

No. 667,625.

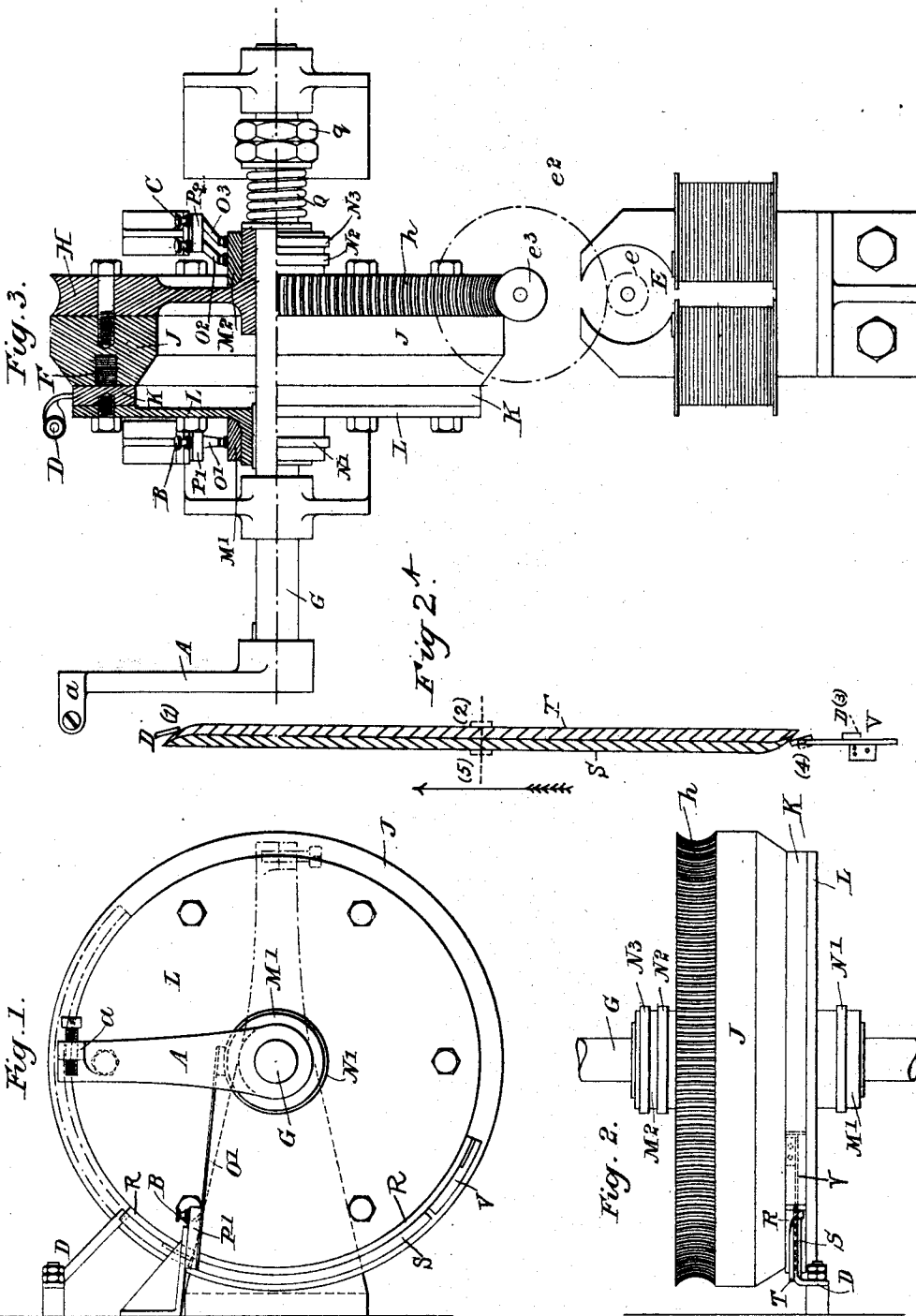
Patented Feb. 5, 1901.

B. HOPKINSON & E. TALBOT.
AUTOMATIC ELECTRIC CIRCUIT BREAKER.

(Application filed July 16, 1900.)

(No Model.)

