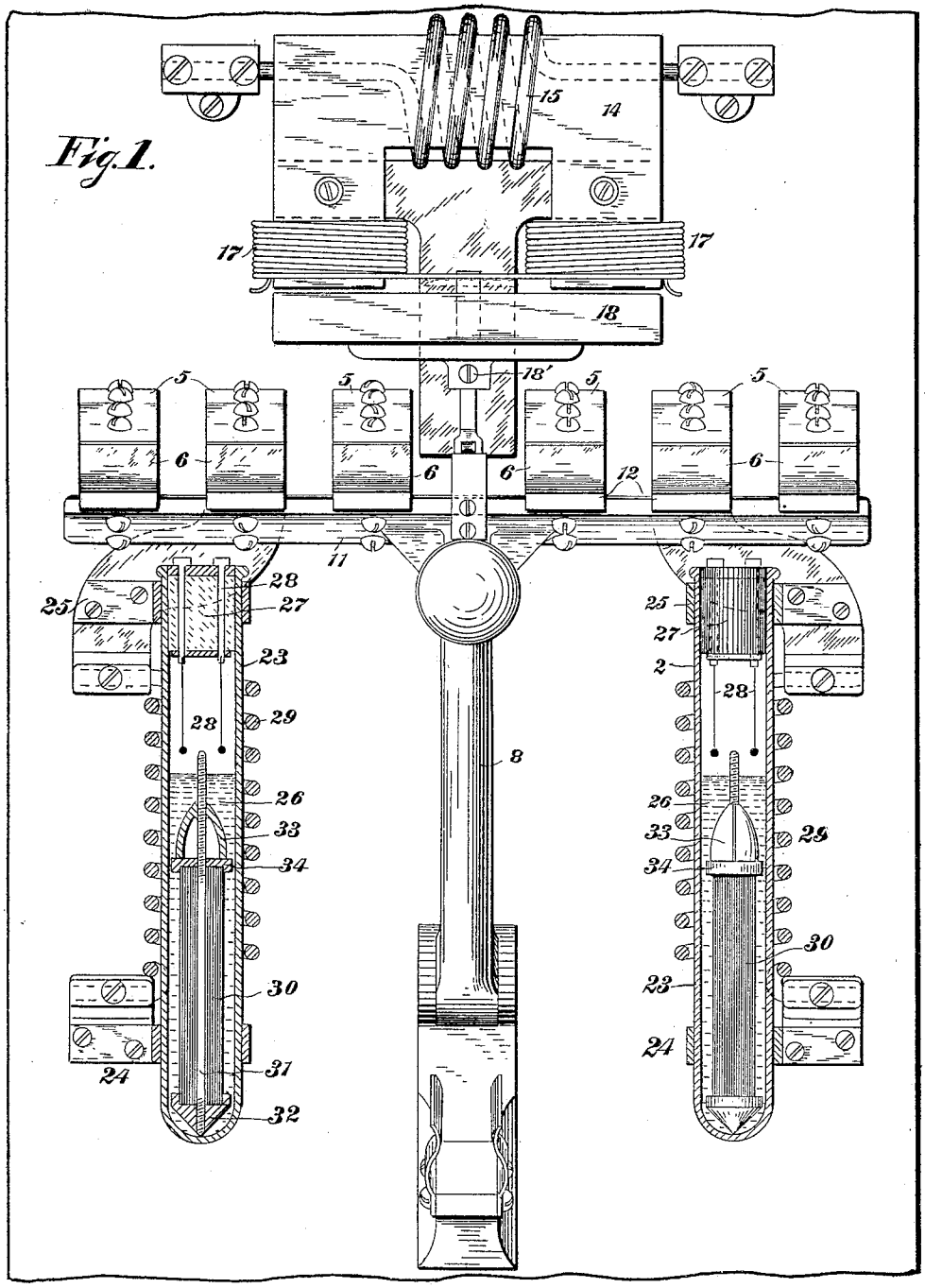
(No Model.) 3 Sheets—Sheet 1.

