5, 1947 2 Sheets-Sheet 1

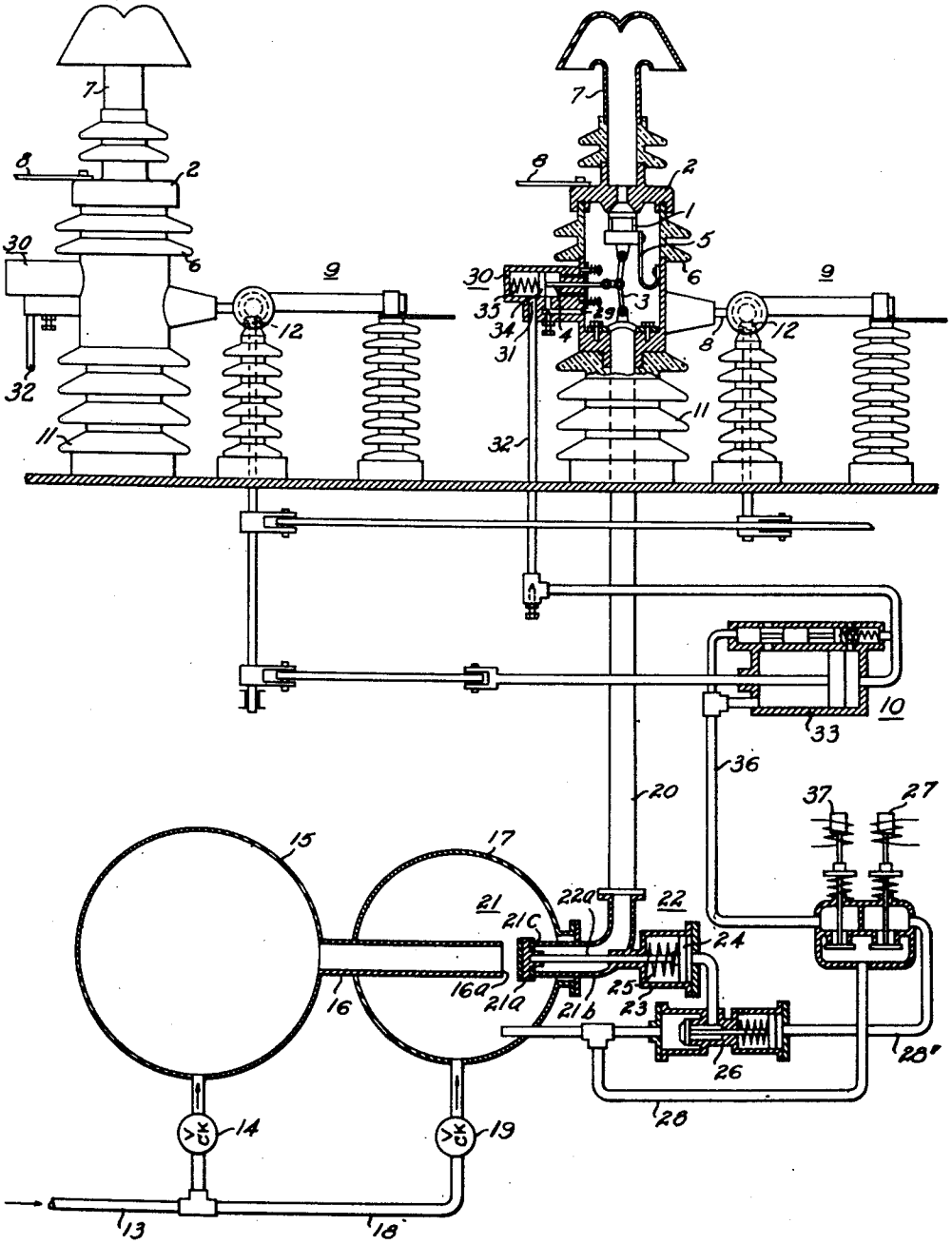

Fig. 1

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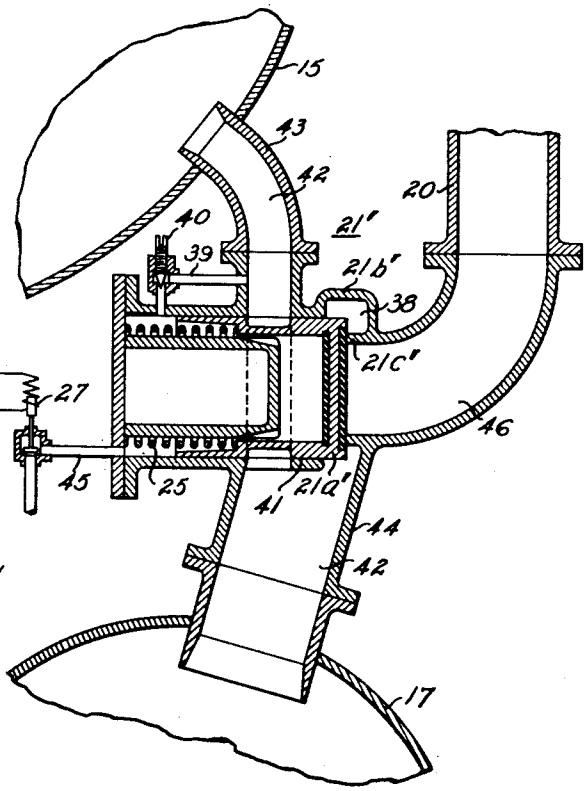

Fig. 2

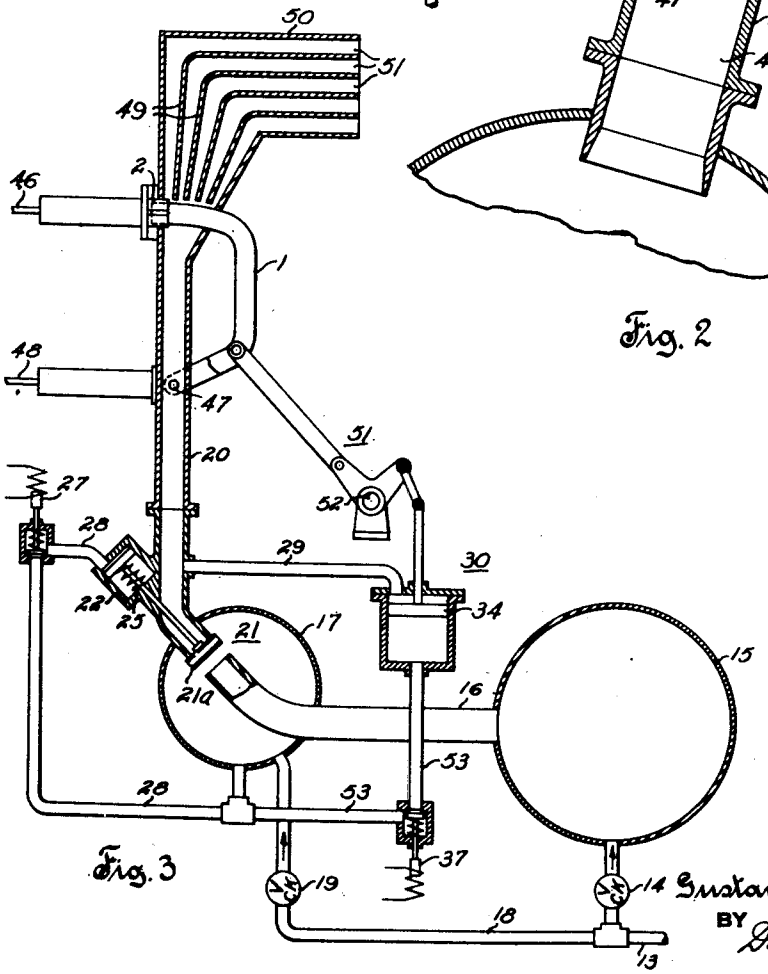

Fig. 3

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GAS BLAST BREAKER HAVING TWO TANKS AND A TANK INTERCONNECTING VALVE

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9 Claims. (Cl. 200—82)

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The present invention relates to electric circuit breakers of the fluid blast type, and more particularly to means for preventing re-establishment of the arc subsequent to a current zero with a minimum of consumption of arc extinguishing fluid.

