(No Model.) 3 Sheets—Sheet 1.

H. E. WALTER.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 434,614. Patented Aug. 19, 1890.

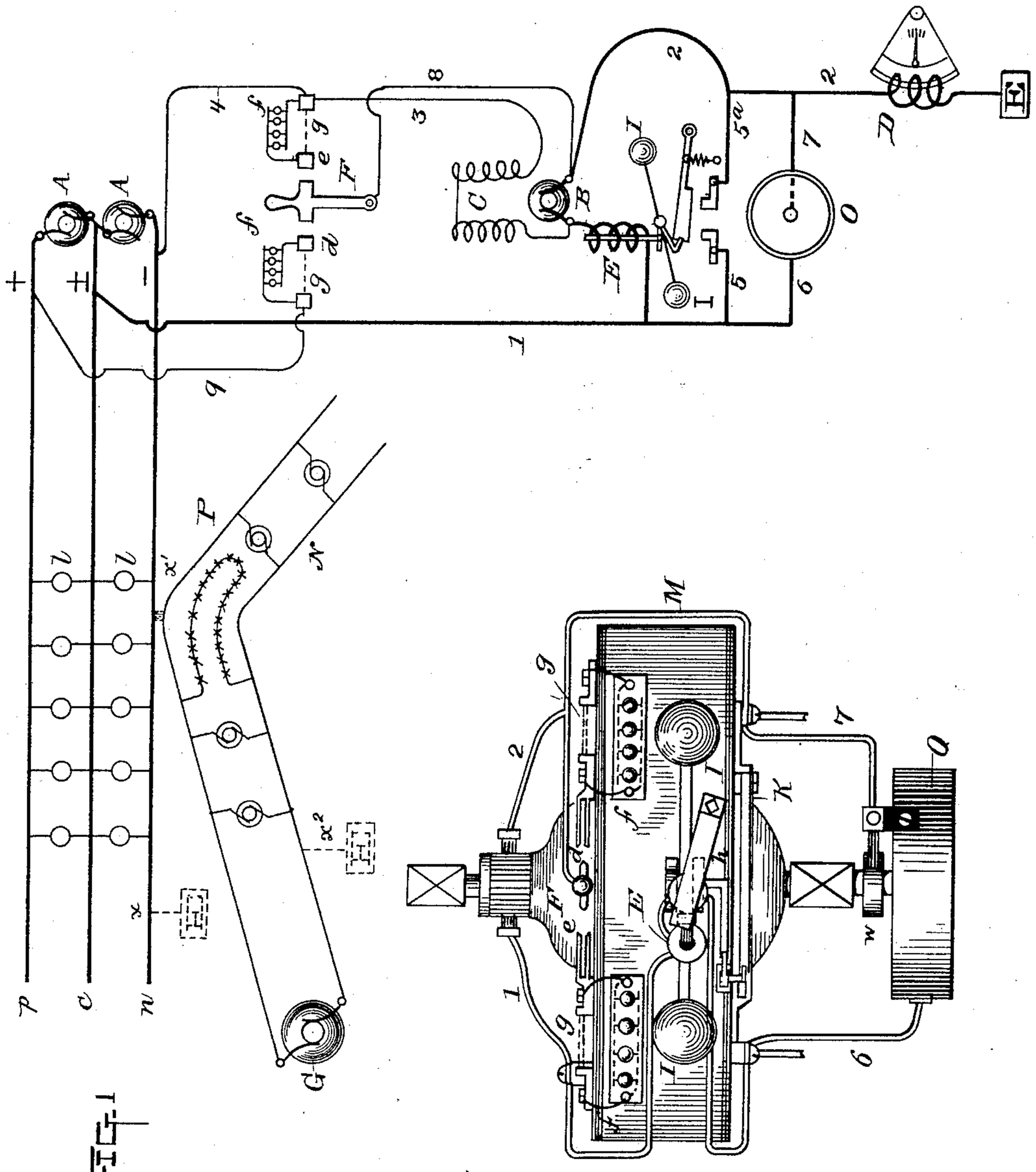

FIG. 1.

FIG. 2.

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(No Model.) 3 Sheets—Sheet 2.

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FIG. 3.

