No. 816,468. PATENTED MAR. 27, 1906.

E. M. HEWLETT.

MAKING AND BREAKING HIGH POTENTIAL CIRCUITS.

APPLICATION FILED DEC. 14, 1898.

2 SHEETS—SHEET 1.

FIG. 1.

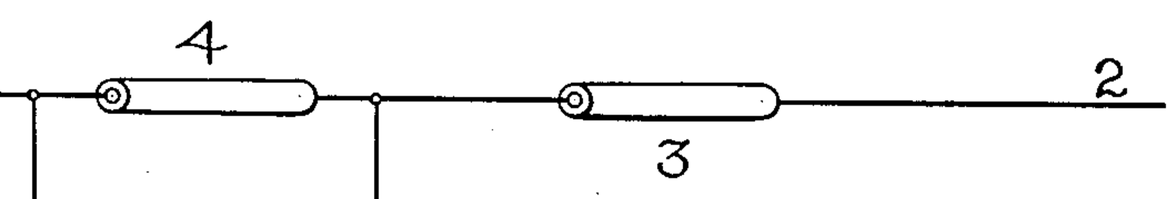
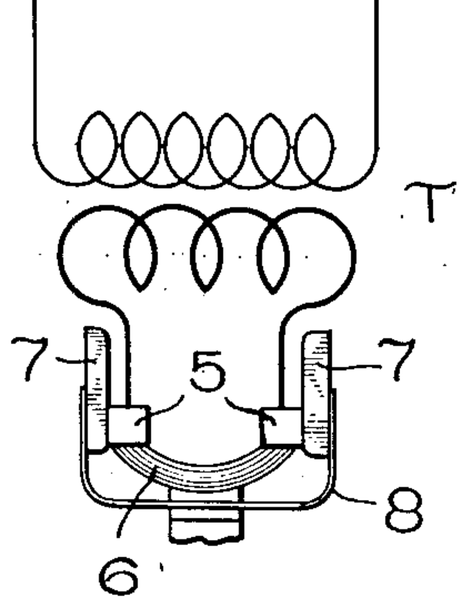
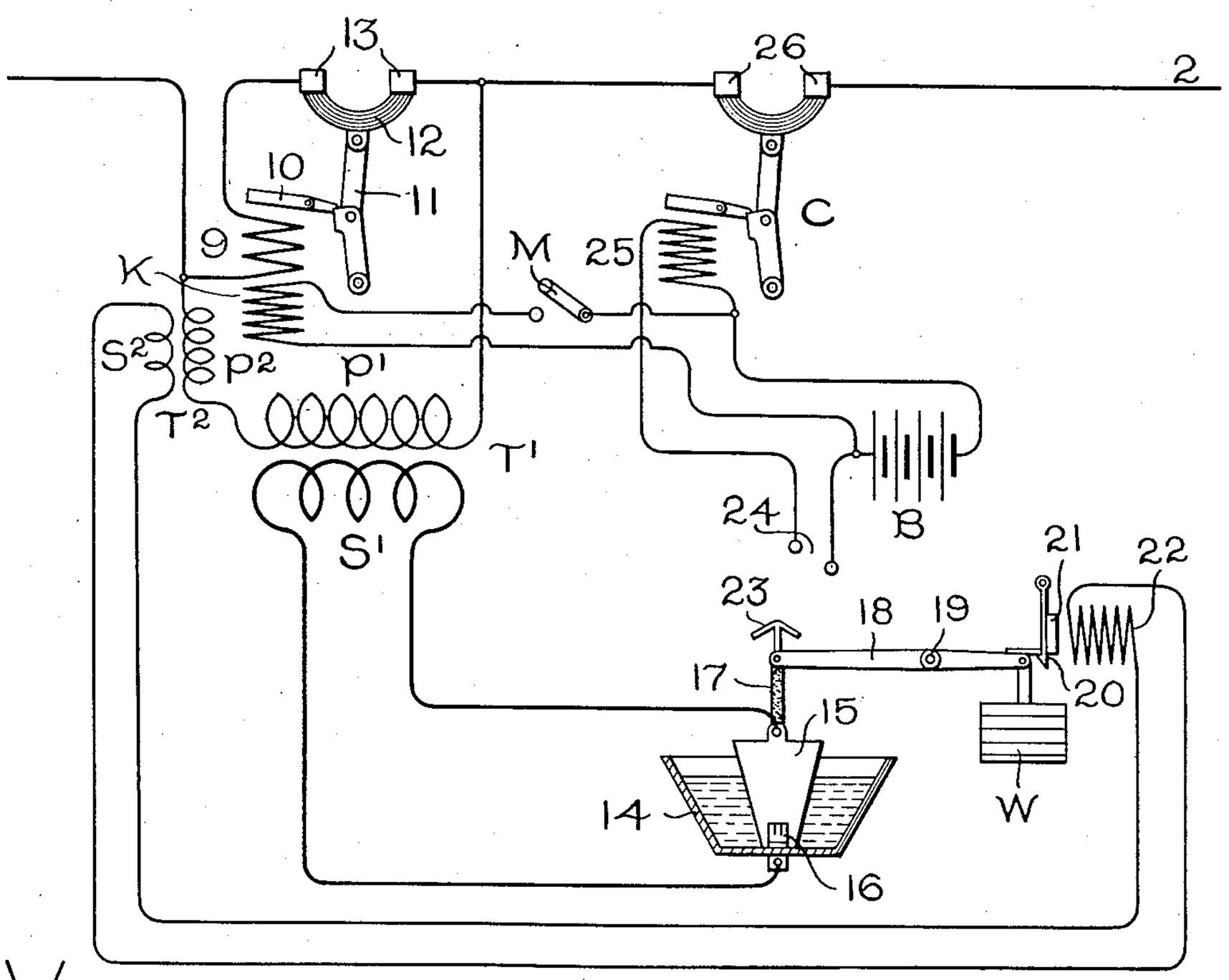


