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B. M. H. P. FERNIER
ELECTRIC CIRCUIT-BREAKERS WITH COMPRESSED FLUID BLOW OUT
Filed July 29, 1939

Serial No.
287,348

6 Sheets-Sheet 1

Fig. 1

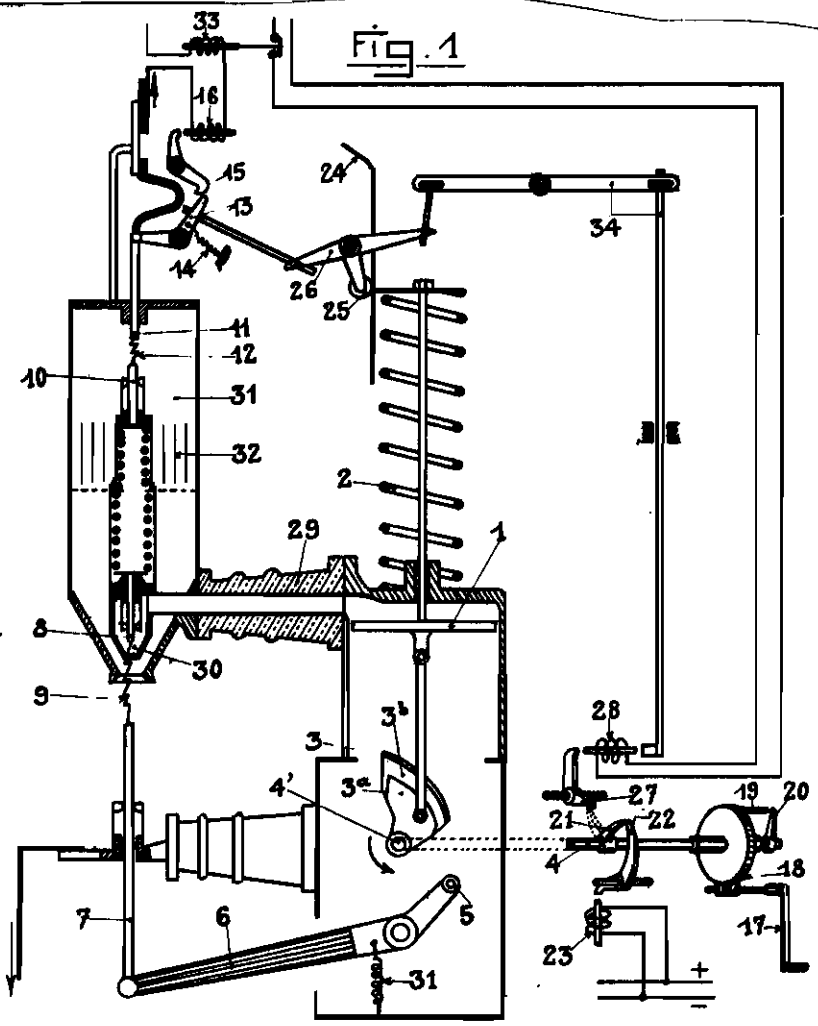
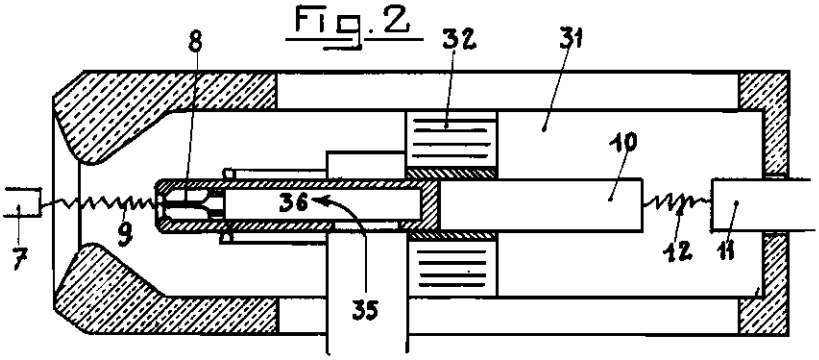


Fig. 2



Inventor:

(Bernard, Marie, Hilaire, Paul) Fernier

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Fig. 3

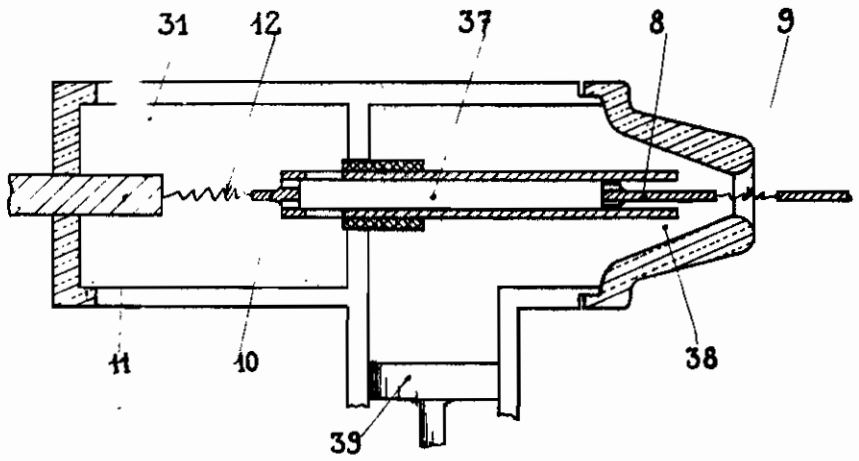

Fig. 4

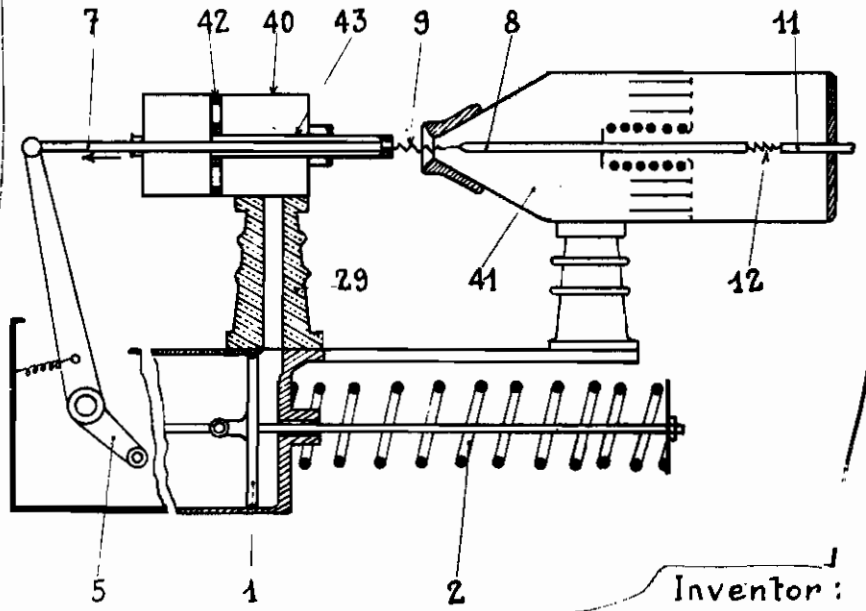

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Fig. 5

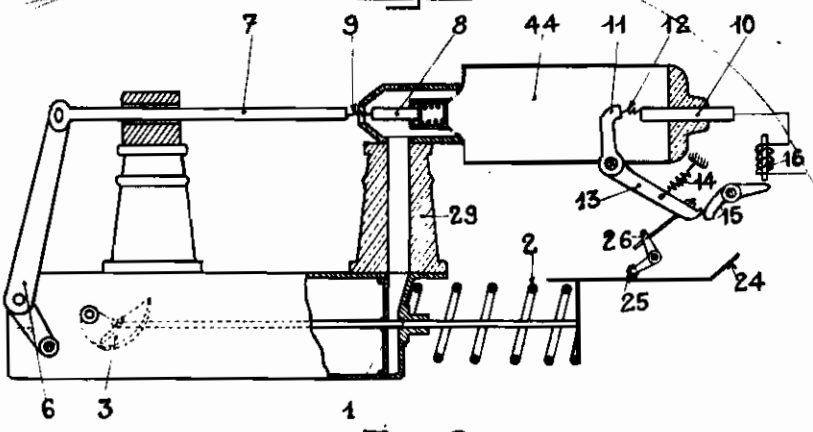

Fig. 6

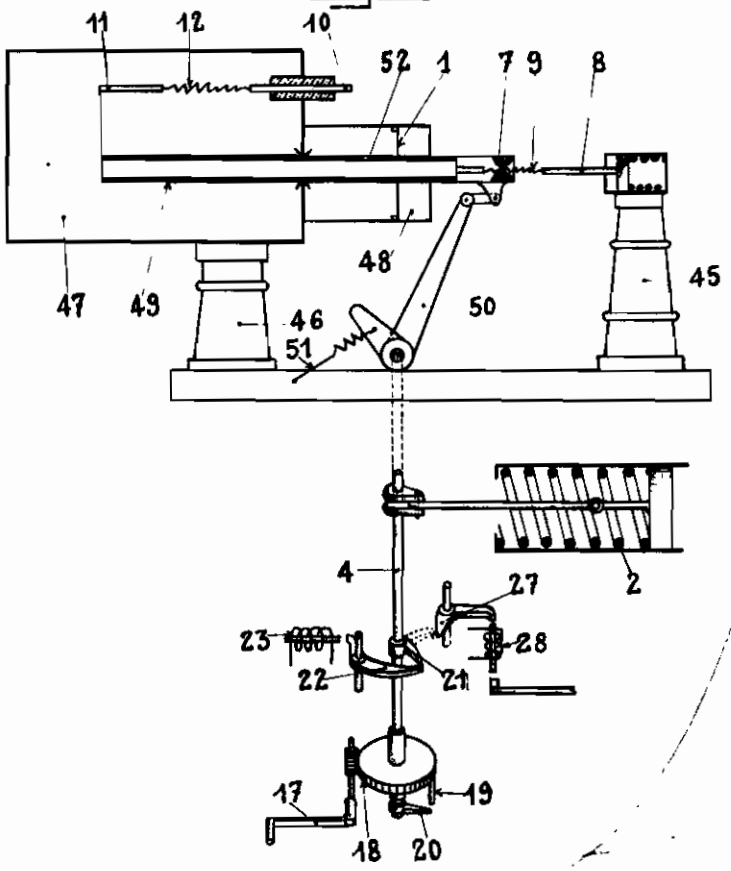