A. J. WURTS.

AUTOMATIC CIRCUIT BREAKER.

No. 570,417. Patented Oct. 27, 1896.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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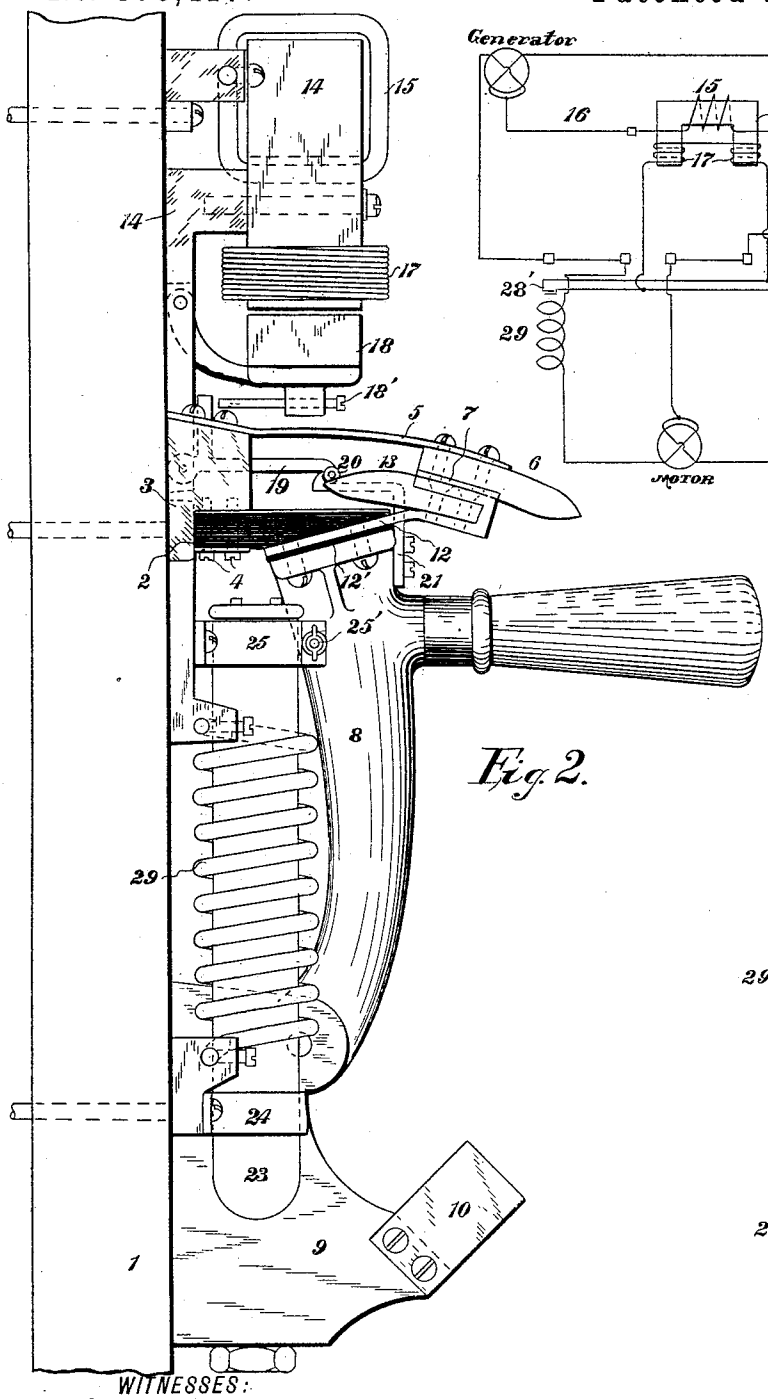
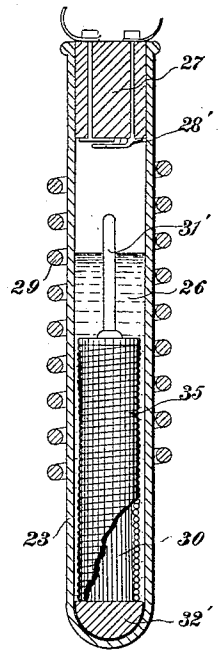


Fig. 2.

