

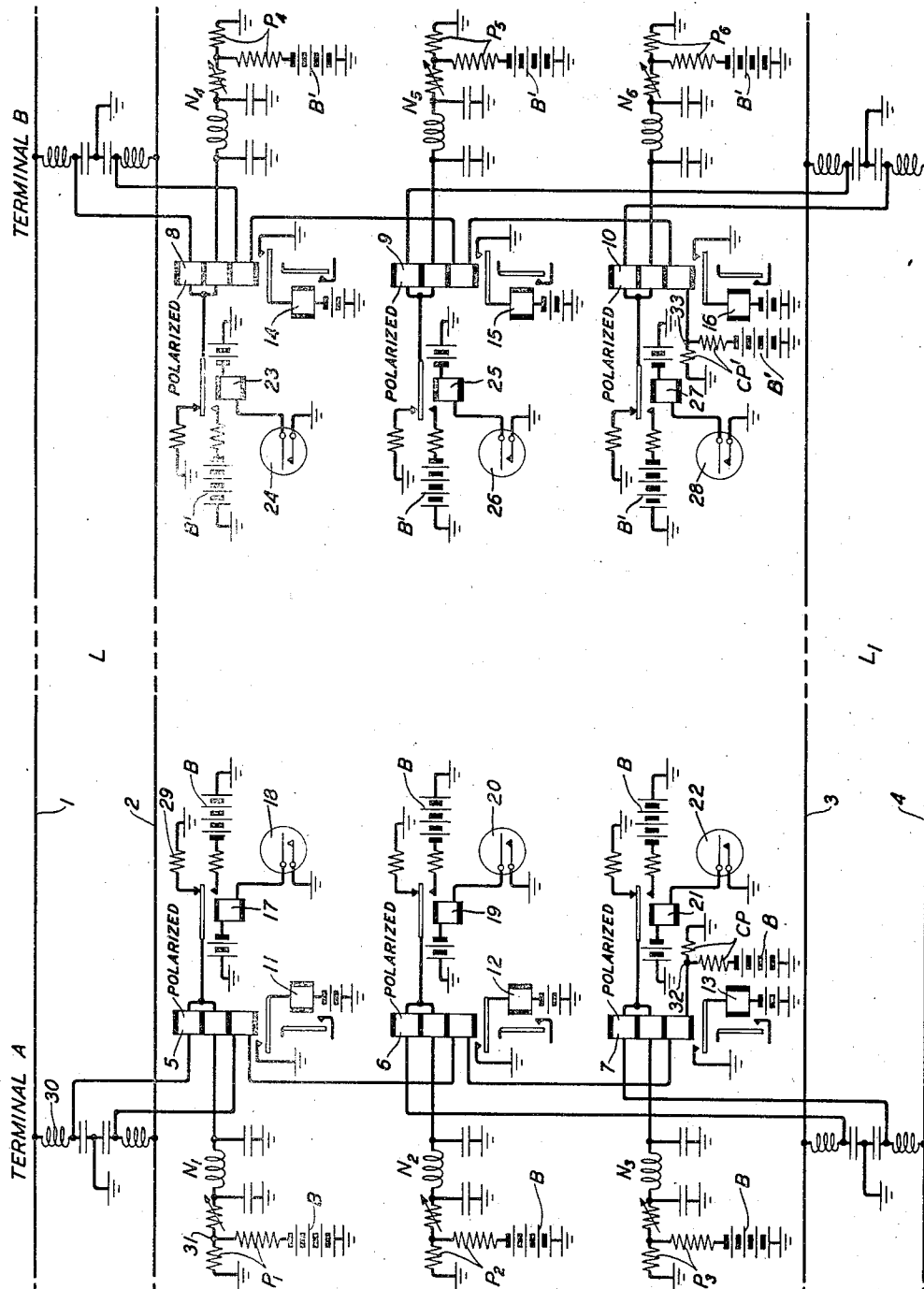
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SYSTEM FOR COMPENSATING FOR DIFFERENCES IN POTENTIAL

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SYSTEM FOR COMPENSATING FOR DIFFERENCES IN POTENTIAL

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This invention relates to what are known as duplex signaling systems commonly used in telephone systems for direct current signaling over relatively long lines.

Such a system is described in Patent 1,287,831 in which compensation for differences in earth potentials at the two terminals of the line is effected by a compensating or third winding on the multiwinding line relay at each terminal, which compensating windings are connected in series between ground at each terminal over a separate line conductor. By this arrangement, differences in potential between the ground connections at each terminal will cause current to flow through both of the compensating windings in series thereby maintaining the proper balance in the differential windings of the two relays.