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Fig. 7

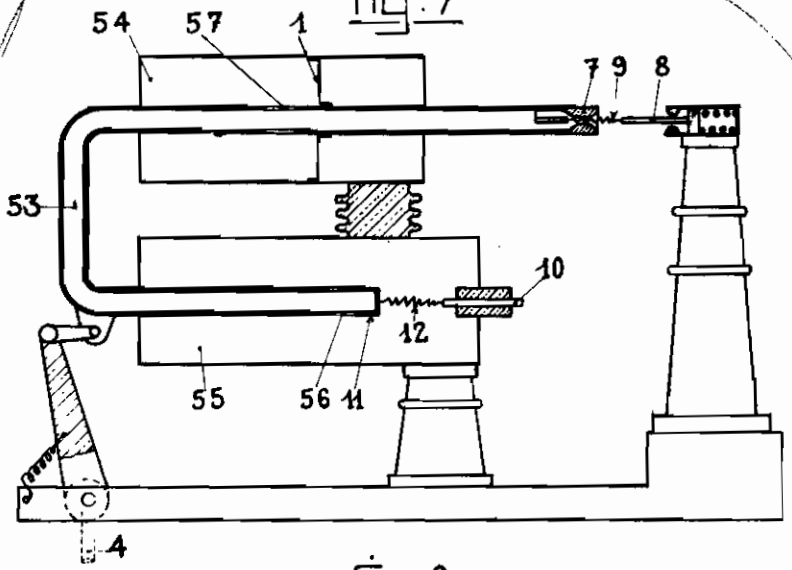
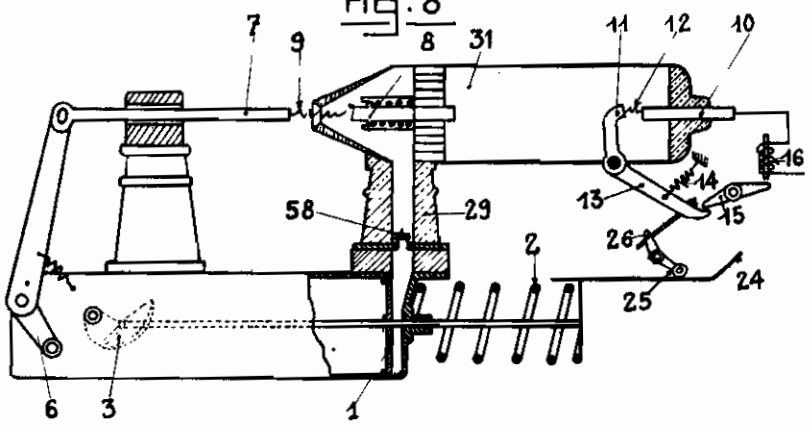


Fig. 8



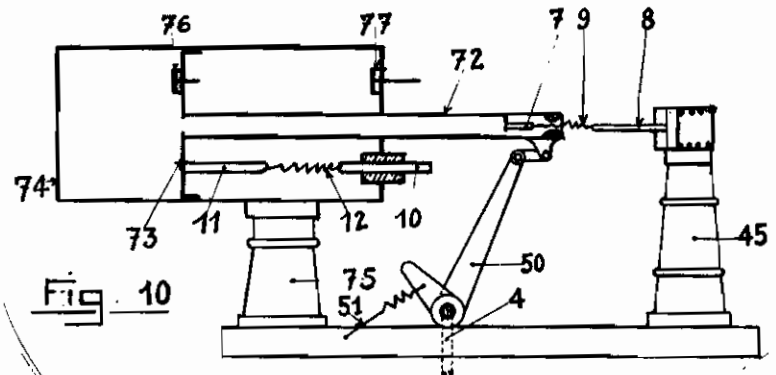


Fig. 10

Inventor:
Bernard, Marie, Victor, Paul Fernier

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Fig. 9

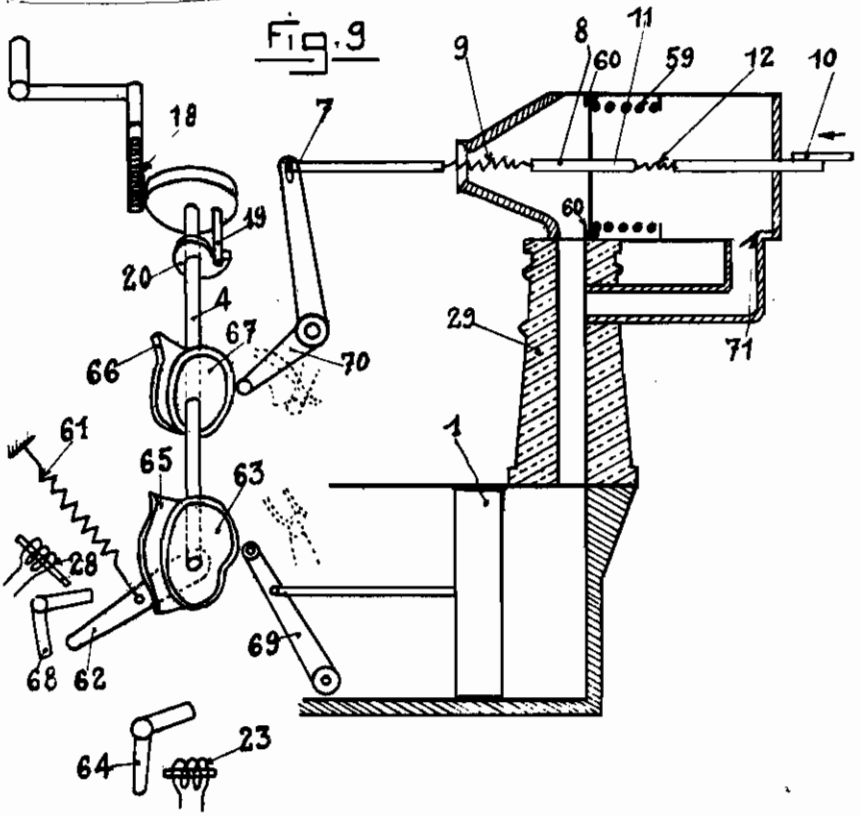
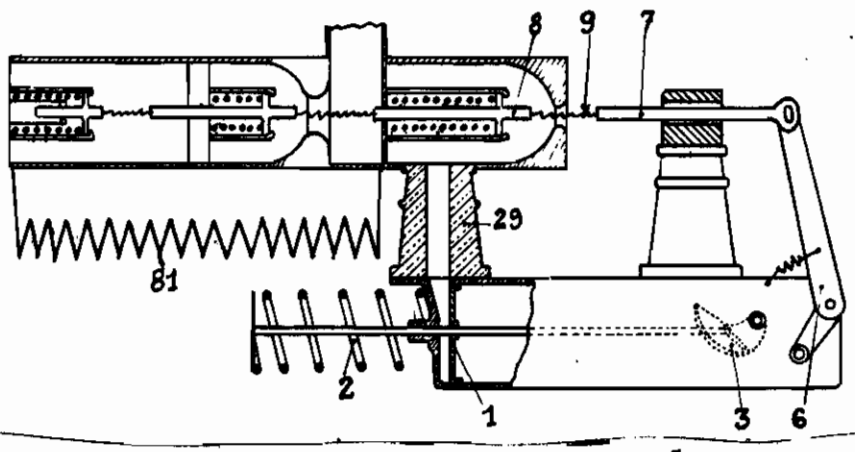


