R. P. JACKSON.

CIRCUIT CONTROLLING APPARATUS.

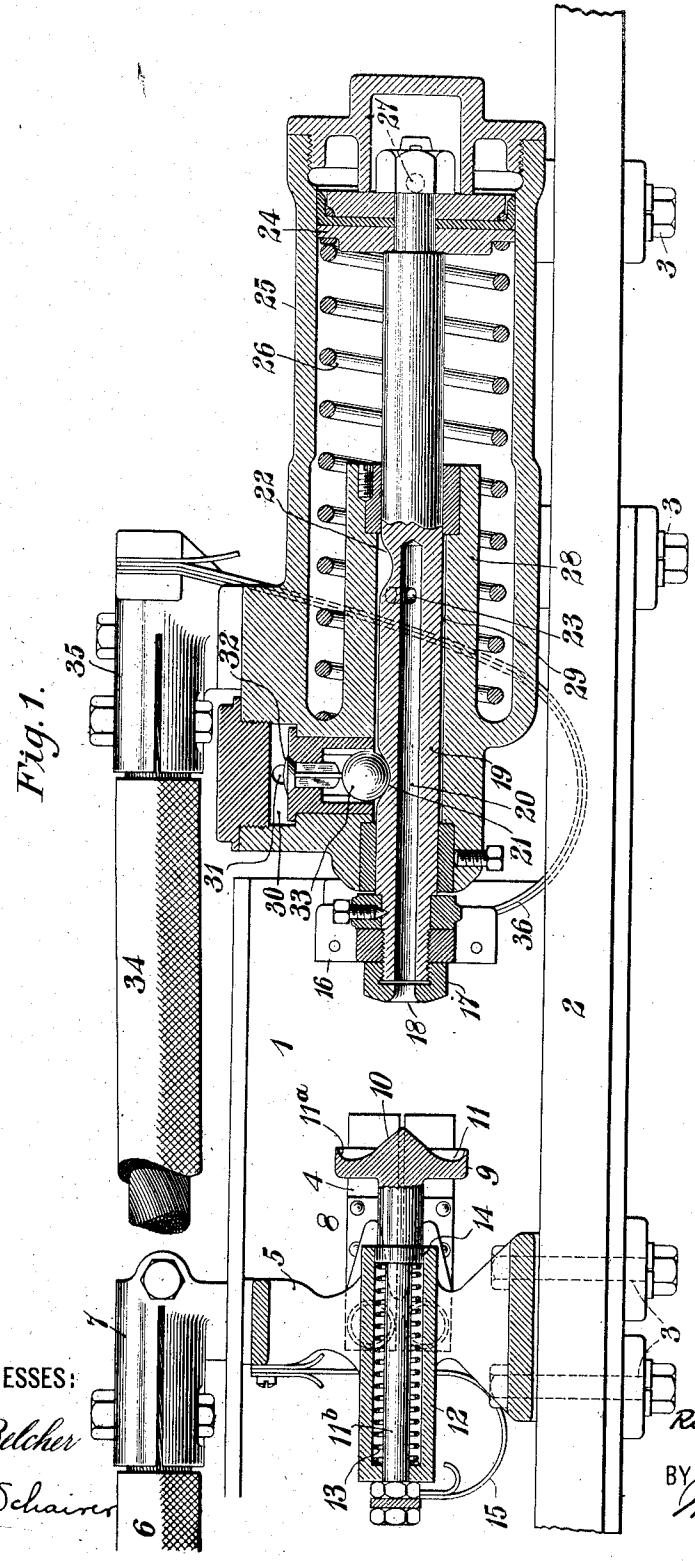
APPLICATION FILED OCT. 8, 1904.

1,043,014.

Patented Oct. 29, 1912.

4 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

C. L. Belcher

Otto S. Schairer

INVENTOR

Ray P. Jackson

BY Wesley G. Carr

ATTORNEY

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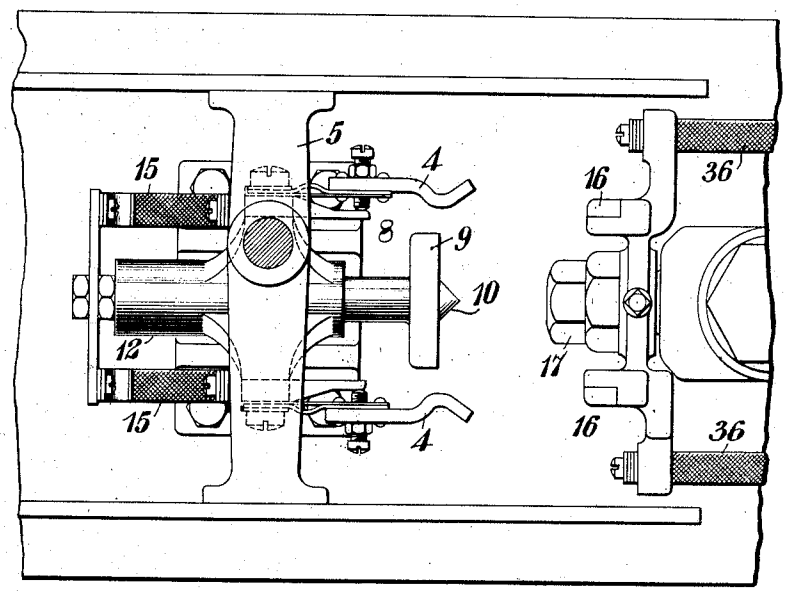
4 SHEETS—SHEET 2.

