

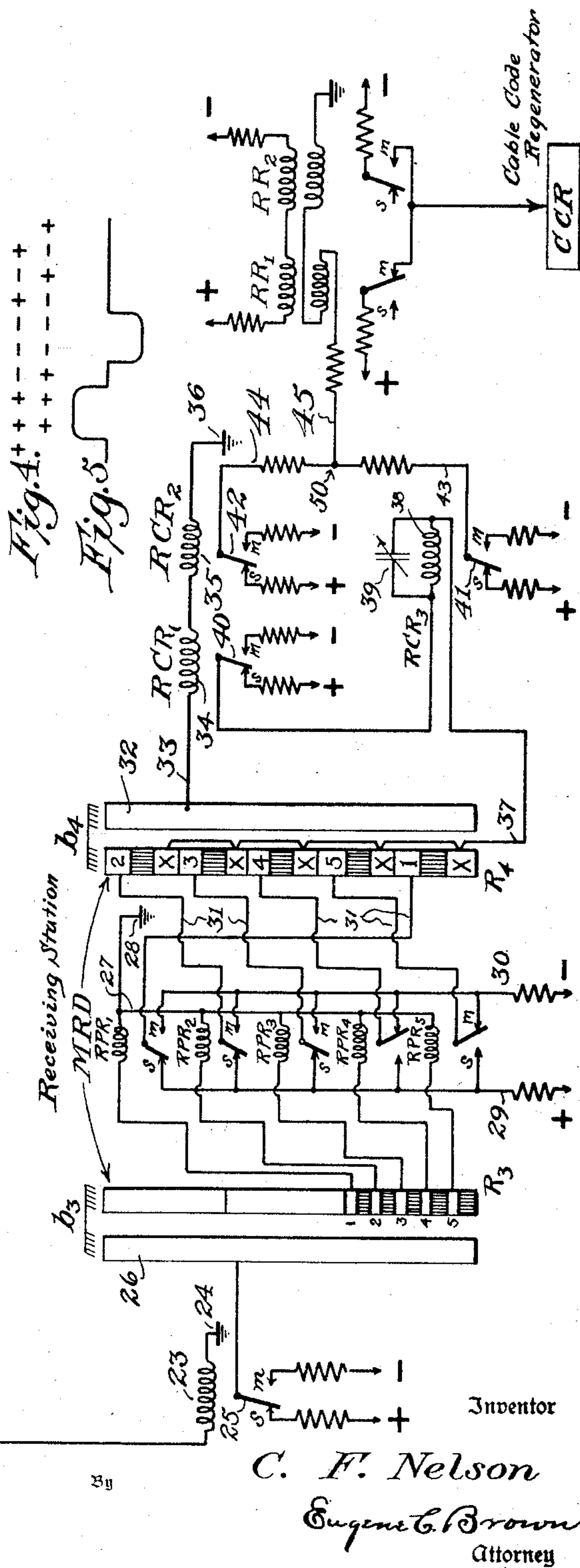
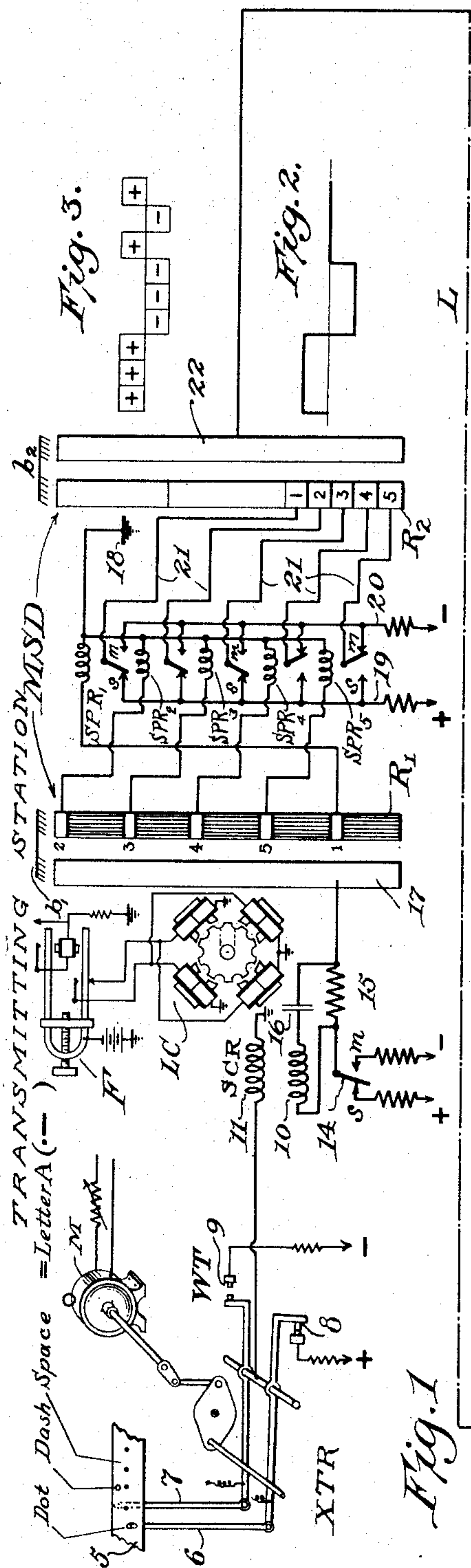
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C. F. NELSON

