

J. W. MILNOR.
 MEANS FOR COMPENSATING FOR DISTURBANCES OF EARTH POTENTIAL.
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1,254,829.

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Fig. 1.

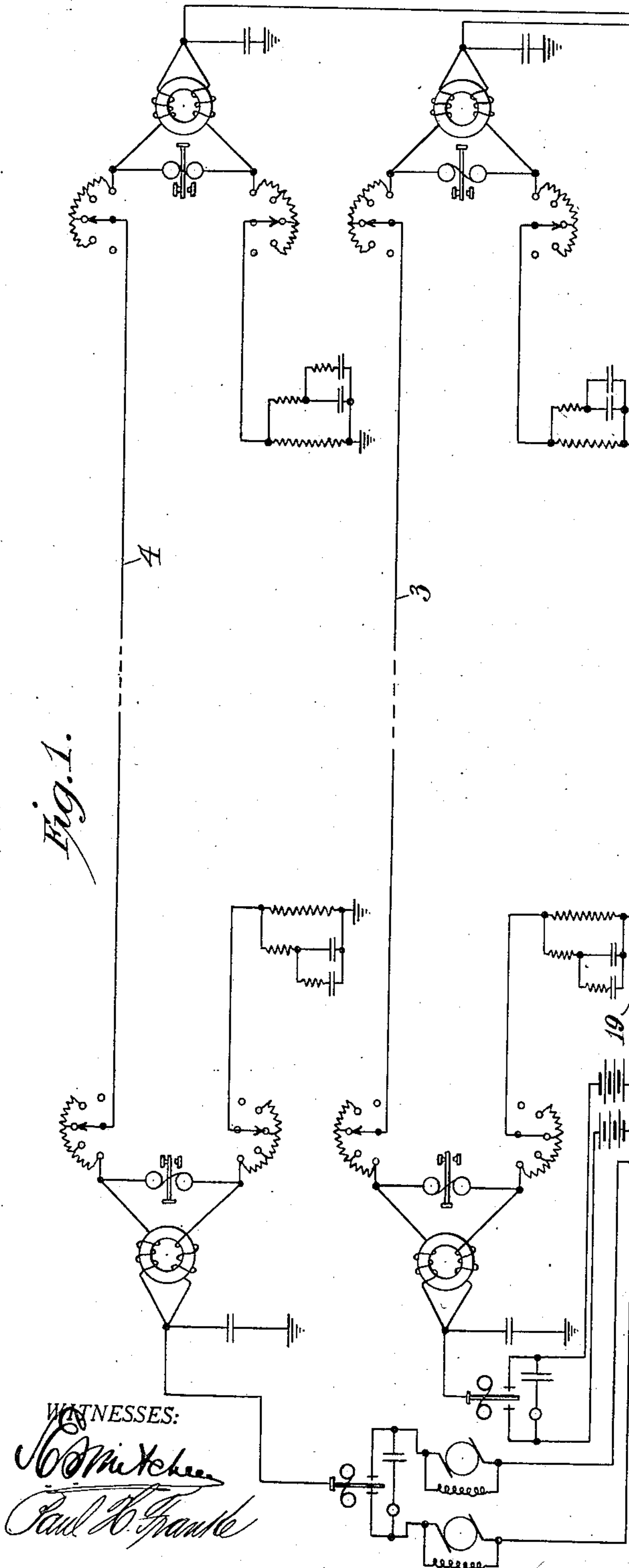
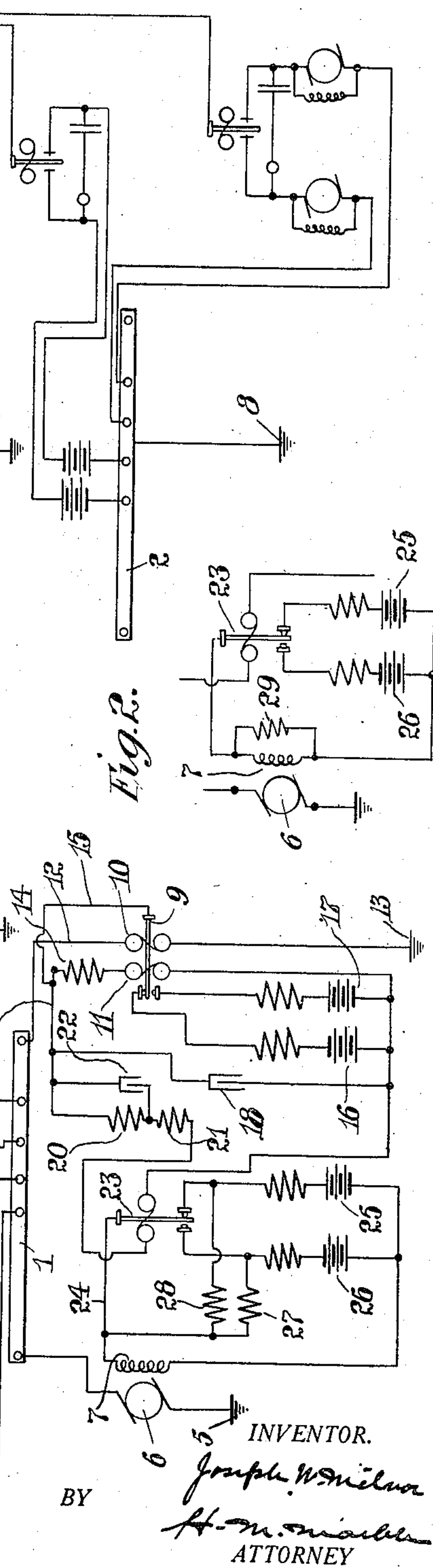