Fig. 12



Inventor:
(Barnes, Morris, Hibben & Fernier)

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6 Sheets-Sheet 6

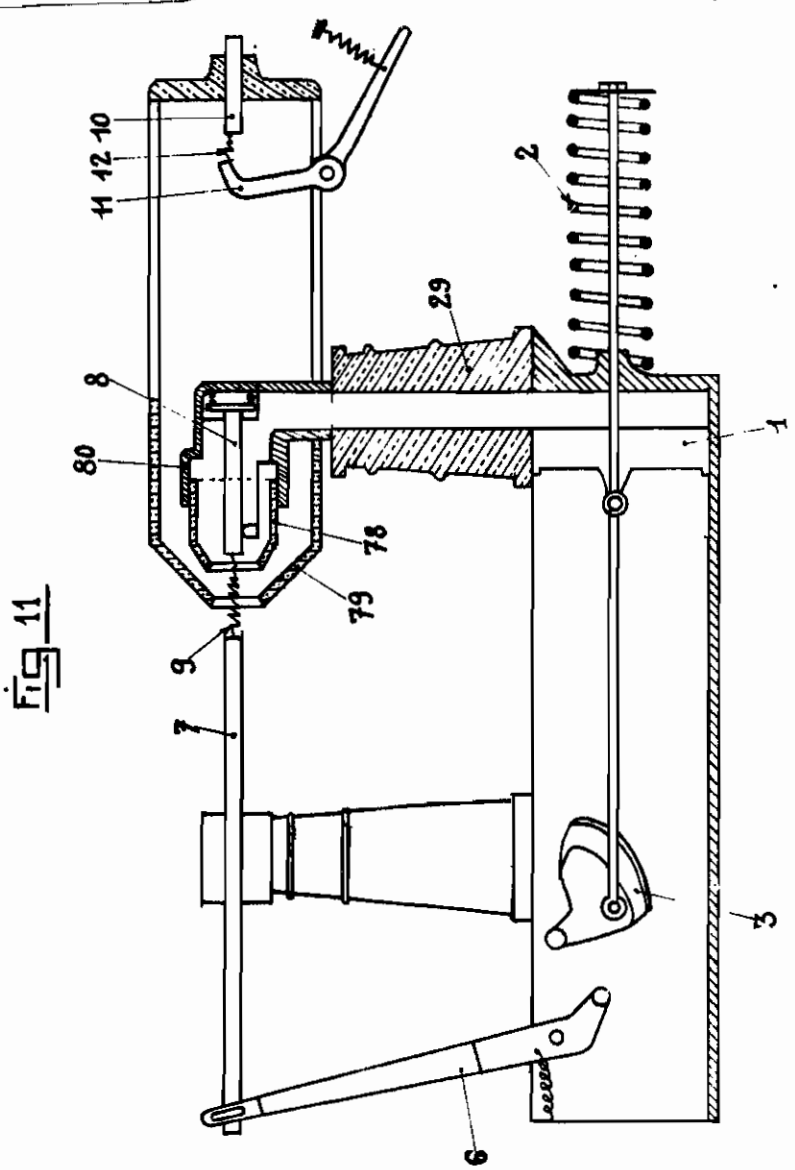

Fig. 11

Inventor:

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ALIEN PROPERTY CUSTODIAN

ELECTRIC CIRCUIT-BREAKERS WITH COMPRESSED FLUID BLOW OUT

Bernard Marie Hilaire Paul Fernier, Lyon, France; vested in the Alien Property Custodian

Application filed July 29, 1939

This invention relates to electric circuit-breakers and more particularly to those which themselves supply the energy required for blowing the arc.

Circuit-breakers which themselves supply the energy required for blowing the arc generally comprise means for storing up potential energy during the operation of closing the contacts and then deliver said energy on separation of the contacts to impart to the fluid for blowing the arc a certain degree of pressure. Compressed air is generally used to blow the arc. The potential energy referred to is predetermined for a given type of apparatus. When the intensities of the short circuit currents to be broken exceed a certain value, the type of circuit-breaker referred to can no longer be used, as it then becomes necessary to supply supplementary energy from a source outside or apart from the circuit-breaker.

One of the objects of the present invention is to provide an electric circuit-breaker with compressed fluid blow out and which supplies its own energy for blowing the arc, in which the rupturing power is increased. With this object in view the circuit-breaker in accordance with the invention contemplates the production by said circuit-breaker of a supplementary quantity of energy over and above a given intensity of current which passes through the arc at break, said supplementary quantity of energy being supplied from a different source from the latter for effecting the blow out.

