Feb. 27, 1940. A. F. CONNERY 2,192,005

METHOD AND MEANS FOR CABLE TRANSMISSION

Filed May 17, 1938 2 Sheets-Sheet 1

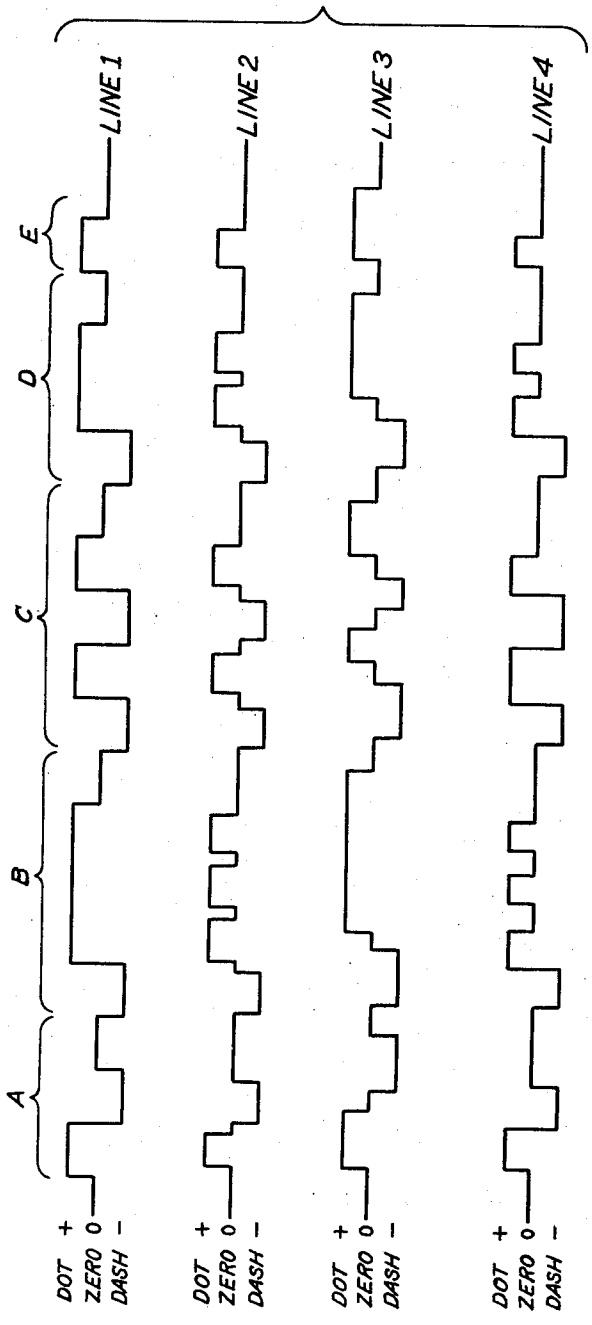

FIG.1.

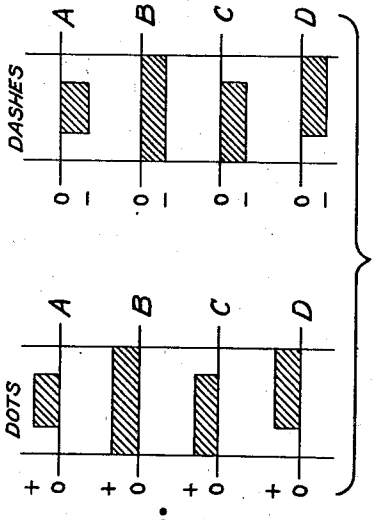

FIG.2.