Fig. 2.



WITNESSES:

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MEANS FOR COMPENSATING FOR DISTURBANCES OF EARTH POTENTIAL.

1,254,829.

Specification of Letters Patent.

Patented Jan. 29, 1918.

Application filed March 10, 1917. Serial No. 153,823.

To all whom it may concern:

Be it known that I, JOSEPH W. MILNOR, a citizen of the United States of America, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Means for Compensating for Disturbances of Earth Potential, of which the following is a specification.

This invention relates to means for compensating for differences of potential between the ground connections at the two ends of a system of electrical communication, such for example, as a telegraph system, and comprises a generator located in one of the ground connections of the system, together with novel control means for that generator, and other features all as hereinafter described and particularly pointed out in the appended claims.

The object of my invention is to provide simple and reliable means for compensating for differences of potential between the grounds at the two ends of a system of communication, and to avoid any periodic oscillation of potential due to the action of the compensating means itself.

I will now proceed to describe my invention with reference to the accompanying drawings, in which Figure 1 is a diagram illustrating a compensating arrangement embodying my invention, in connection with systems of communication extending between the points between which the differences of potential exist; and Fig. 2 is a fragmentary diagram illustrating an alternative arrangement.

In the operation of telegraph systems, telephone systems and the like, much trouble is frequently experienced due to a difference of potential between the grounding points of the system, which difference of potential is commonly due to neighboring electric railways or electric power circuits or the like. This difference of potential, due to causes external to the system of communication, is frequently variable, which makes correction for such difference of potential by ordinary means, yet more difficult. By the present invention such difficulty is overcome.

In Fig. 1 of the accompanying drawings, 1 and 2 designate grounding bus-bars at the two points between which the difference

of earth potential exists; and 3 and 4 designate the line wires of systems of communication extending from the one bus-bar to the other. At the ends of these conductors 3 and 4 I have shown, diagrammatically, the transmitting and receiving arrangements of ordinary duplex telegraph systems, such transmitting and receiving arrangements being too well known to require description here. The systems of communication of wires 3 and 4 are entirely separate and distinct, and there may be as many of these systems between bus-bars 1 and 2, as desired; nor need these systems of communication be of the same nature; that is to say, one might be a telegraph system and the other or others telephone systems.

5 designates an earth connection for bus-bar 1, and 6 designates a generator interposed in that ground connection, 7 being the field windings of that generator. 8 designates the ground connection for bus-bar 2. It will be apparent that generator 6, if properly controlled and operated, will create a potential, equal and opposite to the earth potential existing between ground connections 5 and 8, so neutralizing, or compensating for, the actual difference in earth potential between points 5 and 8.

9 designates a polar relay having two magnet windings 10 and 11. For convenience in illustration, these two windings 10 and 11 are shown as on separate spools; but in practice, and as is well known, these windings will commonly be located on the same spools. Winding 10 is located in a conductor 12 leading from bus-bar 1 to some point 13, at which no potential disturbance exists. This point 13 is usually a point located laterally with respect to conductors 3 and 4; that is to say it is not usually a point which is either in a direct line between points 1 and 2, or a point close to the line conductors 3 and 4. Winding 11 is in a circuit comprising a resistance 14, and a conductor 15 connected to the armature of relay 9; whence the circuit passes through one or the other of two opposed batteries 16 and 17, connected to opposed contact stops of the relay, back to winding 11. A condenser 18 is in shunt relation with respect to winding 11 and resistance 14.

