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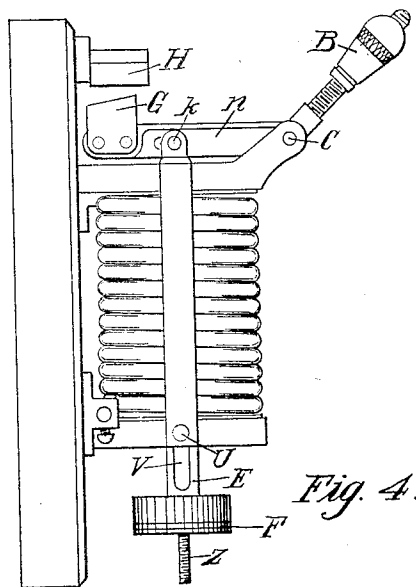
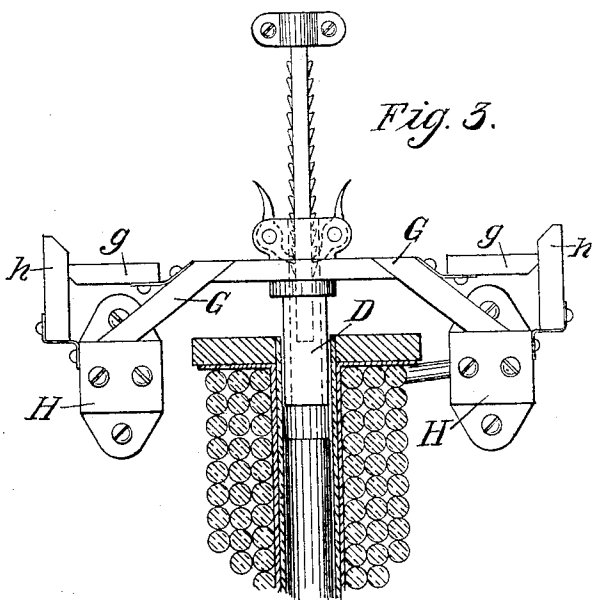
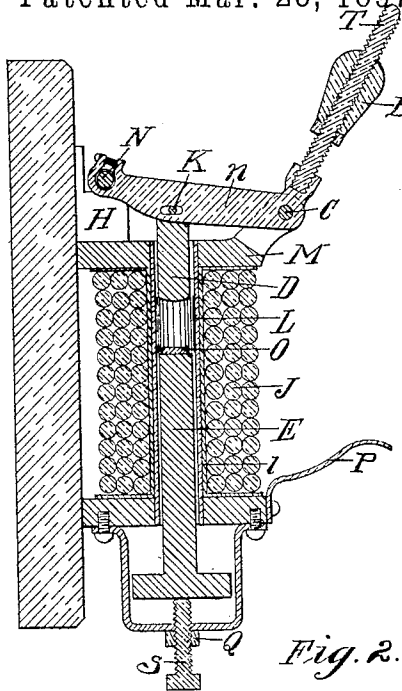
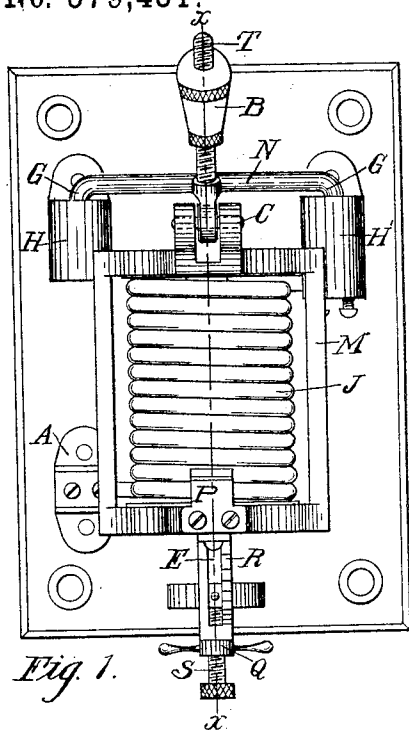
2 Sheets—Sheet 1.

