

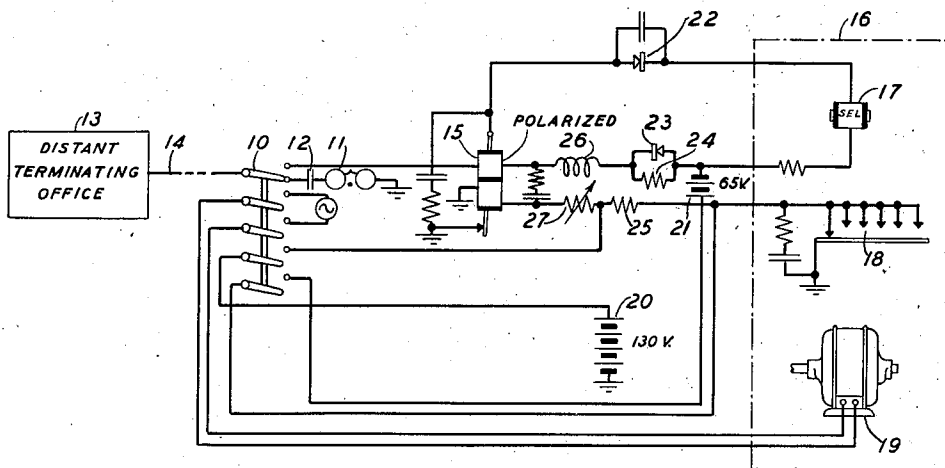
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TELEGRAPH SYSTEM

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TELEGRAPH SYSTEM

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This invention relates to improvements in telegraph systems and more particularly to improvements in methods and apparatus for the transmission of telegraph signals.

It is frequently desirable to transmit telegraph signals by applying two different signaling conditions such as voltages of two different polarities to the telegraph line or voltages of two different magnitudes. In order to apply these two different signaling conditions it is necessary to either provide two sets of transfer switches usually actuated by two different relays and a single source of potential or voltage, or else it is necessary to employ two sources of potential and a single set of transfer contacts or switches. When it is desired to transmit signals from a keyboard transmitter it is necessary to employ a relay to actuate the transfer switch combination because the usual keyboard transmitting arrangement employed at the present time is provided with the equivalent of only a single pair of contacts which either close or open a single circuit through them.

It is an object of the present invention to transmit signals of different polarity or different potential values to a telegraph line by employing two different sources of electrical energy and controlling these sources under the control of transmitting apparatus which merely opens or closes a single circuit through the transmitting device in accordance with the signals to be transmitted.

Transmitting arrangements of a similar type have been proposed in the past for certain types of transmission. In the arrangements proposed in the past the impedance through the transmitting device is different during the transmission of the different signaling conditions. However, when it is attempted to employ this type of transmission in combination with the transmitting system disclosed in United States patents granted to Cramer 2,131,870, on October 4, 1938, and 2,143,000 granted on January 10, 1939, in which variations in leakage resistance of the line do not change nor alter the characteristics or distortion of telegraph signals the difference in impedance presented to the line during the two signaling conditions causes considerable distortion. Consequently, a sending arrangement of these types introduces a certain amount of distortion, frequently called bias, to the telegraph signals and thus partially nullifies the advantage of the type of transmission described in the above-identified patents and in general tends to transmit inferior telegraph signals in any type of transmission system.

Another object of the present invention is to provide an arrangement for overcoming this disadvantage by insuring that the impedance and transmitting apparatus connected to the line is substantially the same for all signaling conditions applied to the line.

In accordance with this invention a non-linear impedance element is inserted in series with the transmission circuit or line circuit in such a way that the impedance of the non-linear element varies with the signaling condition in a manner opposite to the manner of variation of the transmitting circuit and apparatus.

In the embodiment of the invention shown in the drawing the variations in impedance presented to the line by telegraph transmitting systems which employ transmitting apparatus which only opens and closes the line and at the same time transmits different polarities to the line is compensated for by connecting a unilateral conducting device in parallel with a resistance and connecting the parallel combination in series with the line. The unilateral conducting device and resistance combination are arranged so that they will have one impedance when current flows through them in one direction and a different impedance when current flows through them in the opposite direction. In this manner it is possible to insure that the combined impedance of the transmitting apparatus and this network provide the same value of impedance between the line and ground during the application of all of the signaling conditions to the line.

