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2,360,878

TELEGRAPH SYSTEM

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FIG. 1

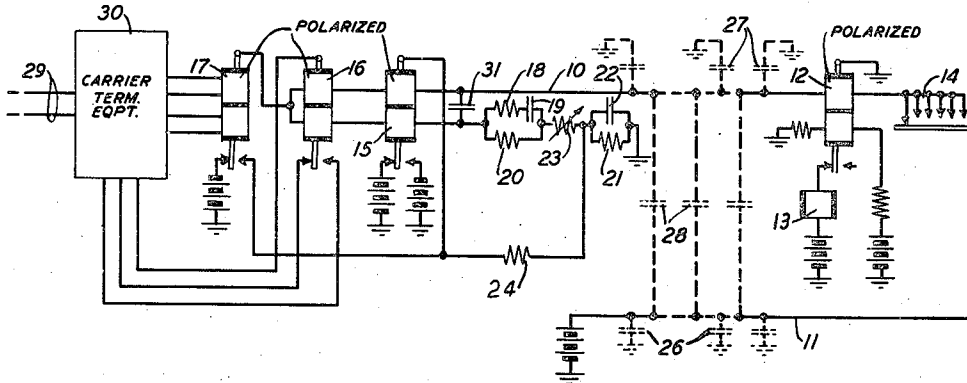
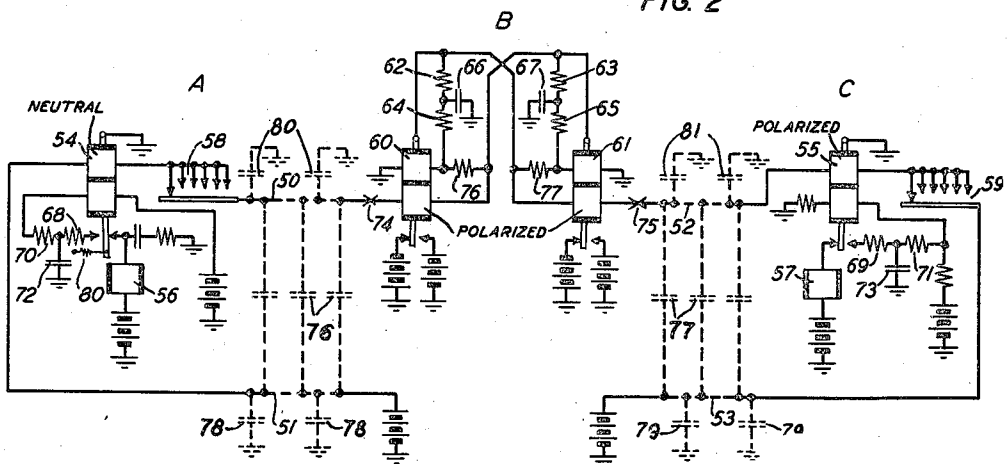


FIG. 2



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TELEGRAPH SYSTEM

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6 Claims. (Cl. 178—59)

This invention relates to telegraph systems and more particularly to the operation of telegraph systems over telegraph lines and cables having high electrostatic constants.

It is sometimes necessary to operate telegraph systems over lines and conductors having such a high electrostatic capacity or storage between each of the conductors or between each of the conductors and ground that steady-state conditions at the receiving end are not arrived at during a unit pulse interval so that the operating conditions of the receiving relay are different at the ends of pulse intervals of different lengths or intervals of time.

The object of this invention is to provide an improved arrangement which will tend to maintain the operating conditions of the receiving relay substantially constant independent of the length of the previously received pulse or pulses which constitute telegraph signals or codes. In accordance with the present invention this is accomplished by applying a potential to a condenser in the artificial line circuit under control of the receiving relay, which potential tends to cause a compensating current to flow through the artificial line winding of the receiving relay.

In previous systems of this type such as disclosed in United States Patent 1,295,553, granted February 25, 1919, to R. C. Mathes, it has been necessary to employ separate or additional relays or additional windings on the various relays.

In accordance with the present invention an improved arrangement is provided for compensating for variations in line current due to the length of pulses applied to the system in which the compensating arrangement is incorporated in and forms a part of the artificial line circuit and controls the current of the artificial line winding of the receiving relay.

The manner of operation of this invention and the above-described objects and features may be more readily understood by reference to the attached drawing in which:

Fig. 1 illustrates a specific embodiment of the invention as applied to a terminal circuit of a carrier current telegraph channel; and

Fig. 2 shows other embodiments of the invention applied to a repeater circuit and to two different types of subscriber or station circuits.

