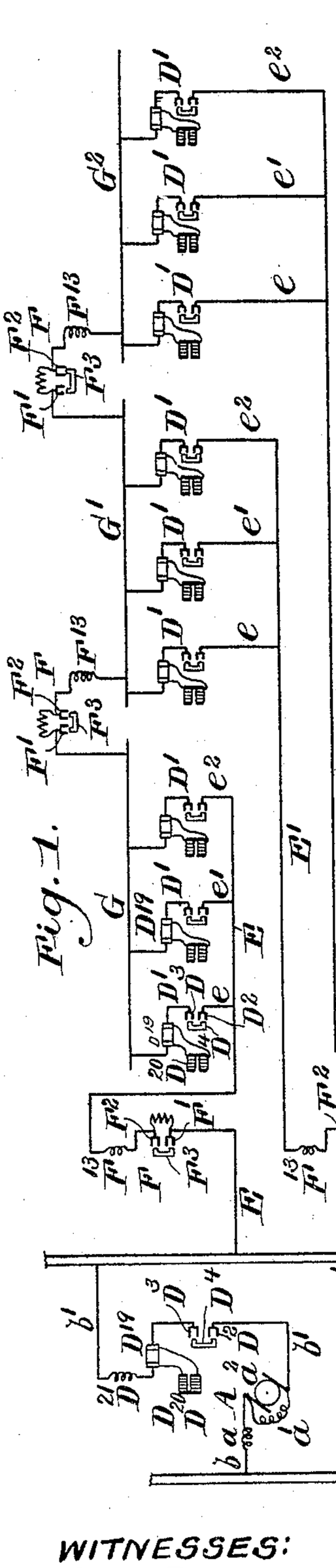
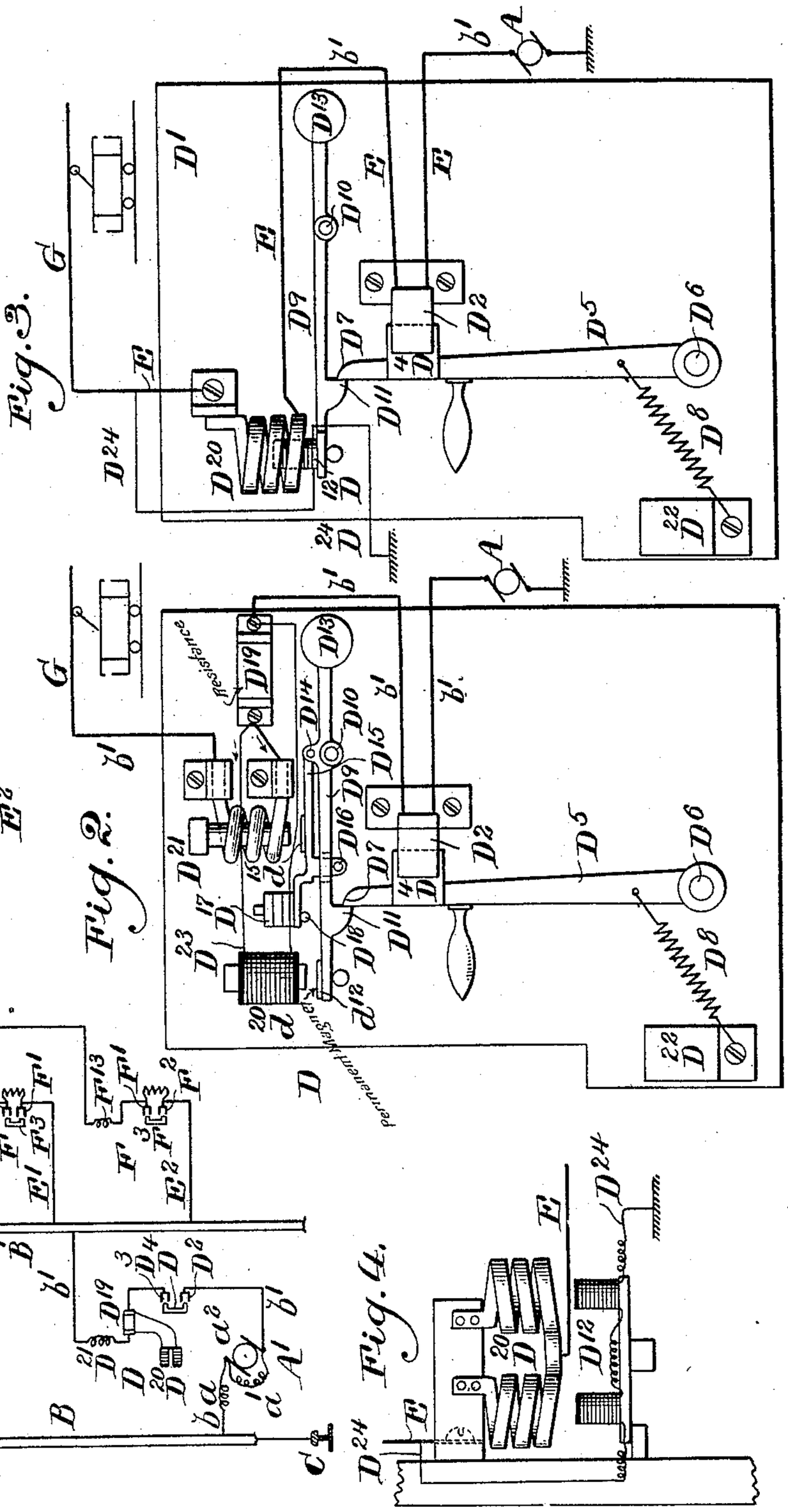
(No Model.) 2 Sheets—Sheet 1.

W. D. GHARKY.

SYSTEM OF DISTRIBUTING ELECTRICAL POWER, &c.

No. 569,634. Patented Oct. 20, 1896.





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(No Model.) 2 Sheets—Sheet 2.

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Fig. 7.