4 Sheets—Sheet 1.



Witnesses
Geo. L. Rice
W. R. Edelen

Inventors.
Bertram Hopkinson & Ernest Talbot
by Philip Mauro, atty.

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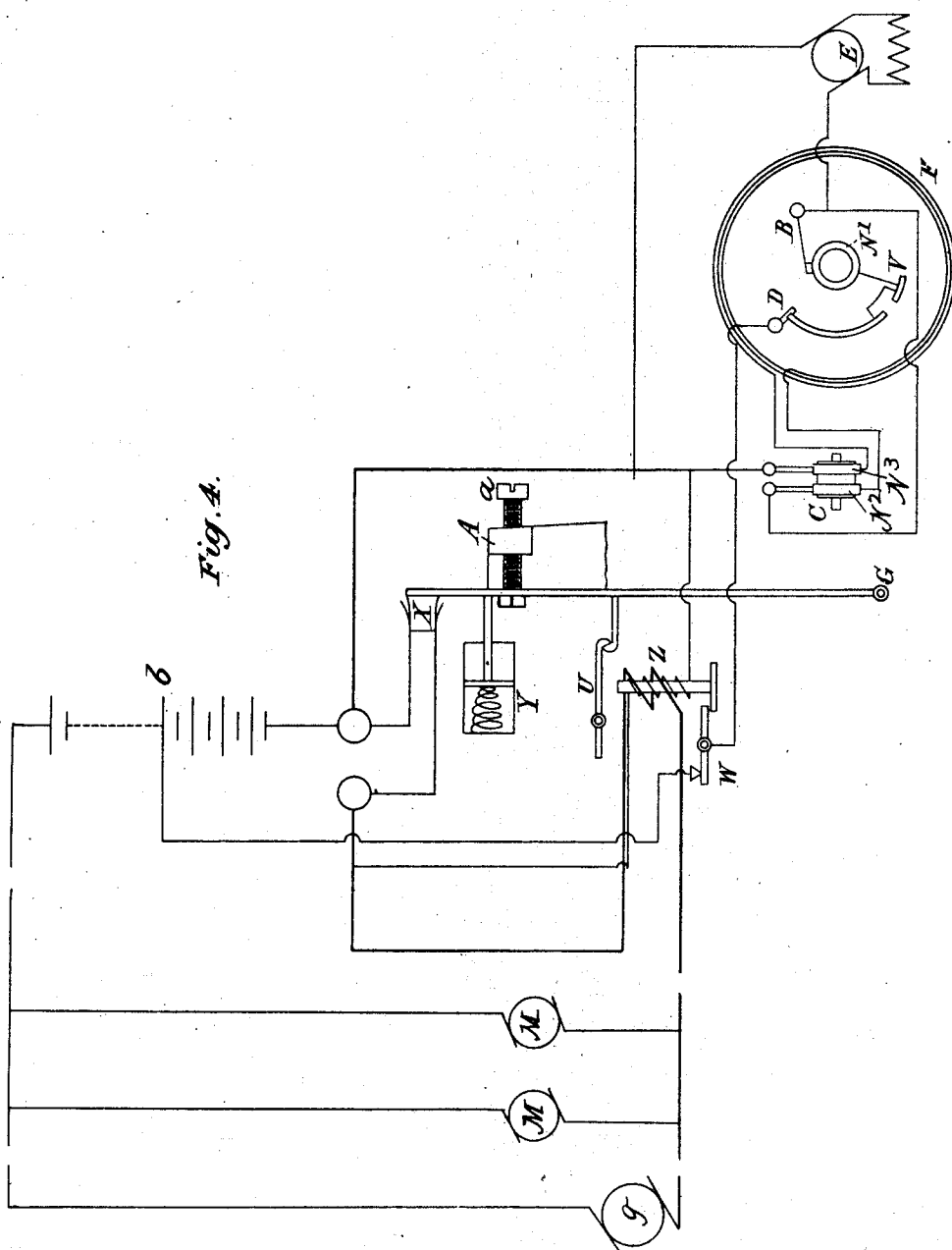
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4 Sheets--Sheet 2.



Witnesses.

W. R. C. Eden
W. R. C. Eden

Inventors.

Bartram Hopkinson
Ernest Talbot
by Phelps Dunbar

No. 667,625.