In accordance with the invention the two quantities of energy referred to may act simultaneously or else said supplementary energy acts first and produces a preponderating blast, the blast produced by the other quantity of energy not beginning to act until some time after said former quantity.

The invention has other aims and objects in addition to those above set forth, all of which will be readily understood from the following description taken in connection with the accompanying drawing of embodiments of the invention herein given for illustrative purposes, the true scope of the invention being more particularly pointed out in the appended claims.

Referring to Fig. 1 there is therein represented partly in elevation and section and partly in perspective a circuit-breaker of the general type described comprising an air compressor having a piston operated by a spring and tensioned before the closing of the contacts of said circuit-breaker, said spring being capable of storing up in advance the energy required for the closing and separating of said contacts as well as the energy required to produce the compressed air required for blowing the arc.

In said figure the compressor piston 1 is connected on the one hand to the free end of a powerful spring 2 and on the other hand to a cam 3 which is operated by mechanism herein shown in perspective for the sake of clearness. A shaft 4 of this mechanism is directed perpendicularly to the plane of said figure and its projection is shown at 4' which designates the axis of oscillation of the cam, which is moved by said mechanism in a contra-clockwise direction. In the course of this rotary movement it can engage and carry with it a roller 5 upon one arm of a bell crank lever 6 which controls the main movable contact 7 of the circuit-breaker, the fixed contact of which is indicated by 8. These two contacts draw an arc herein called the principal arc and designated by 9. Said circuit-breaker is further provided with an auxiliary fixed contact 10 and an auxiliary movable contact 11 which, when the intensity of the current to be broken exceeds a given value, draw an arc herein called the auxiliary arc and designated by 12 and which is struck in series with the main arc (or principal arc).

In this figure the circuit-breaker is shown with its arc drawing contacts separated, the action of the cam 3 on the movable contact 7 then being as follows. Said cam has a full portion 3*a* and a cam groove 3*b*. When said cam engages said roller 5 said full portion 3*a* causes the lever 6 to swing clockwise about its fulcrum thus closing said principal contacts 7 and 8. With the circuit-breaker being thus in circuit closing position, said roller 5 is opposite the entrance of said cam groove 3*b*. The separation of said two principal contacts takes place by a further rotation of said cam 3 in the course of which said roller 5 leaves said cam groove 3*b*. The details of this operation will appear more fully below. The auxiliary movable contact 11 is operated by a bell crank lever 13 against the action of a spring 14 which tends to keep the auxiliary contacts 10 and 11 separated. These two contacts are kept in closed position by a bell crank lever 15, one arm of which is opposite the movable core of an electric relay 16 which is energized by the main current passing through the circuit-breaker.

The tensioning of spring 2 to store up energy to close and then to separate the contacts of the circuit-breaker and to blow the principal arc, is effected as follows:

Rotation of the shaft 4 on which is splined the cam 3 is effected by a crank 17 which by means of an endless screw device 18 of which the wheel is loose upon said shaft, and a lever 19 actuates a driving member 20 carried by said shaft. When in its contra-clockwise rotation said cam brings its end 3a opposite said roller 5, said spring 2 will be tensioned and a pawl 21 engages a bell crank lever 22 of which one arm is opposite the movable core of a winding 23 adapted to effect closing movement of the contacts of the circuit-breaker. Furthermore, by the tensioning movement of said spring 2 an inclined plane 24 is moved to act upon a roller 25 carried by a bell crank lever 26 and thus through a suitable connection swinging said bell crank lever 13 contra-clockwise about a fulcrum to close the auxiliary contacts 10, 11, said lever 13 engaging said bell crank lever 15.

Closing movement of the principal contacts 7 and 8 of the circuit-breaker is effected by sending an energizing current through the winding 23 which causes the movable core of the latter to swing the bell crank lever 22 about its fulcrum thus freeing the pawl 21. Said shaft 4 is thus unlocked, and under the action of said spring 2, said cam 3 is rotated and rotates said shaft 4. During this time the part 3a of said cam 3 causes bell crank lever 6 to swing clockwise about its fulcrum to close the principal contacts 7 and 8. When said contacts are thus closed, pawl 21 engages bell crank lever 27, one arm of which is opposite the movable core of a winding or coil 28 adapted to effect the separation of said principal contact.

To effect an ordinary separation of said contacts an energizing current is sent through said coil 28. The resulting movement of its coil rotates said lever 27 and disengages said pawl 21. Shaft 4 being thus unlocked, cam 3 is caused to rotate by spring 2 which was only partially distended during the closing movement of said principal contacts. However the prinicipal movable contact does not immediately start its movement as the roller 5 passes along the cam groove 3b from which it is not yet freed. During this time the air at the left of piston 1 is pushed back through a hollow insulator 29 which supports a part of the circuit-breaker and into a chamber 30 in which is located the principal fixed contact 8, so as not to effect the separation of said two principal contacts until the air pressure for blowing the arc has reached its most efficient value. As the roller 5 leaves said cam groove 3b thus liberating said lever 6 the latter swings contra-clockwise under the action of spring 31, and thus separates said principal contacts 7 and 8, and the principal arc 9 is blown by the compressed air which continues to blow through said chamber 30, driven by the piston 1 which reaches the end of its stroke under the action of spring 2.

In accordance with the invention supplementary energy for the blast is borrowed from the auxiliary arc. To this end contacts 10 and 11 are located within a chamber 31 preferably separated from the chamber 30 containing the principal fixed contact as above set forth. The gases generated by said auxiliary arc 12 as well as the air within said chamber 31 the pressure of which is increased to a very high degree by the heat generated by said auxiliary arc, are blown against the principal arc 9, either directly or after contacting with a flame shield 32 by which they are cooled, the blast thus furnished being of an intensity proportionate to the intensity of the current to be interrupted.

