

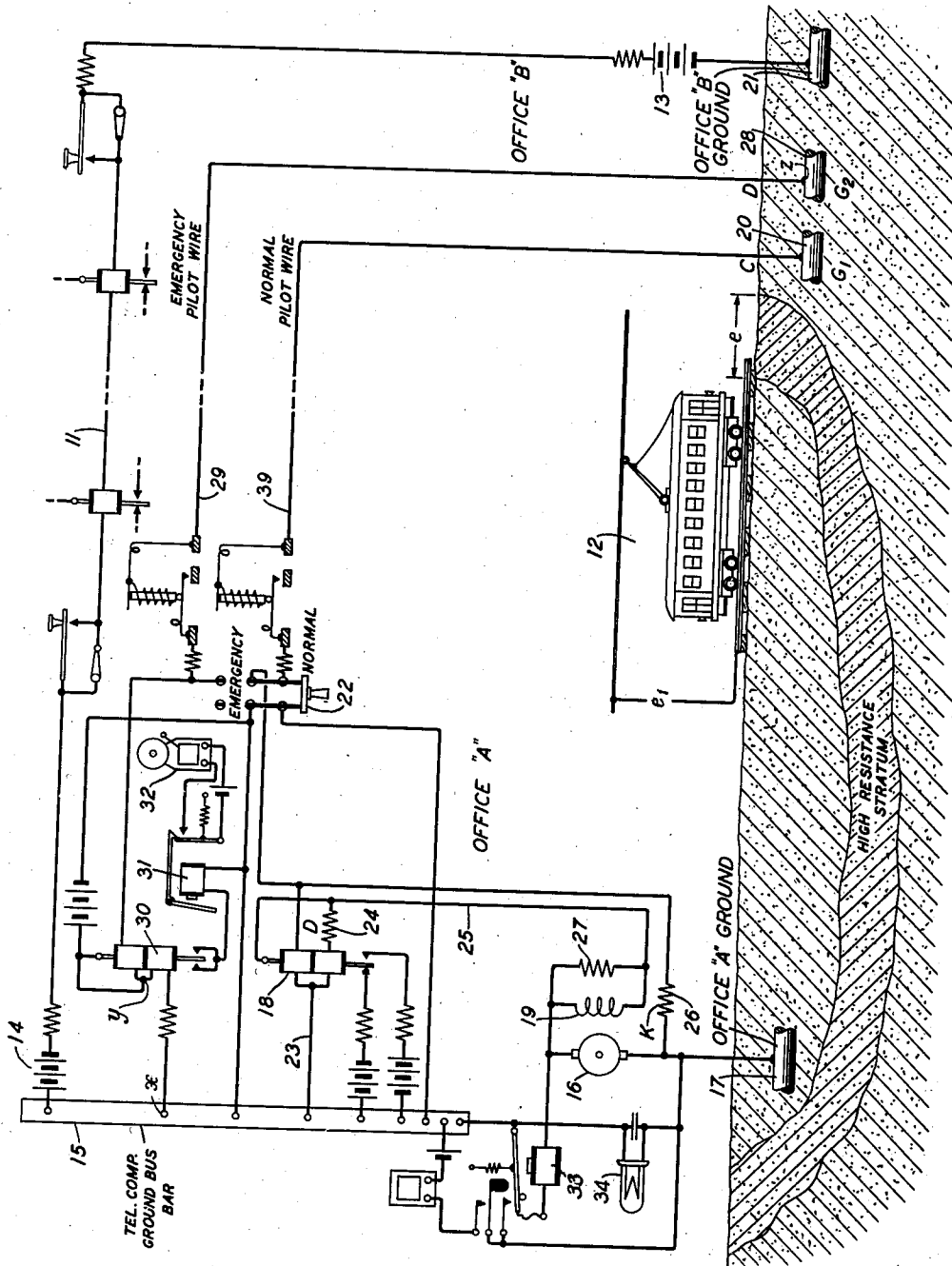
Aug. 26, 1941.

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2,253,583

GROUND POTENTIAL COMPENSATOR

Filed Feb. 18, 1939



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2,253,583

GROUND POTENTIAL COMPENSATOR

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Application February 18, 1939, Serial No. 257,266

3 Claims. (Cl. 178—69)

This invention relates to improvements in potential compensating devices for equalizing potentials of the ground connections at the two ends of a system for electrical communication, such, for example, as a telegraph system. The device, or circuit arrangement, comprises a generator located in one of the ground connections of the system, together with means for reversing the magnetic field of that generator at a high rate of speed by a current first in one direction and then in the other, as required, to compensate for the difference of potential between two such connections.