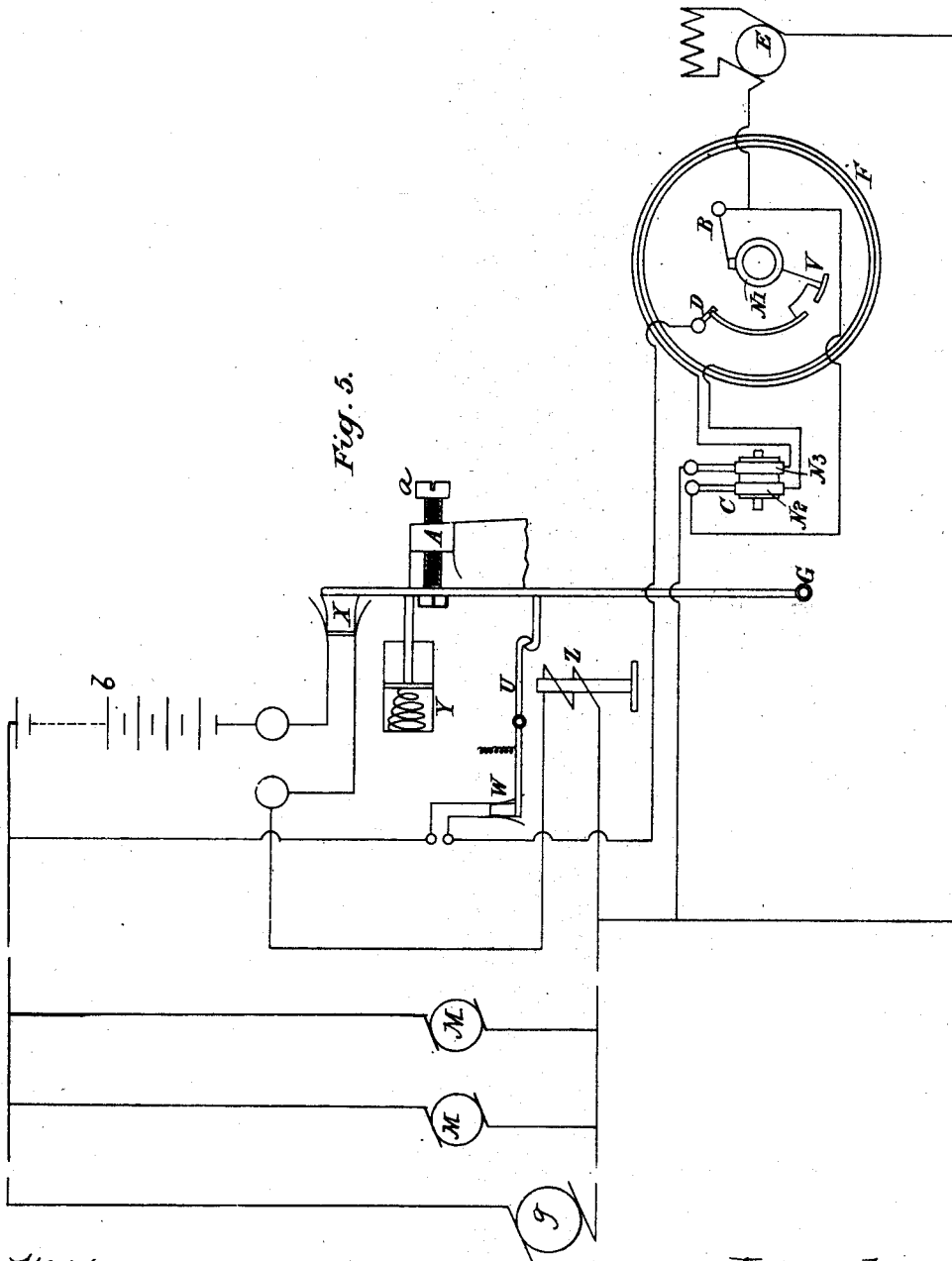
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(No Model.)

4 Sheets—Sheet 3.



Witnesses.
W. R. Edelen.