Batteries 16 and 17 are also connected, alternately, through the contact stops and armature of relay 9, a conductor 19, and resistances 20 and 21 (the former shunted by a condenser 22) to the magnet winding of a second relay 23. The armature of this relay 23 is connected by a conductor 24 to the field coil 7 of generator 6; whence the circuit passes through one or the other of two opposed batteries 25 and 26 to one or the other of the two opposed contact stops of said relay 23, back to the armature of that relay. The armature of relay 23 is shunted by resistances 27 and 28.

The action which results with the circuit arrangements thus described, is as follows:—

Assume that there is no current in windings 10 of relay 9. Obviously, the armature of relay 9 will tend to vibrate continuously between its contact stops, and will so vibrate so long as there is no current in winding 10; which vibration will be assisted by the charging and discharging of condenser 18, which prevents the armature from chattering against one contact stop of the relay only. Because of the vibration of the armature of relay 9, the current through the magnet coil of relay 23 will be reversed constantly, and therefore the armature of relay 23 will vibrate constantly, so reversing the current through the field coil 7 of generator 6. The condenser 22 quickens the action of relay 23. The vibration of the two relays is so rapid that the generator 6 does not have opportunity to build up current to an appreciable degree during the short intervals of closure of its field coil circuit.

Now suppose that there is current through the magnet winding 10 of relay 9, due to difference of potential between the "corrected" bus-bar 1, and the true earth potential at 13; the armature or tongue of relay 9 will then tend to rest against its one contact stop or the other (according to the direction of current in conductor 12) a greater length of time than it does against the other contact stop of that relay. As a result, the tongue of relay 23 will also tend to rest against one contact a greater length of time than against the other, thus enabling the current in generator field winding 7 to build up to a value sufficient to cause the generator 6 to compensate for the difference in potential between bus-bar 1 and ground 13. A strong current in winding 10 of relay 9 (that is to say, a strong current in conductor 12) will entirely overpower the effect of the current in winding 11, and will cause the relay vibrations to stop until the generator voltage has risen to a degree sufficient to compensate for the difference in earth potentials, causing the strong current in winding 10.

Resistances 27 and 28 obviate sparking

at the contacts of relay 23. The same effect may be accomplished by a non-inductive resistance 29 shunting the field-coil 7 of the generator, as shown in Fig. 2; resistances 27 and 28 being omitted in such case.

Heretofore a system for equalizing the potentials of grounding points has been devised, wherein a generator is interposed between one terminal bus-bar and the ground for that bus-bar, such generator being intended to compensate for difference of potential existing between the two terminal bus-bars of the systems, such for example as bus-bars 1 and 2; a special line conductor being employed to connect these two terminal bus-bars, and there being in such line conductor the field magnets of a polar relay, the armature contacts of which relay control two opposing batteries, which are connected in circuit (through the contact points of the relay) with the field coils of the said generator. In practical use of this former system referred to it has been found that the potential of the "corrected" bus-bar oscillates about the mean potential, instead of being steady. In one case the oscillation was found to be equivalent to an alternating current potential of about ten volts with a frequency of about fifteen cycles per second; the potential being between the corrected but-bar and the true earth. The cause of this oscillation of potential is undoubtedly the inductance of the field circuit of the generator, giving to that field circuit a certain time factor, and the time factor of the relay determined in part by its adjustment. By the present invention, this existence of a normal period of the field circuit producing a potential oscillation such as described, is avoided; the relay 9 being self vibratory (except as its normal vibrations are checked by current through the circuit 12 and windings 10) has a relatively high rate, so that the batteries 16 and 17 affect the field windings 7 of the generator 6 not at all, practically, unless there be a distinct current flow in conductor 12 and windings 10 tending to cause the armature of relay 9 to linger against one stop or the other, and so causing the armature of relay 23 to correspondingly linger.

