No. 772,322. PATENTED OCT. 11, 1904.

L. ANDREWS.

FEEDER PROTECTION.

APPLICATION FILED NOV. 6, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

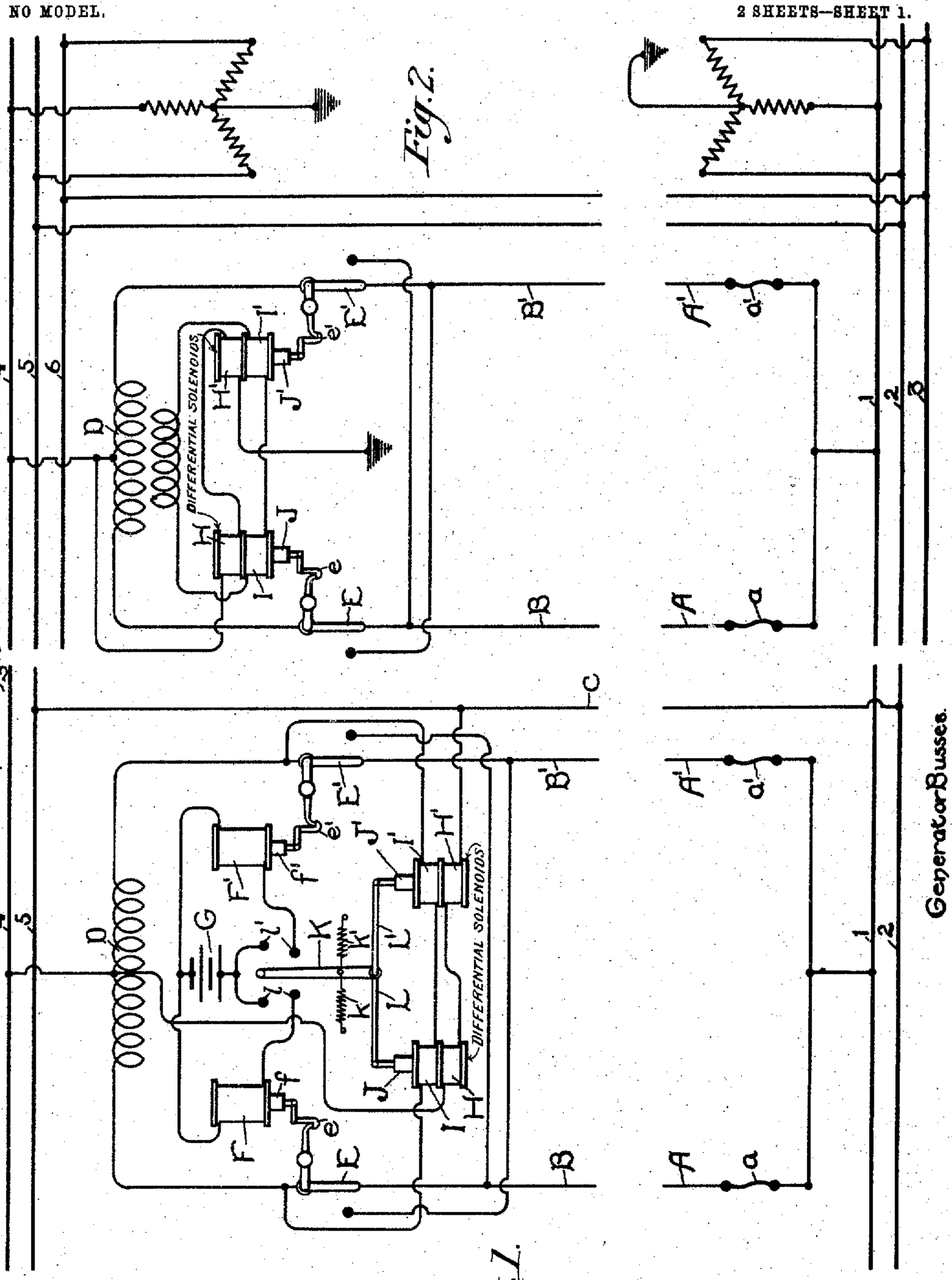

Fig. 2.