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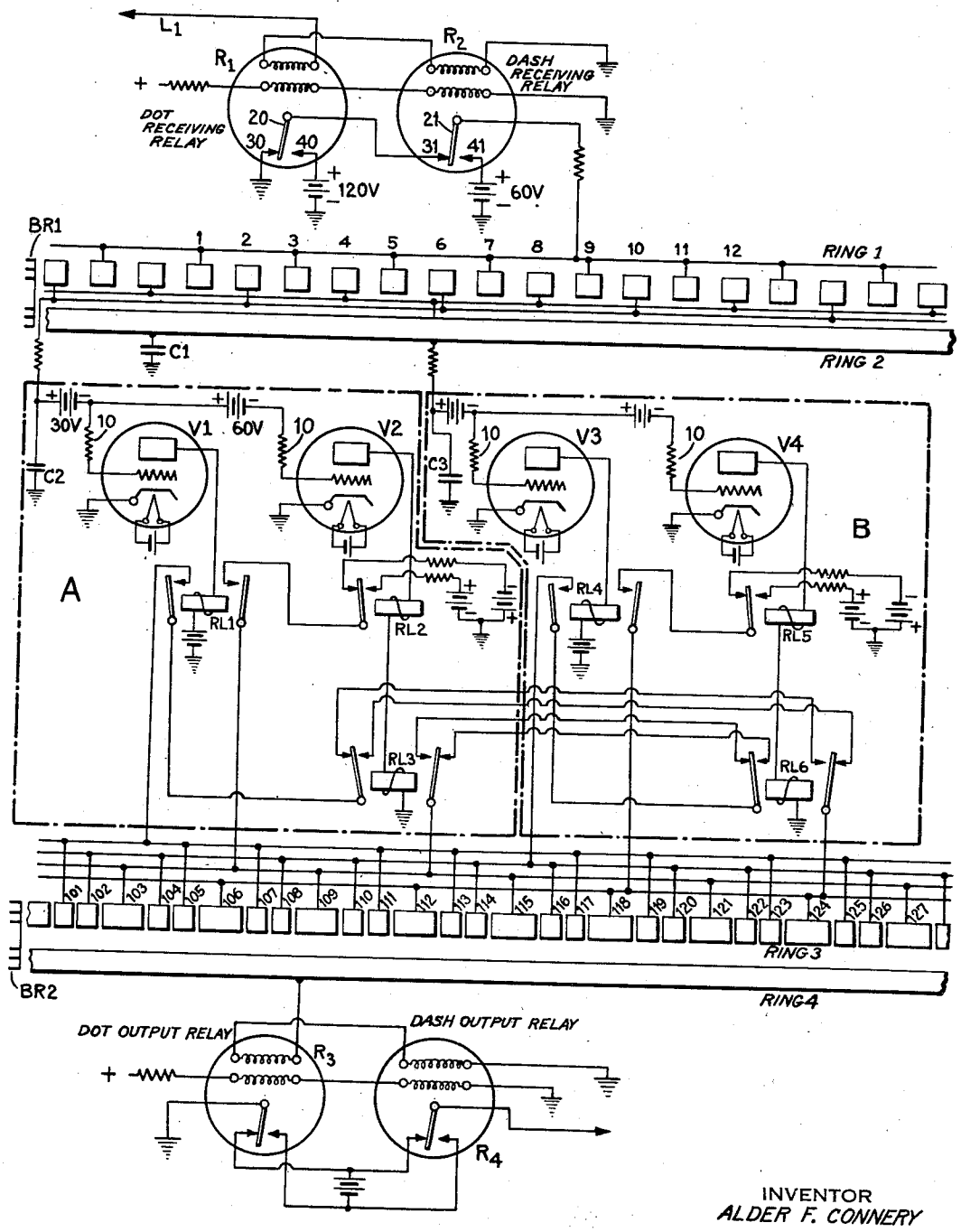
FIG. 3.



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METHOD AND MEANS FOR CABLE TRANSMISSION

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15 Claims. (Cl. 178—63)

My invention relates to improvements in cable transmitting methods and apparatus, and more particularly to methods and apparatus for pre-correcting distortion of these signals transmitted over long cables.

In known cable transmitting systems now in common use the various characters are composed of combinations of positive and negative current impulses and spaces of no current, representing dots, dashes and spaces respectively. In such a system the dot and dashes and the spaces are represented by intervals of the same duration. It is apparent that in such a system the receiving apparatus will respond differently depending upon the particular order of transmission of impulses. Thus, some of the impulses as received will be shortened and others lengthened, depending upon the nature of the signals immediately preceding and following the particular impulse transmitted. This results in a distortion of the received signal impulses and a consequent limitation upon the speed of transmission, so as to avoid too great a distortion.

In an attempt to overcome this disadvantage a method of transmission has been used wherein each current impulse was shortened by a definite percentage and a no current interval of length depending upon this period of shortening was transmitted between each current impulse. This latter system is commonly known as a beat signal system. However, this beat signalling system does not obviate the distortion completely and consequently does not solve the problem.