Fig. 2.



WITNESSES:

C. L. Belcher

Otto S. Schairer.

INVENTOR

Ray P. Jackson

BY

Huley & Coan

ATTORNEY

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4 SHEETS—SHEET 3.

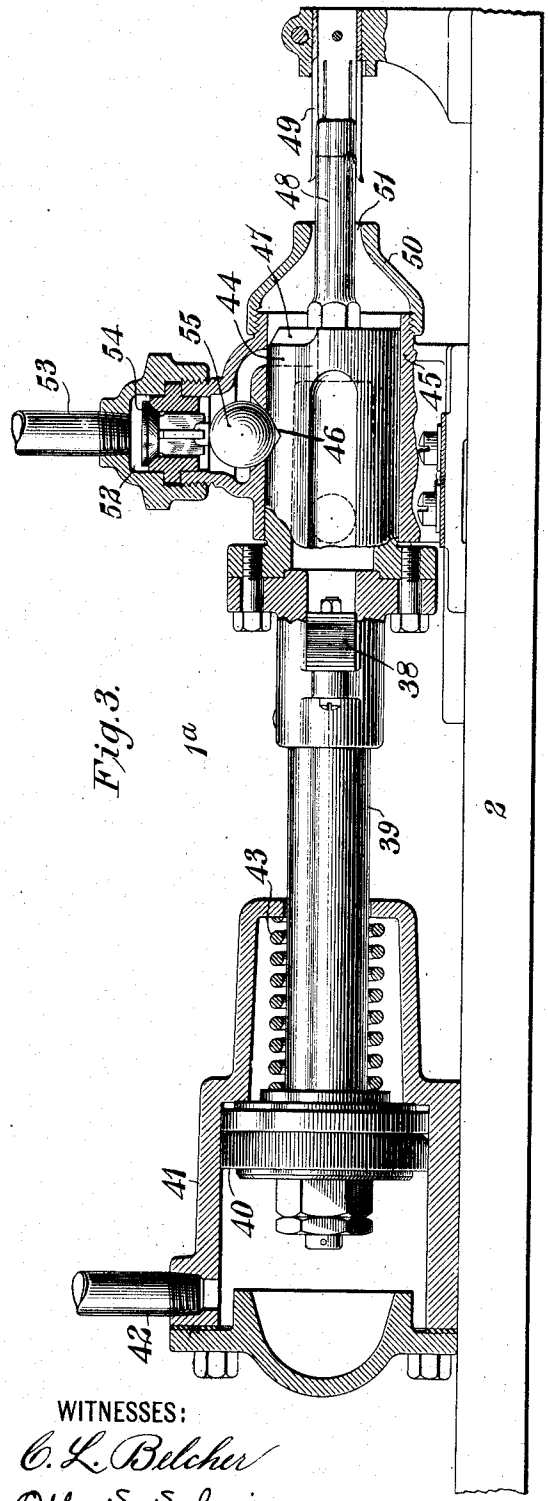

Fig. 3.

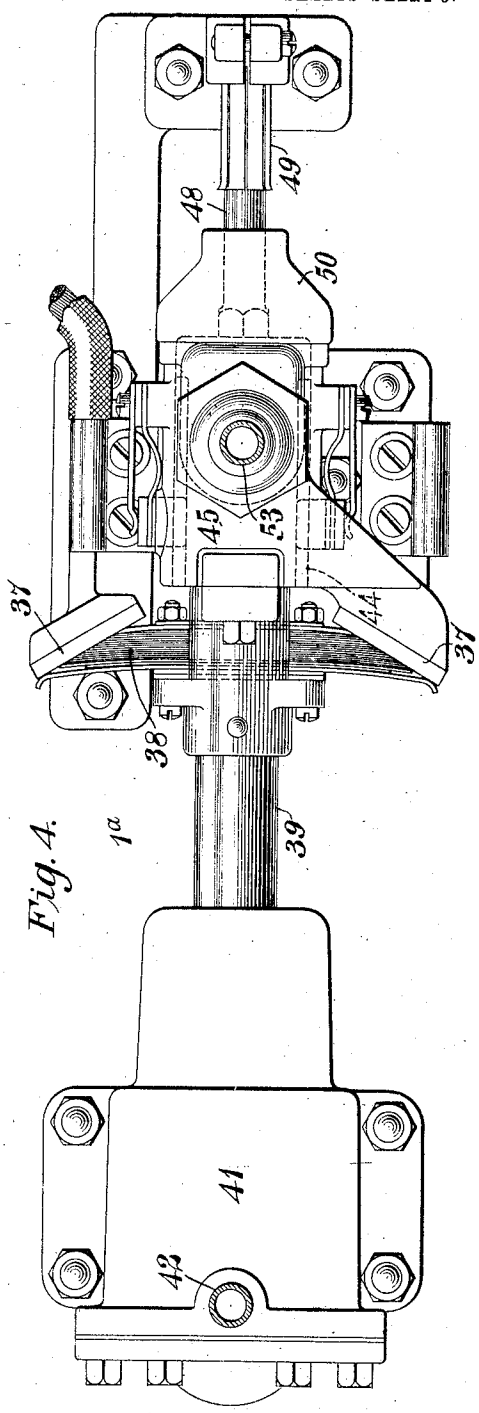

Fig. 4.