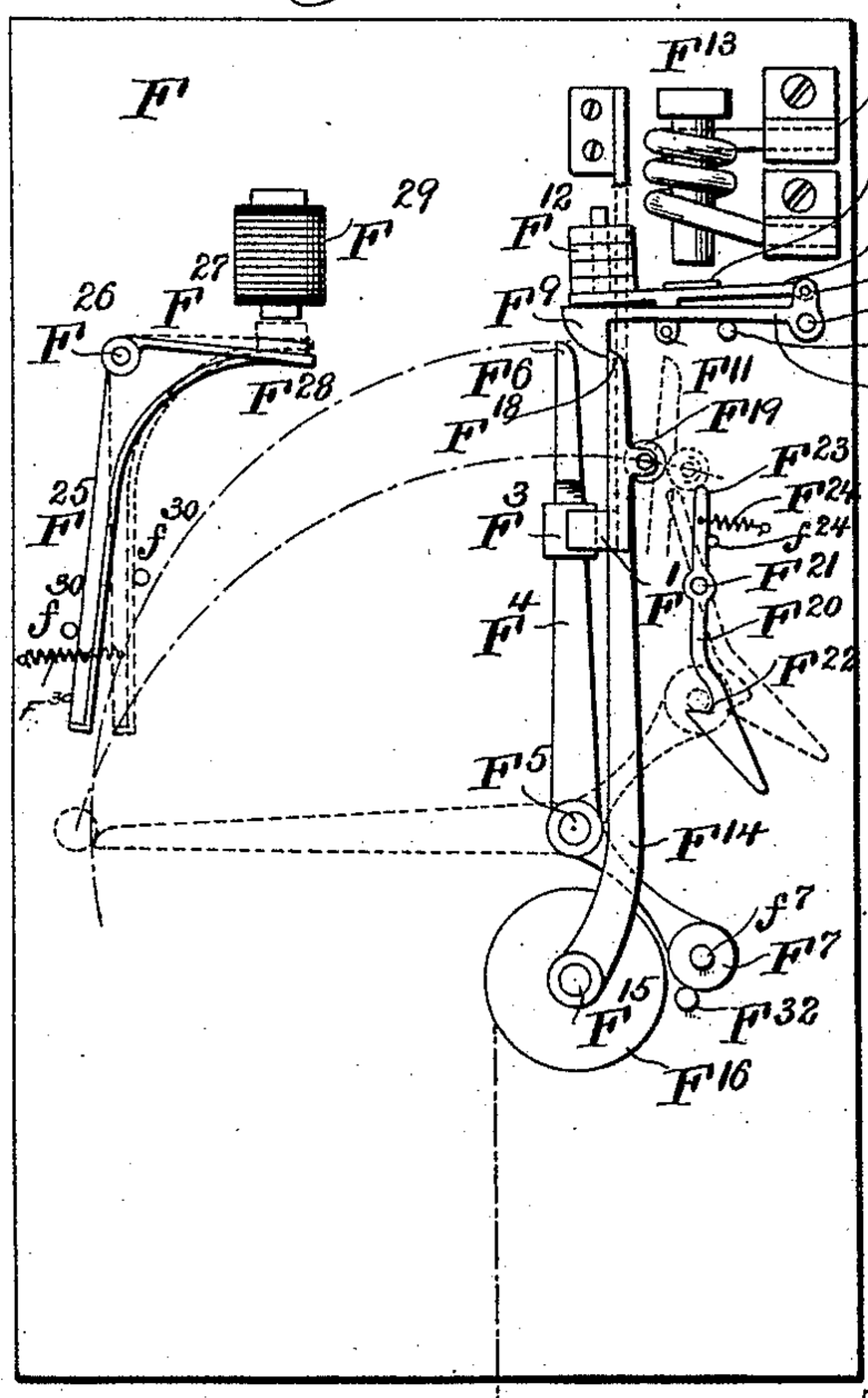


Fig. 8.

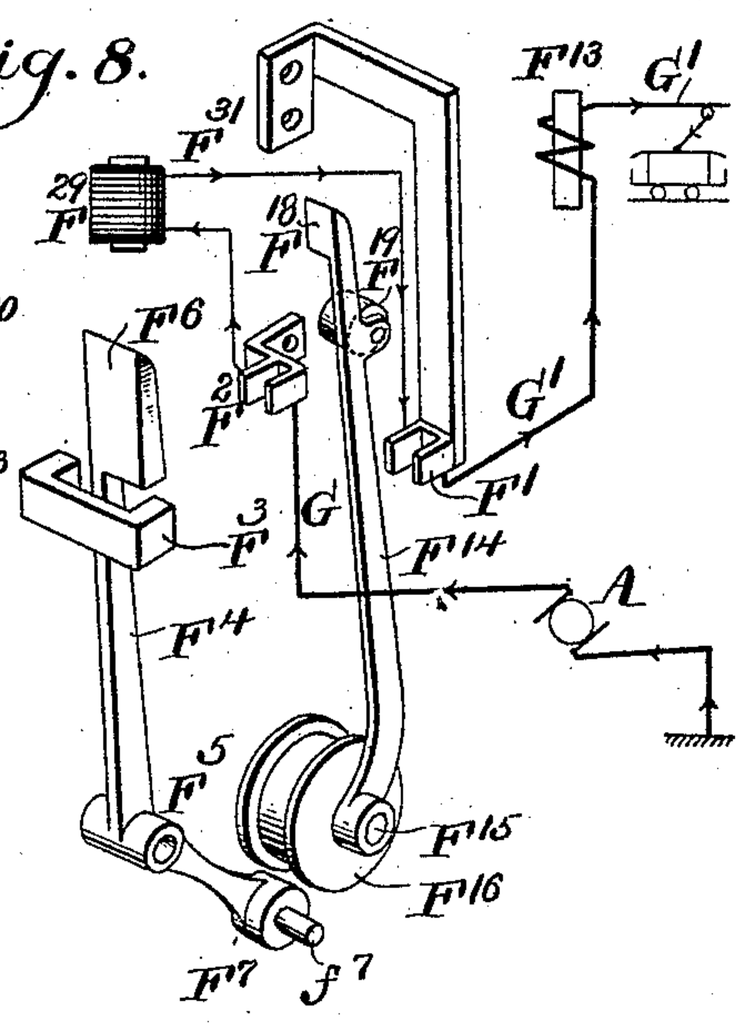


Fig. 5.

