

Jan. 28, 1958

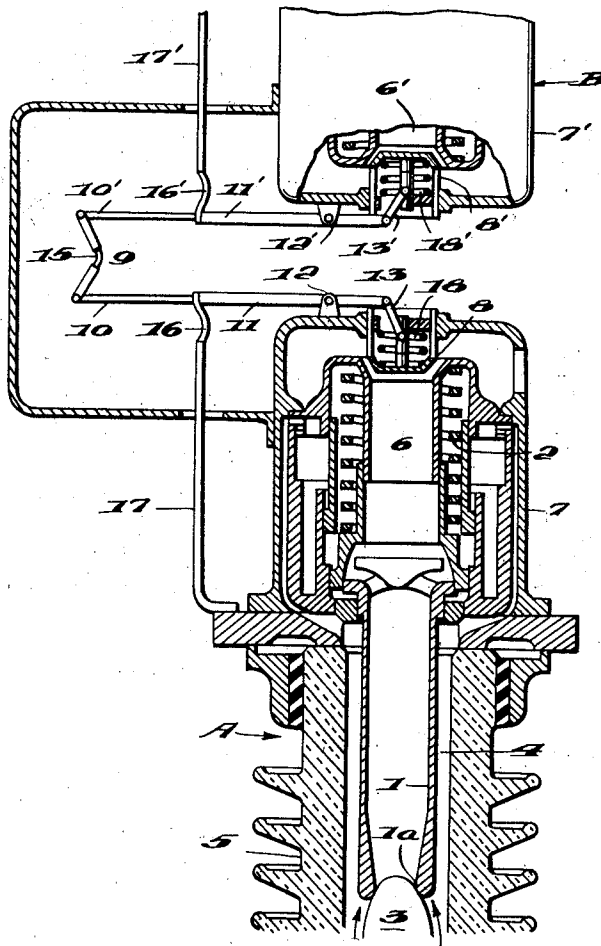
P. BALTENSERGER
GAS BLAST CIRCUIT BREAKER

2,821,607

Filed Jan. 27, 1956

3 Sheets-Sheet 1

Fig. 1.



INVENTOR
PAUL BALTENSPERGER,

BY *Pierce, Scheffler & Parker*
ATTORNEYS

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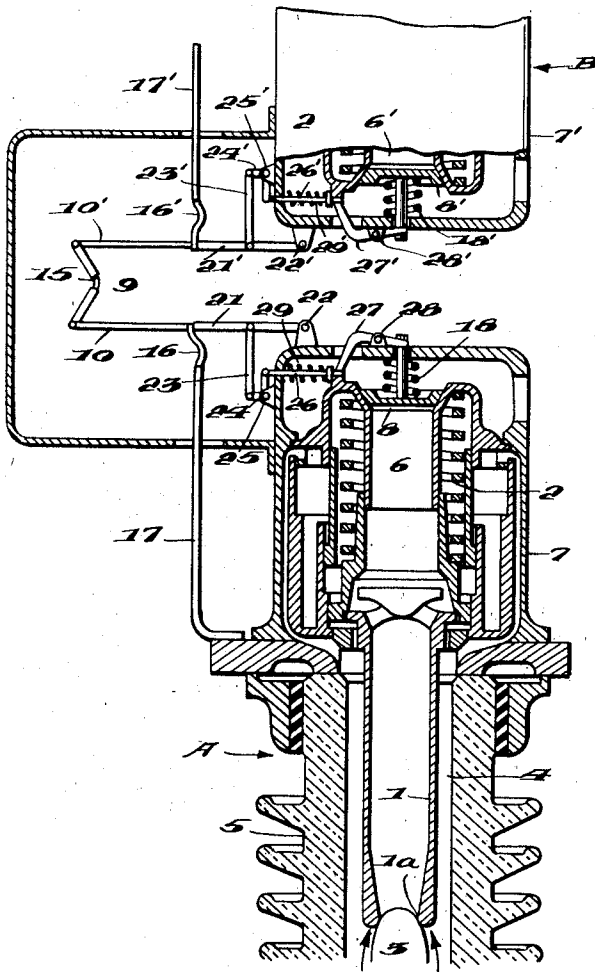
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Fig. 2.