Such an arrangement, however, does not compensate for voltage differences between the signaling batteries at the two terminals of the line which may, at times, be sufficiently great to effect the proper operation of the signaling relays which are, of necessity, adjusted to very close margins as regards their operate and non-operate currents.

An object of the present invention, therefore, is to compensate not only for differences in ground potentials at the two ends of such a system, but also to compensate for potential differences between the signaling batteries at each end during the transmission of signals, particularly dial impulses.

A feature of the invention whereby the foregoing object is attained resides in connecting each end of the compensating circuit to a point in a potentiometer supplied by the respective signaling batteries, thus applying a predetermined fraction of the voltage of each battery to the respective ends of the compensating circuit whereby any difference which may exist between the signaling battery voltages at the two ends of the line, which might otherwise cause distortion and improper operation of the signaling relays, will also cause a proportional flow of current in the compensating winding of each relay in such a direction as to balance out such distortion effect.

The invention will be understood from the accompanying drawing which shows two physical two-wire lines extending between distant terminals arranged to provide three signal transmission channels in each direction.

No attempt has been made to show any particular system of signals other than to diagrammatically indicate a signal transmitting means

such as the contacts of a pulsing device (dial) and a signal receiving device such as a pulse relay per channel at each terminal, it being obvious that any desired system of signal control can be employed both for transmitting and receiving signals over the transmission channels herein provided.

A description of the invention follows: Between the terminals A and B extend two physical two-wire lines L and L' terminating at each end in any desired telephone or other equipment, not shown, as for example, in telephone switching apparatus shown in the before-mentioned Bascom Patent 1,287,831.

For purposes of signaling between terminals, three two-way signal channels are provided comprising line conductor 1 of line L and conductors 3 and 4 of line 2 and multiwound polarized relays 5, 6, 7, 8, 9 and 10. Relays 5, 6, 7, 8, 9 and 10 have three windings each, the upper windings being designated the line windings, the middle designated the biasing windings and the bottom designated the compensating windings.

Associated with each of the above relays is shown an auxiliary pulse receiving relay 11, 12, 13, 14, 15 and 16, respectively, which is caused to respond when its associated polarized relay is operated. Also, associated with each polarized relay are respective transmitting relays and dial contacts 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 and 27, 28. Under normal conditions relays 17, 19, 21, 23, 25, and 27 are released and connect ground through the upper or line winding of their respective polarized relay to one of the line conductors, relay 17, for example, connecting ground through limiting resistance 29, back contact of relay 17, upper winding of relay 5 and impedance coil 30 to line conductor 1 where it meets ground applied to the other end of this same conductor over the back contact of relay 23 and upper winding of relay 8.

If the ground potential is the same at terminals A and B, no current flows in the line windings of relays 5 and 8 and these relays are not affected.

It should be mentioned that although different batteries are indicated on the drawing for each signal channel at each terminal, all the batteries indicated by the reference character B at terminal A are one and the same battery at that terminal and those indicated as B' at terminal B are also one and the same battery for that terminal. It also is assumed that battery B at terminal A and battery B' at terminal B are normally of the same voltage.

Relays 17, 23, 19, 25, etc. while in their normal condition also connect ground to one end of the middle or biasing windings of the respective relays 5, 8, 6, 9, etc., the other ends of which are connected through a network N₁, N₂, N₃, N₄, N₅ or N₆ to a point in a battery potentiometer arrangement P₁, P₂, P₃, P₄, P₅ or P₆, so chosen in practice as to be approximately one-third the potential of the supply battery B or B'. In practice, the values of the two resistance elements of potentiometers P are of the high order of 1500 and 3000 ohms, thus reducing the current drain on the respective battery to a substantially negligible quantity.

Assuming relay 17 to be in its released condition, ground is connected through resistance 29 to one end of the middle winding of relay 5, and as the other end is connected to the point 31 of potentiometer P₁, current will therefore flow in this winding in a direction, which is predetermined by the connection of the two ends of the winding in the circuit, to energize relay 5 in a non-operate direction thus maintaining this relay in a released condition.