The foregoing objects and features of the invention, the novel features of which are specifically set forth in the claims appended hereto, may be more readily understood from the following description of a specific embodiment thereof when read with reference to the drawing which shows in detail one manner of incorporating the invention in a telegraph system.

In the specific embodiment of the invention described herein the invention has been applied to the subscriber's station of the transmitting arrangement described in the above-identified patent to Cramer 2,143,000 in which variations of the leakage resistance of the line do not alter nor change the bias of telegraph signals usually encountered in telegraph transmission systems. The drawing included herewith shows the details of the subscriber's station which may be substituted for the subscriber's station shown in Fig. 1 of said above-identified patent. The equipment at the distant terminating office is symbolically represented by box 13. This equipment

may be in accordance with either form of terminating equipment described in the above-identified patent to Cramer or it may be of any other variation thereof or any other suitable type of equipment. The transmission or telegraph line or conductor 14 extends from the terminating equipment 13 to the subscriber's station shown in greater detail in the drawing. During idle conditions the line extends through switch 10 and condenser 12 to ground through ringer 11. When it is desired to call the subscriber ringing current is applied to conductor 14 at the distant end which causes the ringer 11 to be actuated to call the subscriber.

The subscriber either in initiating a call or answering a call will actuate switch 10 to its operated position where the circuit of the ringer 11 is interrupted and a number of other circuits completed. The lowermost contacts of switch 10 complete the circuit through battery 21 while the second set of contacts from the bottom complete the circuit through battery 20 to the line circuit as will be described hereinafter. The next two sets of contacts, namely the second and third set of contacts from the top of switch 10, apply power to motor 19 of the printing telegraph equipment 16 at the subscriber's station.

The telegraph equipment 16 may be of any suitable type and generally will include a group of transmitting contacts 18, preferably actuated by a keyboard, and a receiving instrument or device controlled by receiving or selector magnet 17. In the embodiment of this invention shown in the drawing the telegraph equipment 16 comprises a printing telegraph transmitting and receiving device, typical examples of which are described in United States Patent 1,745,633, granted to S. Morton et al. on February 4, 1930, and 1,904,164 also granted to S. Morton et al. on April 18, 1933.

The top contacts of switch 10 complete the line circuit from line 14 to the upper winding of receiving relay 15, the noise suppression network or inductance 26, resistance 24 and unilateral conducting device or rectifier 23 in parallel, battery 21, and lower operated contacts of switch 10 to ground through the closed contacts of the transmitting device 18.

The transmitting contacts 18 merely opens and closes the circuit in accordance with the signals to be transmitted from the keyboard in the manner described in greater detail in the above-identified patents to Morton et al.

Receiving relay 15 is also provided with a lower or biasing winding the circuit of which extends from battery 20 through the second set of contacts from the bottom of the operated switch 10, resistance 27, and lower winding of relay 15 to ground. As described in the above-identified patents to Cramer, current flowing through the lower winding of relay 15 tends to maintain this relay in the position shown in the drawing. When spacing signals are received over the line the current flowing through the upper winding of relay overcomes the effect of current flowing through the lower winding of this relay and causes the relay to be operated to its right-hand position where it interrupts the circuit through the selector printing magnet 17 of the receiving equipment 16. The circuit for the selector magnet at this time extends from ground through the contacts of relay 15, the network 22 comprising a condenser and another unilateral conducting device or rectifier, winding of magnet 17, battery 21, the lower contacts of switch 10 to ground through

contacts 18. Thus relay 15 repeats received signals to the selector magnet 17 of the printing or receiving portion of telegraph equipment 16 at the subscriber's station in the well-known manner described in the above-identified patents to Cramer.

As pointed out in the above-identified Patent 2,143,000 granted to Cramer, it is necessary to apply equal and opposite voltages to conductor 14 extending to the distant terminal of line 14 in accordance with the signals to be transmitted over this line in order to secure the freedom from distortion of the telegraph signals. It is also necessary that the impedance from line 14 to ground should be substantially the same during the application of both of these potentials to the line. If the impedance and the effective voltage between the line and ground at the subscriber's station are not substantially the same during the application of both signaling conditions to the line the cable capacity of line 14 will be charged and discharged at different rates during the application of the different signaling conditions to the line and thus tend to distort the telegraph signals. However, when the impedance and effective voltage between the line and ground are the same under both conditions the charging and discharging time of the line will be substantially the same under both conditions and hence no distortion of the type frequently called bias distortion is caused by the transmitting equipment.