INVENTOR
PAUL BALTENSPERGER,

BY *Pierce, Schiffler & Parker*
ATTORNEYS

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Fig. 4.

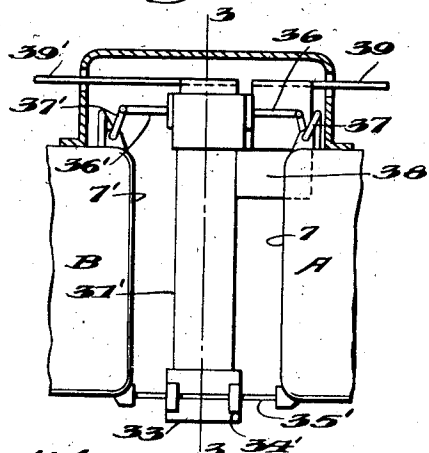


Fig. 3.

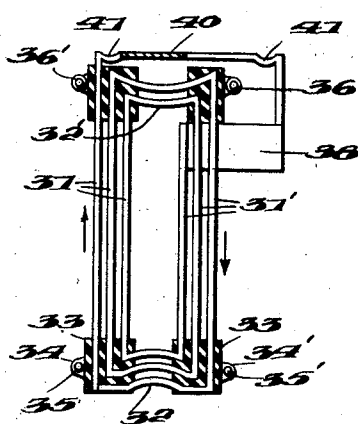


Fig. 5.

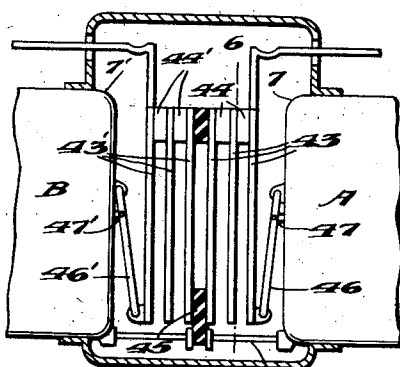


Fig. 6.

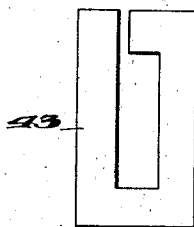


Fig. 7.

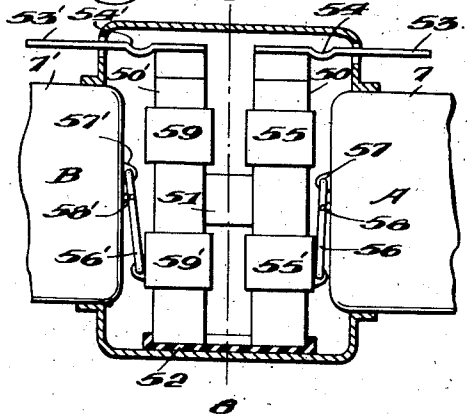
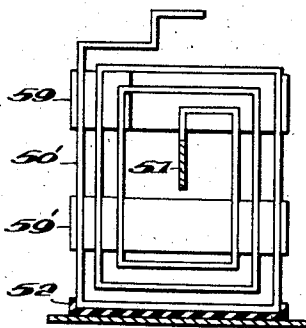


Fig. 8.



INVENTOR

PAUL BALTENSPERGER,

BY

Pierce, Schefflin & Parker
ATTORNEYS

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2,821,607

GAS BLAST CIRCUIT BREAKER

Paul Baltensperger, Baden, Switzerland, assignor to Aktiengesellschaft Brown, Boveri & Cie, Baden, Switzerland, a joint-stock company

Application January 27, 1956, Serial No. 561,872

Claims priority, application Switzerland January 29, 1955

18 Claims. (Cl. 200—148)

The present invention relates to electrical circuit breakers and in particular to those of the gas blast type comprising one or more sets of cooperative pin and nozzle contacts disposed within a chamber into which compressed air is admitted for causing the contacts to be separated thus breaking the electrical circuit and effecting a flow of the pressure air through the nozzle contact which thereby bathes the resulting arc on all sides and assists in extinguishing the same. A circuit breaker operating in accordance with these general principles can be found described in United States Patent No. 2,279,536, issued April 14, 1942, to Hans Thommen and assigned to the same assignee as is the present application.