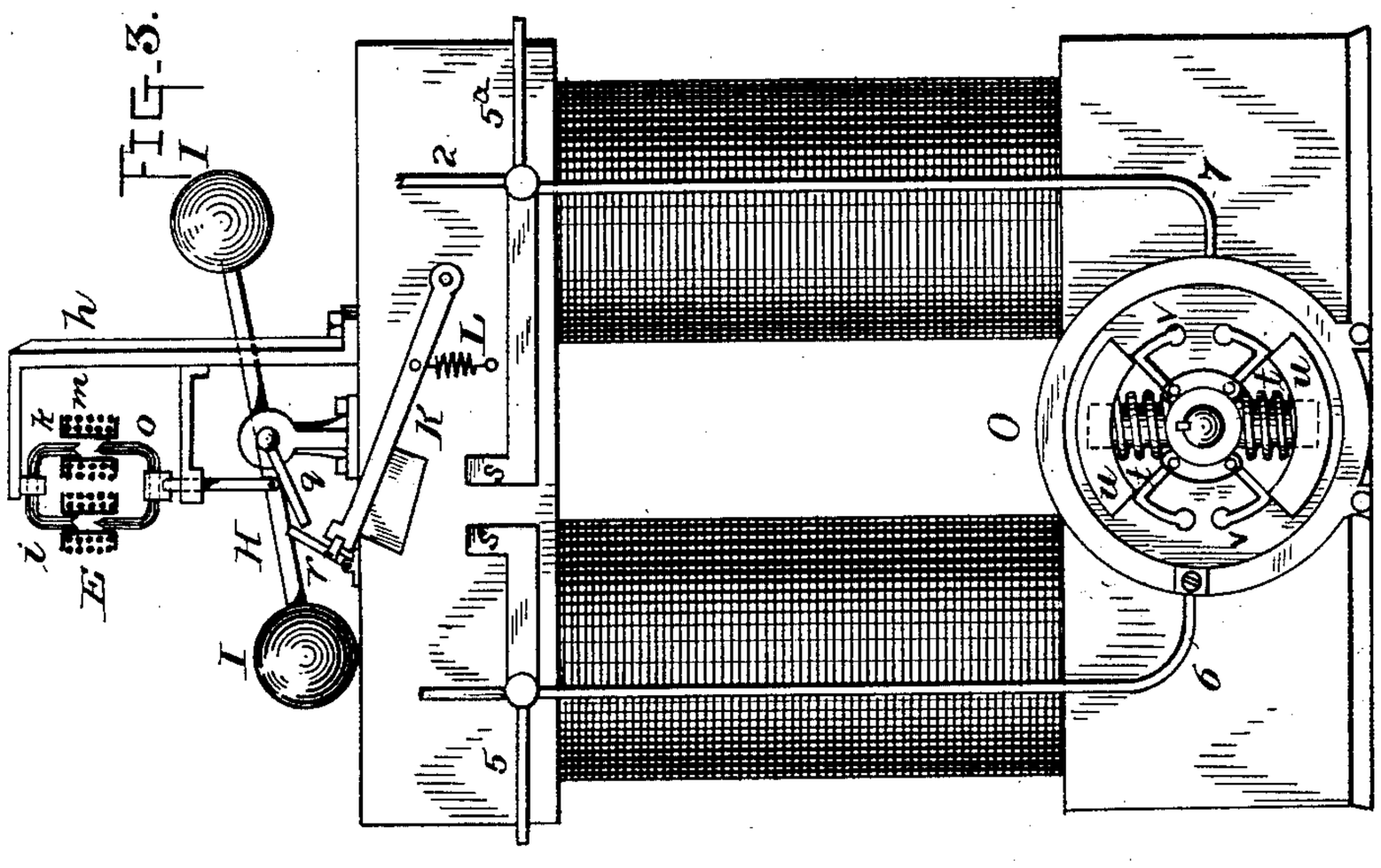