The operation of fluid blast circuit breakers requires a relatively high initial blast intensity for establishing a sufficiently high dielectric level across the gap formed between the separated contacts. Upon once having established the required dielectric level, the same may be maintained by means of a blast of relatively smaller intensity.

There exists for any given set of conditions a most desirable blast intensity-time characteristic. In order to operate a circuit breaker with a minimum consumption of arc extinguishing fluid, the actual blast intensity-time characteristic must be as close as possible to the blast intensity-time characteristic which is the most desirable under prevailing conditions.

Various arrangements may be used for obtaining any desired blast intensity-time characteristic. For instance, arc extinguishing fluid under pressure may be supplied from a blast reservoir or breaker tank having a relatively limited capacity sufficient for one single interrupting process, or may be two interrupting processes, but not substantially exceeding the capacity required for that purpose. Upon initiation of the escape of arc extinguishing fluid from a one-shot tank, the pressure therein decreases rapidly, resulting in a rapid decrease of the blast intensity to the relatively small magnitude required for maintaining the proper dielectric level across the gap formed between the separated contacts of the breaker. Because of this rapid decrease of blast intensity, a fluid blast circuit breaker having a one-shot tank permits to be operated with a minimum consumption of arc extinguishing fluid.

Yet one-shot tank type circuit breakers are unsatisfactory in certain respects. Since it takes considerable time to refill a blast reservoir or breaker tank by means of a compressor, one-shot tank type circuit breakers are inapplicable wherever it is required to effect more than one interrupting operation within a relatively short interval of time as, for instance, in the case of high-speed reclosing service.

For this reason it has become accepted practice, in cases involving a duty cycle comprising more than one interrupting operation occurring within a short interval of time, to provide fluid blast circuit breakers with a blast reservoir or breaker tank having relatively large dimensions

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and sufficient storage capacity to supply the amount of arc extinguishing fluid required for a plurality of interrupting operations. Provision of over-sized blast reservoirs or breaker tanks of that kind, aside from increasing the fixed cost, precludes operation of a fluid blast circuit breaker with a minimum of consumption of arc extinguishing fluid because the large capacity of the tank results in a relatively slow decrease, subsequent to initiation of the escape of fluid therefrom, of the pressure prevailing therein which, in turn, results in maintaining a fluid blast of larger magnitude than required for preventing re-establishment of the arc after initial arc extinction.

Another type of fluid blast circuit breaker comprises a blast reservoir or breaker tank from which the arc extinguishing blast is derived, and, in addition thereto, another fluid reservoir or storage tank which is connected to the blast reservoir or breaker tank by a fluid conduit of relatively large cross section. That fluid conduit is controlled by a differential valve which is normally biased to open position thereof but closes when, owing to opening of the blast valve of the circuit breaker, the difference in pressure between the two aforementioned reservoirs or tanks increases beyond a predetermined value. Since the drop of pressure occurring upon opening of the blast valve is very rapid, this results in rapid closing of the differential valve, thus making it possible to obtain a favorable blast intensity-time characteristic similar to that which can be obtained when using a one-shot or similar small capacity tank. This type of circuit breaker comprises, in addition to the differential valve-controlled tank-interconnecting conduit which has a relatively large cross-section, a tank interconnecting conduit of relatively smaller cross-section, which is permanently open. Upon closing of the blast valve the pressure in the blast reservoir or breaker tank increases gradually owing to the leakage flow of fluid under pressure through the permanently open tank interconnecting conduit of relatively small cross-section. When, owing to that leakage flow, the pressure in the breaker tank reaches a predetermined value, the large tank-interconnecting conduit is opened by the operation of the differential valve which is arranged therein, thus resulting in equalization of the pressure within the two tanks. It is apparent that it requires a relatively long time for the leakage flow between the two tanks to cause the differential valve to open and thereby to make the circuit breaker ready for a second circuit

interrupting operation. For this reason circuit breakers which are provided with a differential valve interconnected two-tank pressure fluid system do not lend themselves very readily to applications involving rapidly recurring circuit interruptions as required, for instance, in the case of high-speed reclosing service. Nor do such circuit breakers lend themselves to a perfect coordination of the operation of the blast valve and the tank interconnecting valve.

