G. E. ARMSTRONG.

GROUND DETECTOR.

APPLICATION FILED DEC. 27, 1915.

1,300,546. Patented Apr. 15, 1919.

Fig. 1.

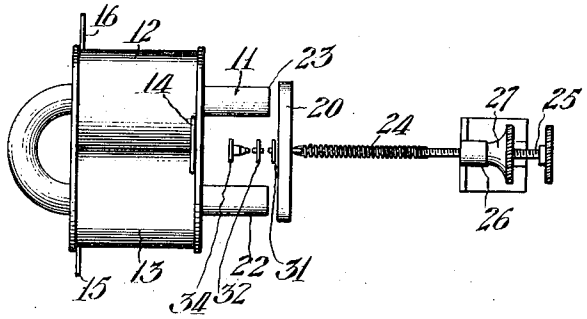


Fig. 2.

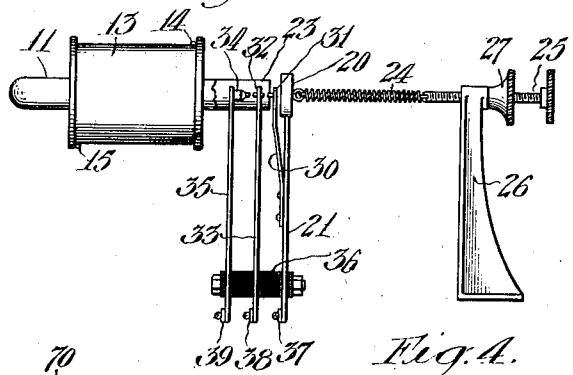


Fig. 3.

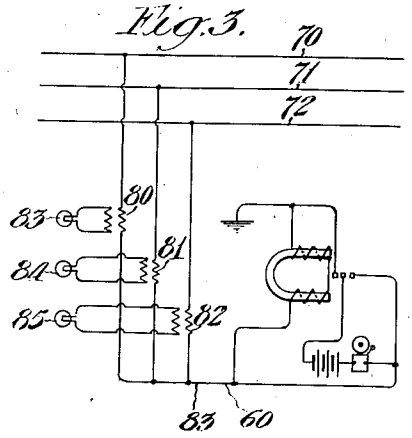
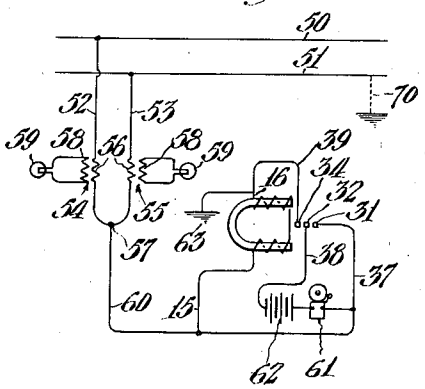


Fig. 4.



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UNITED STATES PATENT OFFICE.

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GROUND-DETECTOR.

1,300,546. Specification of Letters Patent. Patented Apr. 15, 1919.

Application filed December 27, 1915. Serial No. 68,925.

To all whom it may concern:

Be it known that I, GEORGE E. ARMSTRONG, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Ground-Detector, of which the following is a specification.

My invention relates to electric circuits, and the principal object of the invention is to provide a means for indicating when a ground exists on such an electrical circuit.

In the commercial transmission of electricity, it is usual to run the wires either overhead, or under ground, these wires being suitably insulated by various means from the ground. It often happens that this insulation becomes defective so that current flows to the ground. A single ground is often of no consequence, but a double ground, that is to say, the grounding of wires of opposite polarity, will result in a short circuit which may have very serious consequences. The accidental grounding of live wires on objects adjacent to the transmission line also introduces a serious life hazard and fatalities have occurred due to such a grounding. As the transmission lines often run long distances, and as the initial injury to the insulation may be comparatively small, a mere visual inspection of the line will not ordinarily, unless made with great care, disclose any such sources of danger.

The object of my invention is to provide a ground detector which may be located in the central or sub-station, and which will immediately indicate the occurrence of a ground on any circuit. Various devices of this kind are already in use, but so far as I am aware they are all open to the objection that they do not indicate plainly and unmistakably the presence of a high contact resistance ground on a circuit of moderate or low potential. For example, on 2200 volt circuits, it often happens that the wires are carried on wooden poles which in themselves are fair insulators, the wire being, however, insulated from the wooden pole by means of a porcelain insulator. In case of injury to the porcelain insulator the insulation of the line at that point is reduced, and a current will flow down the pole to the earth under such conditions. This current is, however, very small if the pole is dry, and this ground may persist for a considerable time without dangerous results. All operating engineers, however, realize the danger of such grounds especially during rainy weather, and it is a common occurrence to have the lines put out of commission by such grounds, and in some cases losses of life have occurred due to such conditions.