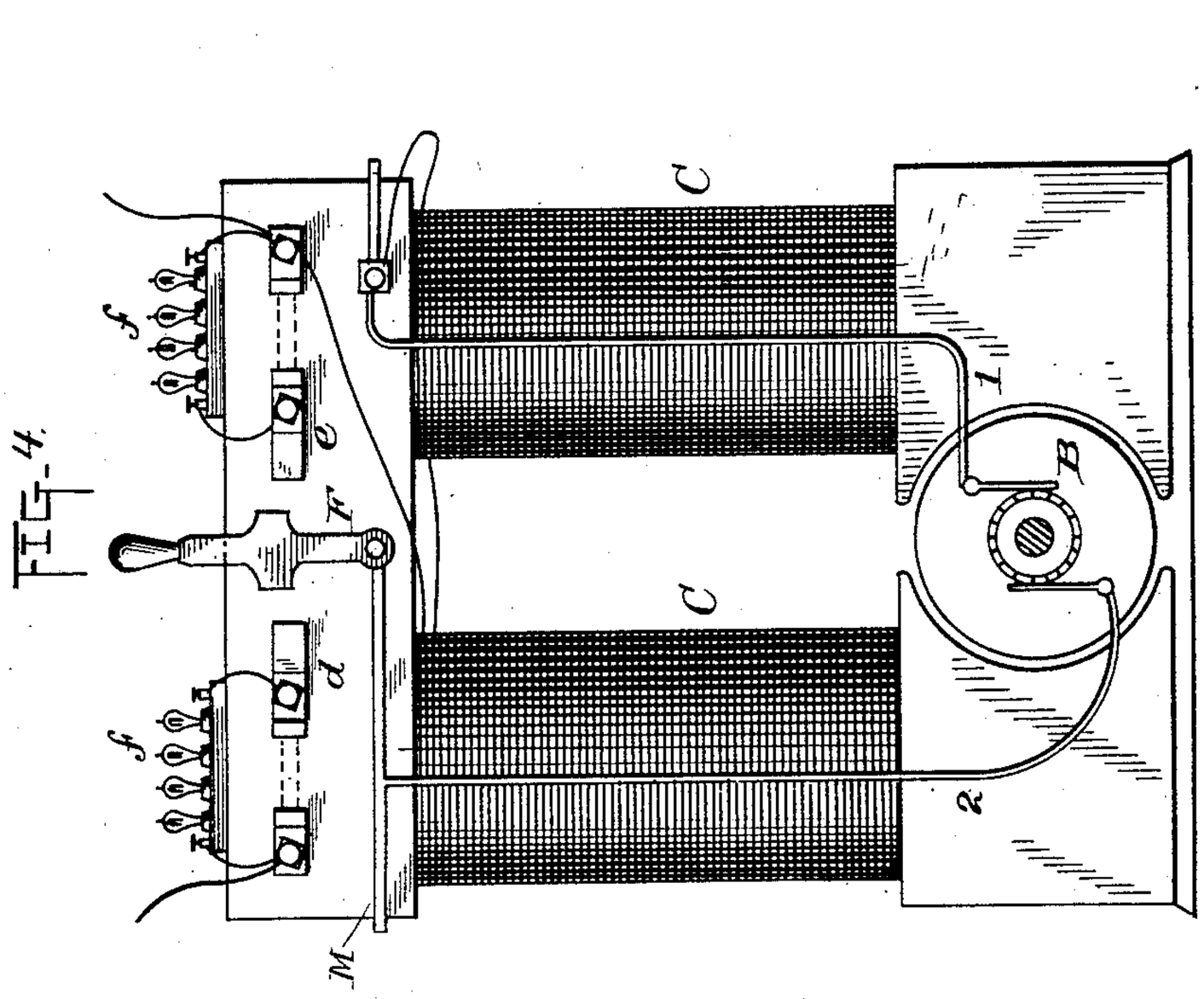