When battery is connected to one end of a channel, for example, when dial contacts 18 are closed, thus causing relay 17 to close its contacts, battery B is substituted for the ground connection including resistance 29, whereupon current flows in the opposite direction in the middle or biasing winding of relay 5, which current flow tends to operate this relay. However, under this condition current also flows in the upper or line winding of relay 5 in a direction which opposes the operating effect of the current in the middle or biasing winding and therefore the relay remains released.

At the other end of the channel, however, if relay 23 remains released, current now flows in the line winding of relay 8 in a direction to cause it to operate, which current overcomes the non-operate effect of the middle winding due to the direction of the current flow therein and therefore relay 8 operates and closes a circuit to operate relay 14.

As before mentioned, the points, such as 31, in the respective potentiometers are so chosen that the potential thereof is a certain predetermined portion of the potential of the battery, in this case one-third. Therefore, when relay 17, for example, is in its normal or released condition and ground is connected at its back contact, current at one-third the potential of the battery B flows in the middle winding of relay 5 in a non-operate direction and no current flows in the upper or line winding, whereas when relay 17 operates and battery B is connected at its front contact, current at the full potential of the battery flows in the upper line winding in a non-operate direction and at two-thirds the potential of the battery B in the middle or biasing winding in an operate direction whereby the relay 5 is still maintained in a non-operate condition.

On the other hand, when relay 17 is operated at terminal A and relay 23 is released at terminal B, current at the full potential of the battery B flows in the upper or line winding of relay 8 in an operate direction and at one-third the potential of battery B' in a non-operate direction in the middle or biasing winding thus causing relay 8 to operate.

In the case of simultaneous signal transmission from each terminal over the same channel, both relays 17 and 23, for example, are operated

thereby connecting battery to line conductor 1 at each terminal through the respective line windings of relays 5 and 8 and if batteries B and B' are assumed to be equal no current will flow in the line windings of these two relays and both will operate due to current flowing in an opposite direction in their biasing windings as previously described.

It will be noted from the drawing that line conductors 1, 3 and 4 are utilized as signaling channels and that a connection at each terminal extends from conductor 2 through the lower or compensating windings of all three polarized relays in series to a point in a fourth potentiometer CP or CP' connected in shunt to the grounded signal batteries B and B', respectively, which point is also the same proportion of the signal battery voltage as that of the point 31 of the potentiometer P₁, for example.

In the patent to Bascom 1,287,831, previously referred to, a compensating circuit is described which serially includes a line conductor and a third winding on each of the signal relays, which circuit is connected to ground at each terminal of the line. Such a circuit arrangement is described as providing compensation for the effect on the signal or line winding of the multiwound relays R₃, R₃' by current flowing in the trunk conductors L, L₂ and L₃ due to a difference in the ground potential between the two terminals of the line.

Bascom's system, however, has no provision for compensating for voltage variations in the signaling batteries at each end of the line and such compensation is not necessary for the type of signaling disclosed in the patent, i. e., supervisory signaling.

In the present arrangement, which provides for dialing in either direction, it is necessary, for the proper functioning of the switching equipment, that the line relays, i. e., relays 5, 8 and 6, 9, etc., follow the received dial pulses within certain definite predetermined limits as otherwise failure in the operation of the switching equipment takes place. To obtain this desired result, the relays 5, 8, etc., are electrically polarized by current flowing in the middle or bias winding. The direction and value of this bias current is fully described in the preceding pages.

As mentioned above, the two batteries at the opposite terminals are assumed to be normally of the same potential and under this condition if the other elements of the circuits are properly proportioned, the relays 5, 8, etc., will respond to the current impulses generated by the dialing contacts at the distant end in such a manner as to control the switching equipment without failure. If, however, in the absence of compensation for differences in battery potential at the two ends of the line, a potential difference occurs, i. e., let us assume for example that the normal voltage of batteries B and B' is 45 volts and that battery B becomes overcharged and its voltage rises to 51 volts, while battery B' remains at its normal value, then a potential difference of 6 volts exists between batteries B and B' and the potential of point 31 of potentiometer B is 17 volts, whereas the corresponding point in potentiometer B' is 15 volts. Now when dial 18 at terminal A is transmitting pulses there will be a greater proportionate flow of current in the operate direction in the upper winding of relay 8 of terminal B, (i. e., current due to 51 volts) than in the non-operate direction in the middle winding of the same relay (i. e., current due to 15

volts), thus causing a greater magnetizing flux in the relay than would be the case if the transmitting battery at the terminal A were at its normal potential of 45 volts. This, of course, will increase the speed of operation of relay 8 and when the pulse ends there will be an equivalent lag in its release with the consequence that the periods during which relay 8 is operated due to the dial pulses are longer than desired and the periods during which the relay is released are shorter than desired, which may affect the operation of the switching equipment which requires a rather definite ratio between the closed and open condition of the contact of the line relay 8.