The novel features of the invention are specifically pointed out in the claims appended hereto which are not limited by the specific embodiments shown in the drawing. These specific embodiments merely illustrate typical types of tele-

graph transmission systems to which the invention is applicable.

Referring now to Fig. 1, 10 and 11 represent the conductors of a pair of wires extending to a telegraph subscriber's station equipment. The station equipment comprises a polarized relay 12 for receiving signals transmitted over the conductors 10 and 11 and repeats the signals to a selector magnet or other receiving instrument 13. The selector magnet 13 may control a printing device or other recording instrument, or it may be an ordinary telegraph sounder or other type of receiving instrument. The contacts 14 represent the contacts of a transmitting instrument which in the usual case will be the contacts controlled by a keyboard transmitting device. Typical examples of transmitting and receiving equipment suitable for operation at the subscriber's station are disclosed in United States Patent 1,745,633, granted to S. Morton et al. on February 4, 1930, and United States Patent 1,904,164 granted to S. Morton et al. on April 18, 1933, which patents are hereby made part of this application as if fully included herein.

The dotted condensers 27 have been shown in the drawing to illustrate the high capacity between line 10 and ground, and the dotted condensers 26 to show the high capacity between the line 11 and ground. The dotted condensers 28 have been shown to illustrate the high capacity between the lines 10 and 11. Lines 10 and 11 extend to a repeater point where break relay 15 and the receiving relay 16 follow the signals transmitted by transmitting apparatus 14. A sending relay 17 is provided for transmitting signals to the receiving relay 12 and the selector magnet 13 at the outlying station. The receiving relay 16 repeats the signals to the carrier current terminal equipment 30 which equipment causes carrier current signals to be transmitted out over the carrier current path 29. The carrier current equipment 30 also receives signals over path 29 which causes the sending relay 17 to be actuated in accordance with these signals. Relay 17 repeats the signals over line 10 to the outlying station.

These relays operate in the usual or normal manner and as is customary, the receiving relay 16 and the break relay 15 are provided with an upper or main line winding and a lower or artificial line winding. The artificial line usually comprises resistances and condensers and is employed to prevent the receiving relay and the break relay from following the signals transmitted by the transmitting relay 17. These re-

lays are prevented from following these signals due to the fact that current flows from the contacts of the sending relay through the respective windings to the main line and artificial line in such a direction that the net effect of the currents flowing through their windings upon the armatures of these relays is independent of the position of the sending relay 17.

The artificial line normally comprises resistances and capacities connected between the artificial line winding and ground. This circuit also provides a biasing circuit for these relays. In other words, with the sending relay in its marking position the current flowing through the lower windings of the relays 15 and 16 tends to operate the armatures of these relays to their spacing positions. The current flowing through the main line windings of these relays, however, is twice the current flowing through the artificial line windings and tends to maintain the relays in their marking positions so long as the loop circuit at the subscriber's station is closed. If the sending relay operates to its spacing position, the current flowing through the main line windings falls to zero, while the current flowing through the biasing windings reverses, thus tending to maintain the relays in their marking positions. At this time, however, it is necessary that the current flowing into the cable capacity of the main line be balanced by current flowing through the artificial line windings to charge the capacity of the artificial lines in order to prevent improper operation of the relays due to these charging currents.

In case of lines having a high capacity such that the time constant of a line is greater than the unit pulse length, that is, greater than the time of the shortest pulse length transmitted over the system, current in the main line windings will not reach its steady-state value or condition during a single pulse length. This means that the current in the line winding at the end of a pulse of unit length will be different from the current flowing through the line winding at the end of a pulse of two or three units in length. Consequently, the responses of the relays at various times will be different if the opposite type of pulse is transmitted following the pulse in question. In order to overcome this difficulty it is desirable to have the current flowing through the artificial line windings also different at the end of pulses of different length and differing in a compensating manner as the current in the main line differs so that the difference between these two currents will be constant so the relay will be operated with the same energy or driving force in all cases.

The artificial line in the specific embodiment shown in Fig. 1 comprises resistances 20, 21 and 23 extending from the right-hand winding terminal of the lower winding of relay 15 to ground. The artificial line also comprises resistance 18 in series with condenser 19 which is connected in parallel with resistance 20 and condenser 22 which is connected in parallel with resistance 21.