FIG. 4.



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(No Model.) 3 Sheets—Sheet 3.

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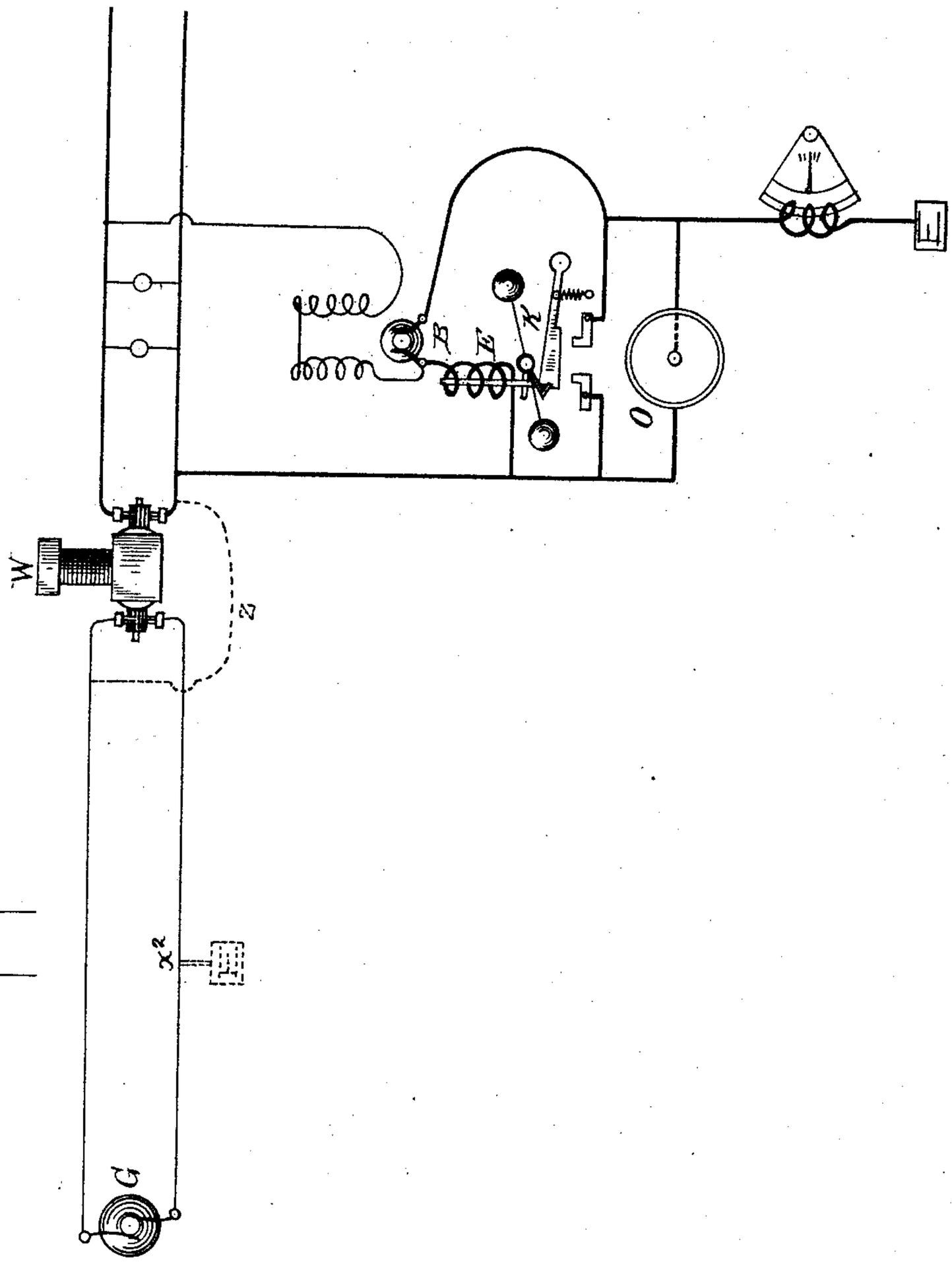

FIG. 5.

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UNITED STATES PATENT OFFICE.

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SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 434,614, dated August 19, 1890.

Application filed May 16, 1889. Serial No. 311,046. (No model.)

To all whom it may concern:

Be it known that I, HENRY E. WALTER, a subject of the Queen of Great Britain, residing at Schenectady, in the county of Schenectady and State of New York, have invented a certain new and useful Improvement in Systems of Electrical Distribution, of which the following is a specification.

In the use of systems of electric lighting employing currents of low potential—such, for instance, as the Edison three-wire system—when such systems are used in connection with transformers, and are thus exposed to contact with other circuits which employ currents of much higher potential, danger may arise to persons employed in connection with the system, for if the high-volt circuit is accidentally grounded, as such circuits are very likely to be, and also becomes accidentally crossed with a conductor of the low-volt circuit, then any person handling the low-volt circuit, which can ordinarily be done without danger, may by grounding the system through his body receive the high-volt current.