It is a further object of my invention to provide a ground detector which is very sensitive, and which will detect ground leakage currents which are far smaller in value than any which can be detected by known methods.

It may be explained that at all times there is some leakage to ground over even the best of transmission lines, this leakage being due to current which flows through the body of, or over the surface of the insulators and insulating materials.

This leakage current, however, in a line which is in first class condition will be practically equal on all the wires so that while the leakage current will vary under different weather conditions, being ordinarily much greater in wet weather, yet the leakage from each of the wires to the ground is practically the same on all of the wires of the circuit.

A further object of my invention is to provide a ground detector which while very sensitive to unbalanced currents flowing to ground, will yet be unaffected by the ordinary leakage of the line so long as this leakage remains practically constant on all the wires of the line.

Further objects and advantages will be set forth hereinafter.

Referring to the drawings which are for illustrative purposes only:

Figure 1 is a somewhat diagrammatic plan view of the relay which I employ.

Fig. 2 is a side view of the relay, a portion of one of the pole pieces of the magnet being broken away to better show the contents.

Fig. 3 is a diagram showing the ground detector as applied to a three phase circuit.

Fig. 4 is a diagram showing the ground detector as applied to a single phase circuit.

The relay proper consists of a core 11 on which are placed magnet coils or windings 12 and 13, these coils being connected together by means of a wire 14, and being provided with terminal wires 15 and 16. The coils 12 and 13 are so wound that they assist each other in magnetizing the core 11. An armature 20 is provided being preferably mounted on a flexible spring 21 in such a manner that it may be attracted by the

pole pieces 22 and 23 of the core 11. The armature 20 is normally held out of engagement of the pole pieces 22 and 23 by a spring 24, the tension of which is adjusted by a screw 25 carried in a standard 26, this screw being locked in position by means of a lock nut 27. Mounted on a spring 30 is a primary contact 31, the spring 30 being secured to the spring 21. A secondary contact 32 is carried on a spring 33 and a tertiary contact 34 is carried on a spring 35. The springs 21, 33 and 35 are preferably secured together by insulation 36, and wires 37, 38 and 39 are connected respectively thereto as shown in the drawing. The arrangement of the contacts 31, 32 and 33 is such that they are all placed in electrical connection with each other, when the armature 20 is attracted against the pole pieces 22 and 23. When the armature is so attracted the contacts 31 and 32 are first connected together, the contact 34 being connected thereafter. In practice the windings 12 and 13 consist of a large number of turns having a high resistance and impedance.

The method of applying the relay to a single phase circuit is illustrated in Fig. 4, in which 50 and 51 are the two wires of the particular transmission line to which the ground detector is to be connected. Connected to the wires 50 and 51 by means of wires 52 and 53 are the primary windings 54 and 55 of two transformers 56, the primary windings 54 and 55 being connected on the other side to the common neutral point 57. The secondary windings 58 of the transformers 56 are each connected to an ordinary incandescent lamp 59. Each of the secondary windings 58 of the transformers 56, and each of the lamps 59 has identical electrical characteristics. A wire 60 connects the common neutral and the wire 37 which is connected to the contact 31. The wire 60 is also connected to one terminal of a bell 61, the other terminal of the bell being connected to a battery 62, the other terminal of the battery being connected through the wire 38 with the contact 32. The wire 15 of the relay is connected to the wire 60, the wire 16 being connected to the wire 39 and to the contact 34, and also being connected to the ground as shown at 63.

The method of operation of the invention is as follows: Under normal conditions the leakage to the ground from the wires 50 and 51 is approximately equal, and practically no current will flow through the wire 60, the leakage currents neutralizing each other in that wire. Current will flow however through the primary windings 54 and 55 of the transformers 56, so that the incandescent lamps 59 will be supplied with practically equal currents and will burn with equal brilliancy. When, however, a ground occurs on the circuit, for example, on the wire 51, as shown at 70, current will flow from the wire 50 through the wires 52 and 60, and through the wires 15, the windings 12 and 13, and the wire 16, to the ground 63. This current passes through the ground 70, and back to the wire 50. If the ground is a light one, this current may have a very low value so that the difference in brilliancy between the incandescent lamps will not be noticeable. The relay is very sensitive, however, and a very low current is sufficient to attract the armature 20 against the pole pieces 22 and 23. When the armature 20 is so attracted the contacts 31, 32 and 34 are all placed in electrical connection with each other with the following results:

First, current from the battery 62 flows through the wire 38, contacts 31 and 32, and the wire 37 to the bell 61, and from the bell 61 back to the battery so that the bell immediately starts to ring. The bell 61 forms an audible signal to notify the station attendant that a ground exists on the circuit to which the ground contact is attached. The bell will continue to ring as long as the ground persists, and the station attendant immediately takes steps to see that the ground is located and removed. Other signaling devices besides the bell 61 may be obviously employed if desired, and such signals may be either audible or visible, or a combination of audible and visible may be substituted, if desired. If the windings 12 and 13 of the relay were made sufficiently delicate to attract the armature 20, where the ground was of very high resistance the windings 12 and 13 would be burned out, should the ground be of very low resistance as often occurs. For this reason the contact 34 is provided, this contact serving to short circuit the windings 12 and 13 when the armature 20 is against the pole pieces 22 and 23, current flowing through wire 39, contacts 34, 32 and 31, and the wire 37, thus short circuiting the windings 12 and 13, and preventing them from being burnt out. As soon as the windings of the relay are short circuited the armature 20 is released to a point where the circuit is broken by the contacts 32 and 34, the armature being immediately attracted again without breaking the circuit between the contacts 31 and 32, so that the bell 61 continues to ring during the time that the armature 20 is vibrated.

The method of applying the device to a three phase circuit is illustrated in Fig. 3, in which wires 70, 71 and 72 represent the three phase circuit, and in which 80, 81 and 82 represent three transformers, each transformer having its primary winding connected on one side to one of the wires 70, 71 and 72, the other terminal of the primary

winding of the transformer being connected to a common neutral 83, this common neutral 83 being connected to the wire 60 on the relay, which is constructed and operates as has previously been described. The operation of the relay on a three phase circuit is exactly similar to that of the operation of a single phase circuit as already described, any leakage which is equal on all three wires having no effect whatever on the relay as it will cause no flow of current through the wire 60. When, however, a ground occurs, the excess current from the ground will flow through the wire 60, and actuate the relay as previously described. I prefer to use the transformers and relays as indicated above. In some leakages, however, a very high resistance or impedance may be substituted for each of the transformers, and the lamps may be dispensed with. These impedances may be in the form of high resistances, banks of lamps, choke coils, or the like, it being however necessary that the impedances connected to the different wires be all of the same electrical characteristics.

I claim as my invention:—

1. A ground detector for an electrical circuit comprising a transformer for each wire of said circuit, each transformer having one end of its primary winding connected to one of said wires, the other ends of all of said primary windings being connected to a common neutral, a lamp connected across the secondary of each of said transformers, said transformers and lamps having practically identical electrical characteristics, a relay having one terminal connected to said common neutral and the other terminal connected to the ground, means by which said relay actuates a signal whenever the current flowing from said common neutral to the ground exceeds a predetermined value, and means by which said relay short circuits its own winding.

2. A ground detector for an electrical circuit comprising a transformer for each wire of said circuit, each transformer having one end of its primary winding connected to one of said wires, the other ends of all of said primary windings being connected to a common neutral, a lamp connected across the secondary of each of said transformers, said transformers and lamps having practically identical electrical characteristics, a relay having one terminal connected to said common neutral and the other terminal connected to the ground, means by which said relay actuates a signal whenever the current flowing from said common neutral to the ground exceeds a predetermined value, and means by which said relay short circuits its own winding after it has actuated said signal.

3. A ground detector for an electrical circuit comprising impedances of identical electrical characteristics, each impedance having one end connected to one of the wires of the circuit and the other end connected to a common neutral point, a relay having one end of its winding connected to said point and the other end of its winding connected to ground, means by which said relay actuates a signal, and means by which said relay short circuits its own winding.

4. A ground detector for an electrical circuit comprising impedances of identical electrical characteristics, each impedance having one end connected to one of the wires of the circuit and the other end connected to a comment neutral point, a relay having one end of its winding connected to said point and the other end of its winding connected to ground, means by which said relay actuates a signal, and means by which said relay short circuits its own winding after it has actuated said signal.

5. A ground detector for an electrical circuit comprising a transformer for each wire of said circuit, each transformer having one end of its primary winding connected to one of said wires, the other ends of all of said primary windings being connected to a common neutral, a lamp connected across the secondary of each of said transformers, said transformers and lamps having practically identical electrical characteristics; a magnetic circuit; a winding disposed about said circuit having one terminal connected to the ground and the other terminal connected to said common neutral; an armature so mounted as to be attracted by said magnetic circuit whenever an electric current of a certain magnitude passes through said winding; a primary contact; a secondary contact; a tertiary contact; means by which said armature may press all three of said contacts into electrical connection with each other; means for connecting said primary contact to the common neutral; a signal having one terminal connected to said common neutral; means for connecting the other terminal of said signal to said secondary contact; and means for connecting the tertiary contact to the ground.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 21st day of December, 1915.

GEORGE E. ARMSTRONG.