On the other hand if the dial 24 at terminal B' is operated there will be proportionally less current flowing in the operate direction in the upper winding of relay 5 (i. e., flux due to 45 volts) than in the non-operate direction in the middle or bias winding of the same relay (i. e., flux due to 17 volts) which will tend to cause relay 5 to operate more slowly. When each pulse ends relay 5 will tend to release more rapidly than when it is energized by the normal flux and now the closed interval of contacts of relay 5 is relatively shorter and the open interval longer than normal which ratio may also affect the operation of the switching equipment at that end of the line.

In the foregoing description, it has been assumed that no ground potential difference exists between the two ends of the line. Of course if such a condition does exist such differences must be compensated for which can be done as shown in the Bascom patent, above referred to, by connecting ground to the end of a compensating circuit including a third winding on each of the two line relays 5 and 8, and a conductor 2 of the line, but this will not affect any compensation for the difference between the potentials of the two batteries.

In the foregoing it has been shown that in a system of the type disclosed in the present application, a compensating circuit connected to ground at both ends will not compensate for variations in the line battery. This result can, however, be obtained by including a fraction of the potential of each battery in the grounded compensating circuit shown in the drawing, i. e., in addition to the three potentiometers P₁, P₂, P₃ of terminal A, and P₄, P₅ and P₆ of terminal B, which are connected in shunt to their respective batteries B and B', a fourth potentiometer CP or CP' is connected in shunt to each battery (B or B') and by connecting one end of the compensating circuit, to point 32 in the fourth potentiometer CP of terminal A and the other end to point 33 in the potentiometer CP' of terminal B. It will be noted that each end of the compensating circuit is still connected to ground, which compensates for differences in ground potential between the two ends of the line, as in the Bascom arrangement, but also by including the battery at each end any increase or decrease from normal of either battery will also affect each relay in the circuit in such a manner as to counteract the undesired effects caused by abnormal currents in the other two windings of the same relay. For example, in the case before assumed, when battery B is 51 volts and B' 45 volts, with the compensating circuit connected as shown in the drawing, there will be a potential difference of 2 volts between point 32 of potentiometer CP at terminal A and point 33 of potentiometer CP' at terminal B which will cause current to flow in the

lower windings of relay 5 and 8 in such a direction as to increase the effective bias in relay 8 to a value which would be equal to that which would exist if the battery B' had been 51 volts instead of 45 volts, and to decrease the effective bias in relay 5 to a value which would be equal to that which would exist if the battery B had been 45 volts instead of 51 volts. Therefore, it can be stated that regardless of the voltage at either end, that is for reasonable variation from normal, the effective bias current at the terminal receiving the dial pulses will always be equal to a value which would exist if the battery at the receiving terminal were the same as that at the sending terminal.

What is claimed is:

1. In a duplex signaling system, a line, a grounded source of direct current and a multiwinding polarized relay at each end thereof, a line winding on each relay connected to one side of the line, a biasing winding on each relay energized in a local circuit by a fraction of the potential of the respective current source, a potentiometer in shunt of each source, and means for compensating for differences in the potentials of the two earth points and also the two current sources, said means including a compensating winding on each relay connected between the other side of the line and a point in the respective potentiometer.

2. In a duplex signaling system, a line, stations at each end thereof, multiwinding polarized signal relays at each station, direct current sources of normally equal potential associated with each relay, a local biasing circuit for each relay including a winding thereof, means for applying a predetermined proportion of the voltage of each source to the respective biasing circuit, a potentiometer in shunt of each current source, a signaling winding on each relay connected to one side of the line, and a compensating winding on each relay included in a circuit from ground at one station through a portion of the respective potentiometer over the other conductor of the line to ground at the other station through an equivalent portion of the potentiometer at the station, said potentiometers associated with the compensating circuit being so arranged that the potential applied to either compensating winding is the same as the potential normally applied to the respective biasing winding.