WITNESSES:

C. L. Belcher

Otto S. Schairer

INVENTOR

Ray P. Jackson

BY

Huley & Carr

ATTORNEY

R. P. JACKSON.

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4 SHEETS—SHEET 4.

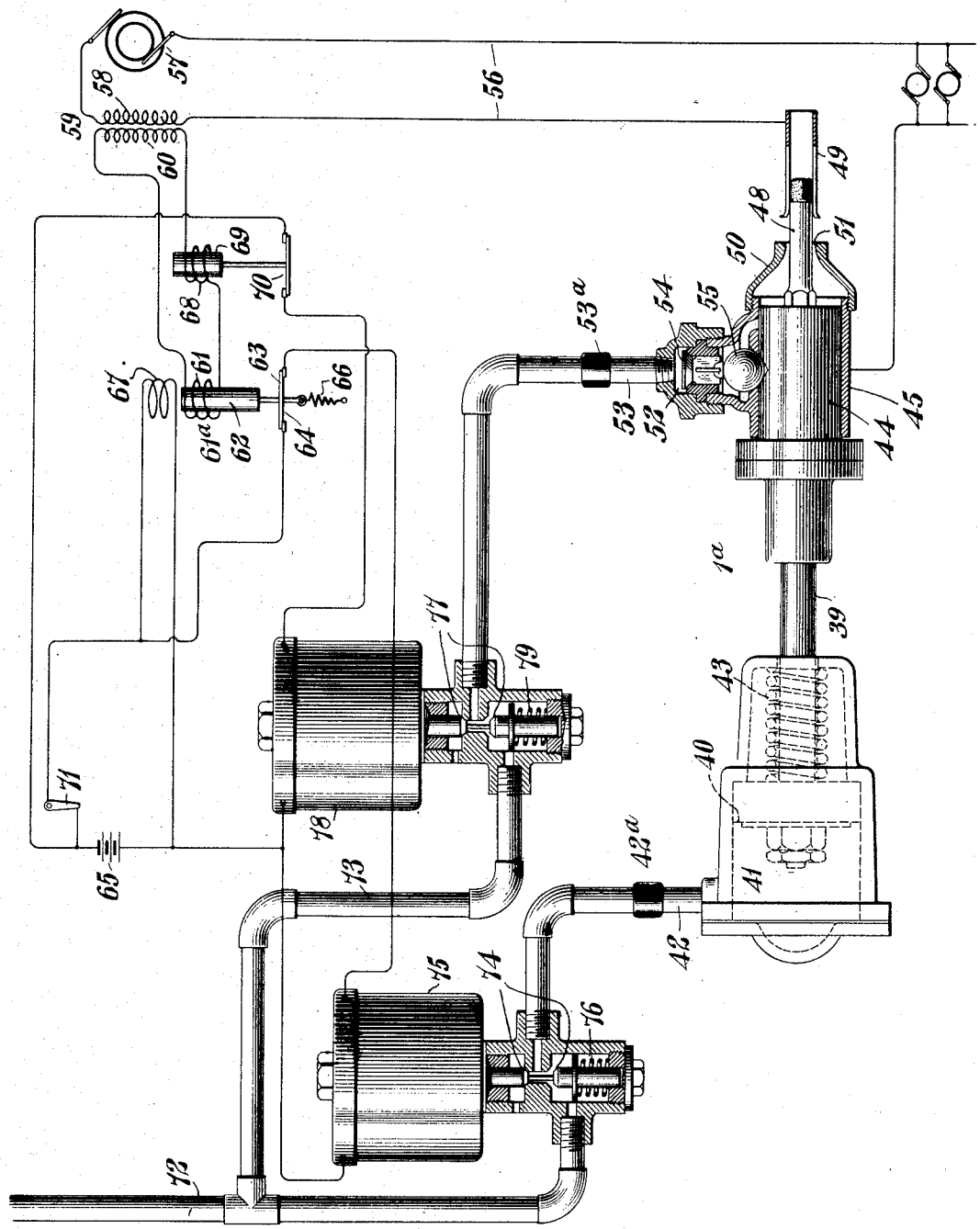

Fig. 5.

WITNESSES:

C. L. Belcher

Otto S. Schairer

INVENTOR

Ray P. Jackson

BY

Huley & Clark

ATTORNEY

UNITED STATES PATENT OFFICE.

RAY P. JACKSON, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

CIRCUIT-CONTROLLING APPARATUS.

1,043,014. Specification of Letters Patent. Patented Oct. 29, 1912.

Application filed October 8, 1904. Serial No. 227,746.

To all whom it may concern:

Be it known that I, RAY P. JACKSON, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Circuit-Controlling Apparatus, of which the following is a specification.

My invention relates to devices for interrupting electric circuits, and particularly to circuit-breaking devices provided with means for extinguishing the arcs that form when the circuit-breaker terminals are separated.

The object of my invention is to provide a simple and efficient means for utilizing a blast of air or other fluid at proper times and during the proper intervals to extinguish such arcs as may form or tend to form between the contact terminals of circuit interrupting devices.

In most cases where the interruption of circuits carrying electrical energy of any considerable magnitude is effected, some arc extinguishing means is generally employed, the most common means being an electromagnet the poles of which are so disposed as to provide a magnetic field across the path of the arc, which serves to extinguish it. The magnetic blow-out has a reasonable degree of efficiency in connection with the interruption of direct current circuits, but it generally fails to satisfactorily meet the requirements of alternating current service, whereas my invention has substantially the same degree of efficiency in the one class of service as in the other.