Fig. 3.

Fig. 4.



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AUTOMATIC CIRCUIT BREAKER.

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Fig. 5.

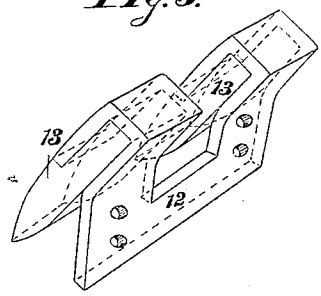


Fig. 6.

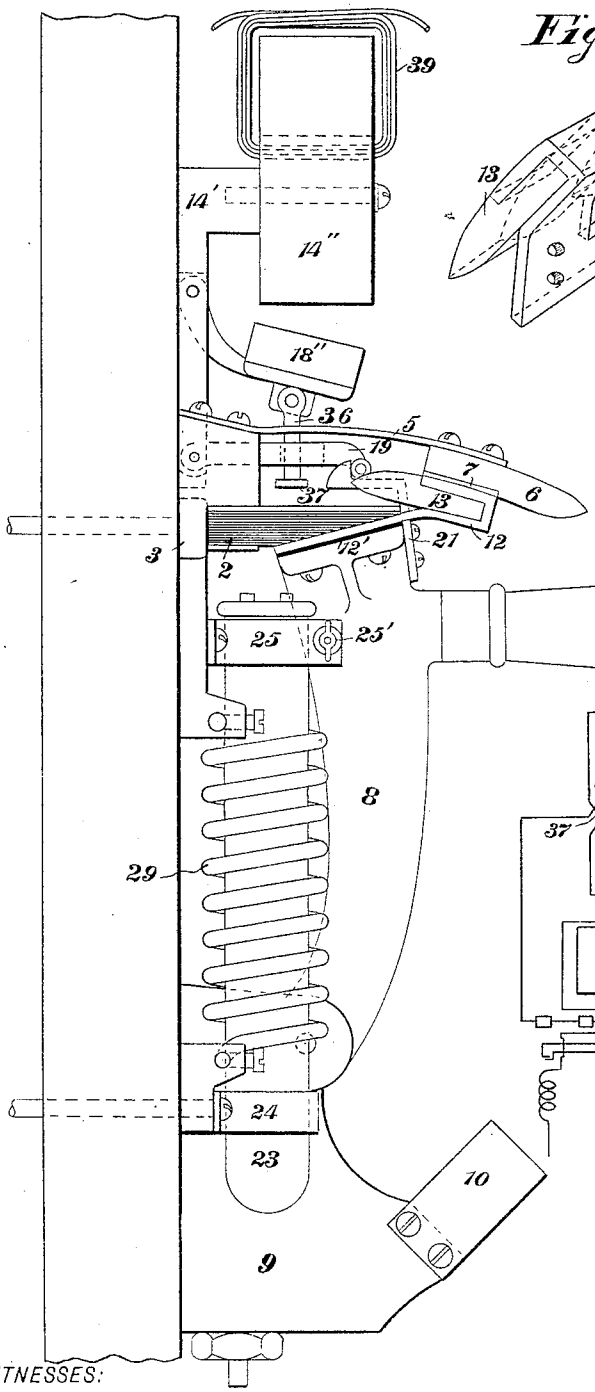
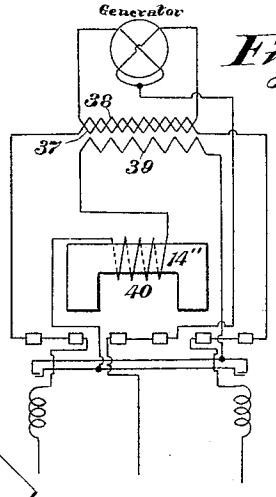


Fig. 7.



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UNITED STATES PATENT OFFICE.