It is, therefore, one object of the present invention to provide a circuit breaker of the fluid blast type which permits rapid sequential interrupting operations with a minimum of consumption of arc extinguishing fluid and which lends itself to high-speed reclosing service.

Another object of the present invention is to provide a circuit breaker of the type comprising a breaker tank, a storage tank, and a valve interconnecting said two tanks wherein said valve is positively actuated independently of the difference in fluid pressure between said tanks.

Another object of the present invention is to provide a circuit breaker of the fluid blast type having a blast reservoir or breaker tank and, in addition thereto, another fluid reservoir or storage tank, wherein the operation of the blast valve and of a tank-interconnecting valve are perfectly coordinated.

A further object of the present invention is to provide a circuit breaker of the fluid blast type which permits high-speed resetting of the blast valve.

Still another object of the present invention is to provide a circuit breaker of the fluid blast type in which the blast valve and the valve interconnecting the breaker tank and the storage tank are combined to form a compact and inexpensive self-contained structural unit.

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

Fig. 1 is a view, partly in vertical cross-section and partly in side elevation, of a circuit breaker of the outdoor type embodying the features of the present invention; and

Fig. 2 is a vertical cross-section through a modified embodiment of the valve means used for controlling the arc extinguishing blast and the valve means used for controlling the flow of fluid under pressure from the storage tank into the breaker tank.

Fig. 3 is a view, partly in vertical cross-section and partly in side elevation, of a circuit breaker of the indoor type or station breaker embodying the features of the present invention.

Referring more particularly to the drawing by characters of reference, Fig. 1 illustrates a high voltage circuit breaker comprising a movable contact 1 which cooperates with a tubular contact 2 to make or break an electric circuit. The movable contact 1 is operated by a toggle linkage 3 which is actuated by a reciprocating rod 4. The movable contact 1 is connected into the circuit by a flexible conductor 5, and is arranged within a tubular insulator 6 forming an arcing chamber. Stationary contact 2 is associated with a structure 7 which serves as an exhaust as well as a cooling means for the arc products. The upper and lower portion of the circuit breaker column are provided each with a terminal element 8. The lower terminal element 8 is connected to a disconnect switch which has been generally indicated by the reference number 9.

Switch 9 comprises bevel gear 12 and is adapted to be operated by a fluid motor 10. The design of disconnect switch 9 and of the fluid motor 10 have no immediate bearing upon the present invention and, therefore, do not call for a more detailed description. A tubular insulator 11 supports the circuit breaker column which consists of the tubular insulator 6 and the aforementioned parts which are arranged therein or associated therewith.

A source of fluid under pressure, such as a compressor (not shown) may supply fluid under pressure through a pipeline 13, which includes a check valve 14, to the storage reservoir or storage tank 15. Storage tank 15 is connected by means of tube 16 to the breaker tank 17. Pipe 18, which includes a check valve 19, by-passes storage tank 15 and is adapted to supply breaker tank 17 with fluid under pressure directly from the compressor. It will be noted that the cross-section of pipelines 13 and 18 is relatively small, while the cross-section of the tube 16 is relatively large. Blast tube 20 connects breaker tank 17 and the tubular supporting insulator 11. The flow of fluid under pressure from tank 15 to tank 17 and the flow of fluid from tank 17 to the tubular supporting insulator 11 and the breaker contacts 1, 2 is controlled by a common valve means which has been generally designated by the reference numeral 21. The valve structure 21 is adapted to be operated by a fluid motor 22 comprising a cylinder 23, a piston 24 and a biasing spring 25. The operation of fluid motor 22 may be initiated by operation of pilot valve 26 which, in turn, may be caused to operate by energizing solenoid trip valve 27. Upon energizing of solenoid trip valve 27, fluid under pressure flows from tank 17 through a pipe line 28 connected thereto, through trip valve 27, and through a pipe line 28' to pilot valve 26. The piston rod 22*a* of fluid motor 22 controls a valve body 21*a* which closes or seals the passage means 20 and opens the passage means 16, or alternatively opens the passage means 20 and closes or seals the passage means 16. It will be noted that the free end of tube 16 and the free end of valve housing 21*b* form valve seats 16*a* and 21*c*, respectively, which are adapted to cooperate with valve body 21*a*. Passages 29 are adapted to supply fluid under pressure from the inside of insulator 6 to the contact operating fluid motor which has been generally designated by reference numeral 30. Fluid motor 30 is adapted to operate contacts 1 and 2 through reciprocating contact operating rod 4 and linkage 3. Air under pressure rushing through pipe 20 and passages 29 causes piston 34 of fluid motor 30 to move from right to left, resulting in moving operating rod 4 from right to left, and consequently in separation of cooperating contacts 1, 2. Upon closing of blast valve 21 spring 35 of fluid motor 30 moves piston 34 from left to right, resulting in moving the operating rod 4 from left to right, and consequently in closing cooperating contacts 1, 2.