In order to effectively extinguish the arcs which are or may be formed with a minimum expenditure of energy and a minimum amount of damage to the contact terminals of the circuit-breaking apparatus, I propose to effect final interruption of the circuit between two contact terminals of small surface area and to so project a blast of air at the point of separation of such contact terminals at the instant of separation, and for a short period of time thereafter, as to invariably and certainly prevent the maintenance of the arc for an appreciable length of time.

Referring now to the drawings, Figure 1 is a view, partially in side elevation and partially in section, of a portion of a circuit-breaker constructed in accordance with my invention. Fig. 2 is a detail, plan view of the circuit-breaker contact terminals shown in Fig. 1. Fig. 3 is a view, in longitudinal section, and Fig. 4 a plan view of a modified form of circuit-breaker embodying my invention. Fig. 5 is a view, partially in side elevation, partially in section and partially diagrammatic, of a system of distribution embodying an automatically controlled means for opening the circuit in case of an overload or short-circuit and, also, manually controlled means for both opening and closing the circuit-breaker.

Referring first to Figs. 1 and 2, the operating members of the circuit-breaker 1 are mounted upon a suitable base-plate or slab 2, to which they are fastened by means of suitable bolts 3. One of the circuit making and breaking members of the device comprises yielding fingers 4 that are mounted upon a frame 5 by means of springs and screws or bolts, as is usual in the art.

The circuit connection to the frame 5, from a cable 6, is made by means of a suitable clamp 7. An auxiliary contact terminal 8 is supported between the fingers 4 and comprises a head 9 having a conical, central portion 10, and an annular depression 11 that terminates in a vane 11^a and a cylindrical stem 11^b. The stem 11^b is mounted in a tube or casing 12 and is surrounded, within the tube, by a coil-spring 13, one end of which bears against the outer end of the tube or casing and the other end against a collar 14 which constitutes a portion of the contact terminal.

The outer end of the stem 11^b is electrically connected to the standard 5 by means of flexible straps 15. This construction and arrangement are such that the terminal 8 is normally held in the position indicated in the drawing, but may be moved rearwardly, against the action of the spring, to such degree as may be required by the degree of movement of the coöperating movable contact terminal which will be now described.

The movable member of the circuit-breaker is provided with main contact terminals 16, of suitable form to coöperate with the fingers 4 and with an auxiliary contact

terminal 17 of tubular form, the axis of the opening 18 in which is in alinement with the axis of the contact terminal 8, so that the end of the conical portion 10 will enter the opening 18 when the two members are brought into engagement and not only effectively close it but also make good electrical contact with the walls thereof. The contact terminals 16 and 17 are mounted upon a piston or plunger rod 19 having a central bore 20 that extends for a considerable portion of its length and constitutes a continuation of the opening 18 in the contact terminal 17. While I have shown the terminal 8 as yieldingly held in advance position by a spring and the terminal 17 as rigidly attached to the plunger rod 19, it will be understood a reversal of these conditions or any other desired structural variation or modification may be adapted which does not involve a material change in mode of operation or result.

The piston or plunger rod 19 is provided, at one side, with two depressions or recesses 21 and 22, the functions of which will be hereinafter more fully described, and also with a lateral bore or passage 23 between the inner end of the bore 20 and the exterior of the rod. One end of the rod or plunger 19 is rigidly fastened to a piston 24 which is suitably packed to make an air-tight fit in a cylinder 25 and is normally held against the corresponding end of the cylinder by means of a coil-spring 26. Compressed air is admitted to and exhausted from the cylinder 25 behind the piston 24, through a suitable inlet opening 27, by means of suitable pipe connections and valves, (not shown). The cylinder 25 is provided with a projecting inner portion 28 that constitutes a bearing for the plunger rod 19 and also a chamber 29 for the reception of the air which is ejected through the passages 23 and 20 to extinguish the arcs which are or may be formed between the contact terminals 8 and 17 when the said terminals are separated.

In order to admit compressed air to the chamber 29 and to cut off the supply when desired, I provide a valve chamber 30, to which the air is supplied, by means of suitable pipe connections, (not shown), through a port 31. Communication between the chamber 30 and the chamber 29 is made and interrupted by means of a valve 32 that is normally seated by the air-pressure behind it and by gravity, or by air-pressure alone in case the valve is not so located and arranged as to be gravity actuated, and in order to unseat the valve to admit the compressed air to the chamber 29, I provide an unseating device, here shown as a ball 33. This ball rests in the recess or depression 21 in the plunger rod 19 when the circuit-breaker is in full open position and in the recess or depression 22 when the circuit-breaker is in full closed position; so that, when in either of these positions, no compressed air is admitted from the chamber 30 to the chamber 29.

The circuit connection to the movable member of the circuit-breaker is made from a cable 34, through a clamping device 35 and flexible strips 36.

The pairs of contact terminals are moved into engagement by means of air-pressure admitted to the cylinder 25 against the piston 24 and are held in such engagement against the pressure of the spring 26 unless and until the air-pressure is withdrawn from the cylinder, either by reason of manual control or automatically, and during the time that the circuit-breaker is closed, the valve 32 is also closed.