Inventors.
Bertram Hopkinson
and Ernest Talbot
by *Philip Moore*

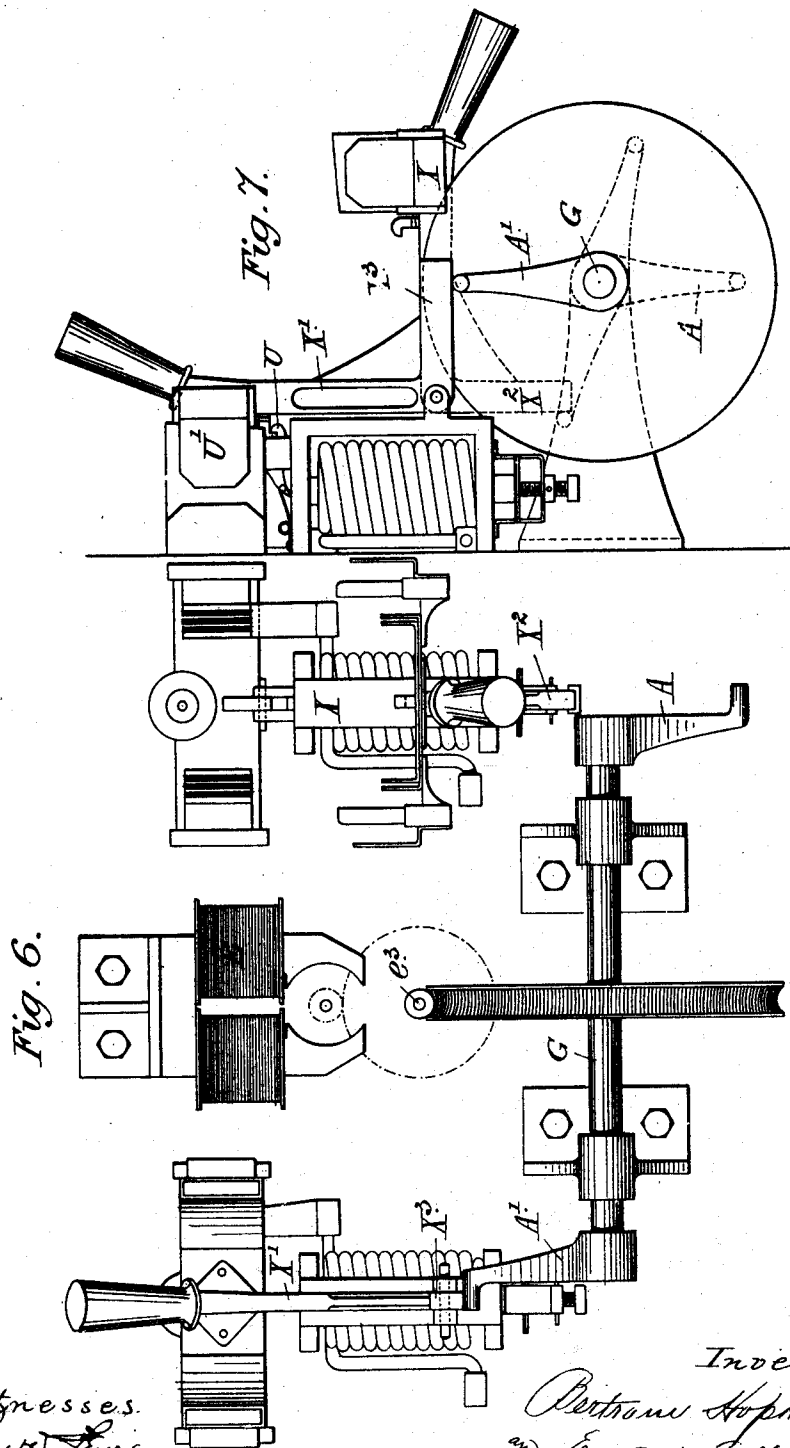
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(No Model.)

4 Sheets—Sheet 4.



Witnesses.
W. R. Edelen.

Inventors.
Bertram Hopkinson
and Ernest Talbot
by *Philip M. Hays*

UNITED STATES PATENT OFFICE.

BERTRAM HOPKINSON AND ERNEST TALBOT, OF LONDON, ENGLAND.

AUTOMATIC ELECTRIC CIRCUIT-BREAKER.

SPECIFICATION forming part of Letters Patent No. 667,625, dated February 5, 1901.

Application filed July 16, 1900. Serial No. 23,786. (No model.)