Furthermore, as pointed out above, due to the fact that the transmitting device 18 merely opens and closes the circuit through it in accordance with the signals to be transmitted it has been necessary in the past to provide at least one and in the patent to Cramer, two repeating relays to apply the opposite voltages to the line. In accordance with the present invention the necessity for the one or two repeating relays to apply the two voltages to the line has been eliminated.

When it is desired to transmit from the subscriber's station over line 14 the transmitting device is actuated. This device in turn causes contacts 18 to open and close the circuit through them in accordance with the signals transmitted over the line. As shown in the drawing, the positive terminal of battery 21 is connected to ground through the transmitting contacts 18 while the negative terminal of this battery is connected through the network comprising rectifier 23 and resistance 24, the network 26 and upper winding of relay 15 to line 14 through switch 10.

When contacts 18 open, the line circuit then extends through switch 10, the upper winding of relay 15, network 26, the network comprising the unilateral conducting device 23 and resistance 24 in parallel, battery 21, lower contacts of switch 10, resistance 25, second set of contacts from the bottom of switch 10 to the positive terminal of battery 20.

Battery 20 is thus connected in opposition to battery 21. Battery 20 is designed to supply twice the potential of battery 65 so that the voltage actually applied to the line will be equal to the voltage of battery 65 but opposite in polarity. Thus, assume, for example, that battery 21 develops 65 volts so that a negative voltage of 65 volts is applied to the line 14 when contacts 18 are closed. Then battery 21 should develop 130 volts which in turn will apply +65 volts to line 14 when contacts 18 are open. However, under these circumstances the line circuit extends through resistance 25 in addition to batteries 21 and 20. When contacts 18 are

closed the line circuit extends directly through these contacts to ground and not through resistance 25. It should be noted that when contacts 18 are closed resistor 25 is connected directly across the high voltage battery 20 so that the resistance of resistor 25 must be of considerable magnitude.

Consequently, when contacts 18 are open the additional impedance of resistance 25 is connected in series with line 14 which impedance is not connected in series with the line when contacts 18 are closed. Hence the impedance from the line to ground is different when contacts 18 are open and when they are closed. The difference of impedance will tend to distort the telegraph signals in the manner described above.

In order to compensate for the variation in impedance from the line to ground when contacts 18 are opened and closed, a network comprising the unilateral conducting device which, in the preferred embodiment of the invention may be a rectifier 23, is connected in parallel with resistance 24 and the parallel combination connected in series between battery 21 and the noise suppression network 26. The rectifier is so connected in the line that it has a very high impedance during the time contacts 18 are closed. In other words, it prevents the flow of current due to the application of a negative potential to the line by battery 21 during the time contacts 18 are closed. This means that the line current must flow through the additional resistance 24 during the time contacts 18 are closed. However the line current will reverse due to the reversal of the voltage applied to the line when contacts 18 are opened. The rectifier or the unilateral conducting device 23 is so arranged that it will present practically a short-circuit around resistance 24 at this time. In this manner resistance 24 is, in effect, automatically inserted in the line circuit when contacts 18 are closed and automatically removed from the line when contacts 18 are opened. It is thus apparent that resistance 24 is, in effect, inserted in series with the line when resistance 25 is removed from the line while resistance 24 is removed from the line when resistance 25 is inserted in the line. By suitably choosing resistances 24 and 25 and the rectifier element 23 and making the voltage of battery 20 equal to twice that of battery 21 it is possible to have the impedance and effective voltage from the line to ground when contacts 18 are closed substantially the same as when contacts 18 are opened. When these conditions are fulfilled the transmitting equipment will not cause bias distortion of the telegraph signals transmitted from the transmitting contacts 18 so that the full benefits of the type of transmission described in the above-identified Cramer patents may be obtained and at the same time without necessity of the repeating relays for transmission from the subscriber's station. The elimination of these relays materially reduces the amount of maintenance and sources of troubles and errors in the transmission from the subscriber's station.