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METHOD OF OPERATING A CHANNEL OF DIFFERENTIAL CABLE
CODE OVER A CHANNEL OF A MULTIPLEX CIRCUIT

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CRESCENT F. NELSON, OF NEW DORP, NEW YORK, ASSIGNOR TO THE WESTERN UNION
TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

METHOD OF OPERATING A CHANNEL OF DIFFERENTIAL CABLE CODE OVER A CHANNEL
OF A MULTIPLEX CIRCUIT

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This invention relates to recorder code operation over a channel of multiplex circuit. It provides means for the transmission and reception of the three-element recorder code signals by converting the three-element sending signals into two-element signals and storing them up on the five segments of the multiplex sending ring in advance of the wiping of the sending distributor brush, and by converting the two-element signals at the receiving end into three-element signals, which in turn are regenerated into their original three-element shape for repeating into a connecting cable circuit.

15 A feature of the system which differs from standard multiplex operation is that the cable code transmitter which transmits into the multiplex distributor is not controlled by the local segments of the distributor but is driven from an independent driving source, and because of this, the speed of the cable code transmitter may be changed within certain limits without requiring a corresponding change in the speed of the multiplex distributor.

20 One of the objects of the present invention is to provide a system in which cable code is transmitted over one of the channels of a multiplex circuit for feeding into a remote submarine cable circuit.

25 Another object is to permit adjustment of the speed of transmission of the cable code over the associated multiplex channel without affecting the other channels of the distributor.

30 A specific object is to control the speed of transmission of the cable code by permitting the cable code transmitter to drift out of phase with the distributor and utilizing the drifting feature to change the cable code transmission speed without necessitating a corresponding change in the multiplex distributor speed.

35 In other words, an object of this invention is to provide means for varying the cable code transmission speed over one channel of the multiplex circuit while maintaining the speed of the multiplex distributor constant.

40 In attaining these objects use is made of means for converting a three-element signal

code into a two-element code for transmission over one channel of the multiplex distributor and of means for converting the two-element code back into the three-element code at the receiving end of the multiplex distributor circuit.

45 Accordingly, I provide at the receiving end of the multiplex distributor circuit special means for deriving a three-element code from the two-element code transmitted over the multiplex channel. For this purpose it is a specific object of the invention to derive at the multiplex receiving end two three-element code signal transmissions so displaced with respect to each other as to time, that a two-element code transmission resembling the original cable code signal transmission is automatically derived therefrom.

50 In the accompanying drawing: Fig. 1 illustrates diagrammatically the equipment and circuit arrangement at the transmitting and receiving ends of the multiplex distributor circuit, assembled in accordance with the present invention.

55 Fig. 2 represents the cable code character "A" transmitted from the cable code transmitter in its original three-element form, in which it is made up of dot, dash and space elements as indicated, the dot represented as positive current, the dash as negative current and the space as the no-current condition.

60 Fig. 3 represents the same character "A" converted into its two-element form by the multiplex sending distributor and its associated circuits. The segments marked plus and minus correspond to the current pulses passed by the segments of the multiplex distributor. This figure indicates that the third or no-current element of the three-element code has been eliminated and replaced by plus and minus elements of the two-element code arranged alternately.

65 Fig. 4 represents the two two-element code signal transmissions of the character "A", displaced as to time, which are derived by the apparatus at the receiving end of the distributor circuit and from which a three-element code signal transmission is produced corresponding generally to the original three-element code signal.

Fig. 5 represents the slightly distorted reproduction at the receiving end of the distributor circuit of the original three-element cable code signal "A" transmitted from the cable code transmitter.

The main line L connects the cable code transmitter circuit with the distant cable code regenerator circuit at which the original signal in regenerated form is repeated into a connecting cable circuit. The details of the cable code regenerator circuit are not shown as these are well understood.

The apparatus diagrammatically illustrated at the transmitting and receiving ends of the line L comprise the following units shown in the order in which they function: Namely, the cable code transmitter XTR; sending converting relays SCR and SPR; multiplex sending distributor MSD; multiplex receiving distributor MRD; receiving converting relays RPR, RCR; and cable code regenerator, CCR.