To all whom it may concern:

Be it known that we, BERTRAM HOPKINSON and ERNEST TALBOT, subjects of the Queen of Great Britain and Ireland, and residents of 26 Victoria street, Westminster, London, England, have invented certain new and useful Improvements in Connection with Automatic Electric Circuit-Breakers for Automatically Closing the Circuit after Breaking, (for which we have applied for British Patent No. 19,539, dated September 28, 1899,) which invention is fully set forth in the following specification.

This invention relates to automatic electric circuit-breakers which are operated so as to break a circuit when the current in that circuit exceeds a certain amount.

The circuit-breakers to which this invention refers comprise a moving part adapted to close the circuit, a spring or weight acting upon such moving part so as to tend to open the circuit, a catch capable of holding the circuit-breaker closed against the action of the spring, and an electromagnetic device operated by the current in the circuit, so as to release the catch and allow the circuit-breaker to be forced open by the spring or weight should that current exceed a certain amount. The latter device may consist of an iron plunger which is pulled up against its own weight by a solenoid carrying the main current, so that it strikes a trigger and releases the circuit-breaker if that current exceed a certain amount. In this specification the said device is referred to as the "plunger" and its motion in releasing the catch is referred to as the "rising" of the plunger.

In electric traction and other cases it frequently happens that the cause of the excess of current lasts but a few seconds, and according to hitherto-existing arrangements the circuit-breakers must then be closed by hand, although it has been proposed to effect the automatic closing by an arrangement in which mercury-cups are used; but such an arrangement is entirely unsuited for the class of circuit-breakers to which this invention relates.

According to this invention we combine with the circuit-breaker a device whereby the circuit-breaker is automatically closed either immediately after opening or at an instant determined by the cessation of the cause of

excess current. In one form according to this invention this purpose is effected by means of a motor which drives one part of an electromagnetic clutch, the other part of which is connected to the moving part of the circuit-breaker. Current is supplied to the motor and to the coil which magnetizes the clutch by a switch or switches arranged so as to be opened and closed at the proper times. The arrangement is such that the circuit-breaker in opening moves independently of the parts actuated by the motor, because at that time the clutch is not magnetized. Current may be supplied to the motor through the same switch as that which supplies the magnetizing-current or through another switch, which performs for the motor-circuit the same cycle of operations that the other switch performs for the magnetizing-circuit.

Figures 1, 2, and 3 of the accompanying drawings illustrate in views at right angles to each other an arrangement of apparatus in accordance with this form of our invention. Fig. 2^a is a diagram, as hereinafter explained. Figs. 4 and 5 are diagrams of electric connections for the said apparatus suitable, for instance, in a storage-battery station at a distance from the main generating-station.

The type of circuit-breaker to which reference is particularly made in this specification is shown in greater detail in Figs. 6 and 7; but our invention can be applied to any type of circuit-breaker by making suitable modifications in the details.

Referring to Figs. 1, 2, and 3, the armature E of an electric motor transmits motion by the toothed wheels ee^2 and worm e^3 through a worm-wheel h , formed on the disk H, to a soft-iron ring J, which is bolted to the said disk H. The said ring J has a groove in it to receive the coil F of insulated wire. The disk H is loose on the shaft G. A disk L is keyed onto the shaft G, the said disk L having secured to it a soft-iron ring K, which therefore cannot move independently of the shaft. Cylinders M' M^2 , of insulating material, are fixed onto the bosses of the disks L and H, these cylinders supporting the conductive rings N' N^2 N^3 . The brushes O' O^2 O^3 , which respectively bear on the rings N' N^2 N^3 , are carried by brush-holders B C, to which they are connected by insulating-blocks P' P^2 , so

that the brushes and their terminals are insulated from one another and from earth. The two ends of the coil F are respectively connected to the rings N² N³.

5 Q is a spring fitted loosely around the shaft G to keep the faces of the rings J and K in contact with each other when not magnetized. The said spring can be adjusted by the nut *q*.

An arm A is keyed on the shaft G and provided at *a* with a connection by which it is fixed to the moving part of the circuit-breaker, the axis of rotation of the said moving part and of the shaft G being in the same straight line, so that the rotation of the shaft G in 10 one direction will close the circuit-breaker, while the circuit-breaker will in opening rotate the said shaft in the other direction.