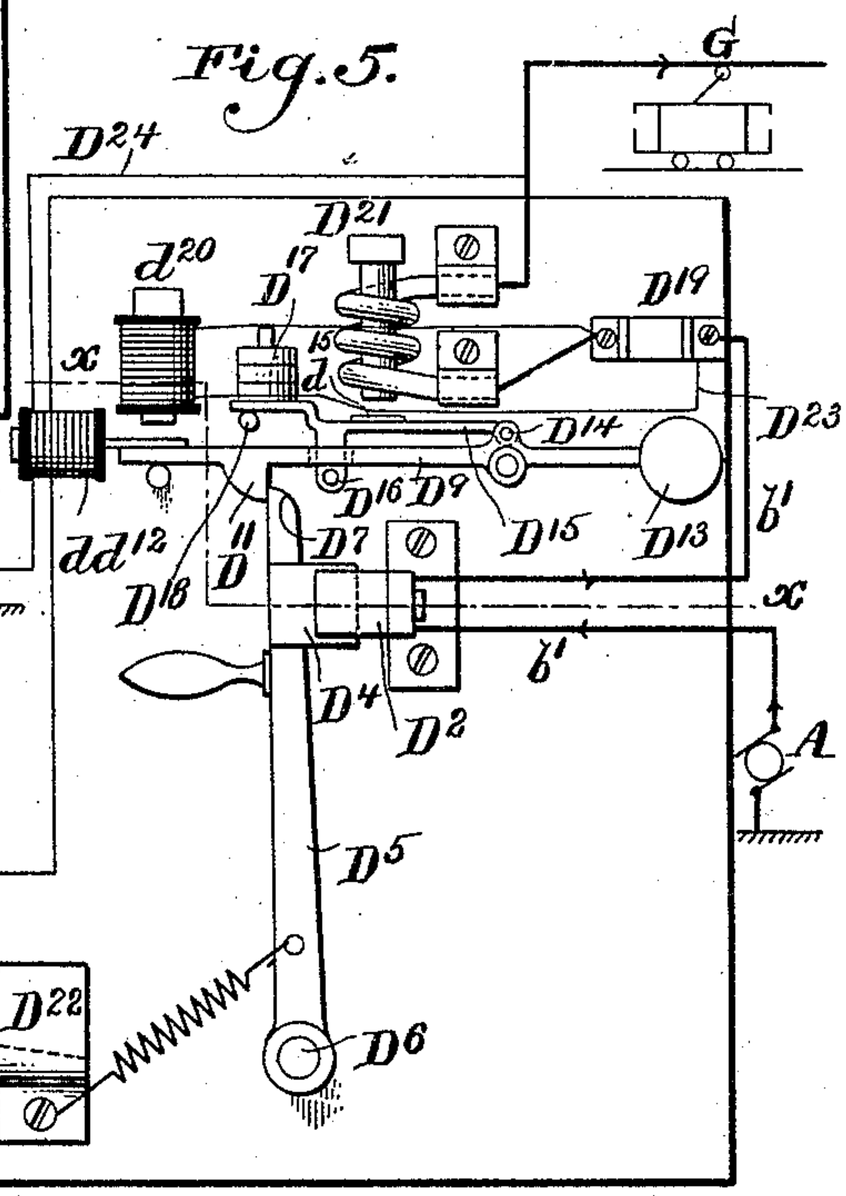
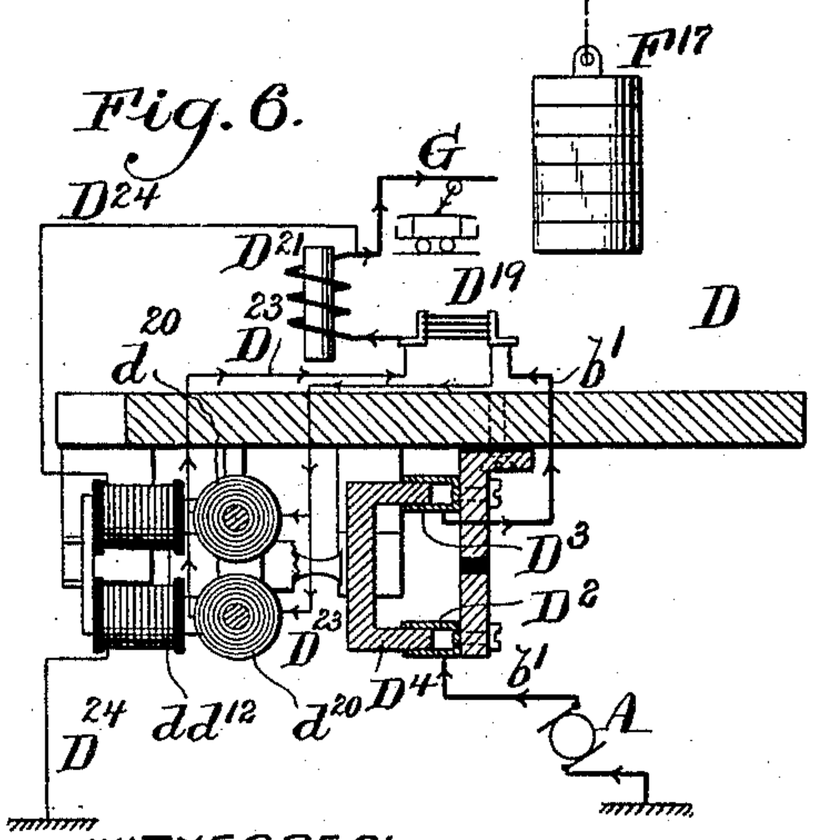


Fig. 6.



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SYSTEM OF DISTRIBUTING ELECTRICAL POWER, &c.

SPECIFICATION forming part of Letters Patent No. 569,634, dated October 20, 1896.

Application filed July 2, 1895. Serial No. 554,712. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM D. GHARKY, a citizen of the United States, residing in the city and county of Philadelphia, State of Pennsylvania, have invented a certain new and Improved System of Distributing Electrical Power and of Automatic Circuit-Breakers, of which the following specification is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My invention relates to the distribution of electrical power, and particularly to the providing in connection with the distributing system of wires of automatic circuit-breakers arranged and constructed in such a way as to obviate difficulties and drawbacks commonly met with in distributing systems.

Generally speaking, the object of my invention is to prevent, in the first place, the destruction of one of a series of dynamos connected in multiple for the generation of electrical power in the case of such a dynamo becoming short-circuited; in the second place, to provide means whereby two or more sections of the distributing-conductor forming a part of the system are normally connected electrically with each other, but are disconnected when and so long as there is an abnormal flow of current from one section; in the third place, to provide automatic means for severing electrical connection between a distributing-conductor and its feed wire or wires in case such feed wire or wires become grounded or short-circuited, and at the same time to provide from an independent source a supply of electrical power to the said distributing-conductor; in the fourth place, to provide means for severing electrical connection of a feed-wire both with a distributing-conductor and with the source of electrical power in case of the grounding or short-circuiting of such feed-wire, and besides these broad general features I aim also to provide improved automatic cut-out devices especially adapted to serve the purposes noted, but useful also in other ways and for other purposes.