In gas blast circuit breaker constructions originally designed, the compressed air for separating the contacts supplied from a tank connected with an air compressor, was generally independent of the magnitude of the load current required to be broken at the contacts. For such reason it originally was necessary that the full amount of air available at the contacts be used regardless of the magnitude of current to be broken at the contacts. The result was an unnecessary waste of compressed air in those cases where the load current was below the maximum for which the breaker was designed and only a relatively small fraction of the total available amount of compressed air was actually necessary to extinguish the arc. Such unsatisfactory arrangement in some cases led to unnecessarily large dimensions for the air compressor and an unnecessarily high stress on the mechanical parts of the circuit breaker. Moreover, there was the possibility that the arc might break off under relatively low current conditions even before the passage through zero, thus causing unnecessary overvoltages.

Because of the foregoing disadvantages it has previously been suggested to regulate the amount of gas flowing to the contact junction, or its pressure, or the type of gas used, in accordance with the magnitude of the current to be broken at the contacts. To this end, it has been proposed that a valve controlling the gas flow be opened to a varying extent in accordance with the magnitude of the pressure produced by the arc itself. Since the arc pressure increases with an increase in the current which is broken it is thus possible to control the amount of gas such as compressed air supplied to the contact chamber. A disadvantage of this arrangement is that the flow of the arc extinguishing agent does not coincide with the start of contact separation but rather lags behind the same. Electromagnets have been provided which are energized by the current flowing through the contacts and which control air valves by means of movable iron cores. Special magnets and coils are required for this purpose which must withstand dynamically and thermally the highest value of current that the breaker is designed to interrupt. However this is difficult to achieve with the very high currents in the highly meshed networks which are common today, and which therefore require additional measures such as shunting of the current.

Another known possibility of varying the gas in ac-

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cordance with the current to be broken at the contacts is to use gas that is at a higher pressure for the higher currents than it is at lower currents, or to use one type of gas at higher currents and another type at lower currents. The control is, in most cases, effected automatically by short circuit relays. This, however, requires additional devices which complicate the construction of the circuit breaker and the air compressor plant.

The device according to the present invention is designed to control the flow of compressed air to the switch contacts in a most simple and direct manner, and without any time lag, by the current to be disconnected at the switch contacts. As known, whenever a conductor loop is formed and current is passed through the loop, electrodynamic forces are formed in the loop which tend to pull the loop apart. This effect is employed in accordance with the present inventive concept, namely in that forces formed in a conductor loop through which is passed the current to be broken at the switch contacts are caused to control operation of a valve in the switch chamber through which valve the compressed air is exhausted, to the end that the amount of compressed air which passes through the contact breaking area and through the nozzle contact to bathe the arc and extinguish the same will be varied in accordance with the magnitude of the current. The valve control may be such that the valve opening varies in accordance with the magnitude of the current; alternatively, the control may be such that the valve remains locked in a closed position until the current reaches a predetermined threshold value at which instant the valve is unlocked and then opens automatically under the force of the compressed air exerted against the same in opposition to a closing spring. Moreover, the invention is applicable to a single circuit breaker or to a plurality of circuit breakers providing a plurality of sets of nozzle and pin contacts connected electrically in series by conductors located outside of the circuit breaker casings, it being possible to arrange for one conductor loop between two circuit breakers to control the air exhaust valves on both breakers.

The return of the valve to its starting position is effected by spring action just shortly after the disconnection process. The inverse method of operation is also possible wherein the exhaust valve is closed by the compressed air and is opened directly by the dynamic action, counter to the air closing force, in the conductor loop.