In case the air-pressure is withdrawn from the cylinder, either by reason of manual control or automatically, the spring 26 will instantly actuate the piston 24 and separate the contact terminals. As the main terminals 4 and 16 are first separated, the circuit will be finally interrupted between the terminals 8 and 17. Prior to such separation, the ball 33 will be raised, by movement of the piston rod 19, and a charge of compressed air will therefore be contained within the chamber 29 and the bore or passage 20, so that when the actual separation of the conical head 10 and the terminal 17 takes place, a blast of air will be projected at such point of separation and will be maintained until the movable member reaches the limit of its movement and the ball 33 drops into the recess 21 and thus permits the valve 32 to close. By reason of the depression 11 and the vane 11^a adjacent to the conical portion 10, the blast of air will be deflected against or adjacent to the main terminals 16 and thereby more certainly insure the interruption of all arcs that may form between any pair or set of terminals. A simple, conical head may be employed, however, if desired.

Referring now to Figs. 3 and 4, the circuit-breaker 1^a is mounted upon a suitable insulating base 2, substantially as in the form shown in Fig. 1, but in this form, the main stationary contact member comprises two contact terminal blocks 37, the inclined contact faces of which are engaged by the correspondingly inclined faces of a laminated contact terminal 38 that is mounted upon and suitably clamped to a piston rod 39. One end of the rod 39 is rigidly fastened to a piston 40 that is located in a cylinder 41, to which compressed air is supplied by means of a pipe 42. When the air is withdrawn from the cylinder 41, the piston 40 is moved to separate the contact terminals by means of a coil-spring 43.

The rod 39 is provided with an enlarged portion or head 44 that is surrounded by a casing 45 in which it has a close sliding fit.

One side of the head 44 is provided with a depression 46 and, at its front end, with another depression 47. Projecting from the free end of the head 44, is a contact terminal rod 48 which makes contact with an auxiliary stationary contact terminal 49, here shown as in the form of a split tube. The casing 45 is provided with a cap 50 the outer end of which is contracted so as to form a narrow annular opening 51 adjacent to the contact rod 48.

Air is admitted to the valve chamber 52 through a pipe 53 and its passage from the chamber 52 to the casing 45 and cap 50 is controlled by a valve 54 which is seated when the controlling device, here shown as a ball 55, rests in either the depression 46 or the depression 47 in the head 44 and is open when the head 44 is in the position intermediate the full closed position and the full open position of the circuit-breaker, the mode of operation and the result attained being substantially the same as in the form of apparatus shown in Fig. 1, except that the blast of air is projected through an annular opening, whereas in the form shown in Fig. 1, it is projected through a cylindrical opening.

Referring now to Fig. 5, the circuit-breaker proper 1^a is the same, so far as the structural features are illustrated, as the form shown in Figs. 3 and 4, except that only one depression 47 is provided in the head 44, the other depression being omitted because the circuit-breaker is here shown as utilized for automatic interruption of the main circuit in case of an overload or short-circuit, whereas the form shown in Fig. 1, and also that shown in Fig. 2, is designed for manual control. The devices shown in Figs. 1, 2 and 3 are also adapted for use in an automatic system for the protection of a circuit in case of overload or short-circuit, but in such a system the recess 21 of Fig. 1 and the recess 47 of Fig. 3 are not needed and may therefore be omitted.

The circuit-breaker 1^a of Fig. 5 is employed for making and breaking a circuit 56 which is supplied with energy by a suitable alternating current generator 57. Connected in the circuit 56, is the primary winding 58 of a transformer 59, the secondary winding 60 of which is connected in series with a magnet coil 61 of an overload device 61^a, the movable armature or core 62 of which is connected to the movable member 63 of a switch 64 that serves, under proper conditions, to make and break an auxiliary circuit which is supplied by a suitable source of current, here indicated as a battery 65, the switch 64 being normally closed and held in that position by any suitable means, such, for example, as a spring 66, acting either alone or in conjunction with gravity and being held in open position, after being moved to that position by the coil 61, by means of a retaining coil 67 that is connected across the battery circuit. A second magnet coil 68 is also connected in series with the transformer secondary 60 and acts upon a movable core or armature 69 to hold a switch 70 closed so long as the main circuit 56 is closed. A manually operated switch 71 is provided for opening the battery circuit when desired.

Air is supplied to the circuit-breaker closing cylinder 41, through pipes 42 and 72, from a suitable source. Air is or may be supplied to the valve chamber 54 from the same source through pipes 53, 73 and 72. The pipes 42 and 53 are provided with insulating sections 42^a and 53^a, respectively, for the purpose of insulating the circuit-breaker from the remainder of the system. Interposed between the pipes 72 and 42, is a double valve 74 that is moved to position to place the pipes 42 and 72 in communication with each other and with the source of compressed air by an electro-magnet 75 and into position to cut off such communication and place the pipe 42 and the cylinder 41 in communication with the atmosphere, by means of a coil-spring 76, when the magnet 75 is deënergized. In a similar manner, a double valve 77 is interposed between the pipes 53 and 73 in such manner that the two pipes are in open communication with each other and with the supply of compressed air when an operating magnet 78 is energized and is moved into and held in position to close such communication and to connect the pipe 53 with the atmosphere by a coil-spring 79 when the magnet 78 is deënergized.