The cable code transmitter XTR may be of the well known Wheatstone type, such as I have shown in my prior U. S. Patents Nos. 1,616,326, and 1,724,803. It is driven by a separate motor M independent of the driving means of the multiplex sending distributor MSD. Accordingly its speed may be varied independently of the fixed speed of the multiplex distributor, the latter being driven as usual by a fork-controlled phonic wheel or La Cour motor as indicated diagrammatically at F and LC.

In the cable code transmitter the tape 5 operates, through the feelers 6 and 7 of a Wheatstone type transmitter WT to selectively close contacts 8 and 9. The transmitter relay SCR is provided with windings 10, 11, for actuating the armature or tongue 14 to its marking and spacing contacts. The tongue 14 of the sending converting relay SCR is connected through a resistance 15 to a solid ring 17 of the multiplex sending distributor MSD. The rings R_1 , R_2 , and 17 and 22 of the distributor are illustrated in developed form, the brushes b_1 , b_2 being rotated by the La Cour phonic motor LC controlled by the fork F in the manner well understood. The resistance 15 is shunted by the relay winding 10 and condenser 16 for the purpose of reversing the relay during its no-current period when the zero elements of the recorder code are being transmitted from the cable code transmitter XTR. The reversing action of the winding 10 takes place when the brush b_1 of the multiplex sending distributor MSD leaves a segment, the condenser 16 discharging in a direction to reverse the relay SCR, as will be explained in more detail hereinafter.

The segmented ring R_1 of the multiplex sending distributor MSD is equally divided into five pick-up positions, each pick-up segment being connected to a sending polar relay

SPR. There are five such polar relays which are connected to the segments 1, 2, 3, 4, 5 respectively of the sending distributor. When the brush b_1 wipes over the contacts 1, 2, 3, 4, 5, it closes in succession the circuits of the five sending polar relays SPR_1 to SPR_5 , extending from tongue 14 of relay SCR thence through resistance 15, solid ring 17, segmented ring R_1 sending polar relays SPR to ground at 18.

The spacing and marking contacts, s and m , of each of the relays SPR are provided with positive and negative battery through the bus bars 19 and 20 respectively, and the tongue of each of these relays is connected by an individual conductor 21 to segmented ring R_2 of the multiplex sending distributor. The solid ring 22 of the distributor is connected to line L.

The relays SPR_1 to SPR_5 set up positive and negative current on the sending segments in advance of the wiping of the sending brush b_2 and when this brush wipes the segments 1 to 5 of ring R_2 , the stored signal impulses are transmitted to line L. As will be explained hereinafter, the speed of the cable code transmitter may conveniently be so adjusted that it will transmit one cable code impulse for every three segments of the rotary distributor. In this case the tongue 14 of relay SCR will remain on the spacing contact (or the marking contact, as the case may be) long enough to transmit positive (or negative) current through the circuits of three of the relays SPR and thus to set up positive (or negative) current on three successively segments of the sending ring R_2 of the distributor.

Under certain circumstances, as will be explained hereinafter, when it is desired to increase the transmission speed of the cable code transmitter, the tongue 14 of relay SCR will remain on its spacing or marking contact, as the case may be, only long enough to span two of the segments 1 to 5 of the distributor ring R_1 , for a certain code unit. Only two of the polar relays will then be operated for the code unit in question and positive, or negative, current will then be set up on only two of the outgoing segments of the distributor and the code unit in question will be shortened correspondingly. Further reference to this feature will be made in explaining the operation of the system.

At the receiving end of the line L, the winding 23 of the receiving relay is shown connected to ground return at 24. The armature or tongue 25 of the relay is connected to the solid ring 26 of the multiplex receiving distributor MRD, and operates between marking and spacing contacts connected to negative and positive battery, respectively.

The segmented receiving ring R_3 is provided with five segments for each channel, the segments for the channel under discussion being connected individually to one terminal

of the windings of a series of receiving polar relays RPR, the opposite terminals being connected by conductor 27 to ground at 28.

The spacing and marking contacts, s and m , of each of the receiving polar relays RPR₁ to RPR₅ inclusive are provided with positive and negative battery through the bus bars 29 and 30 respectively, and the tongue of each of these relays is connected by an individual conductor 31 to segments 1 to 5 of the segmented ring R₄ of the multiplex sending distributor. The solid ring 32 of the distributor as connected by conductor 33 to windings 34 and 35 of receiving converting relays RCR₁ and RCR₂ and to ground at 36.