An additional capacity 31 is connected between the main line and artificial lines and serves to equalize the surge of currents flowing through the upper and lower windings of relays 15 and 16 when transmitting relay 17 is transmitting. Assume now that signals are being transmitted from the transmitting apparatus 14 to the receiving relay 16 and the break relay 15. When the contacts 14 open, current

flowing through the upper windings of relays 15 and 16 will fall to zero so that the current flowing through the lower windings of these relays will actuate these armatures to their spacing positions. If the contacts 14 maintain the line open for only a single pulse interval, current in line 10 may not fall to zero so that some current will still be flowing through the upper windings of these relays when the line is reclosed. Consequently, relays 15 and 16 will tend to reoperate more rapidly than in case the current flowing through their upper windings has fallen to zero. Similarly, if the line remains closed for only a single pulse length, the current flowing through line 10 may not reach its steady-state value so that the current flowing through the upper windings of these relays will not be as great as when the pulses are of greater length. Consequently, the relays will tend to release more quickly. In order to overcome or reduce these difficulties, the potential of the left-hand terminal of condenser 22 is changed through the high resistance 24 by the potential connected to the armature of the break relay 15.

Under idle conditions with the contacts 14 closed for an indefinite period the line current flowing in line 10 will reach its steady-state value and be a maximum. Similarly, the left-hand terminal of condenser 22 will be charged to a positive value due to the fact that the armature of break relay 15 is in its marking position where positive potential is connected to its armature. Hence this potential is connected through resistance 24 to the left-hand terminal of condenser 22. With the left-hand terminal of condenser 22 charged to positive potential and with relay 15 in its left-hand or marking position, an increased current will flow through the lower winding of relays 15 and 16. The circuit for this increased current may be traced from negative battery through the marking contact of the sending relay 17, the lower windings of relays 16 and 15, resistances 20, 23 and 24 to positive battery through the armature and marking contacts of the break relay 15. Under these circumstances both the current flowing through the upper winding of the receiving relays 16 and 15 and also through the lower windings of these relays will be a maximum. Hence the difference will tend to be constant.

When contacts 14 open, relays 15 and 16 will operate to their spacing positions in substantially the normal time. When relays 15 and 16 operate to spacing position, the positive potential is removed from the left-hand terminal of condenser 22 and the circuit through the lower windings of relays 16 and 15 through the armature and left-hand contacts of relay 15 is interrupted. In addition, negative potential is applied to the left-hand terminal of this condenser and also to the artificial line through the resistance 24 and the armature and spacing contacts of relay 15. This negative potential tends to discharge the left-hand terminal of condenser 22 and then later to charge it to a negative value instead of to a positive value. However, the time constants of resistance 24, condenser 22 and the other resistances of the artificial line are such that the left-hand terminal of condenser 22 is not charged to its full negative potential during a single pulse interval. The time constants of these circuits are preferably arranged to be comparable to the time constant of the main line so that steady-state conditions will be reached both in the artificial

line and in the main line at substantially the same time and at approximately the same rate. When the steady-state conditions are reached, the main line current will be zero and the current flowing through the artificial line will be a minimum because the resistance 24 will shunt the lower windings of relays 15 and 16 and bypass some of the current into a portion of the artificial line. Stated in another manner, with a negative potential on the left-hand terminal of condenser 22, the potential drop across the lower windings of relays 15 and 16 will be less, since the left-hand terminals of these windings are connected to negative battery, than it will be when zero or positive potential is applied to the left-hand terminal of condenser 22.

When steady-state conditions are thus arrived at, the difference between the currents flowing in the upper and lower windings of relays 15 and 16 will again be substantially the same so that the current or the force tending to operate and to hold the armatures of these relays in their right-hand position will be substantially the same as described above when steady-state marking conditions prevail.

Since the time constants of the main line and artificial line are substantially the same as described above, the difference between the currents flowing in the main line winding and the artificial line winding of these relays will tend to be substantially constant during the transit from one steady-state condition to another or throughout the time signals are being transmitted by the transmitting device 14 even though the contacts 14 do not remain either open or closed long enough for a steady-state condition to be established. Consequently, relays 15 and 16 operate with substantially the same delay and with substantially the same speed under these circumstances irrespective of how long a pulse of the opposite character preceded the pulse to which the armatures of the relays must respond.

The type of distortion described above depends upon the type of signals and the characteristics of the signals transmitted over the system, sometimes called a characteristic distortion. This type of distortion is also called "zero wander distortion." In accordance with the present invention, by applying a potential of proper polarity to the capacity of the artificial line circuit or network the effect of this type of distortion is greatly reduced if not entirely eliminated.