On the circumference of K and insulated therefrom by the ebonite piece R is fixed a 20 rib S T, occupying about one-fourth of the circumference. One side of the rib S is of brass and the other side T is of ebonite. A spring or brush D is fixed to the base of the machine in such a position that it is always bearing on either S or T when any part of the 25 rib is opposite to it. In Fig. 1 the ring K and the rib S T are shown in full lines and in the position which they occupy when the circuit-breaker is closed and in dotted lines 30 in the position when the circuit-breaker is open. Fig. 2^a is a section of this rib on the dotted line X Y in Fig. 2 developed into a plane. The successive positions of the brush D in relation to the rib are shown dotted on 35 this section and numbered 1 to 5, although, of course, it is the rib that moves and not the brush. Position 1 is that occupied by the brush D when the circuit-breaker is closed. On opening the circuit-breaker the rib moves 40 in the direction of the arrow, and the brush D is pushed over onto the ebonite side T of the rib, as shown in position 2. When the circuit-breaker has opened far enough to bring the other end of the rib opposite to the 45 brush D, the latter springs off the ebonite part T of the rib and comes into contact with the brass tongue V, which is carried on the ebonite piece R and is in metallic connection with the brass side S of the rib. A stop is 50 arranged to prevent the circuit-breaker opening farther than this. On closing the circuit-breaker the rib moves in the reverse direction and the brush D is pushed over by the curved end of the rib, so as to press on the 55 brass side S, successively occupying the positions 4 and 5 and remaining always in electrical connection with the brass side S until the other end of the rib is brought opposite to it, when it springs off and so breaks the 60 connection. The relative positions of the rib and the arm A are so arranged that this takes place just after the circuit-breaker has engaged with its catch in closing. The brush D is therefore again left in the position 1 65 after the closing of the circuit-breaker.

In Fig. 4 the circuit-breaker is shown diagrammatically connected in series with an

accumulator-battery *b*, which is placed in parallel with a distant generator *g* and motors or lamps M M.

The plunger Z of the circuit-breaker is surrounded by the ordinary coil in series with the circuit-breaker, whereby on the occurrence of a short-circuit the said plunger is pulled up and by striking the catch U releases the circuit-breaker. The said plunger Z is also surrounded by a fine-wire coil, connected as a shunt across the terminals of the circuit-breaker, whereby after being pulled up the said plunger is held up so long as the 80 difference of potential between those terminals exceeds a certain value. The magnetizing-coil F of the ring J and the motor E are connected to a portion of the battery *b* and are controlled by the rib on the ring R and 85 by the switch W, which is in series with them. This switch is so placed that it is opened by a projection from the plunger Z on the said plunger rising and closes again when the plunger falls. 90

Assuming the circuit-breaker to be closed, the brush D will be on the non-conductive side of the rib S T, and no current will pass through the motor or the coil F. The ring K and the circuit-breaker will therefore be free 95 to move independently of the ring J. On an excess current occurring the plunger Z will be jerked up and striking the catch U will free the circuit-breaker, which will be driven out by the spring Y. At the same time, the line 100 being dead, there will be a considerable difference of potential between the terminals of the circuit-breaker, so that a current will flow around the fine-wire coil surrounding the plunger Z, which will be held up, and 105 therefore the switch W will be kept open. As the arm A (being connected by the screw A, as shown) gives partial rotation to the shaft G, disk L, and ring K, as soon as the circuit-breaker is completely opened the 110 brush D comes into contact with the spring-piece V. When the short circuit ceases, the difference of potential between the terminals of the circuit-breaker drops to a much smaller value and the plunger Z falls, thus allowing 115 the switch W to close. The circuit of the motor and of the magnetizing-coil F is now completed, and the motor proceeds to drive in the circuit-breaker, the moving part of which is now by magnetic attraction between 120 the rings K and J locked to the parts actuated by the motor. As soon as the circuit-breaker is completely closed the brush D, which has been in contact with the conductive part S of the rib S T, springs over the end of 125 the said rib S T, thus breaking the circuit of the motor and magnet and leaving the circuit-breaker free to come out when next an excess current occurs. Should the short circuit occur again during the operation of replacing the circuit-breaker, the plunger Z 130 will be jerked up by the excess current as soon as the circuit-breaker makes contact, the switch W will be opened, and the cir-

circuit-breaker, being freed, will be driven out again by the spring Y.