In accordance with the invention, the conductor loops producing the dynamic forces for actuating the exhaust valves can be designed in the form of a single turn or in the form of a spiral winding having a plurality of turns and thereby increasing the magnitude of the valve actuating dynamic forces. In such event, it is preferred to give the turns of the spiral a rectangular configuration. Two opposite sides of the rectangular configured turns can be made rigid and the other two opposite sides of the turns can be made flexible. Current flows through opposite sides of each turn in the opposite direction and the increased force between the opposite sides is produced by the sum of the currents flowing on each side. Since the forces are proportional to the square of the currents, the dynamic action of the forces is thus highly increased by this arrangement of the conductor loops, and the motion of the opposite sides of the spiral rectangular winding is then imparted directly to the exhaust valve for its control, or indirectly by way of a locking pin which unlocks the valve when the current reaches a predetermined threshold level.

It is also possible, in accordance with the invention, to use two spacially parallel spiral windings which are entirely rigid in themselves but which are interconnected by line elements that are flexible. In this case, the currents flow in each turn of the spirals in the same direc-

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tion so that they attract each other in a slidable manner, and such forces of attraction are used for the control of the air exhaust valve. Here, too, the electro-dynamically derived exhaust valve actuating forces are much greater than those obtainable with a single turn conductor loop.

The conductor loop can also be arranged in the form of a helix wherein also one obtains the benefit of increased electro-dynamic forces because of the presence of a plurality of turns. In this case, the current flows in each turn of the helical winding in the same direction so that the turns also attract one another, which attraction is utilized for control of the air exhaust valve. In circuit breaker arrangements providing several switching points, where two points each have a common conductor loop for controlling the valve, such loop can consist of two helical parts.

The foregoing briefly described different embodiments of the invention will now be more specifically explained in conjunction with the accompanying drawings which show such embodiments, it being noted in particular that all such embodiments employ one conductor loop to control the air exhaust valves on two adjacently located circuit breakers each having a set of nozzle and pin contacts. In these drawings:

Fig. 1 is a view partly in elevation and partly in vertical central section through a circuit breaker arrangement wherein the electro-dynamic forces used for controlling the air exhaust valves of both circuit breakers are derived from an essentially single turn conductor loop, the extent of the valve opening being varied in accordance with variation in the current to be broken at the circuit breaker contacts such that the greater the current the greater will be the valve opening;

Fig. 2 is a view similar to Fig. 1 and illustrating a different valve arrangement wherein the valve remains locked in the closed position by means of a locking pin which is under the control of the electro-dynamic forces in the conductor loop, the arrangement being such that the pin is withdrawn when the current reaches a predetermined threshold level thus releasing the valve and permitting the same to be opened against a counter, spring derived closing force by the force of the compressed air in the contact chamber applied against the under side of the valve.

Fig. 3 shows a conductor loop in spiral form containing a plurality of rectangularly configured turns, the view being in vertical section and taken on line 3—3 of Fig. 4;

Fig. 4 is a fragmentary view in elevation of a pair of interconnected circuit breakers having their respective air exhaust valves controlled by the spiral conductor loop of Fig. 3 arranged between and common to both breakers;

Fig. 5 is a fragmentary view in elevation of a pair of interconnected circuit breakers having their respective air exhaust valves controlled respectively by helical conductor loops arranged between breakers;

Fig. 6 is a view taken on line 6—6 of Fig. 5 and showing essentially one turn of one of the helical loops;

Fig. 7 is a fragmentary view in elevation of a pair of interconnected circuit breakers having their air exhaust valves controlled respectively by spirally configured conductor loops, the loops being so arranged that the electro-dynamic forces therebetween are such as to draw the loops together by sliding action; and

Fig. 8 is a view taken on line 8—8 of Fig. 7 and showing one of the spiral conductor loops.