In the construction shown and described above the armature of relay 9 is maintained in vibration by the reversal of polarity of the current through the magnet windings 11, effected by the vibration of the armature of the relay, plus the action of the condenser 18. In another application Serial No. 153,822 I have shown an arrangement for compensating for earth potential disturbance, except that in the disclosure of the said companion application the reversal of the current in the magnet coils 11 of the relay 9 is effected by the action of a relay corresponding to relay 23; such relay 23 being

itself kept in vibration by the relay 9. In a further companion application Serial No. 153,824 I have shown a compensating arrangement similar to that herein described except that the relay 9 is kept in vibration by a coil inductively related to the field coil 7 of the generator 6, and in circuit with the windings 11 of the relay 9. Claims generic to these three compensating arrangements are contained in application Serial No. 153,822, in which application I have also claimed the method of compensating for earth potential disturbances, and the method of preventing generator 6 from impressing potential oscillations due to its own inherent qualities, carried out in the apparatus above described.

The means for preventing the "hunting" action of the correcting generator, *i. e.*, the impressing of a voltage oscillation by the correcting generator itself, above described, is not confined to the prevention of, or correction or compensation for, direct current ground potential disturbance, but is applicable also to the prevention of such "hunting" action in the case of correction for alternating current electro-magnetic induction, or alternating current ground potential; and in my companion application Serial No. 153,825 I have shown the means for preventing the "hunting" action of my companion application Serial No. 153,822, employed for correction for alternating current disturbances. The substitution of the means for preventing hunting action, herein described, for the particular means for that purpose shown in my said application Serial No. 153,825 is obvious in view of the relations between the disclosures of the present application and of my application Serial No. 153,822. In such use of the present invention for correction of alternating current disturbances, a control circuit, like the control circuit 12 herein illustrated and described, will be employed, such control circuit being exposed to the influence of the alternating current disturbance just as, in the present application, the control circuit 12 is exposed to the ground potential disturbance.

What I claim is:

1. A ground connection for a system of communication comprising a connection from one point of such system to a grounding point at which disturbances of earth potential may exist, a generator in such ground connection having a controlling field circuit, a source of current supply therefor, two relays, one of said relays arranged by its vibration to reverse the current in said field circuit, the other relay provided with means for causing its own vibration and connected to said first mentioned relay to cause such first mentioned relay to vibrate, such second relay having a magnet coil in addition to that magnet coil by which it is

caused to vibrate, and another ground connection for such system of communication passing through such second magnet coil of such second relay.

2. A ground connection for a system of communication comprising a connection from one point of such system to a grounding point at which disturbances of earth potential may exist, a generator in such ground connection having a controlling field circuit, a source of current supply therefor, two relays, one of said relays having contacts and a magnet circuit whereby it is caused to vibrate, and having also connections to the other relay whereby such other relay is caused to vibrate, such other relay arranged by its vibration to reverse the current in said field circuit, the first mentioned relay having a magnet coil in addition to that coil by which it is caused to vibrate, and another ground connection for such system of communication passing through such second magnet coil of said second mentioned relay.

3. A ground connection for a system of communication comprising a connection from one point of such system to a grounding point at which disturbances of earth potential may exist, a generator in such ground connection having a controlling field circuit, a source of current supply therefor, two relays, one of said relays having contacts and a magnet circuit whereby it is caused to vibrate, and having also a condenser in shunt relation to its contacts, said relay having also connections to the other relay whereby such other relay is caused to vibrate, such other relay arranged by its vibration to reverse the current in said field circuit, the first mentioned relay having a magnet coil in addition to that coil by which it is caused to vibrate, and another ground connection for such system of communication passing through such second magnet coil of said second mentioned relay.

4. In a system of communication comprising a correcting generator, the combination with such correcting generator, of two relays, one of said relays arranged by its vibration to reverse the current in the field circuit of said generator, the other relay provided with means for causing its own vibration, and connected to such first mentioned relay to cause such first mentioned relay to vibrate, such second relay having a magnet coil in addition to that magnet coil by which it is caused to vibrate, such second magnet coil serving for the control of said relay.

5. In a system of communication comprising a correcting generator arranged to correct for external disturbances imparted to the system, the combination with such correcting generator, and a control circuit subjected, like such system of communication, to the disturbance, of two relays, one

of said relays arranged by its vibration to reverse the current in said field circuit, the other relay provided with means for causing its own vibration and connected to said first mentioned relay to cause said first mentioned relay to vibrate, such second relay having a magnet coil in addition to that magnet coil by which it is caused to vibrate, the control circuit passing through such additional magnet coil.

6. In a system of communication comprising a correcting generator, the combination with such correcting generator, of two relays, one of said relays having contacts and a magnet circuit whereby it is caused to vibrate, and having also connections to the other relay whereby such other relay is caused to vibrate, such other relay arranged by its vibration to reverse the current in said field circuit, the first mentioned relay having a magnet coil in addition to that coil by which it is caused to vibrate, and by which it may be controlled.