Normally blast valve 21 is closed by reason of the biasing action of spring 25. When trip valve 27 is energized, air under pressure is permitted to flow from tank 17 through pipe line 28, through trip valve 27, and through pipe line 28' to pilot valve 26, thereby causing the latter to open. This, in turn, permits air under pressure to flow from tank 17 in back of piston 24, thus causing piston 24 to move from right to left, thereby compressing spring 25. When valve body 21*a* is lifted from valve seat 21*c* a blast of fluid under

pressure rushes through valve housing 21b, blast tube 20 and tubular supporting insulator 11 into the arcing chambers formed by the tubular insulator 6. The portion of the blast which branches off through passage 29 causes the contacts 1, 2 to separate as described above. The arc initiated between the separating contacts 1, 2 is acted upon by a blast of arc extinguishing fluid under pressure. The blast storage capacity of tank 17 is sufficient for one complete interrupting operation, i. e. that tank is capable of supplying one initial high-intensity blast and one subsequent low intensity blast which lasts until the contacts of the disconnect switch 9 have parted a safe distance. Consumption of fluid under pressure beyond the amounts needed for arc extinction and for maintaining temporarily the required dielectric level between the separated contacts 1, 2, is strictly precluded by reason of the fact that tube 16 remains closed as long as fluid under pressure is permitted to escape from tank 17 to blast tube 20. When valve 27 and pilot valve 26 are reclosed after a certain time interval (which is achieved by means well known in the art, not shown in the drawing) piston 24 of fluid motor 23 and valve body 21a move from left to right and the flow of fluid under pressure from breaker tank 17 to blast tube 20 is stopped. Simultaneously conduit 16 is opened, resulting in a rapid restoration of the pressure level in tank 17 required for a subsequent interrupting operation.

When piston 34 of fluid motor 30 moves from right to left during the interrupting process of the circuit breaker, it uncovers port 31 of insulating pipe 32, thus permitting cylinder 33 of fluid motor 10 to be supplied with fluid under pressure. This results in opening of disconnect switch 9. Contacts 1, 2 reclose only upon insertion of a sufficient amount of circuit insulation by disconnect switch 9. Upon interruption of the circuit, reclosing thereof is effected by closing of disconnect switch 9. To this end fluid under pressure is admitted to fluid motor 10 by opening closing solenoid valve 37, thus admitting fluid under pressure through pipe 36 to motor 10.

By-pass conduit 18 helps increasing the speed of restoring the initial pressure in tank 17 by means of fluid under pressure directly supplied from the compressor, but may be omitted if this particular feature is not deemed necessary.

As indicated in Fig. 1, the breaker may comprise several identical pole units, one for each phase of a multi-phase circuit.