In accordance with the invention also said auxiliary arc 12 forms before the principal arc when the intensity of the current to be interrupted exceeds a certain intensity value. To this end means are provided herein comprising a relay 16 which operates instantaneously but only when said intensity value is exceeded, the coil 28 for separating the contacts being supplied with current by a relay 33 the operation of which is retarded.

When the intensity of the overcharge current to be interrupted is inferior to said intensity value above referred to, the relay 33 alone operates and said coil 28 causes separation of the arc drawing contact as above set forth. On the other hand when the intensity of the current to be interrupted exceeds said intensity value, said relay 16 operates immediately to free said lever 13 which under the action of said spring 14 separates said auxiliary contacts. Furthermore said lever 13 in turning about its fulcrum acts upon the lever 26 to cause the latter also to turn and move the core of said coil 28 through a suitable link connection 34. The lever 27 is thus freed and the principal contacts 7, 8 start to separate but only when said roller 5 has escaped from said cam groove 3b, that is to say after a certain time has elapsed and therefore unmistakably after separation of contacts 10 and 11.

To the blast produced by said auxiliary arc 12 there is therefore added that produced by piston 1. To facilitate this the currents of compressed air produced by said arc 12 and said piston are directed against the arc 9 along parallel courses. As shown in Fig. 1, said two air currents are concentric.

Said two compressed air currents act simultaneously and thus combine their blowing action. The blast from piston 1 continues after extinction of the arcs 9 and 12, thus scouring the space between and about the principal contacts 7 and 8 and precluding any restriking of the arc.

The invention contemplates the use of any suitable arrangement to produce the concentric flow of said two compressed air currents. In the illustrative embodiment of the invention this result may be obtained by using a principal fixed contact which is hollow and the hollow interior of which communicates with the compressor cylinder as shown in Fig. 2. This figure is a longitudinal section of that part of the circuit-breaker containing the principal fixed contact and the two auxiliary contacts the remainder of said circuit-breaker having the same arrangement as that shown in Fig. 1. Referring to Fig. 1 a channel 35 leads from an insulator 29 and conducts the air propelled by piston 1 into the interior space 36 of said main fixed contact 6.

The interior chamber of the hollow fixed principal contact may communicate with the chamber in which the auxiliary arc is formed. Such an arrangement is shown in Fig. 3. As in the case of Fig. 2 so also in the case of Fig. 3, only that part of the circuit-breaker containing the principal fixed contact and said auxiliary contact is illustrated, the remainder of said circuit-breaker being of the same construction as that shown in Fig. 1. The principal and auxiliary contacts as well as the arcs struck thereby are indicated in said Figs. 2 and 3 by the same reference characters as in Fig. 1. The interior chamber of the hollow fixed contact 8 communicates with the chamber 31 in which the auxiliary

arc is struck and the concentric chamber 38 of said hollow contact communicates with the air compressor which is diagrammatically indicated by said piston 29.

In accordance with the invention a certain degree of simultaneous action of the two compressed air currents referred to may be obtained by directing said currents in opposite directions against said arc 9 as shown illustratively in Fig. 4. In the illustrative embodiment shown in said figure the operation of the main and auxiliary contacts and the generation of the air blast may be and, as is herein shown, are identical with those illustrated in Fig. 1. The corresponding means have been omitted from Fig. 4 in order not unnecessarily to complicate the drawing, only the piston 1, the driving spring 2, the lever 5 for operating the principal movable contact 7, that part of the circuit-breaker containing the principal fixed contact 8 and the auxiliary contacts, as well as the particular means and features to be considered have been shown diagrammatically in order that the invention may be clearly understood. The compressed air heated by the auxiliary arc is conducted to the fixed contact 8, while the air driven by the piston 1 is conducted through said hollow insulator 29 into a cylinder 40 in which said movable contact 7 operates. The gases and the compressed air produced by the arc 12 are directed against that point of attachment of the arc 9 which is within the chamber 41 while the blast of compressed air from the piston 1 is conducted through openings or ports provided in a partition 42 and into a pipe 43 surrounding the movable contact, whence it is directed against the other point of attachment of said arc 9.

The energy for the blast generated by said auxiliary arc and that produced by the compressor may act successively. In that case the blast generated by said auxiliary arc, which always preponderates, starts first and operates alone. The blast from the compressor starts to operate later and adds its operation to that generated by said arc; it scours the space separating and surrounding the contacts and completes the blowing of the arc, thus precluding any restriking of the latter.

Figs. 5, 6, 7, 8, 9, 10, 11, and 12 show illustrative embodiments of the invention for accomplishing the above results.

Referring to Fig. 5 the latter shows a circuit-breaker in which the operation of and means for operating the principal and auxiliary contacts and for generating the air blast for blowing the arc, generated by the compressor and that generated by the auxiliary arc are identical with those of the illustrative apparatus shown in Fig. 1. The only difference resides in the fact that the auxiliary movable contact operates in a chamber 44 and that the air blast from the compressor, conducted through the hollow insulator 29 issues therefrom into said chamber 44.