It is an object of my invention to provide a new method of signal transmission for correcting the distortion of signals transmitted over a long cable.

It is a further object of my invention to provide a suitable apparatus for transmitting signals in accordance with my invention.

It is a still further object of my invention to transmit signals of different lengths and position relative to the previously transmitted signals to pre-correct for distortions occurring in a long transmission line.

In accordance with my invention four different kinds of dots are transmitted depending upon position relative to previously and subsequently transmitted impulses and different kinds of dashes are transmitted corresponding to the several types of dots in dependence upon the type of impulse immediately preceding and following the dot impulses. By using this method the signals as originally transmitted are distorted in a direction opposite to that distortion caused in the transmission line and in this way the signals may be said to be pre-corrected so that upon reception they will be of the proper length. By use of this system a considerable increase in speed of transmission of the signals over long cables may be realized.

While I have outlined above certain of the principles and objects of my invention a better understanding of the invention may be had by a reading of the following description with reference to the accompanying drawings in which

Fig. 1 illustrates several curves used in explaining the principles of my invention,

Fig. 2 illustrates the relative length and position of dots and dashes transmitted in accordance with my invention, and

Fig. 3 illustrates a preferred embodiment of my invention applied to a receiver mechanism and the portions of the description of the improved method as indicated.

The code in common use on long cables is known as Wheatstone cable code or more commonly as cable code. In this code, the letters of the alphabet and other necessary characters are composed of various combinations of dots, dashes and spaces. A dot is signalled by applying a positive potential to the cable conductor for a certain interval of time. A dash is signalled by applying a negative potential for a similar interval of time. During the spacing interval between separate characters, the cable conductor is earthed. When block signals or, 100 per cent transmission, are used, the cable is only earthed between letters and there are no earthing periods between the dots and dashes composing a letter.

In Fig. 1, line 1 is shown in graphic form, the manner in which the potentials are applied to the cable when transmitting the letters A, B, C, D and E, using the block signal method of transmission. In this system the separate dots and/or dashes are transmitted in a block whenever they occur successively in a single word. When the beat signals are used, a dot, for example, is transmitted by applying a positive potential for, say, 80% of the dot time and earthing the cable for the remaining 20%. A dash is transmitted by applying a negative potential for 80% of the dash time and has a similar 20% earthing interval. In Fig. 1, line 2 are shown beat signals as transmitted. The beat type of signals, when a suitable amount of earthing is used, results in slightly reduced distortion of the signal received at the far end of the cable. It will be noticed that there is a short earthing

interval between successive impulses of the same polarity. These earthing intervals are made too short to actuate the receiving instrument and are for the purpose of preventing too great a charge building up on the cable.

It is customary to transmit signals into long cables at as high a speed as it is possible to accurately receive the signals at the far end. If the speed of transmission is too high then the received signals will have excessive distortion and errors will result when these signals are translated. While distortion of the received signals may be due to many causes such as imperfect electrical balance when duplex working is used, distortion due to disturbance caused by extraneous currents etc., it has been found that the amount of distortion is dependent to a large extent upon the type of signal that precedes and follows a given dot or dash. For example, a dot that is preceded by a space will actuate the receiving instrument at a certain instant but if the dot had been preceded by a dash then the receiving instrument will be operated at a slightly later instant. In other words, the exact instant that the receiving instrument is actuated by a dot will depend upon whether the previous signal is a space or a dash. In a similar manner, the instant that the receiving instrument is actuated by a dash will depend upon whether the preceding signal was a space or a dot. It has also been determined that the instant that the receiving instrument ceases to record a dot or dash is affected by the type of signal that follows. A dot, for example, that is followed by a space will end later than a dot that is followed by a dash.

The signal shown in Fig. 1, line 3 is a typical signal, as recorded by the receiving relay from a long cable. In comparing this distorted received signal with the sent signal on line 2, it will be seen that the distortion is as previously described.

In accordance with my invention the type of signal transmitted into the cable is modified in such a way as to anticipate or precompensate for this distortion and in this way reduce the distortion of the signal recorded by the receiving instrument.