Fig. 2 illustrates the manner of incorporating the invention in a cord circuit repeater comprising relays 60 and 61. Here the network comprising resistances 63, 65, and 77 is connected to the biasing or artificial line winding of relay 61, while resistances 62, 64 and 76 are similarly connected to the corresponding winding of relay 60. Relays 60 and 61 form a two-way repeater of a type commonly employed in cord circuits of telegraph switching systems. The connecting and supervisory apparatus and equipment have not been shown but merely indicated by the crosses 74 and 75 since this equipment is well known to those skilled in the art and operates in its usual manner. Details of a typical type of switching system in which such cord circuit repeater may be incorporated are described in Patent 2,237,154 granted to Locke et al. on April 1, 1941, which patent is hereby made a part of this application as if fully set forth herein.

The outlying subscriber station circuits shown in Fig. 2, are also provided with a biasing winding, the current through which is controlled in

part by received signals so that it will vary in such a manner as to compensate for the type of distortion described above.

It will be readily apparent to those skilled in the art that similar compensating arrangements may be employed at the outlying station shown in Fig. 1. If desirable, the station circuit and equipment at either station A or C as shown in Fig. 2 may be substituted for the station circuit and equipment at the outlying station shown in Fig. 1.

The outlying station C is provided with transmitting contacts 59 which are controlled in accordance with message material to be transmitted from station C. The contacts 59 open and close the line conductors 52 and 53 extending to the repeater station B. The polarized relay 55 at station C follows these signals and repeats them to the selector magnet 57 of the receiving instrument at this station. As in the case of Fig. 1, any suitable type of transmitting and receiving equipment may be employed at this station, typical examples of which are described in detail in the above-identified patents to Morton et al. At the repeating station, the polarized relay 61 follows the signals transmitted over conductor 52 and repeats them to station A over conductor 50. Relay 60 does not follow these signals. At station A neutral relay 54 follows the signals transmitted over conductor 50 and repeats them to the selector magnet 56 of the receiving instrument at station A.

Similarly when signals are transmitted from the transmitting contacts 58 at station A over conductors 50 and 51 to station B, the neutral relay 54 at station A follows these signals and repeats them to the selector magnet 56. At station B relay 60 follows these signals received over conductor 50 and repeats them over conductor 52 to station C where polarized relay 55 repeats the signals to the selector magnet 57 of the receiving instrument at station C.

In this case, as in the case of Fig. 1, dotted condensers 76 through 81 indicate a high capacity between the respective conductors and ground and between the respective conductors of the transmitting lines 50, 51, 52 and 53.

The capacity of these lines may be of such value that, when considered with reference to the resistance and inductance the line current does not reach its steady state value during a single impulse interval, but will require two or more impulse intervals before the steady-state conditions are reached. As pointed out above, when it is attempted to operate the usual type of telegraph transmitting and receiving equipment over lines having these characteristics, a type of distortion is encountered which is frequently called "characteristic distortion" because its effects depend upon the particular characteristics of the signals transmitted and the immediately preceding signals. In other words, the operating conditions of receiving relays are different after receiving pulses of a unit interval or a succession of pulses of unit length and after receiving longer pulses of two or more units in length.

In order to compensate for this type of distortion, a network comprising resistances 69 and 71 and condenser 73 is connected to the bias winding of the polarized relay 55. Thus if this relay remains in its spacing condition for an appreciable interval of time, the upper terminal of condenser 73 will be discharged sufficiently to reduce the bias current through relay 55. Con-

sequently, when the next marking pulse is received, relay 55 will operate more promptly since its bias current has been reduced. The reduction in the bias current as well as the time constants of resistances 71 and 69 and condenser 73 is such that the change in bias current tends to compensate for the change in the line current due to the transmission of pulses of different lengths.

Similarly, at station A when the neutral relay 54 is maintained in spacing position for an appreciable interval of time, the upper terminal of condenser 72 will be discharged and a current will flow through the circuit of the lower compensating winding of this relay. The current flowing through this winding will be in such a direction as to tend to aid the operation of relay 54. Relay 54 is a neutral relay and operated to its spacing position under the influence of spring 80 when the current through the main line winding falls to a low value. In this case, since current through the lower winding is not a biasing winding as in the case of relay 55, the current through the lower winding tends to aid the operation of relay 54. The time constants of condenser 72 and resistances 68 and 73 are such that current flowing through the lower winding of this relay tends to compensate for the variations in the respective current flowing through the upper winding of relay 54 due to the fact that the time constants of transmission circuit are such that steady-state conditions are not arrived at during the time of unit code impulses. By properly choosing the value of the respective resistances at stations A and C, and the corresponding condensers so that the time constants of these circuits are substantially the same as the time constants of transmission circuits extending to these stations and adjusting the values of the currents flowing through the bias or compensating windings, it is possible to greatly reduce the effects or compensate for the so-called "characteristic distortion" referred to above.