FIG. 2.





WITNESSES:

A. H. Abell.

A. F. Macdonald.

INVENTOR:

Edward M. Hewlett,

by Albert G. Davis

Atty.

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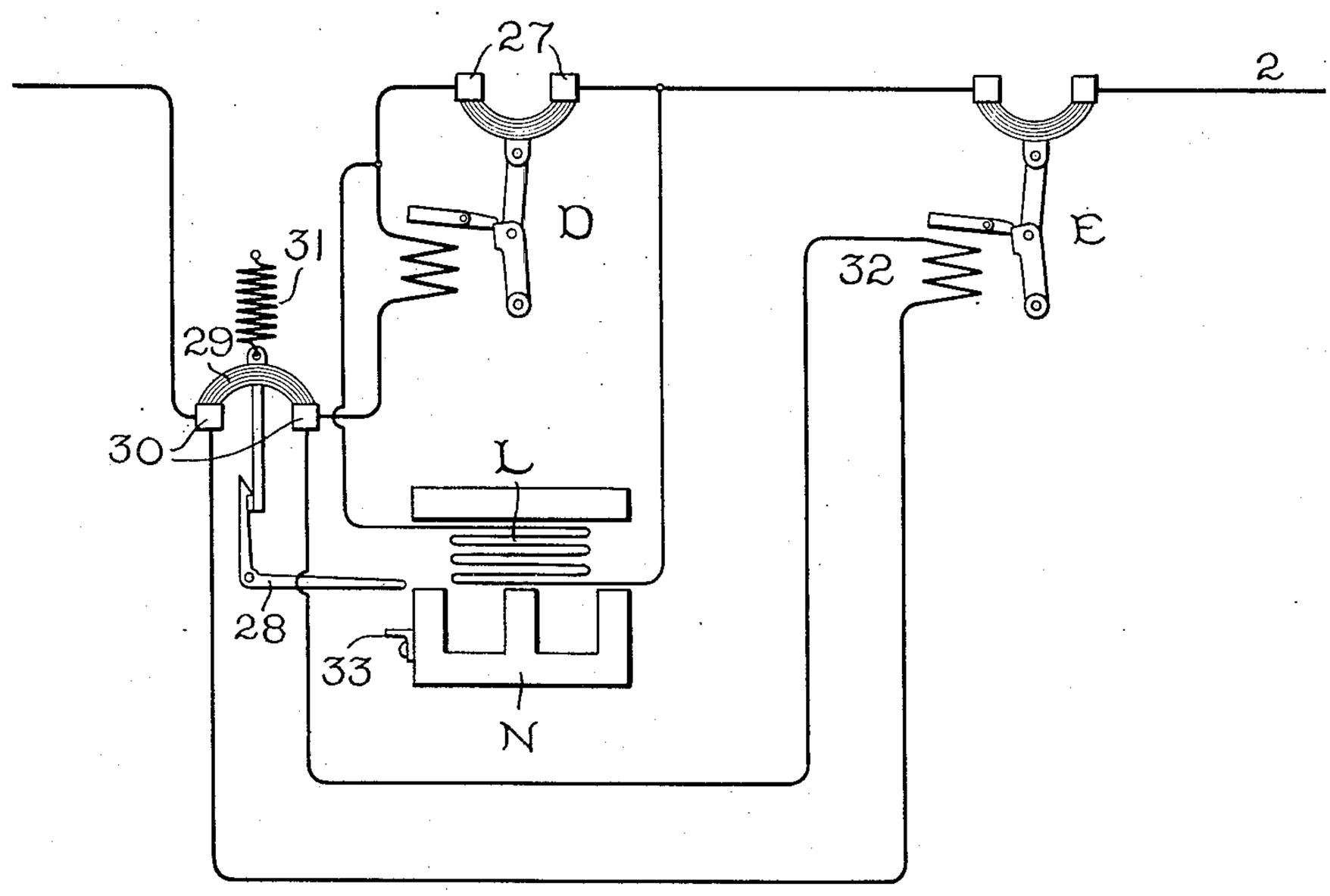
2 SHEETS—SHEET 2.