In the arrangement illustrated in Fig. 5 the fine-wire coil around the plunger Z is dispensed with and the motor and magnet are connected to the line. So long as the latter is dead the circuit-breaker cannot be driven in; but as soon as it becomes alive (which will happen when the cause of excess current has disappeared and the line has been excited at some other point) the circuit-breaker will be driven in. In other respects the arrangement is the same as that illustrated by Fig. 4.

Suppose, for example, that a short circuit occurs in one of the motors M. The circuit-breaker or fuse in the connection between the generator *g* and the line will then be opened, so as to break the connection. At the same time the circuit-breaker X will be opened. The line is now dead; but as soon as the circuit-breaker in the station is replaced the line is again made alive by the generator *g*, and the current supplied from it to the motor and magnetic clutch effects the replacement of the circuit-breaker X.

In order to prevent sticking, owing to residual magnetism, when the current in the magnetic coils is interrupted, we prefer to slightly separate the faces of the rings J and K by thin pieces of non-magnetic material, which may conveniently consist of three slips of copper foil soldered onto the face of the ring K.

According to another form of our invention we arrange two circuit-breakers either one on the line and one in the return-circuit or both in one circuit. These circuit-breakers are closed by gearing driven by an electric motor and so arranged as to operate the two circuit-breakers alternately. The circuit of the motor is closed by the opening of either of the circuit-breakers, and the gearing is so arranged that the closing of one circuit-breaker is completed before the closing of the other circuit-breaker is commenced. The motion of the motor is maintained by a rotating contact-piece or by a fly-wheel after the second circuit-breaker is closed until the gearing is freed from the circuit-breaker, thereby leaving the latter free to be automatically opened when required. By this arrangement of two circuit-breakers should the cause of the excess of current continue when the circuit is closed by the second circuit-breaker it is assured that the first circuit-breaker automatically opens the circuit. Similarly should the second circuit-breaker remain closed it will be opened by the closing of the first.

Figs. 6 and 7 are views at right angles to one another illustrating a method of carrying into effect this arrangement according to our invention. The two circuit-breakers are mounted, so that the axis of rotation of their moving parts X X' are in the same line, and these moving parts are provided with arms X² X³. The shaft G, driven through the

worm-wheel *e*³ by the motor E, carries two cranks A A', pointing in opposite directions and of such length that if either circuit-breaker be open the corresponding crank will engage with the arm attached to its moving part, as shown by dot-and-pick lines in Fig. 7, and in the course of the next quarter of a revolution of the shaft will drive the circuit-breaker home and disengage itself when the operation is completed. During this operation the other circuit-breaker will be free to come out, the crank opposite to it being out of the way of its arm. Should it come out, however, as would be the case if the short circuit be still persisting, it will again be driven in during the next half-revolution of the crank, and in this manner the circuit-breakers will be put in and come out alternately until the short circuit disappears.

In order to prevent the motor from continually running, we prefer to make use of a switch which shall act to break the motor-circuit if both circuit-breakers be in, but to complete it if either be out. Such switch may be of any convenient form. For example, it may conveniently consist of two spring-contacts placed in parallel with one another and in series with the motor and so arranged one on each circuit-breaker that the spring is lifted and the contact broken by the moving part of the circuit-breaker just before its hook U' engages with the catch U. The momentum of the motor will usually be sufficient to push the circuit-breaker through the short distance remaining after the contact is broken; but if insufficient it can be augmented by the addition of a fly-wheel. We prefer with this second form of our invention, as with the first, to make use of a device whereby the motor-circuit is not completed or current not supplied to the motor until the cause of excess current has disappeared. This device will be essentially the same as that described with reference to Figs. 4 and 5. It may consist of a switch operated by an electromagnet whose coils are placed in parallel with both circuit-breakers, or the same result can be attained by working the motor from the line, so that power is not supplied to it unless the line be alive. This device is more particularly applicable to storage-battery stations worked in combination with a central generating-station. The arrangement illustrated in Fig. 4 may, however, be applied to other cases in which the line is fed only at one point. In such a case the resistance of and number of turns in the fine-wire coil actuating the switch W will be so chosen that the plunger will be held up and the switch kept open so long as the resistance in the line is less than a certain amount. As soon as the resistance rises above that amount, as will happen when the short circuit is removed, the plunger will fall, and the switch will thus be closed and the circuit-breaker driven in.