One of the essentials for giving satisfactory service over grounded telegraph systems is that the ground connections at all offices be approximately at equal potentials. Where unstable ground conditions are encountered it is desirable to employ some means of correction. To accomplish this a ground potential compensator has been employed which automatically equalizes by means of the generator in one of the ground connections any differences of potential that may exist between the ground at the two terminals of the system. Ground potential differences that affect telegraph circuits are usually caused by extraneous direct currents flowing in the earth and are generally made more serious by the presence of high resistance strata in the path of the ground current. Where the extraneous current is large only a small ground resistance is required, probably only a fraction of an ohm, to cause quite a considerable difference in potential between points within the area.

In the use of a ground potential compensator in a telegraph system wherein a generator is connected in one of the ground connections of a telegraph system, it has been found that the impedance of the armature of the generator is so high as to cause distortion of telegraph signals in ordinary operation and large distortion when considerable amounts of 60-cycle alternating current flows through it. The distortion effects are reduced if a resistance of a few ohms is bridged between the compensated ground and the office ground at one terminal of the system.

An object of the invention is to reduce the distortion in the signals transmitted over a telegraph system wherein a ground potential compensator is employed.

A feature of the invention is the use of an ohmic resistance bridged between the compensated ground and the office ground at one terminal of the system.

Another feature is the use of a bridging re-

sistance that has a large positive temperature coefficient such as a tungsten filament lamp or a ballast lamp.

A brief description of a telegraph system equipped with a ground potential compensator, wherein the invention is applicable, will be given, so that the invention may be readily understood.

The figure of the drawing shows one possible telegraph system wherein the invention is employed in conjunction with a ground potential compensator.

Referring to the drawing, a telegraph system comprising line conductor 11 is shown extending between offices A and B. At the distant telegraph office B the ground potential is normal and remains so up to some point C beyond the influence of the extraneous current produced by a direct current trolley railway system 12, located near the office A. Assume that the geological formation at office A is such as to effectively impose comparatively high resistance strata between the ground connection at office A and that at office B, a considerable portion of the return current for the railway system will ordinarily flow through the ground. The currents involved are usually so large that even if the resistance of the earth is only a fraction of an ohm, a considerable value of fluctuating voltage is indicated by e and may be set up across the comparatively high resistance strata due to the operation of the railway system. This voltage is effectively in series with each telegraph circuit between office A and office B and is known as a ground potential difference. To neutralize this potential a voltage e is inserted in the ground lead of the telegraph battery at office A by means of a compensator generator.

The arrangement of the compensator to take care of the ground potential difference is, more specifically, as follows: The armature 16 of the generator is connected in series with the telegraph battery 14 between the bus-bar 15 called "compensated ground" and the office ground 17. Associated with the generator is a pilot relay 18 of high sensitivity arranged to control the current through the field winding 19 of the generator, current flowing from the positive telegraph battery when the armature of the relay is on one contact and from the negative telegraph battery with the armature on the other contact. The pilot relay is controlled by current which flows from the compensated ground through the upper winding of the relay 18 over a "pilot wire" 39 extending through a ground 20 at point C outside the affected area.

Now suppose that the office ground 17 at office A is at a lower potential than the ground 21 at office B due to the ground potential difference *e*. When a difference of potential between ground connections 15 and 20 due to the action of the street cars, etc., current flows from connections 15 to 20 in a circuit extending over conductor 23, through the upper winding of relay 18, right-hand blade of switch 22 and conductor 39, causing the armature of pilot relay 18 to move to its opposite contact. The current flowing from point C through the pilot wire 39, through the double throw double pole switch 22 in its normal position, upper winding of pilot relay 18, conductor 23 and through the compensated ground 15, causes the armature of pilot relay 18 to rest on, say, the positively poled contact, thus establishing a current in the field winding 19 of the generator. Assume that this current builds up in the armature a voltage *e* which raises the voltage of the compensated ground. As soon as the potential of the compensated ground becomes higher than the potential at point C, current flows through the pilot relay 18 in the opposite direction causing the armature of the relay to move to the other, or negatively poled, contact and the current to decrease in the field winding 19 of the generator. The voltage produced by the generator is then such as to reduce the potential of the compensated ground 15, and when this potential is reduced below a certain amount, the current again reverses in the upper winding of the pilot relay 18 and the cycle is repeated. The above operations take place rapidly, of course, with the result that the potential of the compensated ground is held practically constant and equal to the potential of the ground at point C. All of the office equipment which requires a compensated ground for its proper operation such as telegraph batteries and artificial lines is, therefore, connected to the compensated ground bus-bar 15. The sensitiveness of the pilot relay is increased by the addition of a vibrating circuit which includes a lower winding of the pilot relay 18, resistance 24, conductor 25, and the armature of pilot relay 18 operated between its associated contacts, compensating bus-bar 15 and conductor 23. The lower winding of pilot relay 18 is so poled that current flowing through it from battery tends to move the relay armature off whichever contact it rests upon. As a result, the relay operates on very small values of pilot wire current so that the compensator follows the ground potential fluctuation closely. With the vibrating circuit, the speed of operation of the pilot relay 18 is high in the order of about 70 cycles and since the relay requires only a small operating current, very little "ripple" is introduced into the ground lead by the action of the compensator.