7. In a system of communication comprising a correcting generator arranged to correct for external disturbances imparted to the system, the combination with such correcting generator, and a control circuit subjected, like such system of communication, to the disturbance, of two relays, one of said relays having contacts and a magnet circuit whereby it is caused to vibrate, and having also connections to the other relay whereby such other relay is caused to vibrate, such other relay arranged by its vibration to reverse the current in the field circuit of said generator, the first mentioned relay having a magnet coil in addition to that coil by which it is caused to vibrate, the control circuit passing through such additional magnet coil.

8. In a system of communication comprising a correcting generator, the combination with such correcting generator, of two relays, one of said relays having contacts and a magnet circuit whereby it is caused to vibrate, and having also a condenser in shunt relation to its contacts, said relay having also connections to the other relay whereby such other relay is caused to vibrate, such other relay arranged by its vibration to reverse the current in said field circuit, the first mentioned relay having a magnet coil in addition to that coil by which it is caused to vibrate, and by which it may be controlled.

9. In a system of communication comprising a correcting generator arranged to correct for external disturbances imparted to the system, the combination with such correcting generator, and a control circuit subjected, like such system of communication, to the disturbance, of two relays, one of said relays having contacts and a magnet circuit whereby it is caused to vibrate, and

having also a condenser in shunt relation to its contacts, such other relay arranged by its vibration, to reverse the current in the field circuit of said generator, the first mentioned relay having a magnet coil in addition to that coil by which it is caused to vibrate, the control circuit passing through such additional magnet coil.

10. A ground connection for a system of communication comprising a connection from one point of such system to a grounding point at which disturbances of earth potential may exist, a generator in such connection having a controlling field circuit, a source of current supply therefor, two relays, one controlling such source of current supply and arranged when operated to reverse the flow of current through that field circuit, the second relay comprising means for causing it to vibrate continuously normally, and connected to the first relay to cause such first relay to vibrate correspondingly, and means causing said second relay, in the event of potential disturbance, to linger against its one contact or the other, according to the character of the potential disturbance.

11. A ground connection for a system of communication comprising a connection from one point of such system to a grounding point at which disturbances of earth potential may exist, a generator in such connection having a controlling field circuit, a source of current supply therefor, two relays, one controlling such source of current supply and arranged when operated to reverse the flow of current through that field circuit, the second relay comprising means for causing it to vibrate continuously normally, and connected to the first relay to cause such first relay to vibrate correspondingly, and a connection from such system of communication to another grounding point, said second relay having a magnet coil in such second ground connection whereby the armature of such second relay is caused to linger against its one contact stop or the other, in the event of existence of material earth potential disturbance.

12. A ground connection for a system of communication comprising a connection from one point of such system to a grounding point at which disturbances of earth potential may exist, a generator in such connection having a controlling field circuit, a source of current supply therefor, two relays, one controlling such source of current supply and arranged when operated to reverse the flow of current through that field circuit, the second relay comprising means for causing it to vibrate continuously normally, and connected to the first relay to cause such first relay to vibrate correspondingly, and a connection from such system of communication to a grounding point

which is free from earth potential disturbances, said second relay having a magnet coil in such second ground connection.

13. In a system of communication comprising a correcting generator, the combination with such correcting generator, of means for normally reversing the current in the field coil of that generator at a rate higher than that of the oscillation which that generator tends to produce, such means comprising two relays, one arranged when operated to reverse the flow of current through such field coil, the second relay comprising means for causing it to vibrate continuously normally, and connected to the first relay to cause such first relay to vibrate correspondingly, and means causing said second relay to linger against its one contact or the other as may be required for correction.

14. In a system of communication comprising a correcting generator arranged to correct for external disturbances imparted to the system, the combination with such correcting generator, and a control circuit

subjected, like such system of communication, to the disturbance, of means for normally reversing the current in the field coil of that generator at a rate higher than that of the oscillation which that generator tends to produce, such means comprising two relays, one arranged when operated to reverse the flow of current through such field coil, the second relay comprising means for causing it to vibrate continuously normally, and connected to the first relay to cause such first relay to vibrate correspondingly, and means controlled by said control circuit causing said second relay to linger against its one contact or the other as may be required for correction.

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

JOSEPH W. MILNOR.

Witnesses:

H. M. MARBLE,
PAUL H. FRANKE.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."