In my invention, a dot, for example, instead of always being transmitted in one certain way, may be transmitted in any one of four different ways. In Fig. 2 four types of dots are shown and indicated as type A, B, C and D. Type A, for example, will be transmitted when the preceding signal is a dot or a space and the following signal is a dot or a space. Type B will be transmitted when the preceding signal is a dash and the following signal is a dash. Type C will be transmitted when the preceding signal is a dash and the following signal is a dot or a space. Type D will be transmitted when the preceding signal is a dot or a space and the following signal is a dash. Four types of dashes corresponding to the types of dots are also shown. Type A will be transmitted when the preceding signal is a space or a dash and the following signal is a space or a dash. Type B will be transmitted when the preceding signal is a dot and the following signal is a dot. Type C will be transmitted when the preceding signal is a dot and the following signal is a space or a dash. Type D will be transmitted when the preceding signal is a zero or dash and the following signal is a dot. The duration of marking of a type A dot in the present case is only 50% of that of a type B or full dot. The type C and D dots are 75% long but the relative phase is different. Tests and experiments indicate that the shortest dot or dash should be about 50% of the length of the longest dot or dash but it is quite likely that under certain conditions other values will be found to be more suitable. When the letters A, B, C, D and E are transmitted in accordance with my invention the sent signal will be in accordance with Fig. 1, line 4. The received signal will have less distortion. Experiments and tests indicate that a given cable may be operated satisfactorily with this new type of transmission at a much higher speed than with the conventional block or beat type signals.

While the embodiment as described in connection with line 4 appears to be the best, it is clear that other systems could be used to accomplish a partial correction of the transmitted signals. For example, instead of correcting each end of the signal element in accordance with the nature of the preceding and following signal element, only one end might be changed in accordance with either the preceding or following element. In this type of system one or more different correcting elements may be added to the start or end of a signal impulse depending upon the nature of the signal element immediately preceding or following it.

Furthermore, it is clear that some other characteristic of the signal, for instance, the voltage may be varied in response to the nature of the preceding and/or following signal impulse to accomplish the desired compensation. Moreover, instead of using only three types of dots and dashes, a greater number could be used to more precisely compensate for received signal distortions.

It should also be understood that, while I have illustrated a system wherein the method of my invention is applied to a three element code, the principles are likewise applicable to other types of codes. For example, distortion of received signals of a two element code may also be compensated by proper predistortion of the transmitted signals. It is clear that in such a system the characters as received will be distorted according to the nature of the successive signals transmitted. In order to compensate for such distortion of the signals a characteristic of the separate elements may be controlled in accordance with the preceding or following signals to precompensate for such distortions.

A schematic diagram of a preferred form of apparatus in accordance with my invention is shown by way of example in Fig. 3. In this figure my invention is shown incorporated in a regenerative repeater. Regenerative repeaters which are well known in the art are for the purpose of automatically repeating the distorted signals received from one section of a cable into another section in corrected form. Means for maintaining the regenerative repeater apparatus in synchronism and phase with the received signals are required but since they are well known in the art and form no part of this invention they will not be described here. The dot and dash receiving relays R_1, R_2 are shown in the spacing or non-operated position. These relays are operated by signals incoming over line L_1 in accordance with the signals impressed on the line. These relays may be connected to a primary receiving relay such as a neutral position polar relay in such a manner as to cause current of proper polarity to operate the dot receiving relay R_1 to marking position when a dot signal is

received and to operate the dash receiving relay to marking position when a dash signal is received. Although in practice, a neutral position, spring biased polar relay and separate local current sources are used, it is clear that this additional apparatus is used only because the signals received are too weak to properly operate the other separate relays. The reverse signals on the line would operate the relays R_1 and R_2 in the same manner if they were of sufficient strength, and since the particular form of line relay is not necessary to an understanding of my invention it has not been illustrated. Brushes BR1 and BR2 and the associated segmented and solid rings represent a developed view of a conventional type rotary distributor. The brushes are assumed to be revolving at a very constant speed and in phase with the received signals, and to travel in a direction from left to right as shown in the drawings.