The main object of my invention is to avoid this danger, and I primarily accomplish this, in the three-wire system, by making a permanent low-resistance ground-connection from the neutral wire of the system at the central station, whereby the high-volt current when it enters upon the low-volt circuit finds a low-resistance path through the earth at this point, whereby the difference of potential between the point where the cross occurs and the ground is reduced practically to zero. While a simple ground-connection will accomplish this much, such a connection has the disadvantage that if an accidental ground occurs on one of the other wires of the low-volt system there is at once a low-resistance cross through the ground between such wire and the neutral wire, which will of course result in a waste of current, and may cause injury to the system. To avoid this, I place in the ground-connection from the neutral wire the armature of an electro-dynamic motor whose field-magnet may be in a shunt between the neutral and one of the other wires or is otherwise kept constantly charged, such armature being of low resistance and proportioned in resistance with relation to the resistance of the generators employed with any high-volt system with which the three-wire system is liable to become crossed, so that its resistance is a fraction of that of the high-volt generator. If a leak to ground occurs on either the positive or the negative wire of the three-wire system, the current will flow through the motor-armature and such motor will start. This in the first place gives an indication of the fact that a ground has accidentally occurred, and according to the direction in which the motor starts it is known whether the ground is on the positive or on the negative conductor; but, further, the revolution of the motor produces a counter electro-motive force which is thrown into the ground-connection and prevents the flow of excessive current through such connection. The motor in fact takes the place of a translating device connected across the two conductors parallel to the other translating devices of the system, and it may, if desired, continue to run, preventing a short-circuit of the system until the accidental ground is found and remedied.

When the three-wire system is crossed with a high-volt system on either of its conductors, the danger to persons handling the system does not arise unless the high-volt system is grounded somewhere; but if it is grounded, then, as above stated, a circuit is established to the neutral wire through the ground-connection containing the motor. Such motor immediately begins to run, and because of the high-volt current energizing it it will be brought up to a very high speed, much higher than that to which it is run by the low-volt current. This speed would be such as to endanger the three-wire system by the high counter electro-motive force developed, and also to endanger the motor itself. To avoid this I place on the shaft of the motor a switch arranged to be operated by centrifugal force when the motor is brought up to high speed, such switch being in a shunt around the motor-armature. This switch when thrown out, as stated, shunts the motor and establishes a dead low-resistance ground from the neutral, as before.

Where there is any danger of the three-wire system becoming crossed with a high-volt system employing an alternating current instead of a continuous one, I place in the

ground-connection from the neutral an additional switch, which is an electro-magnetic switch having a retarded movement and adapted to be operated by an alternating current, and to close a low-resistance ground-connection around the motor-armature. I provide in the ground-connection from the neutral wire an amperometer for the purpose of indicating the current in such ground-connection at any time, such meter or indicator being adapted to carry a heavy current, and also to indicate a very light current. I provide also a switch by which either the positive or the negative wire may be connected to ground through a resistance for the purpose of indicating grounds on the neutral, as will be more fully explained.

In the accompanying drawings, Figure 1 is a diagram illustrating the arrangement of apparatus embodying my invention with special reference to the electrical connections and circuits, and showing also conditions under which the apparatus is brought into use; Fig. 2, a top view of the motor and apparatus used therewith; Fig. 3, a rear elevation of the same with the alternating switch-magnet in vertical section; Fig. 4, a front elevation of the motor with the said alternating-current switch omitted for the purpose of clearness, and Fig. 5 a diagram showing my invention as usual with a two-wire continuous-current transformer system.

Referring mainly to the diagram, Fig. 1, A A represent the generators supplying the three-wire system, of which *p*, *n*, and *c* are the main conductors, *l* being incandescent lamps or other translating devices supplied by the system.

B is the armature of the switching electric motor placed at the central station. One pole of said armature is connected by a heavy conductor 1 with the neutral wire *c*, and the other pole by a heavy conductor 2 with the earth. The coils of the field-magnet C are connected by wires 3 4 from one terminal to the negative main conductor *n*, the other field terminal being joined to the wire *l*, so that the field is connected between the negative and neutral wires and is constantly charged.

D represents the amperometer in the ground-connection 2, above referred to, and E is the magnet controlling the alternating-current switch, which is adapted to close the circuit 5 5ª. The centrifugal switch of the motor-armature is arranged to close the circuit 6 7 around such armature.

F is a pivoted switch-lever connected by wire 8 with the grounded terminal of the motor-armature and arranged to be placed in contact with one or the other of the plates *d* and *e*, which are normally connected through incandescent electric lamps *f* or other suitable resistance, the plate *e* being connected with the wire 4, extending to the negative main, and the plate *d* to the wire 9, extending to the positive main. The plates *d* and *e* are furthermore arranged to be connected with wires 9 and 4 through fusible safety-catches, which may be inserted at *g g*.