ALEXANDER JAY WURTS, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, OF SAME PLACE.

AUTOMATIC CIRCUIT-BREAKER.

SPECIFICATION forming part of Letters Patent No. 570,417, dated October 27, 1896.

Application filed January 10, 1896. Serial No. 574,999. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER JAY WURTS, a citizen of the United States, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Automatic Circuit-Breakers, (Case No. 680,) of which the following is a specification.

My invention relates to automatic circuit-breakers, and has particular reference to devices of this character which are employed in connection with either single or multiphase alternating-current circuits, though not in all respects limited to such relations.

One of the objects of my invention is to provide an efficient device of this character which will automatically open all the branches of a multiphase circuit whenever the current in any one of such branches exceeds a certain predetermined limit, provided such excessive current continues for any considerable length of time.

Another object of my invention is to provide an improved means whereby an alternating-current circuit, whether single or multiphase, will be opened a predetermined interval of time after the occurrence of a maintained excessive current.

A further object of my invention is to provide an improved means for controlling the movement of a solenoid-core.

In the running of certain kinds of electrical machines, particularly induction-motors, operated by multiphase currents, a quantity of current considerably in excess of the normal amount is required to start the motor. This excessive current is taken only momentarily, however, so that an automatic circuit-breaker which is employed for protecting the motors from the injurious effects of overload should not be opened by the action of the momentarily excessive current required for starting such motors. I have accordingly devised a means for releasing such circuit-breakers which will respond so slowly to the action of excessive current that the circuit-breaker will not be released and opened unless such excessive current continues for a certain length of time, which exceeds the time during which the rush of current incident to the starting of the motors exists.

Reference being had to the accompanying drawings, Figure 1 is a view, partially in front elevation and partially in section, of a circuit-breaker constructed in accordance with my invention; and Fig. 2 is a side elevation of the same. Fig. 3 is a diagram showing the main and secondary circuits, and Fig. 4 a section of a modified form of circuit-closing device for the secondary circuit. Fig. 5 is a perspective view of a bridging contact-terminal. Fig. 6 is a side elevation of a modified form of circuit-breaker, and Fig. 7 is a diagram of the circuits through the same.

Referring now particularly to Figs. 1, 2, 3, and 5 of the drawings, 1 is the usual supporting base or plate, formed of marble or other suitable non-conducting material, and 2 are the stationary contact-terminals suitably supported by such base. Each of these stationary contact-terminals consists of a bundle of conductors soldered to a base-piece 3 and also fastened thereto by means of bolts or screws 4, as shown in Fig. 2. The outer free ends of these contact-terminals are beveled, as indicated in the drawings, in order to provide the necessary contact-face for engagement with the movable contact devices. These stationary contacts are arranged in pairs, one for each branch of the circuit. In the present instance the switch is shown as designed for use in a two-phase circuit provided with three line conductors, one of which is common to both phases, there being thus provided three pairs of such contact-terminals. Bolted to each base-piece 3 is a spring 5, which bears at its free end a contact-block 6, formed mainly of carbon or some other suitable conducting and substantially infusible material, and having a contact face-plate 7 of copper or other good conducting metal extending through a portion of its length.

The movable member of the circuit-breaker comprises an arm 8, pivoted to a block or casting 9 upon the base 1, such block or casting being provided with leaf-springs 10 for the reception of the arm 8, and also with the usual spring (not shown) for throwing the arm backward when released. The arm 8 is provided at its free end with a bar 11 of sufficient length to bridge all the stationary contacts, and mounted upon this bar are three contact-

plates 12, suitably insulated from the bar 11 by mica 12′, or otherwise, and so located that they will respectively bridge the several pairs of stationary contacts corresponding to the three conductors of the circuit. Each of the plates 12 is extended beyond the outer edge of the supporting-bar 11, and has fastened to it a contact-piece 13 for engagement with the corresponding stationary contact 6. As shown in the drawings, the plate 12 is bent around the outer ends of the main portions of the pieces 13 and set into the face of the same, so as to provide a metal face which extends over a portion of the length of the said piece to engage with the corresponding plate 7 of the contact 6. The main portion of this contact 13 is formed of carbon or some other substantially infusible conducting material, and is of substantially the same form as the part 6 except that it has a convex bearing-surface, whereas the part 6 has a corresponding cancave bearing-surface, the curvature of these parts being substantially that of the arc of a circle struck from the pivotal axis of the arm 8 as a center when the circuit-breaker is closed.