With reference now to the drawings, and to Figs. 1 and 2 in particular, the gas blast circuit breaker A is seen to comprise a nozzle contact 1 movable longitudinally of itself in an upward direction against the biasing counterforce developed by a helical spring 2, the lower, open end 1a of the nozzle contact 1 being normally urged by spring 2 into engagement with a stationary pin contact 3. Contacts 1 and 3 are located within the interior 4 of a hollow insulator column 5. When the signal occurs to effect separation of the nozzle contact 1 from its

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counter stationary pin contact 3, compressed air is delivered upwardly through the interior 4 of column 5 from a supply tank (not shown) at the base or opposite end of the insulator column 5, the air flowing in the direction indicated by the arrows and causing upward movement of nozzle contact 1 to separate the same from the pin contact 3. Air now flows into the opening 1a at the end of the nozzle contact, bathing on all sides the arc established upon contact separation, and then flows upwardly through the nozzle contact 1 and through the hollow space 6 arranged within a metallic housing 7 built upon the column 5, towards the air exhaust valve 8 disposed at the upper, outlet end of the hollow space 6 and which controls the amount of air permitted to flow upwardly through the nozzle contact.

In accordance with the present invention, the size of the outlet at valve 8 is controlled in accordance with the magnitude of the current flowing through a conductor loop 9 which is comprised of two parallel, spaced apart rigid conductor members 10, 10' which are joined respectively at one end thereof to rods 11, 11' constituting longitudinal rigid extensions of the rigid conductor members 10, 10'. Rod 11 is pivotally mounted intermediate its ends at a fulcrum 12 and the opposite end of rod 11 is connected by a link 13 to the valve member 8. In a similar manner, rod 11' is pivotally mounted intermediate its ends at a fulcrum 12', and the opposite end of rod 11' is connected in a similar manner to a link 13' which is connected to the valve member 8' that controls the compressed air outlet from hollow space 6' of a second circuit breaker B which is identical with circuit breaker A below it and which has been described in detail.

The rigid conductors 10 and 10' are interconnected at their left ends by a flexible conductor 15 and similar flexible conductors 16 and 16' connect the right ends of conductors 10 and 10' with conductors 17 and 17' which lead the circuit breaker current to the nozzle contacts of the circuit breakers A and B.

The action of the current flowing in the conductor loop 9 consisting of the branches 10, 10' and 15 is such as to establish electro-dynamic forces within the loop which tend to cause the rigid conductor members 10 and 10' to move further apart in accordance with the magnitude of the current thus rotating the rods 11 and 11' about their respective fulcrums 12, 12' in such manner as to cause their respectively actuated valve members 8 and 8' to move to a more open position counter to the restoring forces established respectively by their biasing springs 18 and 18'.

In the embodiment of the invention illustrated in Fig. 2 it will be observed that it is basically the same as that shown in Fig. 1 and hence corresponding and like constructed elements have been assigned the same reference numerals. The principal differences lie in the construction of the air exhaust valve and in the means for actuating the same from the conductor loop 9. In particular, according to this arrangement the valves 8 and 8' are locked in their closed positions until the current reaches a predetermined threshold value whereupon the electro-dynamic forces developed in the conductor loop 9 become strong enough to unlock the valves and the latter then open against their loading springs by the pressure of the compressed air in the contact chamber. To this end it will be seen that the rods 21, 21' which constitute longitudinal extensions of the rigid conductors 10 and 10' are pivoted at their opposite ends on fulcrums 22 and 22'. A link 23 interconnects rod 21 at an intermediate point on the latter with one arm of a bellcrank lever 24 which is pivotally mounted at the outer side wall of housing 7 of circuit breaker A on fulcrum 25. The other arm of lever 24 is pivotally connected to one end of a locking pin 26 which projects through an aperture in the side wall of housing 7, the opposite end of pin 26 normally engaging the lower end

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of one arm of a second bellcrank lever 27 fulcrumed at 28, the other arm of lever 27 being connected pivotally to the stem of valve 8. A helical spring 29 surrounds pin 26 and is arranged to bias the pin to the right as viewed in Fig. 2, i. e. in the position where the right end of the pin engages the lower end of the arm of the lever 27 thereby locking the same against rotation, and hence also locking the valve 8 against displacement from its closed position indicated on the drawing. A similar construction is employed to connect rod 21' to the valve 8' of the other circuit breaker B and hence corresponding elements have been assigned the same reference numerals but with primes added thereto for purposes of distinction.