FIG. 3.



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A. F. Macdonald

INVENTOR.
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by Albert G. Davis,
Atty.

UNITED STATES PATENT OFFICE.

EDWARD M. HEWLETT, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MAKING AND BREAKING HIGH-POTENTIAL CIRCUITS.

No. 816,468. Specification of Letters Patent. Patented March 27, 1906.

Application filed December 14, 1898. Serial No. 699,201.

To all whom it may concern:

Be it known that I, EDWARD M. HEWLETT, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Making and Breaking High-Potential Circuits, of which the following is a specification.

In the operation of circuits containing self-induction and capacity, and more especially in those in which high impressed alternating electromotive forces are employed, there is great danger of impairing or breaking down the insulation of the lines when any sudden change takes place in the flow of current therein. Such danger is particularly apt to result disastrously in the case of circuits operating underground cables. When the current passing through such cables is suddenly interrupted or when the cable is connected suddenly with a source of electromotive force, violent electrical oscillations may and often do take place such as to puncture the insulation of the cable and render the same useless. Any sudden changes in the current flowing in a cable other than those caused by making and breaking the circuit of the same are apt to give rise to the same resonant increase in potential, but not in the same degree as that caused by making and breaking the circuit. I have discovered that the dangers referred to may be prevented almost entirely by causing the making or breaking to take place gradually—as, for example, in the apparatus hereinafter described by gradually increasing the impedance of the circuit immediately before breaking the same or in making the circuit by first introducing a large impedance and then gradually and progressively withdrawing it.

My invention comprises a novel organization of parts for utilizing this principle, and it includes certain novel features, which will be more clearly understood by reference to the following description, taken in connection with the accompanying drawings, while the scope of my invention both in its broad as well as in its more limited features will be clearly and particularly pointed out in the appended claims.

Figure 1 illustrates in diagram a type of manually-operated apparatus for carrying out my invention. Figs. 2 and 3 show different forms of apparatus for carrying out the same general operation as that performed by the device shown in Fig. 1, but differing from the latter in being automatically actuated.