Segments 1, 3, 5, 7, 9, etc. of ring 1 are joined together and connected to the tongue of the dash relay R_2. Both the dot and the dash receiving relays are shown in the unoperated or spacing positions that they assume when a zero or no current signal is being received. Segments 1, 3, 5 etc. are all connected to earth through the tongues 20, 21 and spacing contacts 30, 31 of dot and dash receiving relays R_1 and R_2. When brush BR1 passes over segment 1, a circuit is completed between segment 1 and solid ring 2 and condenser C1 connected to solid ring 2 will be charged to the potential that exists between the tongue of the dash receiving relay R_2 and ground. In the present case since the dot and dash receiving relays are both on spacing there will be no charge on condenser C1. If dot receiving relay R_1 were marking and relay R_2 spacing then condenser C1 would be charged to a positive voltage of, for example, 120 volts over contact 40 and tongue 20. If, however, dash receiving relay R_1 were marking then the condenser C1 would receive a smaller charge, for example, 60 volts. When the distributor brushes are operating in proper phase with the received signals the brush BR1 will just be leaving segments 1, 3, 5 etc. during the center or good portion of the received signal. In other words, the instant that brush BR1 leaves the odd numbered segments will be the so-called "pick-up" point.

When brush BR1 reaches segment 2 the charge on condensers C1 and C2 will mix. Condenser C2 is much smaller than C1, for example, about 1/10 the size of C1. Condenser C2 will therefore assume substantially the voltage of C1 and the voltage of C1 will be only slightly altered when the charges are mixed.

The grids of vacuum tubes V1 and V2 are connected to condenser C2 but in series with each is a biasing battery. The grid of tube V1 is biased to a predetermined potential, for example, 30 volts, and the grid of V2 is biased at higher value by its separate battery, for example, 60 volts. The effective bias on V2, however, is the sum of the voltages of the two bias batteries or 90 volts. The type of vacuum tube used is preferably such that when the grid potential with respect to the cathode is negative to a particular value, for example, 15 volts or more, there will be negligible plate current. When the grid voltage is zero or slightly positive there will be maximum plate current. In order to prevent the grid of any tube becoming very positive with respect to the cathode and damaging the tube, a very high resistance 10 may be inserted in series with each grid. With the resistance so located, as soon as the grid tends to draw current a large voltage drop occurs across the series resistor which tends to make the grid less positive. The use of this high resistance reduces the tendency of the condenser to rapidly discharge when the grid is positive.

As previously stated, using the potential values outlined above, when a zero signal is received condenser C1 will have no charge. When a dot is received C1 will have a 120 volt charge. When a dash is received C1 will have a 60 volt charge. When the brush passes onto segment 2, condenser C2 will be charged to a corresponding voltage. The grid of V1 will tend to assume the voltage of C2 minus 30 volts and the grid V2 will tend to assume the voltage of C2 minus 90 volts. The action on these tubes under zero, dot and dash conditions will then be as follows:

	Zero	Dot	Dash
Volts C2	0	+120	+60
Volts V1 grid	−30	+90	+30
Volts V2 grid	−90	+30	−30
Current V1 plate	Zero	Max.	Max.
Current V2 plate	Zero	Max.	Zero

These two tubes V1 and V2 and their associated circuits constitute storage circuit A, enclosed in broken lines at the left of Fig. 3.

From the above table it will be obvious that when a zero signal is received over the cable and stored in circuit A, there will be no plate current flowing from V1 or V2. When a dot signal is received there will be plate current flowing from both V1 or V2. When a dash signal is received there will be plate current flowing from V1 only.

It should be noted that even numbered segments 2, 6, 10, etc. are connected to condenser C2 and tubes V1 and V2, and that alternate even numbered segments 4, 8, 12, etc. are connected to C3 and tubes V3 and V4 which constitute with the associated circuit, storage circuit B enclosed in broken lines to the left in Fig. 3. Tubes V1 and V2 work together alternately with tubes V3 and V4. The first signal received will, for example, control tubes V1 and V2, the second signal will control tubes V3 and V4, the third signal will control V1 and V2 and so on.

In series with the plate of V1 is relay RL1 and in series with V2 are relays RL2 and RL3. In series with V3 is relay RL4 and in series with V4 are relays RL5 and RL6. The tongues and contacts of relays RL1 to RL6 inclusive, are connected to the segmented transmitting ring 3 in such a manner as to apply the proper potentials to the various segments of this ring so that when brush BR2 passes over these segments the dot and dash output relays R_3 and R_4 will be properly operated to transmit signals in accordance with my invention.