W. E. HARRINGTON.

AUTOMATIC ELECTROMAGNETIC CIRCUIT BREAKER.

No. 579,431.

Patented Mar. 23, 1897.



WITNESSES:

*Wm. Stokes Adams*  
*Thomas S. Ferguson*

*Walter E. Harrington* INVENTOR

BY

*Wm. Crossdale*

ATTORNEY.

(No Model.)

2 Sheets—Sheet 2

W. E. HARRINGTON.

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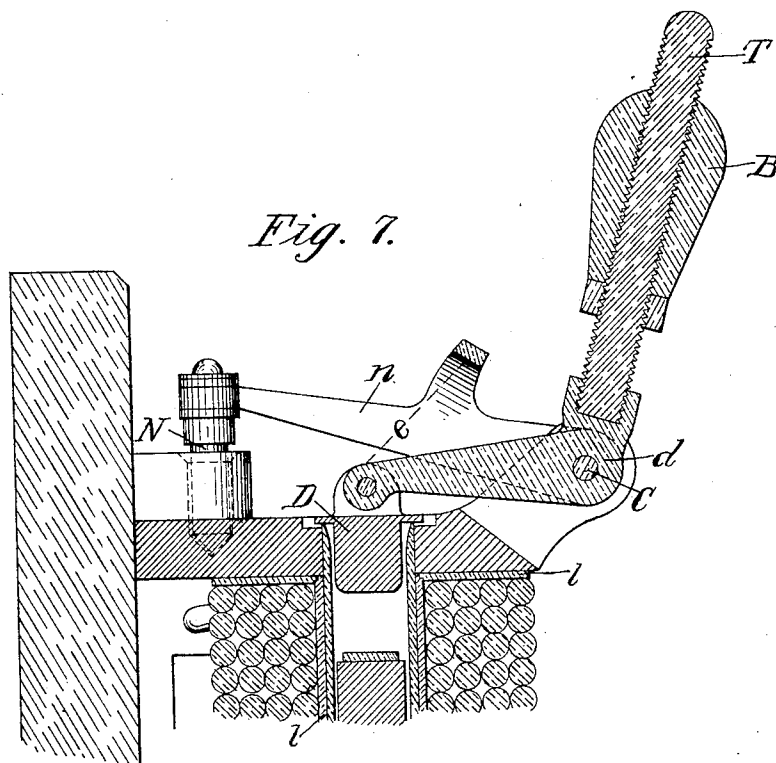


Fig. 7.

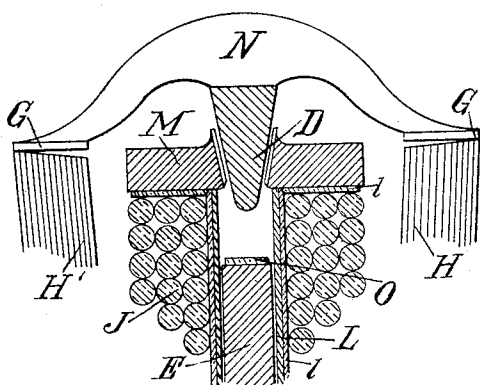


Fig. 6.

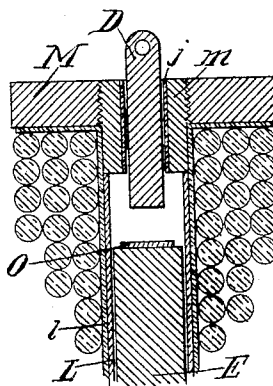


Fig. 5.

WITNESSES:

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# UNITED STATES PATENT OFFICE.

WALTER E. HARRINGTON, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR  
TO THE CUTTER ELECTRICAL & MANUFACTURING COMPANY, OF NEW  
JERSEY.

## AUTOMATIC ELECTROMAGNETIC CIRCUIT-BREAKER.

SPECIFICATION forming part of Letters Patent No. 579,431, dated March 23, 1897.

Application filed May 5, 1896. Serial No. 590,369. (No model.)