As long as the operating current is below a predetermined threshold value determined by the biasing forces exerted respectively by springs 29 and 29', the electrodynamic forces developed in the conductor loop 9 will not be sufficient to withdraw the locking pins 26, 26' from their respective positions beneath the lower ends of the arms of bellcrank levers 27 and 27' with the result that the valves 8 and 8' remain closed. When, however, the circuit current flowing through the contacts 1, 3 of the circuit breakers A and B reaches that predetermined threshold value, the pins 26, 26' will be withdrawn due to movement of rods 21, 21', links 23, 23' and bellcrank levers 24, 24' thus releasing the bellcrank levers 27, 27' so that the latter are now able to rotate about their fulcrums 28, 28' in response to the pressure of the compressed air in the hollow spaces 6, 6' applied against the under faces of valves 8 and 8' thus opening these valves and permitting flow of compressed air therethrough. The counterforce exerted by the biasing springs 29 and 29' can be adjusted thereby to effect a corresponding adjustment in the threshold value of the current necessary to effect an opening of the valves 8 and 8'.

The embodiment of the invention illustrated in Figs. 3 and 4 includes a conductor loop in the form of a spiral comprising a plurality of rectangularly configured turns. Each turn is comprised at two opposite sides by rigid conductor straps 31, 31' and at the other two opposite sides by flexible conductive material 32, 32'. As indicated by the arrows, the current in the several (three) conductive straps 31 passes in the same direction, and the current in the three opposite conductive straps 31' also passes in the same direction. However, the current directions in the two groups of conductors 31, 31' are relatively opposite which increases threefold the force of the currents. Since the electro-dynamic action of the loop increases proportionally to the square of the current, it is about nine times higher.

Each group of the three rigid conductor straps 31, 31' is rendered mechanically rigid by intermediate layers 33 of insulating material and the groups are mounted respectively by bearings 34, 34' on rods 35, 35' extending between two metallic housings 7, 7' of the two circuit breakers A and B. The upper end of conductor group 31 is connected via a rod 36 to a link 37 which is coupled to the compressed air outlet valve corresponding to an exhaust valve 8 in Fig. 1 or to the locking pin corresponding to locking pin 26 in Fig. 2. In a similar manner the upper end of conductor group 31' is connected via rod 36' to link 37' which is coupled to the air exhaust valve or locking pin of its associated circuit breaker B. The current through the conductor loop enters the spiral from conductor strap 38 connected via flexible conductor 41 and conductor 39 to one of the contacts of circuit breaker A shown at the right side of Fig. 4, to the innermost positioned rigid conductor strap 31' and leaves the loop at conductor strap 40 connected to the outermost positioned conductor strap 31, strap 40 being in turn connected via conductor 39' with one of the contacts of circuit breaker B shown at the left side of Fig. 4. The electro-dynamic action of the current passing through the spiral conductive loop shown in Figs. 3 and 4 is

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such as to cause the rigid conductor groups 31, 31' to pivot about their respective support rods 35, 35' thus to actuate the compressed air exhaust valves on the respectively associated circuit breakers.