In Fig. 2 the same reference numerals as in Fig. 1 have been supplied to like parts. Thus, reference numeral 15 indicates the storage reservoir or storage tank, reference numeral 17 indicates the breaker reservoir or breaker tank, and reference numeral 20 the blast tube. The valve structure 21' comprises the valve housing 21b' and a valve body 21a' movably arranged therein. The valve body 21a' has the form of a piston which is biased by a helical spring 25 toward the right. This tends to press the right end surface of piston 21a' against valve seat 21c' formed by valve housing 21b', resulting in a pressure-tight seal between tank 17 and blast tube 20. Fluid under pressure is applied against both the right end surface and the left end surface of piston 21a'. Application of fluid under pressure derived from tank 17 against the right end surface of piston 21a' is effected by means of a substantially annular space 38 formed by valve housing 21b'. Application of fluid under pressure derived from tank 15 against the left end surface of piston 21a' is effected by a fluid conduit 39 comprising the needle valve 40. The lateral surface 41 of piston 21a' is adapted for alternatively opening or closing fluid passage 42 which connects storage tank 15 and breaker tank 17. Passage 42 is formed by valve housing 21b' and the tubular elements 43 and 44 of which the former is secured to tank 15 and the latter to tank 17. In the position shown, the lateral surface 41 of piston 21a' permits fluid under pressure to flow from tank 15 through fluid passage 42 into tank 17. However, no fluid under pressure can escape from tank 17 to the blast tube 20 and the circuit breaker column (shown in Fig. 1) since the right end surface of piston 21a' is tightly pressed against the valve seat 21c'. In the position shown in Fig. 2, the pressure of spring 25 tending to move piston 21a' from left to right plus the pressure of fluid derived from tank 15 through conduit 39 and tending to move piston 21a' in the same direction, by far exceed the pressure of fluid derived from tank 17 and tending to move piston 21a' in the opposite direction. A venting conduit 45 is connected to the left end of cylinder 21b', and this conduit is controlled by solenoid tripping valve 27. Upon energization of tripping valve 27 the left end of cylinder 21b' is instantly vented, resulting in a sudden breakdown of the fluid pressure acting upon piston 21a' in the direction from left to right. Pressure of spring 25 is now far exceeded by the pressure of fluid acting upon the right end surface of piston 21a', resulting in a rapid motion of said piston from right to left. In the left position of piston 21a', the lateral surface 41 thereof closes fluid passage 42, but the right piston end surface is removed from valve seat 21c', and thus a passage 46 is opened which permits escape of fluid under pressure from breaker tank 17 to the blast tube 20. The blast of arc extinguishing fluid through blast tube 20 may be interrupted as soon as the separation between the contacts of the disconnect switch 9 has reached a predetermined minimum value and, thereupon, should be effected as rapidly as possible. To this end, tripping valve 27 is reclosed and fluid under pressure which is directly derived from storage tank 15 and which, therefore, has a relatively high pressure, is allowed to act upon the left end surface of piston 21a'. Now the fluid and spring pressure acting upon the left end surface of piston 21a' by far exceed the pressure acting upon the right end surface of piston 21a', the latter being very small since the pressure in tank 17 decreases rapidly when the tank is being emptied through blast tube 20. Because of the great excess in pressure which acts upon the piston or valve body 21a' in the direction from left to right, passage 46 is reclosed and passage 42 reopened extremely rapidly upon reclosing of solenoid valve 27. It will be apparent from the foregoing that the present rapid reclosing feature is not limited to the structure shown in Fig. 2, but may be achieved in any similar arrangement wherein pressure for the reclosing or resetting operation of the valve structure is derived from a tank, other than the breaker tank, wherein no reduction of pressure occurs previous to the reclosing or resetting operation. The rate at which pressure is built up for reclosing or resetting valve structure 21' may conveniently be controlled by adjusting needle valve 40.