At station B the biasing or upper windings of the two repeating relays 60 and 61 are similarly provided with compensating circuits comprising resistances 62 and 64 and condenser 66 for relay 60 and resistances 63 and 65 and condenser 67 for relay 61. The operation of these compensating circuits is similar to the operation of the corresponding circuits described hereinbefore. For example, consider the operation of the circuit comprising resistances 62 and 64, and condenser 66 during the reception of signals by relay 60 from line 50. With relay 60 in its marking position, as shown in the drawing, an additional circuit path through its upper winding may be traced from negative potential through the marking contact of relay 60 and armature of relay 60 and resistances 62 and 64 to ground through the upper or biasing winding of relay 60. This current adds to the normal biasing current flowing through the artificial line winding 60 and the artificial line resistance 76 under normal conditions. It is noted that in this case the usual artificial line resistance 76 has been moved to the other side of the artificial or biasing winding of relay 60.

Consequently, under these circumstances both the line current flowing through the lower winding of this relay and the biasing current flowing through the upper current of this relay will be a maximum. When relay 60 operates to its spacing position, positive potential is connected to its armature and hence through resistances 62 and 64

to the upper winding of relay 60. This current tends to reduce the effect of the normal biasing current flowing through this winding. Condenser 66, however, tends to retard the immediate effect of the application of this positive potential to the upper winding of relay 60. However, the longer relay 60 remains in its spacing position, the higher the potential of the left-hand terminal of condenser 66 will become and hence the greater the reduction in the biasing current flowing through the upper winding of this relay. The time constants of condenser 66 and resistances 62 and 64 are so arranged that current flowing through the upper winding of relay 60 will reach its steady-state value at about the same time and at approximately the same rate as the current flowing through the main line winding of this relay. Consequently, when the marking pulse is received over line 50, the relay 60 will operate this marking position at substantially the same speed or time lag as when only a unit spacing interval preceded in the marking pulse.

A network comprising resistances 63 and 65 and condenser 67 operates in substantially the same manner in cooperation with relay 61 when signaling pulses are transmitted over the system in the reverse direction.

Thus in the repeater shown at station B of Fig. 2, the circuit of the artificial line or balancing winding of the receiving relays is similarly provided with a condenser, the potential of which is controlled by received signals and tends to cause the effects of the high line capacity to be reduced.

What is claimed is:

1. In a telegraph system, a telegraph transmission channel, a receiving relay, an artificial line network cooperating therewith including a condenser, and apparatus responsive to signals received over said line for applying a potential across said condenser.

2. In a two-way telegraph system, a receiving relay, a network including a condenser cooperating with said relay for preventing the operation of said relay during transmission over said system in one direction, and apparatus responsive to transmission in the opposite direction over said system for applying a varying potential across said condenser.

3. In a telegraph system, a telegraph transmission path, a receiving relay having a main line winding connected to said path, an artificial line network, an artificial line winding on said receiving relay connected to said artificial line network, and apparatus responsive to telegraph signals received over said path for causing a varying current to flow through said artificial line winding on said receiving relay.

4. In a telegraph system, a telegraph transmission path having high electrostatic storage, a receiving instrument connected to said path, an artificial line connected to said instrument, a condenser circuit included in said network having a time constant substantially equal to the time constant of said path, and apparatus responsive to received signals for applying a varying potential across said condenser.

5. In a telegraph system, a telegraph signal transmission line, a receiving relay and break relay each having a main line winding traversed by the current flowing over said main line, an artificial line network including a condenser, an artificial line winding on each of said relays connected in a circuit including said artificial line

network, connections controlled by said break relay for changing the charge on said condenser.

6. In a telegraph system, a telegraph transmission line, a receiving relay and a break relay each having a main line winding traversed by the current flowing over said line, an artificial line network, an artificial line winding on each of said relays connected in a circuit including said arti-

ficial line network, and means controlled by said break relay for varying the current through said artificial line winding to compensate for variations of the current in said line due to the capacity thereof.

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kead, Deceased.*