G represents the generator supplying a high-volt continuous-current system, whose main conductors are represented by P N.

The apparatus above described is preferably arranged as illustrated in Figs. 2, 3, and 4. The motor is provided with an insulating switch-board on each side of its yoke or keeper, and at one side thereof are placed the plates *d e* and the corresponding safety-catch terminals and also the pivoted switch F. The resistance-lamps *f* are set on top of the motor, where is also placed a standard *h* for supporting the alternating-current switch. The magnet or solenoid E of this switch consists of a U-shaped core of iron wires *i*, carrying a spool *k*, on which are wound the coils *m*, and sliding in which spool is another similar U-shaped core *o*. The core *o* carries a pivoted arm H, having weights I at its ends and provided with a finger *q*, adapted to strike a locking-catch *r* when the arm H is raised and disengage the said catch from a switch-lever K, which is then quickly drawn down by the spring L and closes the circuit 5 5ª between the plates *s*.

For the purpose of making connections the copper rod M extends around one end of the keeper from the pivot of the switch F to the end of the plate *s*. This rod or frame forms part of the ground-connection 2 from the armature terminal, and the wire 7 from the locking-switch is also connected to it.

The locking-switch on the armature-shaft consists of a metal ring or casing O and a ring fixed to the shaft, from which two stems *t* extend, on which slide curved shoes *u*, held inwardly by springs on the stems. Spring-catches *v* are provided for locking the shoes *u* against the casing O when they are thrown out against the springs by centrifugal force. Upon the motor-shaft is a collar *w*, on which rests a brush or spring, by means of which the connection 7 is made to the shoes *u*. A connection 6 is made directly to the ring or casing O, so that the circuit 6 7 is closed by the contact of the shoes with the casing.

The operation of these devices is as follows: Suppose a ground-connection to occur on the negative wire *n*, as indicated at *x*. It is evident that a ground-circuit will thereby be formed by means of wires 1 and 2 through the armature B, and the motor will begin to run. If the ground-connection were on the positive side, the motor would begin to run in the opposite direction. It will thus be seen that a ground exists and on which side it exists, and such ground cannot result in injury to the system, since the motor forms a translating device, preventing an excessive flow of current through the earth. The motor may therefore be allowed to run until the fault is located and remedied. The action of the switch E being retarded by the weights I, such switch is not released by the passage of current, because before it can act the counter

electro-motive force of the motor has been thrown into the circuit and prevents the magnet from acquiring sufficient energy to lift the weights. If the accidental ground occurs on the neutral wire, such ground will not affect the motor. In order, however, to test the system at any time for grounds on the neutral, the switch F may be employed, by means of which either the positive or the negative conductor may be connected to ground through the resistance-lamps *f*. Then if there is no ground on the neutral besides the permanent one through the motor B, such motor will run at its normal speed; but if there is also some accidental ground on the neutral this will be indicated by the failure of the motor to start, or by its starting very slowly. The ground on the neutral may then be found and remedied, or it may be "burned out" by shunting the lamps *f* by a fusible strip at *g*, and thus making a dead-cross through the earth. If, as indicated at x', the negative wire comes in contact with a wire of a high-volt system, and such high-volt system has an accidental ground, as at x^2, it will be seen that if a ground is formed from any part of the low-volt system through the person of any one handling the system he will ordinarily receive the full high-volt current; but where my invention is used there is already provided a low-resistance path to ground for the high-volt current, so that the difference of potential is lowered to zero, and this therefore does not occur. When a high-volt connection occurs, the motor B begins to run and attains a high speed, so high as to throw out the shoes *u* of the switch O and close the ground-connection 6 7, so that the motor stops running. The switch O is so constructed that it will not be affected by any speed which can be attained under the normal current of the low-volt system, but only by the high speed given it by the high-volt current. The system is thus protected from the high counter electro-motive force of the motor, and the motor itself is protected from excessive speed, while at the same time the permanent low-resistance ground-connection is maintained. If the system supplied by the generator G is an alternating or discontinuous current system, then the current given by such system to the three-wire system does not start the motor running, but it will heat the armature of the motor to a dangerous extent. At this time, however, the retarded switch E comes into use, and lifting the weighted arm H trips the catch *r* and allows the switch K to close the circuit 5 5^a.