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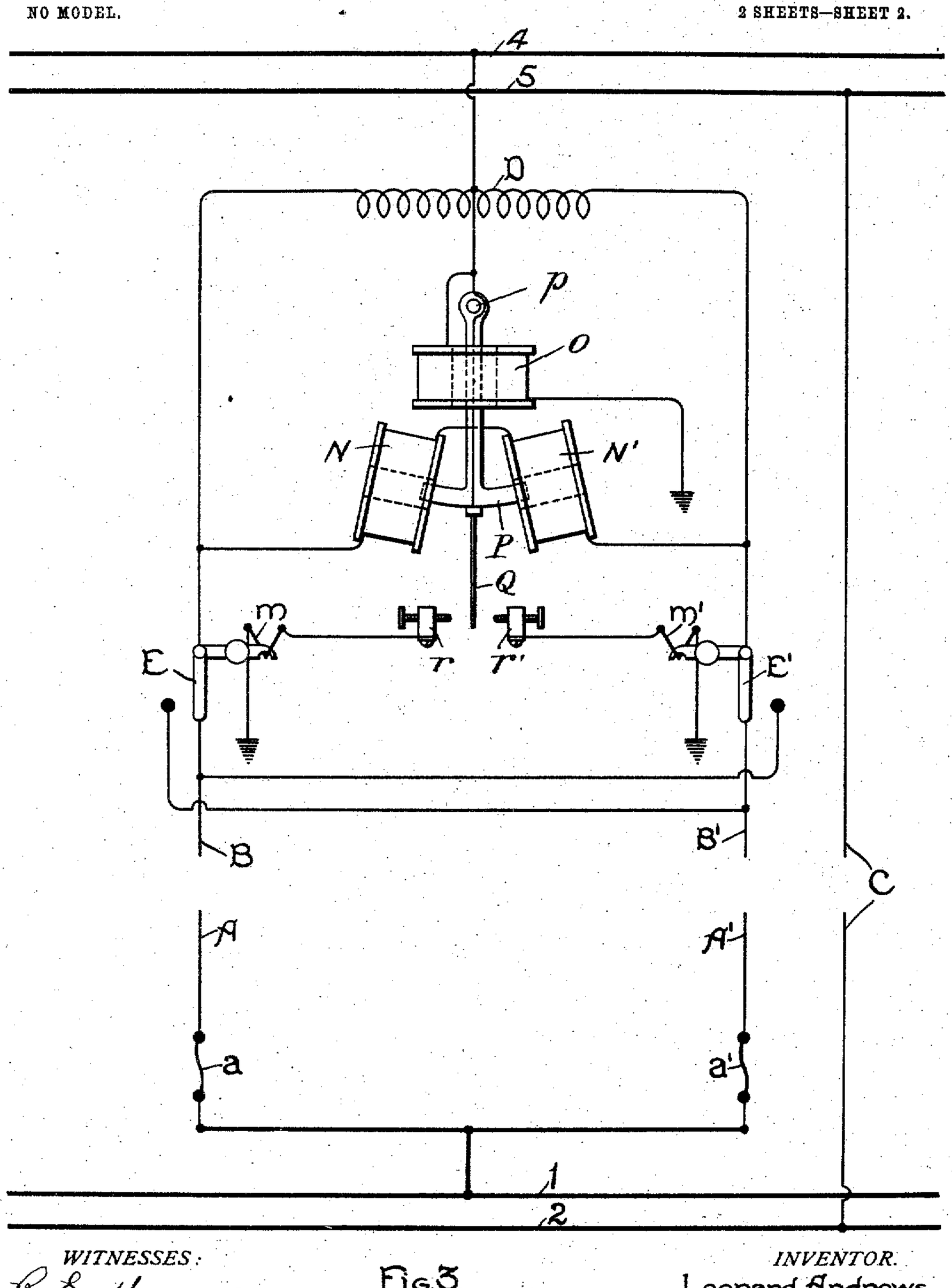

Fig. 3.