According to the embodiment of the invention illustrated in Figs. 5 and 6, the conductor loop is constituted in the form of a pair of helices the turns of which consist of rigid conductor straps 43, 43' of substantially rectangular shape connected serially by means of flexible conductor members 44 and 44'. The helix constituted by the conductor straps 43 and flexible conductor members 44, and the helix constituted by the conductor straps 43' and flexible conductor member 44' are both mounted on a common insulating support member 45 located between the helices, the insulating member 45 being in turn supported upon a shaft 49 extending between the metallic housings 7, and 7', of the two circuit breakers A and B. The innermost conductor strap 43 is fixed to the insulating support 45 while the outermost conductor strap 43 is pivotally connected to one end of a rod 46, the other end of the latter being pivotally connected to the housing 7. To an intermediate point along rod 46 is connected a link 47 which actuates the compressed air valve corresponding to valve 8 in Fig. 1 or the locking pin 26 in Fig. 2. In a similar manner the innermost conductor strap 43' is fixed to the insulating support 45 while the outermost conductor strap 43' is pivotally connected to one end of a rod 46', the other end of the latter being pivotally connected to the housing 7'. To an intermediate point along rod 46' is connected the member 47' which has the same function as member 47. Current flows in the same direction through all turns 43 of the helical conductor loop which they form and hence the electro-dynamic action is such as to cause the individual turns to be attracted to each other thus causing the rod 46 and link 47 to be actuated thereby to actuate the compressed air exhaust valve on the switch contact chamber with which such conductor loop is associated or the locking pin associated with such valve. In a similar manner, current flows in the same direction through all the turns 43' of the helical conductor loop which they form and hence the electro-dynamic action is such as to cause the individual turns to be attracted to each other thus causing rod 46' and link 47' to be actuated, thereby to actuate the compressed air exhaust valve on the switch contact chamber with which such conductor loop is associated or the locking pin associated with such valve. The respective currents in the two helical conductor loops flow in the opposite direction however.

In the embodiment of the invention illustrated in Figs. 7 and 8, each circuit breaker has associated with it a conductor loop in which electro-dynamic forces are developed for controlling flow of compressed air through the breaker, the conductor loops being arranged in the form of substantially rectangular spirals placed parallel with each other and in which the current flow through the respective spirals is so arranged that the spirals attract and move toward each other thereby developing the mechanical forces necessary to control their compressed air exhaust valves. According to this construction, as shown in Fig. 8 all sides of each turn of each spiral are constituted by rigid conductor strap material, the turns of the spiral associated with circuit breaker A being numbered 50 and those associated with circuit breaker B being numbered 50'. The two groups of conductor straps 50, 50' are interconnected at the ends of their innermost turns by a flexible conductive material 51 in order to permit the two groups to move toward or away from each other upon a guide channel 52 made from insulating material. For the same reason, conductor 53 extending from one of the contacts in circuit breaker A to the outer end of the outermost turn 50 is connected to the latter via a flexible conductor 54. Similarly, conductor 53' extending from one of the contacts of circuit breaker B is connected to the outer end of the

outermost turn 50' by flexible conductor 54'. The turns 50 are mechanically positioned in their proper spacial relation by mounting the same upon a pair of spaced insulating supports 55, 55' and one of these, for example the support 55', is pivotally connected to one end of a rod 56 the other end of which is pivotally mounted at a fulcrum 57 located on the wall of housing 7. Along the rod 56 is pivotally connected one end of the member 58 which controls the air exhaust valve in circuit breaker A corresponding to valve 8 in Fig. 1, or the locking pin for such valve in Fig. 2. In a similar manner, the turns 50' are mechanically positioned in their proper spacial relation by mounting the same upon a pair of spaced insulating supports 59, 59' and one of these, for example the support 59', is pivotally connected to one end of a rod 56' the other end of which is pivotally mounted at a fulcrum 57' located on the wall of housing 7'. Along rod 56' is pivotally connected one end of the member 58' which controls the valve or the locking pin for such valve on circuit breaker B. The electro-dynamic action developed in the two spiral loops when the circuit breaker current is put through them is such as to draw the two together thus actuating their respectively associated valves.

In conclusion it will be understood that while several embodiments of the invention have been described and illustrated, various minor changes in the construction and arrangement of component parts may be made without, however, departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. The combination with a circuit breaker of the gas blast type comprising at least one set of relatively movable nozzle and pin contacts, means providing a chamber in which said contacts are disposed and an exhaust valve controlling flow of compressed gas through said chamber and through said nozzle contact, of a conductor loop through which passes the current to be interrupted by said contacts, and means controlling said valve and actuating the same to a more open position by physical movement of said loop in accordance with an increase in the electro-dynamic forces developed in said loop by a corresponding increase in said current.