It will be seen that my invention is adapted for use wherever a low-volt system is in danger of becoming crossed with one employing a high-potential current, as is now often the case where a low-volt incandescent system is run in proximity to arc-light systems, systems employing transformers, and high-volt electric-railway systems. The invention is, however, as stated, specially designed with reference to the use of continuous-current-transformer systems, to prevent danger to the users of the secondary circuits by reason of crosses between the primaries and secondaries in the converters. It will be seen that such a cross would be precisely equivalent to the connection between two separate systems illustrated in the diagram.

It is further evident that my invention is applicable to a two-wire multiple-arc system as well as to the three-wire system shown, the motor and other devices being connected between either of the two conductors and the earth.

Fig. 5 shows the connections for a two-wire system, and also illustrates the use of my invention with continuous-current transformers, as above referred to. From the high-volt generator G a circuit extends to the high-volt commutator of the continuous-current transformer W, and from the low-volt commutator of the transformer extends the low-volt translation-circuit, with which the protective devices are connected, as already explained, the motor-armature B being connected with either side of the two-wire low-tension circuit and its field-magnet in a shunt, as before. The alternating-current switch E K and the centrifugally-operated switch O are also arranged and connected as before explained, and the operation will be readily understood from what has been already stated. The dotted line at *z* indicates an accidental cross between the two windings of the transformer. At x^2, as before, is indicated an accidental ground on the high-volt circuit.

I have illustrated my invention in connection with a three-wire direct-current system and with a two-wire transformer system. Its application to a two-wire direct system or to a three-wire transformer system will be apparent without further explanation.

What I claim is—

1. The combination, in a system of electrical distribution, with main conductors and translating devices in multiple arc, of a ground-connection from one of said conductors, and a device in said ground-connection adapted to develop a counter electro-motive force, substantially as set forth.

2. The combination, in a system of electrical distribution, with main conductors and translating devices in multiple arc, of a permanent ground-connection from one of said conductors, and an electro-dynamic motor in said ground-connection, the same being of low resistance, substantially as set forth.

3. The combination, in a system of electrical distribution, with main conductors and translating devices in multiple arc, of an electro-dynamic motor having an armature of low resistance connected between one of said conductors and the earth, and a separately-charged field-magnet, substantially as set forth.

4. The combination, in a system of electrical distribution, with main conductors and

translating devices in multiple arc, of an electric motor connected between one of said conductors and the earth, a shunt around said motor, and a switch in said shunt controlled by the motor, substantially as set forth.

5. The combination, in a system of electrical distribution, with main conductors and translating devices in multiple arc, of an electric motor connected between one of said main conductors and the earth, a shunt around said motor, and a centrifugally-operated switch on the shaft of said motor controlling said shunt, substantially as set forth.

6. The combination, with a three-wire system of electrical distribution, of a permanent ground-connection from the neutral wire thereof, and a translating device of low resistance in said ground-connection, substantially as set forth.

7. The combination, with a three-wire system of electrical distribution, of an electric motor having an armature of low resistance connected between the neutral wire of the system and the earth, substantially as set forth.

8. The combination, with a three-wire system of electrical distribution, of an electric motor having its armature connected between the neutral wire of said system and the earth, and its field-magnet connected between said neutral wire and one of the other wires of the system, substantially as set forth.

9. The combination, in a system of electrical distribution, with main conductors and translating devices in multiple arc, of a ground-connection from one of said main conductors, and an electro-magnetic switch in said ground-connection closing a shunt around itself, substantially as set forth.

10. The combination, in a system of electrical distribution, with main conductors and translating devices in multiple arc, of a motor in a ground-connection from one of said conductors, an electro-magnet in said ground-connection, a shunt around said motor, a switch in said shunt controlled by said electro-magnet, and means for retarding the operation of said switch, substantially as set forth.

11. The combination, in a three-wire system of electrical distribution, of a permanent ground-connection from the neutral wire thereof, a switch for connecting the positive or negative wire to ground, and an indicator of electric current in the earth-circuit thus formed, substantially as set forth.

12. The combination, in a three-wire system of electrical distribution, of a permanent ground-connection from the neutral wire thereof containing an electric motor, and a switch for connecting either the positive or the negative wire to ground, substantially as set forth.

This specification signed and witnessed this 10th day of May, 1889.

HENRY E. WALTER.

Witnesses:
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