Dot and dash output relays R_3 and R_4 are of the polarized type and are connected so that when a positive potential is applied to solid ring 4 dot output relay R_3 will be operated. A negative potential on solid ring 4 will operate dash output relay R_4. Zero potential on solid ring 4 will result in neither output relay being operated. Each of the output relays are equipped with a biasing winding which holds the armatures to the spacing side when no current is flowing through the main windings.

It should be noted that segmented sending ring 3 is equipped with a number of long segments

103, 106, 109, 112, etc. and between each of the long segments are a pair of shorter segments 101, 102, 104, 105, 107, 108, etc. During the time required to transmit one complete dot, or dash, the brush BR2 passes over one short, one long and one short segment. In case a dot is being transmitted dot output relay R_3 will invariably mark while the brush is on the long segment and in case a dash is being transmitted, dash output relay R_4 will invariably mark while the brush is on the long segment. Whether or not an output relay marks while the brush BR2 is on a short segment depends upon the relative position of relays RL3 and RL6. If both relays are in a similar position, for example, both energized or both deenergized, as shown in Fig. 3, then all the short segments will be dead. If, however, relays RL3 and RL6 are in dissimilar positions, for example, one operated and the other unoperated, then all short segments will become live, provided the circuit is completed through relay RL1 or RL4, as the case may be, and the polarity of each short segment will correspond with the polarity of the adjacent long segment.

This repeater is provided with circuits for storing two signals at a time. Vacuum tubes V1 and V2 and associated equipment constitute one storing circuit and the other storing circuit is composed of tubes V3 and V4 and associated equipment. As previously stated, the received signals are alternately impressed and temporarily stored on either one storing circuit or the other. Each storing circuit is shown in the drawings enclosed in dotted lines and will be referred to as storing circuit A or B. A signal, for example, will be stored in "B" while the "A" signal is being transmitted. While the "B" signal is being transmitted the next signal will be stored in "A" in place of the previous signal.

Although I have shown a repeater in which storage and operation control is effected by means of condensers and vacuum tubes, it is clear that other suitable forms of storage means such as relays or the like may be used if desired. Likewise, a relay arrangement of suitable construction may be used in place of the rotary distributors to distribute the received and retransmitted signals.

It should be noted that ring 1 is displaced with respect to ring 3 so that the stored signal in the storing circuit may change at the moment that the brush BR2 is in the center of a long segment on ring 3 which is controlled by the other storing circuit. This displacement insures that there will be no breaking up or splitting of the transmitted signals.

Having now described the repeater of Fig. 3, a brief description of its operation will serve to more fully explain my invention.

Assume that a dot has been set up in storing circuit A and that brush BR2 is on segment 103 and is approaching the center of the segment. Relays RL1, RL2 and RL3 will be energized closing their respective contacts. A circuit will be completed as follows: From positive battery to the marking contact and tongue of RL2, to right marking contact and tongue RL1 and thence to segments 103 etc. of ring 3. The current will pass through the brush to solid ring 4 and the polarity will be such as to mark dot output relay R_3. The signal output from the output relays is to line L2, therefore, a dot. The exact moment at which this dot will be terminated will depend upon what type of signal follows that dot. If the succeeding signal is a dot or a zero then the preceding dot signal should be terminated just as soon as the brush leaves long segment 103. If the succeeding signal, however, is a dash, then the preceding dot should continue while the brush is on the short segment 104 following the long segment. As soon as brush BR2 reaches the center of the long segment, brush BR1 will be touching a segment which will cause a new signal to be stored in storing circuit B. Assume that the new stored signal is a dot. Relays RL4, RL5 and RL6 will be operated, closing their respective contacts. Since relays RL3 and RL6 are in a similar position, both operated, none of the short segments of ring 3 will be energized, and therefore the signal on the dot output relay will cease when the brush BR2 leaves the long segment. Had the succeeding signal which was set up in storing circuit B been a dash then the previous dot signal would not have ended when the brush left the long segment. A dash on storing circuit B when there was a dot stored on storing circuit A would result in relay RL6 being unoperated while RL3 was operated. The following circuit would be completed: From segment 103 to right tongue and marking contact of relay RL3, to left spacing contact and tongue of relay RL6, to left tongue and marking contact of relay RL4, to the short segment 104 which follows 103. In other words, long segment 103 and short segment 104 are connected together and the dot output relay will continue to mark when the brush BR2 leaves segment 103 and passes onto segment 104.