In Fig. 3 the same reference numerals as in Fig. 1 have been applied to like parts. Storage tank 15 is connected to breaker tank 17 by pipe 16. Both pipe 16 and blast tube 20 are controlled by valve structure 21 which is operated by fluid motor 22. The electric circuit comprises the upper terminal member 46, stationary finger contact 2, the cooperating movable sickle shaped contact 1 which is rotatably supported at 47, and the lower terminal member 48. The arc formed upon separation of contacts 1, 2 is blown by the blast rushing through blast tube 20 against the upstream edges of partitions 49 by which arc chute 50 is subdivided into a plurality of blast passages 51. Opening of solenoid tripping valve 27 causes fluid motor 22 to move valve body 21*a* of valve 21 so as to admit an arc extinguishing blast adjacent contacts 1, 2 and to close passage 16. Fluid under pressure flowing through pipe 29 which branches off blast tube 20 moves piston 34 of fluid motor 30 in a downward direction. Fluid motor 30 thus opens contacts 1, 2, of which the former is connected to motor 30 by a linkage generally indicated by reference numeral 51 and including rock shaft 52. The amount of fluid under pressure stored in tank 17 is sufficient to produce an arc extinguishing blast for one interrupting process and to cause separation of contacts 1, 2. Solenoid valve 27 recloses after a predetermined open time (on account of the provision of means not shown in the drawing) and thereupon valve body 21*a* is reset by the action of spring 25, resulting in reclosing of blast tube 20 and reopening of replenishing conduit 16. Reclosing of contacts 1, 2 is initiated by closing solenoid valve 37 admitting fluid under pressure from tank 17 through pipe 53 to motor 30. The latter causes rotation of contact 1 about fulcrum 47 in a counter clockwise direction, as seen in Fig. 3.

It will be noted that motor 22 is a common means for controlling the contact operating fluid motor 30 as well as the flow of fluid through pipes 16 and 20.

Although but a few embodiments of the present invention have 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 a fluid blast circuit breaker the combination of an arcing chamber, a pair of cooperating contacts arranged in said chamber, actuating means for said contacts, a source of fluid under pressure, a storage tank adapted to be supplied with fluid under pressure from said source, a breaker tank, a valve housing defining a first fluid passage connecting said breaker tank and said arcing chamber, and also defining a second fluid passage connecting said storage tank and said breaker tank, a reciprocating valve body for alternatively opening one and closing the other of said fluid passages, said valve body having an end surface adapted for controlling said first fluid passage and a lateral surface adapted for controlling said second fluid passage.

2. In a fluid blast circuit breaker the combination of an arcing chamber, a pair of cooperating contacts arranged in said chamber, actuating means for said contacts, a source of fluid under pressure, a storage tank adapted to be supplied with fluid under pressure from said source, a

breaker tank, a valve housing defining a first fluid passage connecting said breaker tank and said arcing chamber, and also defining a second fluid passage connecting said storage tank and said breaker tank, a valve seat formed by said valve housing and forming part of said first fluid passage, a piston arranged in said valve housing to be moved to either of two extreme positions, said piston having one end surface adapted to engage said valve seat and close said first fluid passage in one extreme position thereof, and to be disengaged from said valve seat and open said first fluid passage in the other extreme position thereof, said piston having a lateral surface adapted to close said second fluid passage in the disengaged position of said piston end surface and to open said second fluid passage in the engaged position of said piston end surface.

3. In a fluid blast circuit breaker the combination of a pair of cooperating contacts, actuating means for said contacts, a source of fluid under pressure, a first reservoir, passage means having a relatively small cross-section for connecting said source with said first reservoir, a second reservoir, passage means having a relatively large cross-section for interconnecting said first reservoir and said second reservoir, and a two-way valve adapted for controlling a replenishing fluid flow from said first reservoir into said second reservoir and for controlling an arc extinguishing fluid blast from said second reservoir adjacent said pair of contacts, said two-way valve having two positions and comprising means for establishing said replenishing fluid flow and for interrupting said arc extinguishing fluid blast in one position thereof, and for precluding said replenishing fluid flow and for establishing said arc extinguishing fluid blast in the other position thereof.

4. In a fluid blast circuit breaker the combination of a pair of cooperating contacts, actuating means for said contacts, a source of fluid under pressure, a first reservoir, passage means having a relatively small cross-section for connecting said source with said reservoir, a second reservoir, passage means having a relatively small cross-section for supplying said second reservoir with fluid under pressure, passage means having a relatively large cross-section for interconnecting said first reservoir and said second reservoir, a first valve means having an open position and a closed position arranged for controlling the flow of fluid through said large cross-section passage means, a second valve means having an open position and a closed position and connected to said second reservoir for controlling a flow of an arc extinguishing blast from said second reservoir adjacent to said pair of contacts, and a positive mechanical connection between said two valve means for opening said first valve means and simultaneously closing said second valve means, and for closing said first valve means and simultaneously opening said second valve means.