*To all whom it may concern:*

Be it known that I, WALTER E. HARRINGTON, a citizen of the United States, residing in the city and county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Automatic Electromagnetic Circuit-Breakers, of which the following is a specification.

My invention relates to automatic electromagnetic circuit-breakers; and the chief objects of my improvements are to provide a circuit-breaker which will operate to open or close a circuit in a space of time in inverse ratio to the volume of excessive current passing through it, which will be actuated either to open or close a circuit as predetermined, which will be actuated either upon a predetermined maximum or minimum flow of current, and in which the force exerted upon one of the movable cores by normal flow of current may be employed to keep the switch-bridge in position desired. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a front view of one form of my magnetic circuit-breaker with switch-bridge pivoted to magnetic jacket. Fig. 2 is a side sectional view of same on lines *xx* of Fig. 1. Fig. 3 is a front view of a portion of another form of my circuit-breaker, showing switch-bridge not pivoted to magnetic jacket. Fig. 4 is a side view of a portion of my magnetic circuit-breaker constructed to close the circuit or make a short circuit upon a predetermined maximum or minimum flow instead of opening it. Fig. 5 is a side sectional view of portions of magnetic jacket, coil, and non-magnetic tube, showing magnetic ring at upper end of non-magnetic tube. Fig. 6 is a sectional view of a portion of circuit-breaker, showing another form of movable core. Fig. 7 is a view of a portion of circuit-breaker, showing core D pivoted to arm independent of that to which the switch-bridge is pivoted. Similar letters refer to similar parts throughout the several views.

My invention consists, essentially, in the operation of two cores or plungers movable in the magnetic field of a solenoid-coil and acted

upon by a current passing through said coil and a switch-bridge actuated by the operation of the cores or plungers to open or close the circuit.

In the specific device represented in Figs. 1 and 2 the beginning and end terminals are at A and II, respectively. The contact-terminals II and II' are cup-shaped and filled with mercury. Contact is made between these and switch-bridge N by its ends G entering the mercury contained in said cups II and II'. The cores D and E are inserted in the upper and lower openings of the non-magnetic tube L, which extends longitudinally through the center of coil J and magnetic jacket M. The upper core D is prevented from entering entirely into tube L by being attached by pivot K to lever-arm *n*, which supports switch-bridge N. The lower core E is prevented during flow of normal current from being drawn into the tube farther than the desired distance by the counter resistance exerted by its weight. It is also prevented from being drawn entirely out of or away from the tube by the adjusting-screw S. The upper end of the core E is provided with a non-magnetic butt O to prevent it from sticking to the core D when the two come into contact. The insulating substance *l* may be employed as additional insulation between coil J and non-magnetic tube L. The spring P may be employed to break the force of the fall of counterbalance B, and also to retain it in the position to which it has been forced.

The action of the current passing through the coil is to exert a force tending to suck or draw the core D downward into the coil, drawing with it the switch-bridge N, causing the contacts G to remain in the mercury-cup terminals II and II'. Thus the circuit is kept closed or locked by the force of any normal current passing through it. A force is exerted in a similar manner upon core E, tending to suck or draw it upward into the coil, which force when exerted by normal current is counteracted by the weight of the core, as above stated. Upon the flow of a predetermined abnormal or excessive current, however, the force exerted upon the core E, owing to its

adjustment hereinafter described, is sufficient to overcome the counter resistance of its weight, and the core rises in a space of time in inverse ratio to the volume of excessive current passing through the coil, the velocity of the core's movement constantly increasing until it strikes core D with a momentum sufficient to drive core D upward and out of the coil. The switch-bridge to which core D is attached is carried with it, and the contacts G are carried away from and out of the mercury-cup terminals H and H', thus opening the circuit.

Adjustment is effected with respect to the predetermined excessive flow of current necessary to cause an automatic break by regulating, by means of adjusting-screw S, the distance of the upper end of core E from the lower end of core D, also the approach of upper end of core E to the magnetic field within the coil in connection with the weight of the said core, which may be diminished or added to by means of the movable weights. A lock-nut, as at Q, may be used to preserve the adjustment when made. R represents a graduated scale to indicate the adjustment.