In Fig. 1 the line-circuit is indicated at 1 2. The main switch for making or breaking this line-circuit is shown at 3. In order to make or break this circuit gradually, a reactance device is arranged to be introduced in circuit during such operation. For this purpose I have shown a transformer T with its primary arranged to be put in series with one of the mains, as 2. This object is attained by the use of a switch 4, which in its closed position short-circuits the primary of the transformer and which on being opened introduces the primary directly in series with the circuit, as will be readily understood.

Some suitable means is provided for varying the resistance of the secondary, and in the drawings I have illustrated a suitable arrangement for this purpose. The secondary terminals are illustrated at 5 and are shown as short-circuited by the bridging-piece 6, formed of laminated metal, so as to give good contact. Two blocks of carbon 7 7 are electrically connected with the terminals 5 and arranged to slide longitudinally along the same, so as to introduce a greater or less length of carbon into the circuit formed by the transformer-secondary and the spring yoke-piece 8, carrying the carbon blocks. The bridging contact 6 may, if desired, be arranged to operate independently of the resitance-varying device; but in practice I find it preferable to arrange them so as to be simultaneously movable.

Fig. 1 illustrates the condition of the circuit during normal operation. In case it be desired to open-circuit the mains, the first operation to be performed is to open the switch 4. This introduces in circuit the primary of the transformer T, the secondary of which is short-circuited by the bridging contact 6, thus causing the self-induction of the primary to be reduced to a minimum. After having opened the switch 4, and thereby introduced into the circuit a small impedance, the next step is to withdraw the bridging contact 6, and thus insert in the secondary the small resistance due to the carbon blocks 7, interposed between the connecting-yoke 8 and the contact-blocks 5. By gradually sliding the blocks 7 along the contact-blocks 5

the resistance of the transformer-secondary is increased in an obvious manner, thus increasing the impedance of the primary, and so gradually reducing the current in the mains. By properly proportioning the parts in a manner such as will readily be understood by engineers the value of the current in the mains may be reduced sufficiently so that upon opening the main switch 3 no dangerous increase in potential will result.

In making the circuit precisely the reverse operation is gone through with. The switches 3 and 4 being open and the total resistance being inserted in the secondary of the transformer T, the first step is to close the main switch 3, thus making the circuit and including therein a large impedance due to the transformer having its primary in series with the line. The resistance of the secondary is then slowly decreased until finally the terminals 5 are short-circuited by the bridging contacts 6, thus reducing the impedance of the primary-winding to a minimum. The switch 4 is then closed, thus wholly completing the circuit and eliminating the last trace of impedance.

Fig. 2 illustrates diagrammatically an automatically-actuated circuit-breaker, operative upon an overload, and provided with automatically-operated means for either making or breaking the circuit gradually. As before, the main circuit is indicated at 1 2. The circuit-breaker-actuating coil is indicated at 9, and operating in conjunction therewith is the armature 10, which serves to trip the bridging contact-piece of the circuit-breaker in any well-known manner. As shown, one end of the armature 10 serves to retain in place the knuckle of a toggle-lever 11, which operates a bridging contact-piece 12 for connecting together the contact-blocks 13, inserted in the line 2. Shunted about the switch formed by the terminals 13 and bridging-piece 12 is the primary P′ of the transformer T′. In series with the primary P′ is the primary P^2 of another transformer T^2. The secondary S′ of the transformer T′ is connected to a resistance-changing device—such, for example, as a water rheostat 14. This rheostat consists, preferably, of a metallic retaining vessel containing acidulated water and in contact electrically with one terminal of the secondary S′. The other terminal of the secondary is connected to a metallic plate 15, which may be inserted at different depths in the liquid contained by the rheostat, and which in one of its extreme positions is embraced by two metallic spring-fingers 16, secured to the bottom of the retaining vessel 14. The plate 15 is pivotally connected through an insulating-rod 17 with one end of a lever 18, fulcrumed, for example, at 19. A weight W is suspended from the opposite end of the lever and is of such a value as to overbalance the plate 15; but the apparatus is normally retained in the position shown by a catch 20, which engages the lever 18 in any suitable manner. The catch 20 is suitably pivoted and carries an armature 21 within the influence of an actuating-coil 22, excited by current derived from the secondary S^2 of the transformer T^2, already referred to, the primary P^2 of which, as has been noted, is in series with the primary P′ of the transformer T′. The lever 18 carries a bridging contact 23, which operates in conjunction with the terminals 24 to close a local circuit. This circuit has in series therewith some suitable source of electromotive force—as, for example, the battery B and a circuit-breaker coil 25, which operates a circuit-breaker C of any suitable form, thus serving to open the main line 2 at the contacts 26.