The nature of my invention will be best understood as described in connection with the drawings in which it is illustrated, and in which—

Figure 1 is a diagram representing a system for generating and distributing electrical power constructed in accordance with my improvements and provided with my improved cut-out devices. Fig. 2 is an elevation showing an improved cut-out mechanism adapted for use in immediate connection with each of a number of dynamos connected in multiple for the generation of electrical power. Fig. 3 is an elevation of a cut-out device embodying the essential novel feature of the cut-out illustrated in Fig. 2 and especially adapted for use in the feed-wires and near their connection with a distributing-wire. Fig. 4 is a front view of a portion of the mechanism illustrated in Fig. 3. Fig. 5 is an elevation of a cut-out generally similar to that shown in Fig. 2, but illustrating the use of an electromagnet in place of a fixed magnet shown in Fig. 2. Fig. 6 is a plan view of the cut-out shown in Fig. 5, taken on the section-line $x\,x$ of said figure. Fig. 7 is an elevation of an improved automatic cut-out adapted for use in connection with the distributing system and having the capacity of opening the circuit in the event of an excessive flow therefrom and of automatically closing the circuit on the cessation or diminution of such a flow of current; and Fig. 8 is a perspective view, of a diagrammatic nature, illustrating the essential parts of the cut-out mechanism illustrated in Fig. 7.

A and A′ indicate dynamos conventionally represented as of the compound-wound class, a indicating the series winding, a' the shunt-winding, and a^2 the brushes. These dynamos, of which there may be any desired number, are connected in multiple across the bus-bars B and B′ through the conductors b and b', and, as shown, the bus-bar B is connected to the track (indicated at C) and serving as a return-conductor, while the bus-bar B′ is connected with a number of feed-wires E, E′, and E², and, as represented, each of the said feed-wires is connected with a section of distributing-conductor, such connections being indicated at G, G′, and G², and three branches e, e', and e^2 are indicated as leading from each feed-wire to the distributing-sections supplied by it.

D and D′, Fig. 1, indicate automatic cut-outs situated in each of the conductors b',

leading from the dynamos A and A′ to the bus-bar B′, having the capacity of opening the circuit in the wires *b* and *b′* not only on the occurrence of an undue flow of current through such wires, as is the ordinary function of an automatic cut-out, but also upon the occurrence of a reverse flow through such wires, such as would occur, for instance, should the armature of the dynamo A′ become short-circuited, in which case, obviously, the current supplied to the bus-bar B′ by the dynamo or dynamos connected in multiple therewith would flow back on the wire *b′* toward the dynamo A′, and with the effect, if not checked, of greatly injuring, if not destroying, the short-circuited generator.

D′ D′, &c., indicate cut-outs, illustrated in Fig. 1 as placed in the feed-wires or other branches near their connection with the distributing-conductors and having the capacity of breaking the circuit in such feed-wires on the occurrence of a reverse current therein, such as would occur in my construction on the grounding of a feed-wire.

F F, &c., indicate automatic cut-outs, which in Fig. 1 I have indicated as placed in each feed-wire near its connection with the bus-bar, and also between each adjacent section of the distributing-conductor. These cut-outs, in addition to the usual capacity for breaking the circuit in the event of an undue flow of current through the same, are endowed with the additional capacity of automatically closing the circuit when the flow therefrom falls below a determined amount. Thus, as placed in the feed-wires, these cut-outs would at once break the circuit on the grounding of the feed-wire or upon too much work being thrown upon the distributing-conductor supplied thereby, and would at once and automatically close the circuit again on the repair of the wire or the disconnection of the motors or other device bringing an undue strain upon the distributing-conductor. I may here mention, however, that in my system of electrical distribution it is preferable for some reasons to use cut-outs having the ordinary capacity for automatically opening the same in connection with the feed-wires and in the neighborhood of the bus-bar from which they derive current.

The automatic closing as well as opening of the cut-out F is especially valuable in my system where such cut-outs are used, as indicated in Fig. 1, to connect the various sections of the distributing-conductor together. When so used, all or any desired number of the separate sections into which the distributing-conductor is divided are normally in electrical connection with each other, so that if any given section, for instance, G′, has an excessive amount of work thrown upon it it will receive current not only through its particular feed-wire E′, but also from the adjacent sections G and G² of the distributing-conductor, one or both of which in such an event would probably have less than its usual normal work thrown upon it. At the same time should the drain of current from the section G′ exceed the determined amount, the cut-outs connecting it with the sections G and G² will automatically open the circuit, thus preventing injury to the sections G or G² and insuring that they will continue in normal operation irrespective of the injury or other cause bringing about an abnormal flow from the section G′. Immediately upon the reducing of the motor-load the repair of the section G′, or upon such other action as will cause a flow of current therefrom to fall below a determined amount, the electrical connection between it and the sections G and G² will be automatically restored.

It is obvious, of course, that by the use of the cut-outs D in the wires *b′ b′*, leading from the dynamos to the bus-bar, the short-circuiting of the armature of one dynamo will at once result in cutting that dynamo out of electrical connection with the bus-bars more promptly than with the light apparatus, not only saving the dynamo, but obviating a stoppage of the other generators which can continue in normal operation, supplying the bus-bar and the feed-wires leading therefrom with current up to their full capacity. The use of the cut-outs D′ in the feed-wires and near their connection with the distributing-wire results in the cutting out of any grounded feed-wire, entirely severing its connection with the distributing-conductor and enabling the distributing-conductor to receive current from other sources, as, for instance, on the grounding of the feed-wire E′ the section G′ of the distributing-conductor will be at once disconnected from it, the section G′ being kept alive and supplied with current from the conductors E and E².

Obviously the grounding of the feed-wire E′ will also cause the automatic opening of the cut-out F, situated in it near its receiving end, and consequently the feed-wire is, immediately on the occurrence of a short circuit in it, severed from electrical connection either with the distributing-conductor or with the bus-bar, the advantage of which is of course manifest.

In the construction indicated the closing of the cut-outs D′ must be effected by an operator, and would of course only take place after the repair of the feed-wire in which they are situated. For some reasons it is preferable also that the cut-outs F, situated at the receiving end of the feed-wires, should only be automatic in their opening action, as in that case the injured feed-wire cannot under any circumstances receive current unless by the deliberate action of the operator controlling the switches. As shown, however, the cut-outs F in the feed-wire are indicated as having the automatic closing capacity by which the feed-wire is electrically connected with the bus-bar immediately upon the reduction of the flow through it below a determined amount. So that they will automat-

ically close on the cessation of an overload or in case of a ground, the wire having been repaired in the ordinary manner, it is only necessary for the switches or cut-outs D′ to be closed to restore the system to a working condition. The functions of the cut-outs F connecting the sections of the distributing conductor have already been sufficiently indicated, and it will be obvious to those skilled in the art that by my system many drawbacks of the existing systems are done away with, the system as a whole rendered more simple and more easy to operate, and considerable saving rendered possible in the section of the electrical conductors, as I not only enable the different feed-wires to contribute current to a point where a heavy demand is made, but at the same time prevent the risk of injury should the demand or flow from a given point tend to become so excessive as to jeopardize the conductors.