The switch-bridge N is pivoted to the magnetic jacket M at C. When actuated by the movement of core D or the pull of counterbalance B, it is carried over its pivot C and so held by force of gravity.

There are many cases in which it is desirable to open the circuit in the event of a below-normal flow of current. As has been observed, the normal flow of current exerts a force upon core D to draw it downward into the coil. To this force there is a counteracting force exerted upon core D tending to draw it upward out of the coil by the gravity weight of the counterbalance B, which force a normal current is sufficient to withstand. When, however, the flow of current through the coil falls below the predetermined minimum, the force exerted by it upon core D is insufficient to withstand the force exerted by the counterbalance B, which consequently falls and carries with it the switch-bridge N and contacts G away from mercury-cup terminals H and H', thus opening the circuit. Adjustment is effected with respect to subnormal or minimum flow of current necessary to release core D by increasing or diminishing the leverage power of counterbalance B by moving it nearer to or farther from the fulcrum-pivot C by means of the screw-thread upon stem T for said adjustment, as shown.

While I have described my invention as embodied in the specific device shown in Figs. 1 and 2, it will be obvious to any one skilled in the art that the device embodying my invention is capable of considerable variation in detail of construction as well as mode of operation. For example, various forms of contact may be employed instead of mercury-cup contacts. In Fig. 3 the switch-bridge is provided with laminated copper brushes G to contact with smooth flat-surface contacts H,

in which case the suck or downward pull upon core D by flow of normal current tends to increase and improve the contact between G and H. A similar result is accomplished by the form of construction shown in Fig. 6, the laminated copper brushes being at H instead of at G.

The knife-blade or clip contact is among other variations of contact that may be employed.

Carbon-points *g* at the extremities of the switch-bridge N, in Fig. 3, are adapted to bear upon carbons *h*, yieldingly attached to contact-terminals H and H' for final arcing.

The switch-bridge N, which is shown in Figs. 1 and 2 as pivoted to magnetic jacket at C, need not be so pivoted, but may be adapted to fall away when forced from its contact position, as shown in Fig. 6, or it may be so constructed as to be held by means of ratchets, as shown in Fig. 3, in the farthest position to which it has been forced by the impact of the cores. The ratchet device may also be employed in conjunction with the pivoted bridge.

The core D need not be attached to bridge N or its lever-arm *n* in case said core is so constructed either by being widened at its upper end to a greater diameter than the diameter of the tube L, as shown at Fig. 6, or by having a shoulder, as shown in Fig. 7, or where any other suitable means be employed for preventing it from entering entirely into the tube.

The core D may be pivoted to magnetic jacket by an arm independent of switch-bridge or its pivot-arm. This is sometimes desirable in order to relieve the core and its counterbalance from outside influences, as, for instance, the force which is imparted to the switch-bridge and its pivot-arm by the buoyancy of the mercury in the mercury-cup contacts. This has been found to interfere with the nice adjustment of the circuit-breaker. In Fig. 7 the core D is pivoted to magnetic jacket by arm *d*, which is rigid with counterbalance-arm B, while switch-bridge N is pivoted by arm *n* to same pivot C, but moving independently of arm *d*. Arm *d*, being directly beneath arm *n*, has a preliminary movement before impacting-arm *n*, as indicated by dotted line *e*.

The non-magnetic tube L, which extends longitudinally through the coil and the jacket in which the cores are movable, may be dispensed with by covering the magnetic cores with a non-magnetic material, leaving the ends only exposed, or by covering such parts of the jacket or coil as might be likely to come into contact with the cores with a non-magnetic material, or any other similar method of preventing the cores from magnetically sticking to the jacket or coil. I have employed a non-magnetic tube simply as a convenient form of accomplishing this end and for the additional reason that it furnishes a guide for the movement of the cores.

Instead of the set-screw S for the purpose of supporting and adjusting the core E a simple ledge or shelf may be employed to support the core, or a pin U may be used, as shown in Fig. 4, passing through the longitudinal slot V in core E, in which case weights F may be attached to the extension Z of core E, as shown in said Fig. 4, for purposes of adjustment.