In the operation of an apparatus such as just described let it be supposed that the current in the mains 1 and 2 has increased beyond the limit allowed by the circuit-breaker included therein. The current in the circuit-breaker coil 9 then acts to draw down the armature 10, thus releasing the toggle 11 and opening the circuit at the contacts 13. This operation does not actually break the main circuit, but diverts the current through the primaries P′ P^2 of the transformers T′ T^2. The resistances of the respective secondaries are comparatively small so that only a moderate amount of impedance is by this operation introduced into the main line. Current then flows through the actuating-coil 22 and releases the catch 20, thus allowing the weight W to fall, and so raise the contact-plate 15 away from the bottom of the retaining vessel of the water rheostat 14. The resistance of the secondary S′ is thus gradually increased in an obvious manner, and so gradually increases the impedance of the main circuit, and thus reduces the current flowing therein. The downward motion of the weight W forces the bridging contact 23 into connection with the contacts 24, and so closes the local circuit through the battery B or other source of electromotive force and the circuit-breaking coil 25, thus operating the circuit-breaker C, and so opening the main circuit, the current in which has been reduced to a safe amount by the operation of the transformer T′ and the water rheostat operated in conjunction therewith.

The object of using a local circuit for actuating the main circuit-breaker C is to produce a positively-actuated device and obviate the disadvantages involved in the use of a device dependent for its operation upon the current in the circuit to be broken. Instead of a local electric circuit I might employ some mechanically-actuated device, operated, for example, by a weight or spring. This latter arrangement is not, however, in all respects as

desirable as a local circuit, since it will not, like the latter, allow the circuit-breaker to be located in one place and a tripping device in another at a distance therefrom.

While I have shown an arrangement which operates automatically to open-circuit the mains upon the occurrence of an overload, cases may and often do arise in which I desire to be able to open the main circuit at will. To provide for such cases, I supply the overload circuit-breaker 11 12 with an additional coil K, which is connected by a normally open circuit with the battery B or other suitable source of electromotive force. When it is desired to open the main circuit, the switch M is closed, thus operating in an obvious manner to trip the circuit-breaker 11 12, and so produce the sequence of operation already described, the final result of which is to trip the circuit-breaker C and open the main circuit.

In Fig. 3 I have shown an arrangement similar in many respects to that shown in Fig. 2, but differing therefrom in that the impedance which is introduced into the main circuit is varied by varying the magnetic reluctance of the core of the reactance-coil which furnishes the impedance. A further difference consists in operating the main circuit-breaker by energy derived from the main circuit. The circuit-breaker D included in one of the mains 1 2 is of any preferred form. Shunted about the contacts 27 is a reactance-coil L, having an adjustable core N adapted to vary the reluctance of the magnetic circuit. The pivoted catch 28 in the form of a bell-crank lever serves to retain the bridging contact 29 in connection with the contacts 30, inserted in one of the mains 1 2. One end of the catch 28 is engaged by a projection carried by the core N and is so arranged as to release the bridging contact 29 when it has reached its limit of motion into the coil of the reactance device. A spring 31 serves to withdraw the contact 29 when released by the catch 28. The contacts 30 are electrically connected to an actuating-coil 32 of a circuit-breaker E in the main line 2.

In the operation of this device let it be supposed that the current in the lines 1 2 increases abnormally, in which case the circuit-breaker D operates, and thus inserts in the main line 2 the reactance-coil L, the core of which is, as shown, in a position corresponding to minimum impedance. The core N is then drawn into the coil by the attraction due to the current flowing therein. Just before it has reached its limit of motion the projection 33 carried thereby engages the catch 28, thus releasing the bridging contact 29, which is drawn back out of contact with the terminals 30 by its spring 31, and thus introduces the coil 32 of the circuit-breaker E into the main circuit. The circuit-breaker E then operates and opens the main circuit, the current of which has already been reduced to a safe amount by the insertion of the impedance due to the reactance-coil L.