Referring now to the construction and mode of operation of the cut-out devices in my system, I will describe first the cut-outs indicated at D′. (Shown in my preferred form of construction in Figs. 3 and 4 of the drawings.) In these drawings, E represents the feed-wire, in connection with which I have shown this device in Fig. 1. The wire is broken at the point where the switch is to be applied and connected with terminals, such, for instance, as are indicated at D^2 and D^3, Fig. 6. D^4 indicates the switch proper, which in normal position is indicated with the terminals D^3 and D^2, as shown in Fig. 6. The switch proper is provided with means tending to draw it out of contact with the terminals of the line-wire and is held in position to close the circuit by means of a catch, which catch is acted upon to release the switch upon the reversal of current in the conducting-wire, in connection with which the switch operates. This I accomplish by connecting with the switch a device in the nature of a magnet, and providing a coacting magnet occupying a fixed position, one of the said magnets being an electromagnet excited by the normal flow of the current in such a way that it will not move the switch-catch, while upon the reversal of the normal current it will act upon its coacting magnet in such a way as to raise the catch and release the switch, this being readily accomplished by the reversal of the polarity of the one magnet, while that of its coacting magnet remains fixed. The simplest, and I believe the best, form in which this mode of operation is applied to releasing the switch is that illustrated in Figs. 3 and 4, where the switch D^4 is secured on a lever D^5, pivoted at D^6, and provided with a spring D^8, tending to draw it away from the terminals D^2 and D^3. A portion shown in the drawings as the upper end D^7 of the lever D^5 is, when in position to close the switch, engaged by a catch D^{11}, which, as shown, is secured to or formed with a lever D^9, pivoted at D^{10}, and having secured to it a magnet D^{12}, D^{13} indicating a counterbalance by which a portion of the weight of the catch end of the lever is counterbalanced. As shown in Figs. 3 and 4, what I have referred to as the "magnet" D^{12} is a coil, or rather two coils, of non-magnetic material, through which a limited amount of current drawn from the line-wire E is permitted to flow through the take-off wire D^{24}, the resistance of this wire being of course regulated so that only sufficient current will pass through it for the purpose in view. The coils D^{12} are not provided with any magnetic core, but themselves serve as cores entering the coils D^{20}, which, as shown in Figs. 3 and 4, form a part of the main conductor E, and which should preferably be made of non-magnetic material, and I will mention here that my preference for the use of non-magnetic material in the construction of these coils is founded on my desire to increase their sensitiveness, it being well known that magnetic material, such as soft iron, is apt to take a magnetic set, and that a reversal of its polarity requires an appreciable time. The winding of the coils D^{12} and D^{20} is such that when the current is passing in normal direction through the coils D^{20} they will tend to repel the coils D^{12}, thus actually pressing down upon the end of the lever D^9, but upon the reversal of current through the coils D^{20} their polarity is changed and they immediately exercise an attractive force upon the coils D^{12}, and by drawing up said coils raise the end of the lever to a sufficient degree to release the lever D^5 from the catch D^{11}, permitting the spring D^8 to draw the lever away and open the switch, D^{22} being a socket provided to catch and hold the lever D^5 after it has moved to the open position.

In Fig. 2 of the drawings I have indicated a modified construction operating, however, in an essentially similar way. In this figure d^{12} indicates a fixed permanent magnet attached to the end of the lever D^9, and d^{20} indicates an electromagnet of ordinary construction placed in operative position with regard to the fixed magnets d^{12}. In this figure also the coils of the electromagnets d^{20} are connected with the line-wire here marked b' by means of a shunt D^{23}, connected with a line-wire on each side of the resistance-piece D^{19}, and it will be readily seen that in this construction a reversal of the current in the line-wire b' will result in a reversal of the current in the shunt D^{23} and the consequent reversal of the polarity of the magnet d^{20}, which normally exercises a repelling effect upon the magnet d^{12}, opposing like poles to like, while on the reversal of the current the polarity of the electromagnet is reversed, so that unlike poles of the two magnets are opposed and a consequent attraction ensues, which acts upon the catch and releases the switch, as before described.

Still another modification is illustrated in Figs. 5 and 6, where in place of the non-magnetic coils D^{12} of Fig. 3 and the fixed magnet

d^{12} of Fig. 2 I show an electromagnet attached to the lever D^9 and indicated at $d\ d'$. In this case of course the electromagnet $d\ d^{12}$ is excited by a branch wire D^{24}, as in the case illustrated in Fig. 3. In other respects the construction of the device shown in Fig. 2 and the operation is the same.

For some uses it is desirable that the switch or cut-out adapted to open the circuit on an occurrence of a reversed current should also have the capacity of opening the circuit on the occurrence of an excessive flow of current. This is the case with regard to the cut-outs indicated at D D, in connection with the dynamos A and A', and in Figs. 2 and 5 I have shown a modification of the switch by which it is adapted to serve these double purposes. All that is necessary is to secure to the lever D^9 an armature and to place in operative position with regard to it an electromagnet excited by the current passing through the conductor in which the catch is situated, and so proportioned and constructed that it will overcome the forces tending to hold the catch in position only when the current passing through the conductor exceeds a determined amount. This is of course *per se* an old and familiar device. When used in connection with my reversed-current cut-out, I prefer to construct a device, as illustrated in Figs. 2 and 5, with the double purpose, first, of making the work to be accomplished by the magnets operating by the reversal of the current less than that of the magnet actuated by the excess of the current, and, second, of enabling the magnet operating by excess of current to act upon the catch in a manner rather like a jerk or blow than a steady pull. This I accomplish by pivoting to the lever D^9 D^{14} a lever D^{15}, the outer end of which is normally supported on a stationary catch D^{18}, while a lug D^{16} extends through or alongside of the lever D^9 and is provided with a pin or other engaging device which will come in contact with the lever D^9 only after the lever D^{15} has begun to move upward.

D^{17} indicates weights placed upon the lever D^{15}, d^{15} the armature secured to the said lever, and D^{21} the electromagnet excited by the current in the conductor in which the cut-out is situated. When the current passing through the coils of the magnet D^{21} becomes sufficient to raise the lever D^{15} and the weights placed upon it, the said lever will move quickly upward until its lug D^{16} engages the lever D^9, and its engagement will be in the nature of a jerk or blow, tending to facilitate the elevation of the lever D^9 and the release of the catch D^{11}. It will also be noticed that by this construction the coacting magnets or devices in the nature of magnets situated at the outer end of the lever D^9 have not only the advantage of greater leverage in acting upon the catch, but have only to raise the lever D^9 and not the lever D^{15}, which remains practically stationary while the lever D^9 is being raised by the said coacting magnets.