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UNITED STATES PATENT OFFICE.

LEONARD ANDREWS, OF MANCHESTER, ENGLAND.

FEEDER PROTECTION.

SPECIFICATION forming part of Letters Patent No. 772,322, dated October 11, 1904.

Application filed November 6, 1903. Serial No. 180,028. (No model.)

To all whom it may concern:

Be it known that I, LEONARD ANDREWS, a subject of the King of England, and a resident of Manchester, England, have invented certain new and useful Improvements in Feeder Protection, of which the following is a specification.

My invention relates to protective devices for systems of distribution, and especially to those systems in which a plurality of feeders are connected in parallel both at the generating and at the receiving end. In such a system it is very important that if one of the parallel feeders becomes short-circuited a rush of current from the other feeders should be prevented and the faulty feeder should be cut out in order to prevent the blowing of the fuses in all the feeders and the complete shutdown of the system. Protective devices to accomplish this end have been described in United States Patent No. 726,837, issued to me under date of May 5, 1903.

My present invention consists in improvements in the protective devices for such a system.

In the accompanying drawings, Figure 1 represents an arrangement embodying my invention applied to a single-phase system. Fig. 2 represents a modification of the same applied to a three-phase system having the neutral point grounded. Fig. 3 represents a further modification of the same.

In Fig. 1, 1 2 represent the bus-bars at the generating-station.

A A′ represent the generating-station end of two feeders, connected in parallel through fuses *a a′* or other protective devices to station bus-bar 1. B B′ represent the receiving end of the same feeders, connected through the differential or discriminating choke-coil D to the receiving bus-bar 4.

C represents the mains of opposite polarity, the duplicate feeders and protective devices being omitted for the sake of simplicity. The discriminating choke-coil D is of sufficient capacity to offer a high impedance to the flow of current from one feeder to the other, but offers no impedance to an equal flow of current from the feeders to bus-bar 4. In the circuit of feeders B B′ are inserted the switches E E′, which are constructed with weighted levers which tend to open the switches whenever they are released by the catches *e e′*. Catches *e e′* are connected to and operated by the cores *f f′* of the solenoids F F′. The windings of these solenoids are connected in a normally open circuit with any source of current at the receiving-station, (indicated in the drawings at G.)

L represents a balanced lever pivoted at its central point and carrying the arm K, which makes contact as the lever moves in either direction with contacts *l l′*, thus closing the circuit of solenoid F or F′. Lever L and contact-arm K are held normally in a central position by springs *k k′*. At the two ends of lever L are supported the two cores J J′. These cores are acted upon by the compound solenoids, the windings of which are made by coils I H and I′ H′, respectively. The coils I I′ are connected in series between the two feeders, and consequently under normal conditions no current is flowing through the windings. Windings H H′ are connected in series through the middle of the winding of the choke-coil D to the opposite polarity of the system. Current is therefore always flowing through the windings H H′; but the attraction of these two windings on cores J J′ is balanced and so produces no deflection of lever L.

The operation of the system is as follows: Under normal conditions all parts are in the positions indicated in the drawings. If now feeder B becomes short-circuited, fuse *a* will blow, thus disconnecting the feeder from the generator-station bus-bar. If it were not for the discriminating choke-coil D, a heavy current would flow from feeder B′ back along feeder B to the short circuit and would blow fuse *a′* likewise, thus completely shutting down the system. Choke-coil D, however, is of sufficient capacity to prevent any serious current-flow from the healthy feeder to the faulty one. Under these circumstances, however, there is a large voltage drop from the