It will be understood, from the foregoing description, that in the case of an overload on the main circuit 56, the increased current above the normal which flows through the coil 61 will raise the core or armature 62 and thereby open the switch 64, and when the core or armature has been thus operated, it will be held in position to maintain the switch 64 in open position by means of current from the battery 65 through the coil 67, irrespective of the current in the main circuit. When this switch 64 is opened, the magnet 75 will be deënergized and consequently the air will be exhausted from the cylinder 41, through the pipe 42, to the atmosphere and the circuit-breaker will be opened. As soon as the circuit-breaker terminals 48 and 49 are separated from each other, the blast of air will be ejected through the opening 51 to extinguish the arc, and, upon the interruption of the arc, the coil 68 will be immediately deënergized, so that the switch 70 will be opened, the magnet 78 deënergized and the supply of air to the valve chamber 52 be cut off by reason of the action of the coil-spring 79.

In order to re-set the apparatus, the switch 71 is opened and the coil 67 is accordingly deënergized and releases the switch 64, which is immediately closed by the spring 66. By again closing the switch 71, the magnet 75 will be energized and air admitted to the cylinder 41, which will close the main circuit-breaker 1^a, and as soon as this is closed, the switch 70 will close, provided the generator 57 is in operation, thus closing the circuit through the magnet 78, which, in turn, will actuate the valve 77 to admit air to the valve chamber 52, and the members of the system will then all be in position for controlling the operation of the circuit-breaker either automatically or manually, the latter being effected by merely opening the switch 71.

By the use of this system of control, the circuit-breaker cannot close after an overload has caused it to be opened until the switch 71 is opened, no air is discharged upon the contact terminals during the closing of the circuit-breaker and no air can be discharged upon the terminals after the arc is extinguished, even if the piston has not then reached the limit of its movement.

The details of construction may obviously be varied, within considerable limits, without departing from the spirit and scope of the invention, and I desire it to be also understood that the invention is not limited to the employment of any specific fluid as an arc-extinguishing agent.

I claim as my invention:

1. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a fluid-pressure-actuated piston having a piston rod upon which one member of each of said pairs of terminals is mounted, a spring for separating the terminals, and means for directing a blast of air through one of the auxiliary contact terminals and against the other when the circuit is being broken.

2. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, one of which is convex and the other concave, a fluid-pressure-actuated piston, a piston rod upon which one member of each of said pairs of terminals is mounted, a spring for separating the terminals, and means for directing a blast of air through one of the auxiliary contact terminals and against the other while the piston is between its extreme positions.

3. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a piston having a piston rod which is provided with a recess in one side and carries one member of each of said pairs of terminals, a cylinder, a valve chamber, a valve located therein and a valve-lifting device that rests in the recess in the piston rod when the circuit-breaker is closed.

4. In a circuit-breaker, a fluid-pressure cylinder, a piston having a piston rod, main and auxiliary contact terminals carried by said piston rod, main and auxiliary stationary contact terminals adapted to be engaged by the piston rod terminals, resilient means tending to maintain the terminals out of engagement, and a spring that is compressed by the auxiliary stationary terminals when the breaker is closed.

5. In a circuit-breaker, the combination with a normally-seated valve, of a movable member having one or more recesses and a contact terminal and being located adjacent to said valve, and a valve-actuating device that is movable into and out of said recess or recesses as said member is moved.

6. In a circuit-breaker, the combination with a fluid-containing chamber having a normally-seated discharge valve, of a movable member having one or more recesses and a contact terminal and being located adjacent to said valve, and a valve-actuting ball located between said valve and said member.

7. In a circuit-breaker, the combination with a fluid-containing chamber having a normally-seated discharge valve, of a reciprocatory plunger provided with a contact terminal and having one or more side recesses, and a valve-actuating device located between the valve and the plunger in the path of movement of the recess or recesses.

8. In a circuit-breaker, the combination with a fluid-containing chamber having a normally-seated discharge valve, of a reciprocatory plunger provided with a contact terminal and having one or more side recesses, and a valve-actuating ball interposed between the valve and the plunger in the path of movement of said recess or recesses.

9. In a circuit-breaker, the combination with a hollow plunger, provided with a contact terminal and having one or more side recesses, of a fluid-containing chamber adjacent to said plunger and having a normally-seated discharge valve, and a ball interposed between said plunger and said valve.

10. In a circuit-breaker, the combination with separable contact terminals, of means controlled by a movable terminal for directing a blast of fluid through one of the terminals and against the other at the instant of separation, and means also controlled by said movable terminal for cutting off said blast when the arc is extinguished or immediately thereafter.

11. In a circuit-breaker, the combination with separable contact terminals, of a chamber containing arc-extinguishing fluid located adjacent to but not inclosing said terminals, and means for effecting a discharge of fluid from said chamber through one of said contact terminals and against the other

when they are separated and for stopping such discharge when the arc is extinguished or immediately thereafter.

12. In a circuit-breaker, a cylinder, a piston, a piston rod, contact terminals carried by said piston rod, corresponding contact terminals adapted to be engaged by said piston rod terminals, resilient means tending to maintain the terminals out of engagement, means for effecting engagement of said terminals, and means controlled by said piston rod for directing a blast of air through it and one of the terminals when the terminals are being separated.

13. In a circuit-breaker, two pairs of contact terminals, means for causing successive engagement and disengagement of the members of each pair, and means controlled by one of the movable terminals for directing a blast through it and against the coöperating terminal.

14. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, means for separating said pairs of terminals successively, and means controlled by one of the movable terminals for directing a blast of air through it and against the coöperating terminal at the instant of separation.

15. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a piston, a piston rod which carries one terminal of each of said pairs of terminals, resilient means tending to maintain the terminals of each pair out of engagement, means for applying fluid-pressure to the piston to effect movement of the contact terminals, and a spring that permits the stationary, auxiliary terminal to yield when the movable auxiliary terminal is moved into engagement therewith.

16. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a piston, a piston rod which carries one terminal of each of said pairs of terminals, resilient means tending to maintain the terminals of each pair out of engagement, means for applying fluid-pressure to the piston, a chamber from which an air blast may be directed upon the auxiliary terminals when the circuit is being broken and means for controlling the supply of air therefrom.

17. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a piston, a piston rod which carries one terminal of each of said pairs of terminals, a resilient means tending to maintain the terminals of each pair out of engagement, means for applying fluid-pressure to the piston, means for directing an air-blast upon the auxiliary terminals, and means for cutting off the supply of air except when the circuit is being broken.

18. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a piston, a piston rod which carries one terminal of each of said pairs of terminals, resilient means tending to maintain the terminals of each pair out of engagement, means for applying fluid-pressure to the piston, means for directing an air blast upon the auxiliary terminals, and means for restricting the air blast to the time when the piston is between its extreme positions.

19. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a piston rod which is provided with recesses in one side and which carries one member of each of said pairs of terminals, resilient means tending to maintain the terminals of each pair out of engagement, a chamber from which a blast of air may be directed upon the auxiliary contact terminals, a valve in said chamber, and a valve-actuating ball which normally rests in one of the piston rod recesses.

20. In a circuit-breaker, a cylinder, a piston, a piston rod which carries contact terminals, resilient means tending to maintain the circuit-breaker in open position, means for admitting compressed fluid into the cylinder to maintain the circuit-breaker in closed position, and means for directing compressed fluid against the contact terminals when the piston is in motion or in an intermediate position.

21. In a circuit-breaker, a cylinder, a piston, a piston rod which carries contact terminals, resilient means tending to maintain the circuit-breaker in open position, means for admitting compressed fluid into the cylinder to close the circuit-breaker and to hold it closed, and means for directing compressed fluid through one of the contact terminals and against the coöperating terminal when the circuit is being broken.

22. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a cylinder, a piston having a hollow piston rod upon which one of the auxiliary contact terminals is mounted, and a chamber having a valved port controlled by the hollow piston rod to admit compressed fluid thereto when the circuit is being broken.

23. In a circuit-breaker, a pair of main contact terminals, a pair of auxiliary contact terminals, a cylinder, a piston, a hollow piston rod carrying one of the auxiliary contact terminals at its outer open end, means for admitting compressed fluid to the hollow piston rod when the circuit is being broken, resilient means tending to maintain the circuit-breaker in open position and means for admitting compressed fluid to the cylinder for maintaining the circuit-breaker in closed position.

24. In a circuit-breaker, a pair of main

contact terminals, a pair of auxiliary contact terminals, a cylinder, a piston having a hollow piston rod provided with recesses in one side and carrying one of the auxiliary contact terminals at its outer open end, a valve chamber which communicates with the hollow piston rod, a valve, and a ball which normally rests in one of the side recesses in the piston rod.

25. In a circuit-breaker, a cylinder, a piston, a hollow piston rod having a side inlet port, means for admitting compressed fluid to said port as the piston rod starts rearwardly from its forward position, a hollow arc-receiving contact terminal at the outer free end of said piston rod, a coöperating conical, arc-receiving contact terminal and current-conducting contact terminals one of which is carried by the said piston rod.

26. The combination with a main circuit and a circuit-breaker comprising a cylinder, a piston, a piston rod, contact terminals carried by said piston rod, other terminals to engage therewith and a chamber from which an air blast may be directed upon the contact terminals, of means for admitting a supply of compressed fluid to the said cylinder in order to operate the circuit-breaker, and means for discharging fluid from said chamber only when the piston rod contact terminals are moving from one extreme position to the other.

27. The combination with a main circuit and a circuit-breaker comprising a cylinder, a piston, a piston rod, contact terminals carried by said piston rod, other terminals to engage therewith, and a chamber from which an air blast may be directed upon the contact terminals, of means for admitting a supply of compressed fluid to the said cylinder in order to close the circuit-breaker, and means for discharging fluid from said chamber only when the piston is in motion or in an intermediate position.

28. The combination with a main circuit and a circuit-breaker comprising a cylinder, a piston, a piston rod, contact terminals carried by said piston rod, other terminals to engage therewith, and a chamber from which an air blast may be directed upon the contact terminals, of means for admitting a supply of compressed fluid to the said cylinder in order to close the circuit-breaker, and a valve which is opened to discharge fluid from said chamber only when the piston is in motion or in an intermediate position.

29. The combination with a main circuit and a circuit-breaker comprising a cylinder, a piston, a piston rod, contact terminals carried thereby, other terminals to engage therewith and a chamber from which an air blast may be directed upon the said contact terminals, of means for admitting a supply of compressed fluid to the said cylinder in order to close the circuit-breaker, a valve which is opened to discharge fluid from said chamber only when the piston is in motion or in an intermediate position and means for admitting compressed fluid thereto while the main circuit is closed.