Passing next to the construction of the cut-outs indicated at F in Fig. 1 of the drawings, and reference being had to Figs. 7 and 8, in which I have illustrated such a cut-out in the best form devised by me, I will state in the first place that the essential features of my device and invention consist in providing a switch which is acted upon in two ways, that is to say, it is acted upon by a force tending to move it away and open the circuit, and a force tending to raise it to operative position and close the circuit, the said forces acting or prevailing alternately, and the force tending to open the switch being normally restrained by a catch which is only released on the occurrence of an excessive current in the conductor in which the switch is situated. I also provide a second catch placed and arranged so as to engage the switch and hold it open and operate it by an electromagnet excited by a shunt spanning the break in the main conductor and so arranged as to release the switch and permit it to return to position to close the circuit when the current passing through such shunt falls below a determined amount. These essential features of my automatic cut-out devices F are capable of embodiment in many modifications, but, as constructed and arranged in Figs. 7 and 8, will be found both simple and efficient in operation. In these figures F' and F^2 represent the terminals of the conductors G and G', and F^3 is the switch adapted to span and connect these terminals. The switch is secured to a lever F^4, pivoted at F^5 and provided with some constantly-acting means for restoring it to position to connect the two terminals. As shown, such means are indicated by the counterweight F^7, from which projects a pin f^7, and which, as shown, rests against a stop F^{32} when in position to close the circuit, the said stop acting as a buffer which prevents the switch from too forcibly striking against the terminals when coming into contact with them in the closing of the switch.

F^6 represents a side projection from the lever F^4.

F^{14} is a lever pivoted at F^{15} at a point eccentric to the pivot F^5 of the lever F^4 and acted upon by a constant force tending to move it against the lever F^4. As shown, it is provided with a drum F^{16}, around which is wound a cord sustaining a weight F^{17}, which of course tends to give the lever F^{14} a constant movement of rotation from right to left. The top of the lever indicated at F^{18} is adapted to engage with a catch to be hereinafter described, and to the lever is secured a roller F^{19}, which is placed so as to come in contact with the said extension F^6 at the top of the lever F^4.

F^9 is a catch adapted to engage with the top F^{18} of lever F^{14} and secured on a lever F^8, pivoted at f^8 and resting normally against the stop F^{33}. A second lever F^{10} is preferably

pivoted at a point f^{10} on the lever F^8 and is provided with a stop-lug F^{11}, by which it engages the lever F^8 after rising for some distance above it. Upon the lever F^{10} is secured an armature f^{13} and adjustable weights F^{12}, and in connection with the armature f^{13} I provide an electromagnet F^{13}, excited by the current in the conductor in which the switch operates.

F^{20} is a lever pivoted at F^{21} and having a catch-jaw F^{22} at its end, and to the other end, F^{23}, of the lever I attach a spring F^{24}, which holds it normally in contact with the stop f^{24}. The position of this stop-lever is such that when the switch-lever F^4 is moved to the position indicated in dotted lines in Fig. 7 it will engage the pin f^7 on the counterweight F^7 and holds the switch-lever in position indicated, while the position occupied by the end F^{23} of the catch-lever is such that as the lever F^{14} revolves it will be struck by the roller F^{19} and moved to the position indicated in dotted lines in Fig. 7, thus releasing the switch-lever F^4.

F^{25} F^{27} is a bell-crank lever pivoted at F^{26}, the end F^{25} serving as a catch or stop, but being normally drawn out of operative position by a spring F^{30}, f^{30} f^{30} indicating stops which limit the motion of the catch-lever.

F^{28} indicates an armature on the lever F^{27} of the catch-lever, and F^{29} an electromagnet excited in a shunt-circuit F^{31}, connecting the terminals F' and F^2, the said shunt-circuit having high resistance, so that only a limited amount of current can pass through it.

The operation of the device as illustrated is as follows: Normally the switch, the lever F^{14}, the catch F^9, and the other parts of the apparatus occupy the positions indicated in full lines in Fig. 7. On the occurrence of an excessive current in the conductor G' the energy of the electromagnet F^{13} is increased to a point where it will act upon the catch F^9 through the mechanism described, raising it and releasing the lever F^{14}, which then, by a force acting constantly upon it, revolves to the left, its roller F^{19} acting in contact with the projection F^6 of the lever F^4 and pressing said lever over to the position indicated in dotted lines in Fig. 7, of course opening the circuit. Just before releasing the switch-lever F^4 it is brought to the position in which it is engaged with the catch F^{22}, and it therefore remains in the position shown in dotted lines while the lever F^{14} is completing its revolution and until its roller F^{19} strikes against the end F^{23} of the catch-lever F^{20} and releases the switch-lever from engagement with said catch, whereupon its counterweight F^7 will descend, causing the switch-lever to move backward toward the terminals F' and F^2 and out of the range of the catch F^{22}. As soon as the switch is opened the current exciting the magnet F^{13} ceases or falls to a low point, and therefore the catch F^9 is released and falls to the position shown in Fig. 7, where it engages and arrests the further motion of the lever F^{14}. The opening of the switch also causes a current of electricity to flow through the shunt F^{31} and to excite the electromagnet F^{29}, which thereupon acts upon the armature F^{28}, bringing the catch-lever into the position shown in dotted lines in Fig. 7, in which position its arm F^{25} engages and stops the switch-lever F^4 after it is released from the catch F^{22} and prevents its returning to a position to close the circuit, and the switch will therefore remain open until the current passing through the shunt and the electromagnet F^{29} falls below the point at which the attraction of the magnet will be sufficient to hold the stop-lever in position to engage the switch-lever, and immediately upon the release of the stop-lever the switch-lever will return to the position shown in full lines in Fig. 7 and close the switch.

It will readily be seen that the energizing of the magnet F^{29} will depend upon the flow of the current from the section G' of the conductor. The amount of current permitted to flow through the shunt is of course small and its existence will depend entirely upon the withdrawal of current from section G' being maintained, for instance, as long as such section of the wire is grounded, or what is equivalent to a ground, connected with a large number of motors arranged to take current from the section.

The use of the mechanical stop F^{22} is simply to give sufficient time for the energizing of the magnet F^{29} and the movement of the stop-lever actuated by it to a position in which it will intercept the return of the switch-lever. Obviously, therefore, it is not an essential part of the device, although I believe a useful one. It will be obvious also that the switch-lever may have a rotary instead of an oscillating movement—for instance, that the switch might be attached directly to the lever F^{14}, so that the weight F^{17} or equivalent force would act both to open and close the switch—the stop-lever F^{25} F^{27} in such a case being placed to intercept and arrest the completion of the rotary movement. It will be also obvious that my cut-out construction involving the mechanism for opening and closing the switch automatically can be usefully employed when the catches, the position of which determines the opening and closing, are actuated by means different from those illustrated by me. For instance, the catches F^9 or F^{25} instead of being actuated by the current passing over the wire controlled by the switch may be operated by hand or by any devices for communicating motion.