2. The combination with a circuit breaker of the gas blast type comprising at least one set of relatively movable nozzle and pin contacts, means providing a chamber in which said contacts are disposed and an exhaust valve controlling flow of compressed gas through said chamber and through said nozzle contact, of a conductor loop through which passes the current to be interrupted by said contacts, and linkage means coupling said loop itself to said valve for actuating the same to a more open position by physical movement thereof in accordance with an increase in the magnitude of the current passing through said conductor loop.

3. A gas blast circuit breaker as defined in claim 2 wherein said means coupling said conductor loop to said valve is constituted by linkage actuating a locking pin, said locking pin being biased to a rest position by a loading spring, said pin when in said rest position cooperating with said valve and locking the same against movement by the pressure of the compressed gas from a spring closed position, the counter force exerted on said locking pin by its loading spring being determinative of the threshold magnitude of said current at which the electro-dynamic forces in said conductor loop become sufficiently strong to actuate said locking pin from its rest position and thereby unlock said valve.

4. A gas blast circuit breaker as defined in claim 3 wherein said valve includes a stem portion connected to one arm of a bellcrank lever, the other arm of said lever being lockable against displacement by engagement with said locking pin.

5. A gas blast circuit breaker as defined in claim 3 wherein the counter force exerted on said locking pin by its

loading spring is rendered adjustable by adjusting said loading spring.

6. A gas blast circuit breaker as defined in claim 3 wherein said locking pin is actuated thereby to open said valve when said current to be disconnected at said contacts becomes higher than the operating current.

7. A gas blast circuit breaker as defined in claim 3 wherein said locking pin is actuated thereby to open said valve when said current to be disconnected reaches a predetermined magnitude below the operating current.

8. A gas blast circuit breaker as defined in claim 1 wherein said valve includes a spring restoring the same to its initial rest position upon termination of flow of the compressed gas.

9. A pair of series of connected gas blast circuit breakers each as defined in claim 1, said conductor loop being common to both breakers and controlling their respective compressed gas exhaust valves.

10. A gas blast circuit breaker as defined in claim 1 wherein said conductor loop is constituted by a spiral providing a plurality of turns and which thereby establishes a correspondingly higher electro-dynamic action for controlling said compressed gas exhaust valve.

11. A gas blast circuit breaker as defined in claim 10 wherein the turns of said spiral are of rectangular configuration, two opposite sides of each turn being of rigid conductive material and the other two opposite sides of each turn being of flexible conductive material.

12. A pair of gas blast circuit breakers each as defined in claim 11 wherein the rigid conductors comprising the opposite sides of said spiral loop are grouped into two sets, one of said rigid conductor sets being connected to the compressed gas exhaust valve on one of said breakers and the other of said rigid conductor sets being connected to the compressed gas exhaust valve on the other breaker.

13. A gas blast circuit breaker as defined in claim 1 wherein said conductor loop is constituted by a helix providing a plurality of turns and which thereby establishes a correspondingly higher electro-dynamic action for controlling said compressed gas exhaust valve.

14. A gas blast circuit breaker as defined in claim 13 wherein the turns of said helix are of rectangular configuration and adjacent turns are interconnected by flexible conductive material.

15. A pair of gas blast circuit breakers each as defined in claim 13 and which further includes insulator means disposed between the two circuit breakers and upon which one end of each conductor helix is mounted, the other end of each conductor helix being connected to the compressed gas exhaust valve of the breaker associated therewith.

16. A pair of gas blast circuit breakers as defined in claim 15 wherein the current flows through said conductor helices in opposite directions.

17. A pair of gas blast circuit breakers each defined in claim 1 wherein the conductor loop for each breaker is constituted by a spiral providing a plurality of turns, said spirals being of rigid conductive material and electrically interconnected by flexible conductive material and being arranged in parallel spaced relation for sliding movement on guide means therefor located between said breakers.

18. A pair of gas blast circuit breakers as defined in claim 17 wherein the current flows through the turns of both spirals in the same direction thereby attracting the same to each other.

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