As described in the above-identified Cramer Patent 2,143,000, the selector magnet 17 also follows the signals transmitted by the transmitting contacts 18. Inasmuch as the polarity at the upper terminal of battery 21 is reversed, as described above, in accordance with the trans-

mission of signals by the transmitting contacts 18, the selector magnet 17 also follows these signals due to the fact that the rectifier element 22 is connected in series with the winding of magnet 17. Rectifier element 22 is so connected that it will permit current to flow through the selector magnet 17 when the transmitting contacts 18 are closed but presents a high impedance to the current flowing through the circuit of magnet 17 when contacts 18 are opened. This, in effect, causes magnet 17 to receive current during the time contacts 18 are closed and no current during the time these contacts are opened. In this manner magnet 17 receives and follows the signals transmitted to line 14 by contacts 18.

The additional current taken by magnet 17 during the time contacts 18 are closed may, in effect, cause a minor variation in the effective resistance between conductor 14 and ground during the time contacts 18 are opened and closed. However, this small variation may be compensated for by a small difference in the impedance of the rectifier 23 and resistances 24 and 25 so that the effective impedance between line 14 and ground, including the impedance of selector magnet 17 and rectifier 22 as well as the other impedances discussed above, will be substantially the same both during the time contacts 18 are closed and during the time contacts 18 are opened.

At the completion of transmission to or from the subscriber's station shown in the drawing, switch 10 will be restored to the position shown in the drawing whereupon the circuits assume their idle condition and then await the reclosing of switch 10 to initiate the next transmission to or from this station.

What is claimed is:

1. In a telegraph system, a telegraph transmission conductor, telegraph signal transmitting apparatus capable of opening and closing a single circuit only, two sources of electrical energy, electrical connections including impedance elements connected between said conductor and said transmitting apparatus and said sources of energy for transmitting two different signaling conditions to said conductor, and a non-linear impedance element connected in said conductor to maintain the combined impedance of said non-linear element and said connections and said transmitting device substantially constant.

2. In a telegraph system, a signal transmission conductor, telegraph transmitting apparatus capable of opening and closing only a single circuit in accordance with telegraph signals to be transmitted, an impedance element, two sources of electrical energy, circuit connections for connecting said impedance element and said two sources of electrical energy in series relation with each other and with said conductor, circuit connections for including said impedance element and one of said sources of energy in said single circuit of said transmitting apparatus, a non-linear impedance also connected in series in said series circuit for maintaining the impedance through said series circuit substantially constant and independent of the operation of said transmitting apparatus.

3. In combination, a telegraph transmission path, an impedance element in series with said path, a first source of electrical energy connected in series with said path, a second source of electrical energy of different magnitude from said

first source connected in series with said path in opposition to said first source of electrical energy, telegraph transmitting apparatus connected in shunt relation to said impedance and one of said sources of energy for completing a shunt around said impedance and source of energy in accordance with signals to be transmitted, and a unilateral conducting circuit element also connected in said series circuit for maintaining the impedance of said series circuit substantially constant independently of the completion of said shunt.

4. In combination, a transmission conductor, an impedance element connected in series with said conductor, a first source of electrical energy connected in series with said conductor, a second source of electrical energy having a magnitude of substantially twice the magnitude of said first source and also connected in series with said conductor in opposition to said first source, transmitting apparatus for shunting said impedance and said second source in accordance with signals to be transmitted over said conductor, and a unilateral conducting device connected to said conductor to maintain the impedance of said series circuit substantially constant independently of said shunting of said impedance.

5. In a telegraph transmission system in which the distortion of received signals is independent of variations of leakage resistance, a transmission conductor, means for applying two substantially equal and opposite voltages to one end of said conductor comprising a first source of voltage connected in series circuit relation with said

conductor, a second source of voltage of substantially twice the magnitude of said first source connected in a series circuit relation with said first source and said conductor and in opposition to said first source, an impedance element connected in series relation with said second source, a shunt circuit connected around said impedance and said second source, telegraph transmitting apparatus connected in said shunt circuit for opening and closing said shunt circuit in accordance with signals to be transmitted, and a network connected in series with one end of said line, a unilateral conducting device for maintaining the impedance of said series circuit from said line substantially constant independently of the opening and closing of said shunt circuit.

6. In a telegraph system, a telegraph transmission channel, a plurality of sources of potential, a transmitting apparatus for transmitting the signals capable of only opening and closing a single circuit in accordance with signals transmitted, connections between said transmitting apparatus and said channel and said sources of potential for causing two different polarities of potential to be connected to said line in accordance with the opening and closing of said single circuit by said transmitting device, and a network comprising a unilateral conducting device included in said connections for maintaining the impedance through said circuit and transmitting apparatus substantially the same when each of said polarities is applied to said line.

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