While my cut-out devices are especially adapted and intended for use in the system illustrated and described in the first place, they are obviously capable of independent use in many connections where the same or an analogous effect is desired.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a system for the distribution of electrical power consisting of a series of distributing-conductors as G, G′, G², and independent feed-wires leading from a source of electrical power to each conductor, the combination of two or more distributing-conductors with one or more automatic cut-outs adapted as described to normally connect adjacent conductors and to sever their electrical connection when there is an abnormal flow of electrical current from one conductor, and means for automatically actuating the cut-out to restore connection on the reduction of flow from said conductor beyond a determined amount.

2. In combination with a distributing electrical conductor as G, G′, two or more feed-wires as E, E′, leading thereto from a source of electrical supply and each connected therewith at one or more points, and one or more automatic cut-outs situated in the feed wire or wires and arranged as described to sever the electrical connection between the feed-wire and the distributing-conductor in case of a reversal of current in the feed-wire.

3. In combination with a distributing electrical conductor as G, G′, two or more feed-wires as E E′ leading thereto from a source of electrical supply and each connected therewith at one or more points, one or more automatic cut-outs situated in the feed wire or wires and arranged as described to sever the electrical connection between the feed-wire and the distributing-conductor in case of a reversal of current in the feed-wire, and an automatic cut-out or cut-outs situated near the power end of a feed wire or wires and adapted as described to sever its connection with the source of electrical supply when there is an abnormally excessive flow of current on said wire or wires.

4. In combination with a distributing electrical conductor as G, G′, two or more feed-wires as E, E′, leading thereto from a source of electrical supply and each connected therewith at one or more points, one or more automatic cut-outs situated in the feed wire or wires and arranged as described to sever the electrical connection between the feed-wire and the distributing-conductor in case of a reversal of current in the feed-wire, an automatic cut-out or cut-outs situated near the power end of a feed wire or wires and adapted as described to sever its connection with the source of electrical supply when there is an abnormally excessive flow of current on said wire or wires, and means for automatically actuating the cut-out to restore connection on the reduction of flow from said feed wire or wires beyond a determined amount.

5. The combination of two or more distributing-conductors as G, G′, G², with independent feed-wires leading from a source of electrical power to each such conductor, one or more automatic cut-outs normally connecting adjacent distributing-conductors and adapted as described to sever the connection on the occurrence of an abnormal flow from one of such conductors, means for actuating the cut-out to restore the electrical connection on the reduction of flow from the cut-out conductor, beyond a determined amount, and automatic cut-outs situated in the feed-wires normally connecting the feed-wires with the distributing-conductors, but adapted to sever said connection on a reversal of the current through the feed-wire.

6. The combination of two or more distributing-conductors as G, G′, G², with independent feed-wires leading from a source of electrical power to each such conductor, one or more automatic cut-outs normally connecting adjacent distributing-conductors and adapted as described to sever the connection on the occurrence of an abnormal flow from one of such conductors, means for actuating the cut-out to restore the electrical connection on the reduction of flow from the cut-out conductor, beyond a determined amount, automatic cut-outs situated in the feed-wires adjacent to the distributing-conductor and normally connecting the feed-wires with the distributing-conductors but adapted to sever said connection on a reversal of the current through the feed-wire, and automatic cut-outs situated in the feed-wires adjacent to the source of electrical power adapted to sever electrical connection on the occurrence of an abnormally excessive flow.

7. The combination of two or more distributing-conductors as G, G′, G², with independent feed-wires leading from a source of electrical power to each such conductor, one or more automatic cut-outs normally connecting adjacent distributing-conductors and adapted as described to sever the connection on the occurrence of an abnormal flow from one of such conductors, means for actuating the cut-out to restore the electrical connection on the reduction of flow from the cut-out conductor, beyond a determined amount, automatic cut-outs situated in the feed-wires adjacent to the distributing-conductor and normally connecting the feed-wires with the distributing-conductors but adapted to sever the connection on a reversal of the current through the feed-wires, automatic cut-outs situated in the feed-wires adjacent to the source of electrical power adapted to sever electrical connection on the occurrence of an abnormally excessive flow, and means for actuating said cut-outs to restore the electrical connection on the reduction of the flow from the feed-wire beyond a determined amount.

8. The combination of two or more dynamos with a common electrical conductor receiving current therefrom, a cut-out situated in the connection from each dynamo to the common conductor, means for actuating said cut-outs to sever said connection on the reversal of current therein, and means for actuating said cut-out to sever said connection on the occurrence of an excessive flow of current through said connection.

9. The combination of two or more dynamos with a common electrical conductor receiving current therefrom, a cut-out situated in the connection from each dynamo to the common conductor, means for actuating said cut-out to sever said connection on the reversal of current therein, two or more feed-wires leading from the common conductor to a distributing conductor or conductors, automatic cut-outs situated in each feed-wire adapted to sever electrical connection on the increase of flow from the feed-wire beyond a determined amount, and automatic cut-outs situated in the feed-wires adjacent to their connection with the distributing-conductor adapted to sever electrical connection on a reversal of current in the feed-wire.

10. In combination with two sections of an electrical conductor, a switch adapted to connect said sections, means as spring D^8 for opening the switch, a catch for holding the switch closed, an armature-magnet connected with the catch a coacting magnet, one or both of said magnets being an electromagnet, and one magnet being excited by the current flowing through the conductor so as to change its polarity on a reversal of said current, said coacting magnets being combined with the catch as described and so as to disengage it when the normal polarity of the magnet excited by the current in the conductor is reversed.

11. In combination with two sections of an electrical conductor, a switch adapted to connect said sections, means as spring D^8 for opening the switch, a catch for holding the switch closed, an armature-magnet connected with the catch, a coacting magnet, one or both of said magnets being an electromagnet, and one magnet being excited by the current flowing through the conductor, said magnets being so wound as to oppose like poles to its coacting magnet when the current in the main conductor is flowing in normal direction and opposite poles when the current is reversed, and the coacting magnets being combined with the catch as described and so as to disengage it and release the switch when their poles attract each other.

12. In combination with two sections of an electrical conductor, a switch adapted to connect said sections, means as spring D^8 for opening the switch, a catch for holding the switch closed, an armature-magnet connected with the catch, a coacting magnet, one or both of said magnets being an electromagnet, and one magnet being excited by the current flowing through the conductor, so as to change the polarity on a reversal of said current, said coacting magnets being combined with the catch as described and so as to disengage it when the normal polarity of the magnet excited by the current in the conductor is reversed, and an electromagnet excited by the normal current through the main conductor arranged to act upon the catch and release the switch when the flow from the conductor becomes excessive.