The function of a resistance 26 is to provide a path to ground to insure continuous vibration of the pilot relay 18 in case the pilot wire 39 is opened. This resistance is fixed at a value so high that there is no appreciable effect under normal operation of the compensator.

A resistance 27 which is provided as a shunt around the field winding 19 of the generator is provided and is adjusted to such a value as to absorb the discharge when the field circuit is opened and thereby prevent sparking at the contacts of the relay, and is adjusted to such a value as to absorb the discharge when the circuit including the field winding 19 is opened,

thereby preventing sparking at the contact of the pilot relay 18.

An emergency pilot wire 29 is provided to connect ground 28 at point D located between point C and office B, to an alarm circuit which will hereinafter be described and to a switch contact of constant ground switch 22, the latter contact being effective in cases of emergency when the switch 22 is operated to its emergency position to connect pilot wire 29 to the upper winding of pilot relay 18 when pilot wire 39 becomes inoperative. In normal operation, in case pilot wire 39 opens or any of the compensator equipment fails to function normally, the ground potential between an outlying point of constant ground, such as ground connections 20, 21 and 28 and the compensated bus-bar 15, will cause current to flow through the emergency line 29 and thereby cause the alarm equipment to give a signal.

The alarm circuit is arranged to operate if an opening or break occurs in the pilot wire 39 and the compensator generator fails to function to maintain ground connections 20 and 28 and compensating ground bus-bar 15 at a constant voltage. Should a difference exist in potential between compensated ground bus-bar 15 and the constant potential ground at connections 28 and 21, a current will be established through the winding of differential voltage relay 30 to thereby move its armature into engagement with either of its contacts, depending upon the direction of the current flow, to operate alarm relay 31 which might serve as a visual indication and signal 32 which might serve as an audible indication. The alarm circuit path is so arranged that the resistance between *x* and *y* is approximately equal to that between *y* and *z*. Normally the constant ground switch 22 is in its normal position and any difference in potential between point C and office ground (compensator bus-bar 15) is effective in the upper winding of pilot relay 18 to connect positive or negative battery to the compensator generator. An open condition on either side of the differential voltage relay or fuse, or heat coil, failure will cause an unbalance, and differential voltage relay 30 consequently starts the alarm. The alarm will also be given if sufficient difference in potential exists between ground connection 28 and ground (compensator bus-bar 15) to operate differential voltage relay 30. A further alarm is provided in a bell ringing alarm attachment (not shown) on circuit breaker 33.

It is necessary in order to set forth the importance of a principal feature of the present invention to describe a complete system, as hereinafter outlined, to which the invention is applicable. It has been found that the impedance of armature 16 of the generator of the ground potential compensator is so high that it causes distortion of telegraph signals in ordinary operation and large distortion when considerable amounts of 60-cycle alternating current flows through it. These effects are reduced by a resistance such as tungsten filament lamp 34 which has a large positive temperature coefficient being connected between compensated ground bus-bar 15 and ground connection 17. A purpose of the resistance having a high temperature coefficient is to prevent overloading of the generator when large ground potentials occur.

What is claimed is:

1. A telegraph system comprising separated

offices, grounding points at each of said offices, means at one of said offices for equalizing the potentials at said grounding points, parallel paths included in said means, an electric current generator in one of said paths for generating 5 current opposing any flow of current between grounding points due to differences in potentials at the grounding points at said separated offices and an impedance element included in the other of said paths arranged to automatically adjust 10

its resistance value in accordance with the intensity of current generated by said generator.

2. A telegraph system in accordance with claim 1 wherein said impedance element is a ballast lamp having a high positive temperature coefficient.

3. A telegraph system according to claim 1 wherein said impedance element is a tungsten filament lamp.

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