3. In a duplex signaling system, a line, stations at each end thereof, a grounded source of signaling current at each station, said sources being normally of substantially equal potential but subject to independent variations, multiwinding polarized signal relays at each station, a local biasing circuit for each relay including one winding thereof and means for applying a potential thereto comprising a potentiometer in bridge of the respective source, said potentiometers being so arranged that the potential applied to each biasing winding is the same proportion of the voltage of the associated source, switching means at each station normally connecting ground through a second winding of the respective relay to one conductor of the line and adapted, when operated, to substitute the respective grounded source for said ground connection and to reverse the current in the biasing winding and change the applied potential thereof, a second potentiometer at each station in shunt of the respective source, and a compensating circuit including the other conductor of the line, a third winding on each relay and a connection to ground

at each station through a portion of the respective second potentiometer, the point of connection to each compensating potentiometer delivering the same proportion of the voltage of the associated source as the normal potential applied to the corresponding biasing winding.

4. In a duplex signaling system, a line, equal potential grounded sources of signaling current at each end thereof, said grounds and current sources being independently subject to variations of potential, a multiwinding polarized signal relay at each end of the line, one winding of each relay being in a signal circuit including one conductor of the line, a second winding being in a local biasing circuit energized by the respective current source and a compensating circuit, including a third winding on each relay, extending from the grounded source at one end over a second line conductor to the grounded source at the other end, said compensating windings being so arranged and connected in the circuit as to compensate for effects on the respective relays caused by currents flowing in said biasing and signal windings due to a difference in potential between said grounded sources.

5. In a duplex signaling system, a two-conductor line, a station at each end thereof, a multiwound polarized relay and a grounded source of direct current at each station, a potentiometer in bridge of each source, switching means at each station normally connecting ground through one winding of the respective relay to one side of the line and through a second winding to a predetermined point of the respective potentiometer, the potential of said points being equal fractions of the voltage of the respective sources, said switching means being adapted, when operated, to substitute the respective grounded source for said ground connection and said first and second windings being so proportioned and connected that operation of either means will cause operation of the distant relay only, a second potentiometer in bridge of each source and a connection from the other side of the line at each station through a third winding on the respective relay to a point in the respective second potentiometer which is at the same voltage as the point in the first potentiometer thereat, said third windings being so connected that current flowing therethrough due to a difference in potential between the two grounded sources will compensate for the effect in the first and second windings caused by said potential difference.

6. In a duplex signaling system, a two-conductor line, a station at each end thereof, a multiwound polarized relay and a grounded source of direct current at each station, said sources being normally of equal potential, a normal connection at each station from one side of the line to ground including one winding of the respective relay, a potentiometer in bridge of each source and of substantially equal resistance, a connection from the same proportionate point in each potentiometer to ground including a second winding of the respective relay, transmitting means at each station for simultaneously

substituting the respective grounded current source, for said ground connection, to both the first and second windings thereat, a second equal potentiometer in bridge of each source, and connections from points therein of the same potential as the connecting point of the respective first potentiometers to the other side of the line including a third winding of the respective relay, said third windings being so arranged and connected that any current change in said first and second windings due to a difference in potential between said two grounded sources will be neutralized by the current flowing in the third windings.

7. In a duplex signaling system, a two-conductor line, a station at each end thereof, a multiwinding polarized relay and a grounded source of direct current at each station, said sources being normally of equal potential, a normal connection at each station from one side of the line to ground including one winding of the respective relay, a potentiometer in bridge of each source at each station, a connection from a predetermined point in each potentiometer to ground including a second winding of the respective relay, transmitting means at each station for simultaneously connecting the respective current sources in series with both the first and second relay windings thereat, said relay windings and current sources being so connected that under normal or no-signal conditions each relay will be biased in a non-operate direction by current flowing in the second winding determined by the potential of the predetermined point in the respective potentiometer and only such current will flow in the first winding as may be due to a difference between the ground potentials at the two ends of the line, when signals are being transmitted over the line current will flow in the first winding at the transmitting station in a non-operable direction and in the second winding in an operate direction determined by the potential of the predetermined point of the potentiometer associated therewith, which current is insufficient to overcome the non-operate flux caused by the current in the first winding, and at the receiving station current of a certain value continues to flow in a non-operate direction in the second winding thereat determined by the associate potentiometer connecting point and of a greater value in the first winding in an operate direction to overcome the biasing action of the second winding current and cause the relay to operate, and when both the stations are simultaneously transmitting only such current will flow in the first windings of the two relays as may be due to differences in the potentials applied at the two ends and both relays will operate due to the operate direction of the current flowing in the second windings and any differences in earth potential, or in the current sources, at the two ends of the line will be compensated for in both relays by current determined by these differences flowing in the third winding.

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