When the brush passes onto segment 105 dash output relay R_4 should mark in place of dot output relay R_3. The circuit will be as follows: From segment 105 to left marking contact and tongue of relay RL1, to left tongue and spacing contact of relay RL3, to right marking contact and tongue of relay RL6, to long segment 106. Short segment 105 and long segment 106 are therefore joined together. A circuit goes from segment 106, to right tongue and marking contact of relay RL4, to left tongue and spacing contact of relay RL5, to negative battery. Segments 105 and 106 as well as 107 are all connected together and are polarized negatively. The dash output relay will therefore mark while the brush passes over segments 105 and 106. It does not necessarily follow that the dash relay will also mark while the brush is passing over segment 107 because while the brush is in the center of long segment 106 the next signal will be stored on storing circuit A, and segment 107 may be disconnected from segment 106 so that when the brush passes onto segment 107 that segment will be dead and the dot and dash output relays will be spaced by the biasing current in the second winding and therefore a zero or earthing signal will be transmitted.

It should be noted that each long segment has adjacent to it on each side a short segment. These two short segments are permanently strapped together and they may or may not be connected to the long segment depending upon the relative position of relays RL1, RL3, RL4, RL6. Briefly stated, if there is a dot stored in one storing circuit then the brush BR2 in passing from one long segment to the next via the two short segments will find that each short segment has the same polarity as the adjacent long segments. Whenever the brush BR2 is passing from one long segment to the next via the two short segments and a dot and a dash are not stored then the short segments will not be con-

nected to the adjacent long segments and the output from the repeater while the brush is passing over them will be a zero signal.

While I have illustrated a preferred embodiment of my invention in the form of regenerative repeater as shown in Fig. 3, it should be distinctly understood that my invention is not limited to that particular arrangement. It is clear that instead of using a repeating system as shown, the impulses from a transmitter could be directly controlled so as to properly actuate a receiver, without distortion.

Furthermore, transmission in accordance with the method of my invention, may be accomplished by use of a perforated tape transmitter, or by manual means. If perforated tape is to be used it is merely necessary that means be provided to make different length and position of perforations dependent upon the position of the dot or dash to be transmitted relative to the preceding impulse as outlined above. Accordingly predistorted impulses would be transmitted over the line in accordance with the tape perforations.

Likewise, if manual keying is to be used, it is merely necessary that the operators control the length and position of the dot or dash transmitted in accordance with the relative location in the series of impulses to be transmitted.

Although I have only illustrated and described a limited number of preferred embodiments of my invention, it should be understood that these constitute merely examples of my invention and should not be considered as limitations thereof. What I consider as my invention and desire to protect is defined in the appended claims.

What is claimed is:

1. A method of telegraph signalling to avoid distortion of received signals which comprises transmitting signals as a series of impulses of different nature, and variably controlling the duration of the impulses transmitted in dependence upon the type of signal impulse preceding and following said transmitted impulse.

2. A method of signalling over a long line which comprises impressing a positive current impulse on said line to represent one type of character element, impressing a negative current impulse on said line to represent another type of character element, grounding said line to represent a third type of character element, and changing the length of the positive and negative character impulses in dependence upon the nature of the signal element preceding and following the character impulse.

3. In a telegraph system using a code composed of positive and negative current impulses and spaces of no current as signal elements for signalling over a line, the method of compensating for inherent distortion of received signals due to the type of signal elements occurring successively during transmission of a message which comprises impressing current impulses and spaces on said line in sequence to represent the different characters of a message, and variably controlling the duration of each impulse impressed on the line in dependence upon the nature of the successively impressed impulses to precompensate for the inherent distortion in reception.

4. A method of signalling over a long line using a code combination of positive and negative current impulses as character elements and spaces of no current between characters, which comprises varying the length of the character elements in dependence upon the nature of the preceding and following character elements or spaces.

5. A method of signalling over a long line which comprises impressing a positive current impulse on said line to represent one type of character element, impressing a negative current impulse on said line to represent another type of character element, grounding said line to represent a third type of character element, and changing the length of the positive and negative character impulses in dependence upon the nature of the signal element preceding and following the character impulse.

6. A method of signalling in accordance with claim 5, in which the length of the signal impulses is varied by changing the time of initiating and terminating the impression of the signal impulse in response to the character element or space preceding and following the impulse.