It is obvious that the portion of the plate 7 which makes contact with the part 7 of the contact 6 may be a separate piece, if desired. It is here shown as an integral part of the plate 12 in order to provide a better conducting-path for the current. As the volume of current to be interrupted by this breaker will, however, ordinarily not be very great, the screws which fasten the auxiliary contact-plate with the main contact will probably under ordinary circumstances afford a sufficiently good conducting-path for the current.

14 is a magnet-core preferably laminated and suitably fastened to and supported by a base-piece 14′. This core is provided with a few turns of wire 15, forming part of the middle or common conductor 16 of the circuit, and the two legs of the core are each surrounded by a coil 17 of fine wire, these coils 17 being connected in series and so arranged with reference to the coil 15 that when the circuit through them is closed they will be inductively influenced by the current through the coil 15 and have an opposite magnetizing effect upon the core 14, and thus neutralize the normal magnetizing effect of the current in the coil 15.

18 is an armature pivoted to the base-piece 14′ and provided with a screw or other projection 18′. 19 is a latch also pivoted to the base-piece 14′ or some other suitable support, and provided at its outer free end with a roller 20. This roller engages with the hooked end or catch of a plate or piece 21, projecting from the free end of the arm 8. Projecting upwardly from the latch 19 is a piece 22 in position to be engaged by the screw 18′ when the armature 18 falls in order to withdraw the latch and release the movable member of the breaker.

As will be readily understood from the foregoing description, when a normal current is carried by the main circuit the magnetizing effect of the current in the coil 15 will serve to retain the armature 18 in contact with the free ends of the core 14; but if the current in this circuit fails for any reason, or if the circuit including the coils 17 is closed so as to counteract the magnetizing effect of the coil 15, the armature 18 will be released and will effect the release of the movable member of the breaker, which will be instantly thrown open.

In order to guard against the opening of the circuit when a current in excess of the normal current is only momentary, I provide a device which will be now described.

23 is a tube formed of insulating material, preferably glass, and supported by means of a pair of clips or brackets 24 and 25, the upper clip 25 being provided with a clamping-screw 25′, in order that the tube may be adjusted longitudinally, if desired, the reason for such adjustment being more fully set forth hereinafter. These tubes are partially filled with liquid 26, glycerin being a desirable liquid for this purpose, its character being such that the movement of a solid body through it must necessarily be slow. I do not desire to limit my invention, however, as regards the particular liquid employed. The upper end of each tube is closed, preferably by means of a stopper 27, of some suitable insulating material, such as wood, cork, or vulcanized fiber, and through this stopper extend two contacts 28. Each tube 23 is surrounded by a coil 29, which forms a part of the corresponding side of the main circuit, and inside the tube is a core which is mainly formed of magnetizable material and is provided with means for closing the circuit between the two contact-terminals 28. This core, as shown in Fig. 1 of the drawings, is constructed of a bundle of iron wires 30, through which extends a rod 31 of any suitable material, screw-threaded at both ends. Upon its lower end is mounted a cap 32 of insulating material, such, for example, as wood, and on its upper end is a circuit-closing piece 33, formed of good conducting material and screwed upon the upper end of the rod 30. This circuit-closing piece is preferably slotted, as indicated at the right in Fig. 1, in order to prevent the setting up of Foucault currents therein by induction from the coil 29. Between this circuit-closing piece 33 and the bundle of wires 30 is a cap 34 for engagement with the upper ends of the wires, and together with the cap 32 and rod 30 retaining such wires in a compact bundle. The upper ends of the contacts 28 are connected in circuit with the coils 17, as is clearly indicated in Fig. 3 of the drawings, so that when an excessive current traverses either of the coils 29 the core will be caused to move upward, but on account of the body of liquid in the tube the core will move slowly until it has nearly reached the limit of its upward move-

ment, so that there will be no danger of its closing the secondary circuit unless the excessive current continues for a material length of time, the period necessary for the closing of the circuit being determined by the position of the tube 23, which may be adjusted longitudinally to the desired position.