30. The combination with a main circuit and a circuit-breaker comprising a cylinder, a piston, a piston rod, contact terminals carried thereby, other terminals to engage therewith, a chamber from which an air blast may be directed upon the contact terminals, and a valve which is opened to discharge fluid from said chamber only when the piston is in motion or in an intermediate position, of an electro-magnetically controlled valve which governs the supply of fluid to said cylinder, a source of energy, and a master switch which controls the electrical circuit of said last named valve.

31. The combination with a main circuit and a circuit-breaker comprising a cylinder, a piston, a piston rod, contact terminals carried thereby, other terminals to engage therewith, a chamber from which an air blast may be directed upon the contact terminals, and a valve which is opened to discharge fluid from said chamber only when the piston is in motion or in an intermediate position, of an electro-magnetically controlled valve which governs the supply of fluid to said cylinder, a source of energy, a master switch which controls the electrical circuit of said last named valve, and an electro-magnetically controlled valve which governs the supply of fluid to the said chamber.

32. In a circuit-breaker, a contact terminal having a conical, central portion and a surrounding annular depression.

33. In a circuit-breaker, a contact terminal having a convex, central portion and a concave surrounding portion.

34. In a circuit-breaker, a contact terminal having a convex, central portion and a concave surrounding portion, in combination with a coöperating, tubular contact terminal the axis of which is in alinement with the axis of the convex portion.

35. In a circuit-breaker, a contact terminal having a central projection, an adjacent vane and an intervening curved depression.

36. In a circuit-breaker, a contact terminal having a conical, central portion, a surrounding, annular vane and an intervening annular depression.

37. In a circuit-breaker, a tubular contact terminal and a coöperating contact terminal in alinement therewith having a convex, central portion, an adjacent vane and an intervening, annular depression.

38. In a circuit-breaker, a tubular contact terminal, means for projecting a stream of insulating fluid through said terminal, and a coöperating contact terminal having a

convex, central portion, a surrounding vane and an intervening, annular depression.

39. In a circuit-breaker, a tubular contact terminal, means for projecting a stream of insulating fluid through said terminal, and a coöperating contact terminal having a convex, central portion, an adjacent vane and an intervening, annular depression for deflecting the stream of insulating fluid upon adjacent parts.

40. In a circuit-breaker, main contact terminals, an auxiliary, tubular contact terminal, means for projecting a stream of insulating fluid through said terminal, a cooperating, auxiliary contact terminal having a convex, central portion, an adjacent vane and an intervening, annular depression for directing the stream of insulating fluid upon the adjacent main contact terminals.

41. In a circuit-breaker, a tubular contact terminal, means for projecting a stream of insulating fluid through said terminal, and a coöperating imperforate contact terminal in alinement therewith against which the fluid is projected.

42. In a circuit-breaker, the combination with main contact terminals, of adjacent auxiliary and coöperating contact terminals, means for effecting engagement and disengagement of the members of each of said pairs of terminals, means for directing a stream of insulating fluid between the auxiliary contact terminals, and means for deflecting the stream upon the adjacent main contact terminals.

43. In a circuit-breaker, the combination with coöperating, main contact terminals, of auxiliary contact terminals, one of which is tubular and the other of which serves as a stopper for the end of the tube, means for effecting engagement and disengagement of said terminals, and means for delaying the separation of the auxiliary contact terminals until after the separation of the main contact terminals.

44. In a circuit-breaker, a contact terminal having a convex, central portion and a surrounding concavity, and a coöperating, tubular contact terminal the axis of which is in alinement with the axis of said convex portion, one of said terminals being spring-actuated.

45. In a circuit-breaker, the combination with main contact terminals, of auxiliary contact terminals, means for effecting engagement and disengagement of said terminals, means for delaying disengagement of the auxiliary contact terminal until after the separation of the main contact terminal, and means for directing a stream of insulating fluid between the auxiliary contact terminals while the circuit is being broken.

46. In a circuit-breaker, the combination with main contact terminals, of auxiliary contact terminals, means for effecting engagement and disengagement of said terminals, means for delaying the disengagement of the auxiliary contact terminals until after the separation of the main contact terminals, means for directing a stream of insulating fluid between the auxiliary contact terminals while the circuit is being broken, and means for deflecting the stream of insulating fluid from the auxiliary contact terminals upon the main contact terminals.

47. In a circuit-breaker, the combination with main contact terminals, of auxiliary contact terminals, that are spring-actuated in the same direction, means for effecting engagement and disengagement of said terminals, and means for directing a stream of insulating fluid between the auxiliary contact terminals while the circuit is being broken.

48. In a circuit-breaker, the combination with main contact terminals, of auxiliary contact terminals, one of which is spring-actuated, means for effecting engagement and disengagement of said terminals, means for directing a stream of insulating fluid between the auxiliary contact terminals while the circuit is being broken, and means for deflecting the stream from the auxiliary contact terminals upon the main contact terminals.

49. In a circuit-breaker, a tubular contact terminal, a coöperating contact terminal, one of said terminals being spring-actuated, means for projecting a stream of insulating fluid through the tubular contact terminal while the circuit is being broken, and means for deflecting the stream upon adjacent parts.

50. In a circuit-breaker, a tubular contact terminal, a coöperating contact terminal in alinement therewith having a convex, central portion and a surrounding concavity, one of which is spring-actuated, and means for projecting a stream of insulating fluid through the tubular contact terminal while the circuit is being broken.

In testimony whereof, I have hereunto subscribed my name this 5th day of October 1904.

RAY P. JACKSON.

Witnesses:
E. Ernest Rose,
Birney Hines.