7. A method of signal transmission which comprises representing characters of a signal by positive current impulses, negative current impulses and spaces or no current periods as character elements, and variably controlling the length and relative time relation of positive and negative transmitted impulses in accordance with the nature of the character elements preceding and following the said transmitted impulse.

8. A method of signal transmission using characters represented by elements of positive current impulses, negative current impulses and terminating periods of no current, which comprises transmitting positive or negative current impulses of one length when the preceding and following character element is of the same type or a terminating period, and transmitting a current impulse lengthened on one end by a predetermined amount when the preceding or following character element is of opposite polarity, and transmitting a current impulse lengthened on both ends by a predetermined amount when the preceding and following character element is of opposite polarity.

9. A telegraph system for transmitting signals over a long line, comprising means for applying positive current impulses, negative current impulses and periods of no current to said transmission line to represent signal character elements, and means responsive to the nature of the preceding character element and the following character element to variably control the length of each of said positive and negative character elements.

10. In a telegraph system using a code composed of positive and negative current impulses and spaces of no current as signal elements for signalling over a line, means for compensating for inherent distortion of received signals due to the type of signal elements occurring successively during transmission of a message comprising transmitting means for impressing current impulses and spaces on said line in sequence to represent the different characters of a message, and control means cooperating with said transmitting means responsive to the nature of the successively transmitted impulses to variably control the duration of said current impulses to precompensate for the inherent distortion in reception.

11. In a telegraph system using a code composed of positive and negative current impulses and spaces of no current as signal elements for signalling over a line, means for compensating

for inherent distortion of received signals due to the type of signal elements occurring successively during transmission of a message comprising transmitting means for impressing current impulses and spaces on said line in sequence to present the different characters of a message, means in said transmitting means for producing signal current impulses of different lengths, and control means responsive to the nature of the successively transmitted signals for impressing current impulses of said different lengths on said line dependent upon the successively transmitted signals to precompensate for said inherent distortion in reception.

12. A telegraph system for transmitting signals over a long line, comprising means for applying positive current impulses, negative current impulses and periods of no current to said transmission line to represent signal character elements, and means responsive to the nature of the preceding character element and the following character element to variably control the duration of each of said positive and negative character elements.

13. A telegraph system for transmitting signals over a transmission line, comprising means for applying to said line current impulses of one polarity to represent a dot, for applying to said line current impulses of the opposite polarity to represent dashes, and for grounding said line to present spacings, means for applying said current for a predetermined length of time to represent a dot or dash in response to the condition that the signal elements immediately preceding and following it are of the same character or are spaces, and means for lengthening the period of time for which current is applied to the line to represent a dot or dash in response to the condition that the preceding or following character element is of opposite polarity.

14. A telegraph repeater for repeating and regenerating signals to avoid distortion in reception of signals repeated into a long transmission line comprising a receiving distributor, means responsive to received signal elements of dot impulses, dash impulses and spaces for receiving said signals, signal storage means coupled to said distributor to alternately store said received signal elements, a transmitting distributor means coupled to said signal storage means for transmitting signal elements corresponding to said received signal elements, and means responsive to signals successively stored in said storage means for controlling the nature and length of said transmitted signal elements in response to the preceding and subsequently stored signal element.

15. A telegraph repeater for repeating signals composed of current impulses of positive polarity, current impulses of opposite polarity and spaces of no current as character elements, comprising receiving relay means responsive to received signal character elements, a receiving distributor, said distributor comprising a segmented ring and a solid ring, means connecting alternate segments of said segmented ring to said relay means whereby signals received may be applied to said segments, means for connecting alternate ones of said remaining segments to different storage circuits, a condenser connected to said solid ring, means for transferring received signals to said condenser and subsequently to one of said storage circuits over said distributor, an output distributor comprising a segmented ring having a plurality of central segments each between two outer segments, means for coupling said output segmented ring with said storage circuits, means responsive to received signal impulses for establishing positive, negative or no current connections to the central segments of said output distributor ring, means responsive to preceding or following character elements of opposite polarity for causing said storage circuits to connect one or both of said outer segments to said central segment, and means responsive to the polarity established on said output segmented ring segments for operating transmitting relay means to transmit a signal of a length dependent upon the condition of said central segment and said outer segments.

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