healthy feeder to the middle point of choke-coil D, since the current in both parts of the coil is now in the same direction unbalancing the choke-coil, the differential effect consequently disappearing and each half of the coil D acting simply as an ordinary choke-coil, and consequently the voltage on bus-bars 4 5 is lowered. It is necessary, therefore, that the balance of the choke-coil should be restored. This is accomplished in the following manner: When feeder B short-circuits and there is a tendency for current to flow from feeder B′, current will pass through windings I′ and I of the compound solenoids from B′ to B. These compound solenoids are so wound that under these circumstances the current in windings I′ and H′ oppose each other, while the current in windings I and H assist. Core J is thus drawn down. Contact-arm K moves to the left, closing the circuit across contacts *l*. Solenoid F is thus energized and draws up its core *f*, thereby releasing switch E from its catch *e*. The weighted lever of switch E throws the switch to the auxiliary contact, which is cross-connected to feeder B′. Thus both ends of choke-coil D are connected to feeder B′, and it consequently offers no impedance to the flow of current. Thus the faulty feeder is automatically and instantaneously cut out. The balance of the choke-coil is restored and the operation of the system is not interrupted.

It will be noted that the operation of the discriminating cut-out formed by the lever L and the compound solenoids is always operative under a short circuit of one of the feeders, since, on the one hand, windings H H′ of the compound solenoids are connected to the opposite polarity of the system, so that current is always flowing in the windings whether the feeders are loaded or not, and, on the other hand, no matter how severe a short circuit there will be sufficient voltage across the terminals of the choke-coil to send a sufficiently large current through coils I I′ to operate the cut-out with certainty. Thus I avoid the difficulties arising from the use of cut-outs which either depend upon the flow of current through the mains, and thus are inoperative when the mains are on open circuit, or which depend upon the potential across the mains, which disappears in case of a heavy short circuit under ordinary circumstances where no choke-coil is used in such manner that a voltage is always maintained.

Fig. 2 shows a modification of my invention applied to a three-phase system with a grounded neutral. With this arrangement the coils I I′ instead of being connected between the feeders are connected to a secondary wound on the core of the choke-coils. By this means a low-voltage winding may be used and the same result is obtained as in the arrangement of Fig. 1, the coils I I′ being connected to points symmetrical with respect to the middle point of a choke-coil, as in Fig. 1, although in this case the connection of these coils to the feeders is inductive and not direct, as in Fig. 1. The only necessary condition in the connection of these coils is that they shall be connected to points symmetrical with respect to the middle point of choke-coil D, so that any unbalancing of current-flow in the halves of the choke-coil, with a consequent potential difference, will produce a voltage across the terminals of these coils. Also the solenoids F F′ in Fig. 1 are dispensed with, the cores J J′ of the compound solenoids acting directly upon the catches *e e′* of switches E E′. With this arrangement there is always a pull upon the cores J J′; but by means of any well-known setting device such as is used in ordinary overload circuit-breakers the pull may be adjusted so that cores J J′ will not be drawn up unless coils H and H′ are assisted by current in coils I I′. The coils H H′ instead of being connected directly to the opposite polarity of the system are connected indirectly by way of the ground, as indicated in the drawings. As in Fig. 1, the duplicate feeders and protective devices for the other mains are omitted for the sake of simplicity.

In Fig. 3 a modification is shown in which the coil O takes the place of the two coils H H′ of Fig. 1 and a single T-shaped core P is employed in place of the two cores J J′ of Fig. 1. The T-shaped core of Fig. 3 is pivoted at *p* and is magnetized by coil O, which produces like poles at the two tips of the cross-piece of the T. Under normal conditions no current is flowing through coils N N′, which take the place of coils I I′ in Fig. 1, and consequently there is no attraction upon the core. If, however, one feeder becomes grounded, current flows through coils N and N′ and produces magnetizations which in one coil opposes and in the other coil assists the magnetization of the cross-piece of the core P. Core P is thus drawn in one direction or the other, according to which feeder is grounded, and the contact-arm Q, carried thereby, makes contact with *r* or *r′*, thereby closing the circuit through one of the fuses *m m′*, which are connected to a source of current—as, for instance, from the middle point of choke-coil D to ground, and thus indirectly to the opposite polarity of the system. The fuse whose circuit is closed is blown, thus releasing its switch and cross-connecting its feeder, as has been already described. In place of the fuses *m m′* the solenoids F F′ of Fig. 1 may be used, if desired.