13. In combination with two sections of an electrical conductor, a switch adapted to connect said sections, means as springs D^8 for opening the switch, a catch for holding the switch closed, an armature-magnet connected with the catch, a coacting magnet, one or both of said magnets being an electromagnet, and one magnet being excited by the current flowing through the conductor, said magnets being so wound as to oppose like poles to its coacting magnet when the current in the main conductor is flowing in normal direction, and opposite poles when the current is reversed, and the coacting magnets being combined with the catch as described and so as to raise it and release the switch when their poles attract each other, and an electromagnet excited by the normal current through the main conductor arranged to act upon the catch and release the switch when the flow from the conductor becomes excessive.

14. The combination with two sections of an electrical conductor, a switch adapted to connect said sections, means as spring D^8 for opening the switch, a pivoted lever D^9 having a catch D^{11} adapted to engage the switch and hold it in position to close the circuit, a magnet as D^{12} secured to said lever, a magnet as D^{20} arranged to coact with magnet D^{12}, one or both of said magnets being an electromagnet, and one magnet being excited by the current flowing through the conductor, said magnets being wound in such a way as to oppose similar poles to its coacting magnet when the current is flowing in normal direction, and opposite poles when the current is reversed.

15. In combination with two sections of an electrical conductor, a switch adapted to connect said sections, means as springs D^8 for opening the switch, a pivoted lever D^9 having a catch D^{11} adapted to engage the switch and hold it in position to close the circuit, a magnet as D^{12} secured to said lever, a magnet as D^{20} arranged to coact with magnet D^{12} and one magnet being excited by the current flowing through the conductor, said magnet being wound in such a way as to oppose similar poles to its coacting magnet when the current is flowing in normal direction, and opposite poles when the current is reversed, a lever D^{15} pivotally connected to lever D^9 at one end and engaged at the other as specified so as to permit lever D^9 to move independently of it under the action of magnets D^{12} D^{20} but to carry said lever D^9 with it when said lever D^{15} is moved, an armature d^{15} secured to lever D^{15} and an electromagnet D^{21} excited by the current in the main conductor and adapted to raise the lever D^{15} and with it lever D^9 on the occurrence of an abnormally excessive current.

16. The combination with two sections of an electric conductor of a switch, means tending to return said switch to a position to close the

circuit, means tending to move said switch to a position to open the circuit, a catch arranged to normally intercept the last-mentioned device and prevent its acting on the switch, means for releasing said catch, a second catch or latch arranged to engage the switch when opened and resist the devices tending to close it again, and means for releasing said second catch to permit its closing of the switch.

17. The combination with two sections of an electric conductor of a switch, means tending to return said switch to a position to close the circuit, means tending to move said switch to a position to open the circuit, a catch arranged to normally intercept the last-mentioned device and prevent its acting on the switch, an armature connected with said catch, an electromagnet excited by the current in the main conductor arranged to act on the armature and raise the catch when an abnormally excessive flow occurs in the conductor, a second catch or latch arranged to engage the switch when opened and resist the devices tending to close it again, and means for releasing said second catch to permit its closing of the switch.

18. The combination with two sections of an electric conductor of a switch, means tending to return said switch to a position to close the circuit, means tending to move said switch to a position to open the circuit, a catch arranged to normally intercept the last-mentioned device and prevent its acting on the switch, an armature connected with said catch, an electromagnet excited by the current in the main conductor arranged to act on the armature and raise the catch when an abnormally excessive flow occurs in the conductor, an electromagnet situated in a shunt connected to each section of the conductor and a catch actuated by said electromagnet and arranged to be thrown by its action into engagement with the switch to prevent it from closing and to maintain said engagement until the current flowing through the shunt to the conductor falls below a determined amount.

19. The combination with two sections of an electric conductor of a switch, constantly-acting means tending to return said switch to a position to close the circuit, intermittently-acting means tending to move said switch to a position to open the circuit, a catch arranged to normally intercept the last-mentioned device and prevent its acting on the switch, an armature connected with said catch, an electromagnet excited by the current in the main conductor arranged to act on the armature and raise the catch when an abnormally excessive flow occurs in the conductor, a mechanical catch arranged to engage the switch in position to open the circuit at the time that the device which opens the switch releases it, and to be released by the action of the opening device after a short interval, an electromagnet situated in a shunt connected to each section of the conductor and a catch actuated by said electromagnet and arranged to be thrown by its action into engagement with the switch to prevent it from closing and to maintain said engagement until the current flowing through the shunt to the conductor falls below a determined amount.

20. The combination with two sections of an electric conductor of a switch as F^3, a lever F^4 supporting the switch means for moving the lever to close the switch, a wiper-lever F^{14} pivoted eccentrically to the pivot of lever F^4 and arranged to engage said lever in the position it occupies when the switch is closed and to release it after moving through a determined arc, constantly-acting means for revolving the wiper-lever in a direction to force the switch open, a catch as F^9 adapted to engage the wiper-lever and prevent its opening the switch, an electromagnet as F^{13} excited by the current in the main conductors and arranged to raise the catch F^9 when an abnormally excessive current flows through said conductor, a shunt F^{31} connecting the two sections of the conductor, an electromagnet F^{29} excited by the shunt-current, and a catch F^{25} actuated by the magnet F^{29} and adapted when said magnet acts upon it to engage the switch-lever F^4 and hold the switch open.

21. The combination with two sections of an electric conductor of a switch as F^3, a lever F^4 supporting the switch means for moving the lever to close the switch, a wiper-lever F^{14} pivoted eccentrically to the pivot of lever F^4 and arranged to engage said lever in the position it occupies when the switch is closed and to release it after moving through a determined arc, constantly-acting means for revolving the wiper-lever in a direction to force the switch open a catch as F^9 adapted to engage the wiper-lever and prevent its opening the switch, an electromagnet as F^{13} excited by the current in the main conductor and arranged to raise the catch F^9 when an abnormally excessive current flows through said conductor, a shunt F^{31} connecting the two sections of the conductor, an electromagnet F^{29} excited by the shunt-current, a catch F^{25} actuated by the magnet F^{29} and adapted when said magnet acts upon it to engage the switch-lever F^4 and hold the switch open, and an automatic catch F^{22} adapted to engage the switch-lever and hold the switch open when it is released by the wiper-lever said catch being acted on by the wiper to release the switch as the wiper completes its movement after opening the switch.

WM. D. GHARKY.

Witnesses:
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