Fig. 6 shows an illustrative embodiment of the invention diagrammatically in which the principal and auxiliary movable contacts as well as the piston of the compressor are made in a single movable member. The principal fixed contact 8 is carried by an insulator 45. A second insulator 46 located opposite said insulator 45, carries an assemblage of two cylinders 47 and 48 mounted end to end. A pipe 49 is slidably mounted in said two cylinders and carries at its right end the principal movable contact 7 and at its left end the auxiliary movable contact 11. The compressor comprises a cylinder 48 of which the piston 1 is secured to said pipe 49. Said cylinder 47 forms the chamber in which the auxiliary arc 12 is formed. Movement of said pipe 49 is effected by one arm of a bell crank lever 50 upon the other arm of which acts a powerful return spring 51 which tends to keep said contacts 7 and 8 separated from each other. Clockwise rotation of said bell crank lever 50 closes said contacts. Rotation of said lever is effected by a spring mechanism which acts upon the shaft of said lever and is similar to that shown in Fig. 1 but without the piston 1. Operation of closing said contacts and separation thereof are effected exactly as in the case of the apparatus shown in Fig. 1. Separation of said auxiliary contacts prior to separation of said principal contacts is herein conveniently effected by suitably locating the movable contacts 7 and 11 relatively to each other upon said pipe 49. In said figure the auxiliary arc 12 is longer than the principal arc because it was struck prior to the latter. The separation of said principal contacts is prevented at the start of the movement of separation of said auxiliary contact by backing up the fixed contact 8 with a spring to cause it to follow up its movable contact at the start of their separation movement.

The contacts of the circuit-breaker being in closed position their separation is effected by freeing the rotary shaft on which said bell crank lever 50 is fulcrumed. Said lever will then be sharply rotated by said spring 51 thus causing the pipe 49 to slide toward the left of said figure. As already stated the spring which backs up said fixed contact 8 keeps the latter in contact with said movable contact 7 during the beginning of the sliding movement of said pipe 49, whereas said contacts 11 and 12 separate and form the auxiliary arc 12. The air contained in the cylinder 47 is thus put under great pressure and flows through the pipe 49 toward the principal arc 9. On the other hand piston 1 which is integral with said pipe 49 propels the air at its left side through port 52 provided in said pipe 49, into the latter. The two blasts of fluid are thus directed in parallelism against the principal arc 9 to blow the latter.

Fig. 7 shows a modification of the circuit-breaker just described, which is operated the same as the latter. A tube 53 carries at one of its ends the principal movable contact 7 and at its other end the auxiliary movable contact the same as in Fig. 6. This pipe 53 is slidably mounted in two superposed cylinders 54 and 55, the cylinder 54 forming the compressor the piston 1 of which is integral with the pipe 53, while the cylinder 55 forms the chamber in which the auxiliary arc 12 is formed. The formation in succession of the auxiliary arc 12 and the principal arc 9 takes place as in Fig. 6 owing to the fact that the principal fixed contact 8 is backed up with a spring.

The contacts of said circuit-breaker being closed the separation thereof is effected by freeing the rotary shaft upon which the bell crank lever 50 is fulcrumed, thus allowing the latter to be sharply rotated by action of the tensioned spring 51 whereby said pipe 53 is moved toward the left of said figure. By a judicious determination of the length of the lower part of said pipe and thanks to the spring backed fixed contact 8 the auxiliary arc 12 will be struck before the principal arc. The air contained in cylinder 55 is thus put under high pressure and enters said

pipe through a port 56 provided in the latter. On the other hand the air at the left of piston 1 is compressed by the latter and is propelled into said pipe through a port 57. The two blasts of fluid are thus directed in parallelism against the principal arc 6 to blow the latter.

In both of the illustrative embodiments represented in Figs. 6 and 7 respectively, means may be provided, such as a valve for example, to control the port of communication with the compressor cylinder and prevent the entrance into said cylinder of the air and gases emanating from the chamber in which the auxiliary arc is blown.

Such an arrangement is shown in Fig. 8 as applied to a circuit-breaker of the type represented in Fig. 5. As the latter has been described in detail, Fig. 8 shows only what is absolutely necessary for the comprehension of this feature of the invention.

In the passage formed in the hollow insulator 29 and which connects the compressor cylinder with the chamber containing the principal fixed contact 8 there is provided a valve 58 which remains closed so long as the pressure is sufficiently high within the chamber in which the auxiliary arc is struck, and thus prevents passage into the compressor cylinder of the compressed fluid produced by said auxiliary arc. Just so soon, however, as said pressure in said chamber 31 drops below that produced by said compressor, said valve 58 will be raised and the compressed fluid from said compressor is added to that produced by said auxiliary arc, for blowing the principal arc 9.

The invention also contemplates the provision of means, if desired, for preventing the compressed air and gases formed by said auxiliary arc, from driving said piston back at the moment the auxiliary contacts break the circuit. An illustrative embodiment of this feature is shown in Figure 9.

Referring to said figure the circuit-breaker therein shown is similar to that of Fig. 1. The principal contact 8 called "fixed" is mounted upon a support which is slidable in the chamber in which the auxiliary arc 12 is formed under the action of a spring 59 in said chamber. The movable auxiliary contact 11 is carried by said same support. In Fig. 9 the contacts are open. When said contacts are closed the movable contact 7 pushes back the contact 8 and with it said support thus closing the auxiliary-contacts 11 and 12 which form the auxiliary arc. It will be clear that on opening said contacts, movement of the contact 7 to the left first separates the contacts 10 and 11, whereupon said support having its movement by spring 59 arrested by stop 60, contact 8 will also be arrested and contact 7 will separate from the latter to draw the arc.

The closing and separating movements of the contacts of the circuit-breaker are effected by suitable driving means, said means herein illustratively comprising a powerful spring 61 which is tensioned by lever 62 carried by a cam 63 splined upon a shaft 4 similar to the shaft of the spring tensioning mechanism of the circuit-breaker of Fig. 1. When said spring is tensioned the end of the lever 62 is locked by the bell crank lever 64, the lower arm of which can be acted upon by the movable core of the coil 23 of the contact closing mechanism. The operation of closing the contacts frees the lever 64 and said spring 61 is partially distended, thus rotating the shaft 4 by means of the cam surfaces 65 and 66 of the cams 63 and 67 respectively. Piston 1 is thus moved to the left of said figure and the principal movable contact 7 is moved toward the right thereof. The lever 62 is stopped and locked by a pawl 66. The spring 61 has, as stated, been only partially distended the remainder of its potential energy serving to separate the contacts of the circuit-breaker.