A fixed magnetic piece *m* may be inserted in the head of magnetic jacket, as shown in Fig. 5, to reduce magnetic resistance and so that when core E rises in the coil and impacts core D, driving it upward, core E, having a diameter greater than that of the interior of said magnetic piece, adheres to its lower edge, thus preventing core D from returning to its normal position and closing the circuit.

Instead of the non-magnetic butt O being upon the end of core E the same may be fixed upon the end of core D, or any equivalent means, movable or fixed between the two cores, may be employed to keep them from magnetically sticking.

In the device specifically described adjustment is effected by means of regulating the distance between the cores and by adding to or lessening the weight of core E and adding to or lessening the leverage weight of counterbalance B. Additional adjustment may be effected by the employment of springs or weights to act directly or indirectly upon either or both cores, or springs may be employed entirely to substitute the force of gravity, acting directly or indirectly, as through lever and counterbalance, upon the cores, in which case it is not necessary that the cores have a vertical movement.

The circuit to be opened or closed may be either part of the circuit wherein the variation of current or voltage occurs or any other circuit. Instead of opening the circuit the switch-bridge may be adapted to be carried by the thrust of the cores or the pull of the counterbalance or similar force toward contact-terminals H and H' of another circuit, as shown in Fig. 4, and so close it, or the terminals H and H' may be in the same circuit in which the variation of current or voltage occurs, and the effect of bridging of the terminals H and H' is to cause a short circuit, cutting out a portion of the line.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In an electromagnetic circuit-breaker the combination with the switch of two cores and a solenoid-coil, the cores movable in the magnetic field of the coil and adapted to be actuated by the current passing through the coil to actuate the switch and the switch-bridge attached to one of the cores, which is arranged and adapted to be actuated by the force of a normal flow of electric current to hold the terminals of the switch-bridge in contact with the main contact-terminals with

an efficiency in direct ratio to the volume of current flowing through the coil.

2. In an electromagnetic circuit-breaker the combination with the switch of two cores, a solenoid-coil and a counterbalance, the cores movable in the magnetic field of the coil and adapted to be actuated by the current passing through the coil, the switch-bridge attached to one of the cores and the counterbalance attached to the switch-bridge and adjusted and adapted to carry the switch-bridge with its terminals toward or away from the main contact-terminals upon the flow through the coil of a predetermined below-normal current.

3. In an electromagnetic circuit-breaker the combination with the switch of two cores, a solenoid-coil and carbon contacts, the cores movable in the magnetic field of the coil and adapted to be actuated by the current passing through the coil to actuate the switch, the carbon-points at the extremities of the switch-bridge adapted to bear upon the carbons yieldingly attached to the main contact-terminals for final arcing.

4. In an electromagnetic circuit-breaker the combination with the switch of two cores, a solenoid-coil and a ratchet device, the cores movable in the magnetic field of the coil and adapted to be actuated by the current passing through the coil to actuate the switch, the ratchet device adapted and adjusted to hold the switch out of contact after having been actuated.

5. In an electromagnetic circuit-breaker the combination with the switch of two cores and a solenoid-coil, the cores movable in the magnetic field of the coil and adapted to be actuated by the current passing through the coil to actuate the switch, with movable weights and set-screw as means of adjustment with respect to amount of excessive current or voltage necessary to actuate it.

6. In an electromagnetic circuit-breaker the combination with the switch of two cores and a solenoid-coil, the cores movable in the magnetic field of the coil and adapted to be actuated by the current passing through the coil to actuate the switch, with movable counterbalance as a means of adjustment with respect to minimum amount of current or voltage necessary for its actuation.

7. In an electromagnetic circuit-breaker the combination with the switch of two cores, a solenoid-coil and a movable arm independent of the switch-bridge, the cores vertically movable in the magnetic field of the coil and adapted to be actuated by the current passing through the coil to actuate the switch, the upper core pivoted to the arm having a movement independent of the switch-bridge.

WALTER E. HARRINGTON.

Witnesses:

JNO. STOKES ADAMS,  
WM. M. SCOTT.