5. In a fluid blast circuit breaker the combination of an arcing chamber, a pair of cooperating contacts arranged in said chamber, actuating means for said contacts, a source of fluid under pressure, a first reservoir, passage means connecting said source with said reservoir, a second reservoir, a fluid motor including a cylinder body defining a first fluid passage for connecting said second reservoir and said arcing chamber, and also defining a second fluid passage for connecting said first reservoir and said second reservoir, a valve seat forming part of said first fluid passage,

a differential piston movably arranged within said cylinder body and having one end surface thereof adapted to engage said valve seat for closing and to be disengaged from said valve seat for opening said first fluid passage, means for supplying fluid under pressure to opposite ends of said piston, tripping means including a venting valve for venting said cylinder body adjacent to one end of said piston, means including a biasing spring for normally keeping said piston in position, means for causing moving of said piston within said cylinder body in response to an opening operation of said venting valve, said piston having a lateral surface adapted to close said second fluid passage when said first fluid passage is open and to open said second fluid passage when said first fluid passage is closed.

6. In a fluid blast circuit breaker the combination of an arcing chamber, a pair of cooperating contacts arranged in said chamber, actuating means for said contacts, a source of fluid under pressure, a storage tank adapted to be supplied with fluid under pressure from said source, a breaker tank, a first passage means connecting said storage tank and said breaker tank, a second passage means connecting said breaker tank and said arcing chamber, a valve having a reciprocating common valve body for controlling both said passage means and comprising means for alternatively closing one and opening the other of said passage means, a fluid motor for operating said common valve body comprising a cylinder and a piston operatively arranged therein, closable venting means responsive to a circuit condition for venting said cylinder on one end thereof, biasing spring means for normally keeping said piston in position and resetting said piston upon being moved out of position, means for supplying fluid under pressure to opposite ends of said cylinder comprising a passage means for establishing a direct connection between said storage tank and the end of said cylinder adapted to be vented by said venting meas.

7. In a fluid blast circuit breaker, the combination of a pair of cooperating contacts, actuating means for said contacts, a source of fluid under pressure, a first reservoir supplied with fluid under pressure from said source, a second reservoir supplied from said first reservoir, a first valve means in the connection between said second reservoir and the space adjacent said contacts to prevent a flow of an arc extinguishing blast from said second reservoir adjacent said pair of contacts under the action of the pressure in said second reservoir, a second valve means providing an open interconnection between said first reservoir and said second reservoir, and common operating means for simultaneously actuating said first valve means to open position and said second valve means to closed position

and alternatively said first valve means to closed position and said second valve means to open position.

8. In a fluid blast circuit breaker, the combination of a pair of cooperating contacts, actuating means for said contacts, a source of fluid under pressure, a first reservoir supplied with fluid under pressure from said source, a second reservoir supplied from said first reservoir, a first valve means in the connection between said second reservoir and the space adjacent said contacts to prevent a flow of an arc extinguishing blast from said second reservoir adjacent said pair of contacts under the action of the pressure in said second reservoir, a second valve means providing an open interconnection between said first reservoir and said second reservoir, common motor means for simultaneously actuating said first valve means to open position and said second valve means to closed position and alternatively said first valve means to closed position and said second valve means to open position, and a second motor means actuated by the fluid under pressure in said second reservoir for controlling the operation of said common motor means.

9. In a fluid blast circuit breaker, the combination of an arcing chamber, a pair of cooperating contacts arranged in said chamber, actuating means for said contacts, a source of fluid under pressure, a storage tank adapted to be supplied with fluid under pressure from said source, a breaker tank, a first passage means connecting said storage tank and said breaker tank, a second passage means connecting said breaker tank and said arcing chamber, valve means comprising a reciprocating common valve body for preventing a flow of an arc extinguishing blast from said breaker tank to said second passage means and for providing an open interconnection in said first passage means between said storage and breaker tanks, and common operating means for actuating said valve means to open said second passage means and close said first passage means and alternatively close said second passage means and open said first passage means.

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