The operation of separating the contacts by said coil 26 disengages the pawl 68 from said lever 62 thus freeing the latter. The cam 63 then acts upon lever 69 to move piston 1 toward the right, shortly after the cam 67 which has operated the principal contact 7 controlling lever 7 and previously separated said auxiliary contacts, said contact 11 being moved toward the left by its spring 69, has subsequently separated said principal contacts 7 and 6. Piston 1 thus drives the air at its right toward the insulator 28 and through the latter against the principal arc 9. On the other hand the compressed air coming from the chamber in which the auxiliary arc 12 is struck, opens a valve 71 and is thus also driven against said principal arc. This compressed air cannot drive back the piston 1, the latter being held against movement backwardly by cam 63.

The invention also contemplates the use of a combination of suitable means, herein illustratively valves for successively or simultaneously causing the compressed fluid contained in the chamber in which the auxiliary arc is struck and in the compressor cylinder, respectively, to flow from said chamber and said cylinder against the arc 9. An illustrative embodiment of this feature is shown in Fig. 10.

The circuit-breaker represented in said figure is somewhat analogous to that of Fig. 6. Herein it comprises a pipe 72 which is moved by mechanism which is identical with that of said figure. Said tube forms the rod of a piston 75 which operates within a cylinder 74 mounted upon a suitable support such as an insulator 75. The principal fixed contact 8 is carried by an insulator 45 and is provided with a spring to enable the auxiliary arc to be struck before the principal arc, as has been explained in describing the circuit-breaker of Fig. 6. The principal movable contact 7 is mounted within the entrance of said tube 72. The fixed auxiliary contact 10 is mounted upon the cylinder 74 while the auxiliary movable contact 11 is mounted upon the piston 73. The chamber within which the auxiliary arc 12 is struck is therefore annular in shape. Said chamber communicates with cylinder 74 by means of a valve 76 on said piston 73, which constitutes the air compressor which is thus in communication with the contact 7 through the pipe 72. Upon separation of the contacts this pipe is moved toward the left of said figure. As has been already explained the auxiliary arc 12 is struck prior to the striking of the principal arc 9. The arc 12 increases the pressure of the air within said annular chamber formed by the pipe 72 and said cylinder 74 and thus opens the valve 76 allowing the compressed fluid to escape through the tube 72. The two blasts of fluid for blowing the arc thus flow in parallelism against the arc 9. When the currents which are interrupted are weak, the pressure created within said annular chamber does not suffice to open said valve 76 and the movement of said piston creates a partial vacuum in said chamber. To overcome this objectionable feature a second valve 77 is provided in

the rear wall of said cylinder, through which the space behind the piston in said cylinder is caused to communicate with the outer atmosphere whenever the pressure in said annular chamber does not exceed that required for operating said valve 76.

In accordance with the invention the apparatus represented in Figs. 5 and 9 may be provided with means for causing a concentric flow of the compressed fluid blasts, as is represented in Fig. 11. The majority of the parts and instrumentalities of the circuit-breaker in Fig. 11 are identical with those of the circuit-breaker of Fig. 5. The only difference resides in the construction and arrangement of the blast nozzle for the principal arc 9. This nozzle comprises two concentric mouth-pieces 78 and 79, the former being mounted for sliding movement within its support 80 whenever the pressure produced by the auxiliary arc 12 exceeds that produced by the piston 1. In such case said mouth-piece 78 is retracted and uncovers the end of the fixed contact 8 which is thus placed in the most favorable position relatively to the neck of said mouth-piece.

Any one of the forms of circuit-breakers above described may be provided with a resistance serving to delay the re-establishment of the tension. Said resistance may be applied either mechanically or pneumatically and will preferably shunt the auxiliary arc and, the casing arising, the principal arc. Fig. 12 illustrates an example of such an arrangement applied to a circuit-breaker the majority of the instrumentalities of which are identical with those of the circuit-breaker shown in Fig. 5. When the intensity of the current (short circuit) to be cut is weak, the interruption of said current is effected without the insertion of said resistance by using only the blast produced by the compressor. When however said intensity becomes considerable the arc of the auxiliary contacts produces a blast and inserts or throws said resistance 81 into operation. The current which remains for the principal contact to cut is therefore only a current the intensity of which has been reduced by said resistance.

A capacity may be substituted for said resistance in all the circuit-breakers of the latter type and said capacity may be rendered operative either mechanically or pneumatically and will preferably shunt the auxiliary arc and the case arising the principal arc.

The compressed air blast produced by the compressor cylinder may not only act simultaneously with that supplied from the chamber in which the auxiliary arc is struck but may also act after the arc has been extinguished. This has the advantage that the space about the contacts is efficiently and thoroughly scoured, any restriking of the arc being thus precluded. This operation takes place automatically in the majority of the apparatus above described, by causing the principal contacts and the auxiliary contacts to move at a suitable regulated speed and by making the compressor plant of suitable dimensions.

Among the many advantages possessed by apparatus embodying the present invention may be mentioned the increase in the rupturing power of the usual circuit breakers which themselves compress the air required for blowing their arcs, as well as the possibility of regulating the intensity of the arc-extinguishing blast proportionally to the intensity of the current to be cut, and the fact that small arcs can be extinguished as well as larger arcs.

BERNARD MARIE HILAIRE PAUL FERNIER.