I do not desire to limit myself to the particular construction and arrangement of parts here shown, since changes therein which do

not depart from the spirit of my invention and which are within the scope of the appended claims will be obvious to those skilled in the art.

Having thus fully described my invention, I claim as new and desire to protect by Letters Patent—

1. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device operative upon the unbalancing of current-flow in said choke-coil, one winding of said device being connected between the opposite polarities of the system, and a second winding being connected to be energized upon the unbalancing of current-flow in said choke-coil and a switch in the circuit of a feeder adapted to be operated by said device.

2. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device having one winding connected between the opposite polarities of the system, and a second winding connected to points symmetrical with respect to the middle point of said choke-coil, and a switch in the circuit of a feeder adapted to be operated by said device.

3. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device operative upon the unbalancing of current-flow in said choke-coil, one winding of said device being connected between the opposite polarities of the system, and a second winding being connected to be energized upon the unbalancing of current-flow in said choke-coil and a switch adapted to be operated by said device and to transfer the connection of one end of said choke-coil from one feeder to another.

4. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device having one winding connected to be energized by an unbalancing of current-flow in said choke-coil and a second winding connected between the opposite polarities of the system, and a switch adapted to be operated by said device.

5. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device having one winding connected to be energized by an unbalancing of current-flow in said choke-coil and a second winding connected between the opposite polarities of the system, and a switch adapted to be operated by said device and to transfer the connection of one end of said choke-coil from one feeder to another.

6. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device having one winding connected to be energized by a difference of potential between said feeders and a second winding connected to be energized by the potential difference of the system, and a switch adapted to be operated by said device.

7. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device movable in either direction upon a relative reversal of current in either part of said choke-coil, one winding of said device being connected between the opposite polarities of the system, and a second winding being connected to be energized upon the unbalancing of current-flow in said choke-coil and switches in the circuits of said feeders adapted to be operated respectively by the movement of said device in either direction.

8. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device having windings energized respectively by the potential difference between said feeders and by the potential between the opposite polarities of the system, and switches adapted to be operated by said device.

9. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device having one winding connected between points symmetrical with respect to the middle of said choke-coil and a second winding connected between the middle of said choke-coil and the opposite polarity of the system, and a switch adapted to be operated by said device.

10. In combination, parallel feeders, a differential choke-coil, an electromagnetic device having one winding connected between points symmetrical with respect to the middle of said choke-coil and a second winding connected between the middle of said choke-coil and the opposite polarity of the system, and a switch adapted to be operated by said device and to transfer the connection of one end of said choke-coil from one feeder to another.

11. In combination, parallel feeders, a differential choke-coil connecting said feeders, an electromagnetic device having one winding connected to a source of potential proportional to the potential between said feeders and a second winding connected to a source of potential proportional to the potential between the mean voltage of said feeders and the opposite polarity of the system, and a switch adapted to be operated by said device.

12. In combination, parallel feeders, a choke-coil connected to said feeders, a magnet-winding connected in a circuit from the center of said choke-coil to the opposite polarity of the system, a movable member adapted to be magnetized by said winding, a magnet-winding adapted to be energized by a difference of potential between said feeders and to assist in energizing said member, and a switch adapted to be operated by the movement of said member.

13. In combination, parallel feeders, a choke-

coil connecting said feeders, a magnet-winding connected in a circuit from the center of said choke-coil to the opposite polarity of the system, a movable core adapted to be magnetized by said winding, two magnet-windings adapted to be energized by a difference of potential between said feeders and to differentially magnetize said core, and a switch adapted to be operated by the movement of said core.

Signed at London this 19th day of October, 1903.

LEONARD ANDREWS.

Witnesses:
A. NUTTING,
H. D. JAMESON.