In Fig. 4 is shown a modification of the circuit-closing device, in which the iron wires 30 are held together by means of a cord 35, wrapped around them, and the contacts 28′ are so arranged that the upper end of the rod 31′ will press them into engagement instead of bringing a circuit-closing bridging-piece between them, as is the case in the construction shown in Fig. 1. In other respects the form shown in Fig. 4 is substantially the same as that shown in Fig. 1.

The device shown in Fig. 4 or the modification shown in Fig. 1 is admirably adapted for use as a dash-pot, if, instead of clamping it in position, it be left free to move longitudinally through its coil. When used for this purpose, the circuit-contacts carried by stopper of the tube would obviously be omitted and the tube might be entirely filled with liquid, if desired. The differential movement between the core and tube due to the mechanical resistance of the liquid is such as to render the device peculiarly desirable in many cases where retardation of the movement of a mechanical element is necessary.

In the form of the apparatus illustrated in Figs. 1 and 2, the circuits of which are diagrammatically shown in Fig. 3, the armature is normally held in contact with the poles of the magnet and is dropped to release the movable member of the circuit-breaker either when the current fails in the main circuit or when there is an overload which persists for a sufficient length of time to close the secondary circuit. It is necessary to employ this form of the apparatus only in cases where it is desired to automatically open the circuit-breaker both for overload and the failure of current in the main circuit. In view of the fact that it is sometimes difficult to so adjust the apparatus that the armature will be maintained in its position in contact with the poles of the magnet through wide variations in the amount of current in the circuit and also because of the humming noise which is caused by the action of the alternating current upon the iron of the core and armature, it is often preferable to employ a breaker in which the armature is normally separated from the poles of the magnet and is raised into engagement therewith in order to release the movable member of the breaker. Such a form of apparatus is illustrated in Figs. 6 and 7. The several parts of this form of apparatus, with the exception of the features which will be hereinafter specifically pointed out, are the same in construction and mode of operation as those heretofore described. The armature 18″ of this form of breaker is pivoted to the base-piece in substantially the same manner as the armature 18, already described, and is provided with a depending pin 36, which extends through an opening of somewhat larger size in the latch 19′ and is provided at its lower end with a head 37. It will be understood from this construction that in the normal condition of the apparatus the armature will be in its lowest position and will serve to withdraw the latch 19′ from the catch 21 only when it is raised into contact with or proximity to the ends of the magnet-core 14″. It will be seen by reference to Fig. 7 that two primary coils 38, one for each outer conductor of the two-phase circuit, are employed and that a single secondary coil 39 is located in inductive relation to the said primary coils. The coil 39 is in series with a coil 40 on the core 14″, and the terminals of the circuit including these coils 39 and 40 are constructed and arranged in the same manner as the terminals of the secondary circuit described in connection with the other form of the apparatus.

It will be understood from the foregoing description that if the current of either phase increases beyond the critical amount and is maintained for a sufficient length of time to close the secondary circuit a secondary current will be set up by induction in the coils 39 and that such current will energize the coil 40, thus magnetizing the core 14″ and raising the armature 18″, the lost motion between the head 37 of the pin 36 and the latch 19′ having the effect of causing the head 37 to give a sharp quick blow to the latch and thus withdraw it from the catch 21.

In cases where the voltage of the main circuit is not too high the coils 38 and 39 of Fig. 7 may be dispensed with and the coil 40 included in a shunt to the main circuit, which is normally open and which may be closed by either of the circuit-closing devices above described, as will be readily understood.