In some cases I may dispense with the circuit-breaker E and open the circuit directly at the switch 29 30. The arrangement shown, however, possesses the advantage that the circuit-breaker D and the parts cooperating immediately therewith may be located at one point, while the main circuit-breaker E may be located at any other point on the line, whether distant or otherwise.

Although I have shown by way of illustration certain arrangements which I have found desirable for carrying out my invention, I do not desire to be limited thereto, for it is evident that many changes and rearrangements may be produced for accomplishing the objects of my invention without departing from the spirit thereof.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The combination with an electric circuit, of an impedance for said circuit, a shunt around said impedance, means in said shunt responsive to change of current density for automatically opening said shunt on an overload, a circuit-breaker outside of said shunt, and means controlled by the opening of said shunt for operating said circuit-breaker.

2. The combination with an electric circuit, of an impedance, an automatic cut-out for cutting said impedance into circuit upon the occurrence of predetermined electrical conditions in said circuit, and a second cut-out included in circuit and responsive to the action of the first cut-out to break said circuit.

3. An electric circuit having a switch included therein, a transformer-primary arranged to be cut into circuit by the opening of said switch, a variable resistance in the transformer-secondary and a second switch in said circuit arranged to be operated when said resistance is increased.

4. An electric circuit having in series therewith two switches, a transformer-primary shunted about one of said switches and means for varying the resistance of the transformer-secondary.

5. An electric circuit having a circuit-breaker included therein, a coil in a branch circuit across said circuit-breaker, means controlled by the opening of the circuit-breaker for varying the impedance of the coil, and means for completely opening said circuit after varying the impedance of said coil.

6. An electric circuit having an overload circuit-breaker included therein, a coil arranged to be included in the circuit when the circuit-breaker is opened, means controlled by the opening of the circuit-breaker for increasing the impedance of the coil after it is included in circuit, and means for subsequently breaking said circuit.

7. An electric circuit having a circuit-breaker included therein, a coil arranged to be included in the circuit when the circuit-breaker is opened, means controlled by the opening of the circuit-breaker for varying the impedance of said coil, and means for automatically opening said circuit after the impedance of said coil has been varied.

8. An electric circuit having a circuit-breaker included therein, a liquid rheostat arranged to receive energy over leads shunted about said circuit-breaker, and means, brought into action upon the opening of said circuit-breaker for completely opening said circuit.

9. The combination with a plurality of electromagnetic circuit-breakers included in an electric circuit, one of said breakers having its trip-coil included in said circuit, and means responsive to the opening of the first breaker to trip the second.

10. The combination with a plurality of electromagnetic circuit-breakers, each provided with individual tripping means, and means responsive to the opening of one breaker to energize the trip-coil of the other to open it.

11. The combination with an electric circuit, of an electromagnetically-tripped circuit-breaker therein having its trip device actuated directly from said circuit, of a second circuit-breaker, and means responsive to the opening of the first breaker to actuate the trip of the second breaker to open it.

12. The combination with an electric circuit, of two automatic cut-outs therein, one of said cut-outs being connected to open on overload in said circuit, means controlled by said opening for gradually reducing the current in the circuit and subsequently operating the second cut-out.

13. The combination of an electric circuit, of an inductance therein, an automatic cut-out normally shunting the same, a switch in circuit and a trip-coil energized through the agency of the inductance when the automatic cut-out acts.

14. The combination with an electric circuit, with two automatic cut-outs therein, one of said cut-outs being connected to open upon the occurrence of predetermined electrical conditions in said circuit, and means controlled by said opening for reducing the current in the circuit and subsequently operating the second cut-out.

In witness whereof I have hereunto set my hand this 12th day of December, 1898.

EDWARD M. HEWLETT.

Witnesses:
B. B. HULL,
A. D. LUNT.