Having now particularly described and as-

certained the nature of this invention and in what manner the same is to be performed, we declare that what we claim is—

1. The combination with an electric circuit-breaker adapted to be automatically opened upon the passage of abnormal currents over the line, of means for automatically closing the circuit-breaker comprising an electromagnetic mechanism and normally open local circuit to supply current to actuate the said mechanism and means actuated upon the opening of the circuit-breaker for closing the local circuit and holding it closed until the said mechanism acts to return the circuit-breaker to its closed position.
2. The combination with an electric circuit-breaker adapted to be automatically opened upon the passage of abnormal currents over its line, of means for automatically closing the circuit-breaker comprising an electromagnetic mechanism and normally open local circuit to supply current to actuate the said mechanism, a switch controlling said local circuit, and means for effecting the closing of said switch upon the difference of potential between the terminals of the open circuit-breaker falling below a certain value, whereby the said mechanism operates to close the circuit-breaker.
3. The combination with an electric circuit-breaker adapted to be automatically opened upon the passage of abnormal current over its line, of means for automatically closing the circuit-breaker comprising an electromagnetic mechanism and local circuit for supplying current to actuate the said mechanism, two switches in said local circuit, one normally open and the other normally closed, means actuated by the opening of the circuit-breaker for closing said normally open switch and maintaining it closed until the circuit-breaker is closed, and means actuated by the current in the circuit-breaker whereby when said current is abnormal the normally closed switch is opened.
4. The combination with an electric circuit-breaker adapted to be automatically opened upon the passage of abnormal current over its line, of means for automatically closing the circuit-breaker comprising an electric motor, a local circuit for supplying current to drive the motor, two switches in said local circuit, one normally open and the other normally closed, means actuated by the opening of the circuit-breaker for closing said normally open switch and maintaining it closed until the circuit-breaker is closed, and means for opening the normally closed switch and for holding it open until the difference of potential between the terminals of the then open circuit-breaker falls below a certain value.

5. Means for replacing a circuit-breaker the said means consisting of an electromagnetic clutch one part of which is fixed to the moving part of the circuit-breaker and the other part of which is driven by a motor so as to close the circuit-breaker, and a switch fixed to the said moving part of the circuit-breaker and operating to close the circuit of the electromagnet while closing the circuit-breaker and to open the said circuit immediately after the circuit-breaker has engaged with its catch and to keep it open during the act of opening the circuit-breaker until the moving part thereof has been fully thrown out substantially as hereinbefore described.

6. Means for replacing a circuit-breaker, the said means consisting of an electromagnetic clutch one part of which is adapted to move and to be moved by the moving part of the circuit-breaker and the other part of which is driven by a motor so as to close the circuit-breaker, a switch movable with said moving part of the circuit-breaker and operating to close the circuit of the electromagnet while closing the circuit-breaker and to open the said circuit immediately after the circuit-breaker has engaged with its catch and to keep it open during the act of opening the circuit-breaker until the moving part thereof has been fully thrown out, and a second switch included in the circuit of the electromagnet and opened and held open by the action of the plunger of the circuit-breaker.

7. The combination of two circuit-breakers in series, a motor, and gearing driven by the motor and adapted to replace the circuit-breakers alternately and during the replacement of one to leave the other free to come out, substantially as hereinbefore described.

8. The combination of two circuit-breakers in series, of gearing driven by a motor so arranged as to replace them alternately and during the replacement of one to leave the other free to come out, and a switch or switches included in the motor-circuit and so arranged that the said circuit is broken when the circuit-breakers are in and made when either is or both are out.

9. The combination of a circuit-breaker, a line supplied with current both through the circuit-breaker and at some other point and an automatically-operating electromagnetic mechanism for replacing the circuit-breaker actuated by current drawn from the said line.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

BERTRAM HOPKINSON.
ERNEST TALBOT.

Witnesses:

WILLIAM JOHN WEEKS,
HENRY DENIS HOSKINS.