While I have described the application of my invention to a two-phase system of distribution having three wires, I desire to be understood that it is equally well adapted to circuits having a different number of phases and a different number of conductors. It will also be understood that instead of locating the secondary-circuit-closing means in the two separate branches such means may be located in the line which is common to the two phases, if desired. I prefer the construction shown, however.

It will also be understood that other changes and modifications may be made without in any way departing from the spirit and scope of the invention.

I claim as my invention—

1. In a time-limit circuit-breaker for alternating-current multiphase circuits, the combination with a plurality of pairs of stationary contact-terminals, one pair for each line conductor and a plurality of bridging contacts having a single movable support, of a latch, an armature for effecting the withdrawal of

the same, primary and secondary armature-controlling coils the latter being in a normally open circuit and a plurality of devices respectively actuated by excessive current of the corresponding phase to close the secondary circuit a predetermined interval of time after the occurrence of such excessive current.

2. In a time-limit circuit-breaker for alternating-current multiphase circuits, the combination with a plurality of pairs of stationary contact-terminals, one pair for each line conductor, and a plurality of bridging contacts having a single movable support, of a latch, an armature for effecting the withdrawal of the same, a primary controlling-coil, a normally open secondary circuit having a portion in inductive relation to said primary coil and a plurality of devices respectively actuated by excessive current of the corresponding phase to close the secondary circuit.

3. In a time-limit circuit-breaker for alternating-current multiphase circuits, the combination with a plurality of pairs of stationary contact-terminals, one pair for each line conductor, and a plurality of bridging contacts having a single movable support, of a latch, an armature for effecting the withdrawal of the same, a primary coil for each phase of current, a normally open secondary circuit having a portion located in inductive relation thereto and serving when energized to actuate the armature, and devices actuated by excessive current of either phase to close the secondary circuit a predetermined interval after such current becomes excessive.

4. In a circuit-breaker for alternating-current multiphase circuits, the combination with separable contact-terminals, a latch therefor and an armature for effecting the withdrawal of the same, of a plurality of primary coils respectively traversed by the different phases of current, a normally open secondary circuit having a coil in inductive relation to said primary coils and a magnetizing-coil adjacent to said armature and means actuated by excessive current of either phase to close the secondary circuit.

5. The combination in an electric circuit, of a tube of non-conducting material having a body of non-conducting liquid partially filling the same and a pair of terminals at or near its upper end, with a solenoid surrounding said tube and a core inside the tube provided at or near its upper end with means for closing a circuit through said terminals, the liquid in said tube serving to retard the movement of said core.

6. The combination with a tube partially filled with non-conducting liquid and a conducting-coil surrounding the same, of a pair of terminals in the upper end of said tube and a magnetizable core movable upwardly through said liquid under the action of current in said coil and provided with means for closing a circuit through said terminals.

7. A circuit-closing device comprising a receptacle provided with stationary contacts at or near its upper end, a body of liquid partially filling said receptacle, a magnetizable body in said liquid, provided with means for closing the circuit through said stationary contacts when brought into engagement therewith and a main-circuit coil surrounding said receptacle, and serving, when sufficiently energized to raise said magnetizable body against the resistance of the liquid in which it is located.

8. An automatic circuit-closing device comprising a glass tube partially filled with liquid and having a stopper provided with a pair of contacts, a main-circuit coil surrounding said tube and a subdivided core located in the body of liquid and provided with means for closing a circuit through said contacts, when drawn upward by the action of the current in said coil.

9. A circuit-closing device comprising a longitudinally-adjustable non-conducting tube, having a stopper provided with secondary-circuit terminals and partially filled with liquid, a bundle of iron wires in said liquid, provided with means for closing the circuit through said terminals, a main-circuit coil surrounding said tube and means for clamping the tube in the position to which it may be adjusted.

In testimony whereof I have hereunto subscribed my name this 9th day of January, A. D. 1896.

ALEXANDER JAY WURTS.

Witnesses:
W. A. DICK,
JAMES B. YOUNG.