When the brush b_3 of the distributor MRD wipes over segments 1 to 5 of segmented ring R₃, the receiving polar relays RPR are operated in succession to set up positive and negative current on the sending segments of the segmented ring R₄ in advance of the wiping of the brush b_4 . A code impulse received in relay winding 23 may span three of the segments of the receiving multiplex distributor, or in the particular circumstances referred to hereinbefore, it may span only two segments.

The receiving apparatus operated through the multiplex receiving distributor, MRD comprises a staggered relay arrangement comprising three receiving converting relays RCR₁, RCR₂, and RCR₃. As already explained the windings 34 and 35 of relays RCR₁ and RCR₂ are connected in series to the solid ring 32 of the multiplex receiving distributor MRD and to ground as 36. The segmented ring R₄ of the distributor comprises a series of segments 1 to 5, to which the individual conductors 31 from receiving polar relays RPR₁ to RPR₅ inclusive, are respectively connected. In addition, the segmented ring R₄ comprises five segments marked X, which are conductively coupled together and to a conductor 37, thence through winding 38 of receiving converting relay RCR₃ to the tongue 40 of relay RCR₁. A condenser 39 shunts the winding 38 of relay RCR₃ and is adjusted to delay the operation of relay RCR₃ for a purpose to be explained later.

The tongue 41 of relay RCR₃ and the tongue 42 of relay RCR₂ are connected by individual conductors 43 and 44 to a common point 50, thence by conductor 45 to receiving apparatus diagrammatically illustrated and the cable code regenerator CCR. The tongue 42 of relay RCR₂ moves between its spacing and marking contacts to apply positive and negative current to the conductor 45. Similarly the tongue 41 of relay RCR₃ moves between its spacing and marking contacts to apply positive and negative current to the conductor 45. When the tongue 42 is on its marking contact and the tongue 41 is on its spacing contact, or vice versa, the positive and negative currents neutralize each other

and hence a no-current condition exists in conductor 45 and its associated receiving and cable code regenerating apparatus.

Such a condition will exist at intervals even though both relays RCR₂ and RCR₃ repeat the same code units in the same sequence, since the operation of the relay RCR₃ is delayed by the predetermined action of the shunt condenser 39 to operate one whole impulse behind the operation of relay RCR₁, or until the brush b_4 has reached the end of an X segment. This delay in the energizing of relay RCR₃ will cause the signals set up by the operation of the relays RCR₁ and RCR₂ to be repeated by the relay RCR₃ one time-unit later or one impulse out of phase. This is indicated diagrammatically in Fig. 4 in which the upper line of characters shows the impulses set up by the operation of relays RCR₁ and RCR₂. The tongue 42 of relay RCR₂ will immediately transmit the impulse to the point 50. While the tongue 40 of relay RCR₁ is operated simultaneously with the tongue 42, when the brush b_4 wipes over a pick-up segment, the energization of relay RCR₃ is delayed by the action of the condenser 39 until the brush reaches the end of the next succeeding X segment. Hence the impulses are transmitted by the tongue 41 of relay RCR₃ to the point 50 simultaneously with the next succeeding impulse transmitted by the tongue 42 of relay RCR₂. This difference in phase is indicated in Fig. 4, where the lower line represents the impulses transmitted by relay RCR₃ delayed the time of one unit impulse behind those transmitted by relay RCR₂. It is evident from this that the tongues 42 and 41 of relays RCR₂ and RCR₃ will be on contacts of opposite polarity for the single reversal elements, as in the space diagram of Fig. 3, and no-current or zero current will be transmitted into conductor 45 at these instants. However during the transmission of the dot and dash elements the tongues 42 and 41 will be on contacts of like polarity and hence will transmit current through conductor 45 to the repeating relays RR₁ and RR₂. There is a slight distortion of the signals sent into the conductor 45 from the original three element code signals, as indicated in Fig. 5. These signals are then repeated in corrected form into the connecting cable circuit by means of the usual regenerating cable code rotary distributor as indicated. The repeating relays are provided with the usual biasing windings which normally hold their tongues against their spacing contacts.

The operation of the system will be clear from the above description. Suppose it is required to operate a cable code channel at 600 centerholes or 160 letters per minute over a channel of a triple multiplex, the speed of which may be assumed to be 360 revolutions per minute.

In this case the five segments of the distributor sending ring which are assigned to the cable code channel will transmit 360 times 5 segments, or 1800 impulses per minute. If the cable code transmitter transmits 500 tape center holes or impulses per minute into this channel, the transmitter will transmit one cable code impulse for every three segments of the distributor. If the cable code transmitter were operatively connected to the multiplex distributor, so that the comparative speeds of the multiplex distributor and the cable code transmitter were exactly the same, the multiplex distributor brush would always wipe over three segments for each cable code centerhole or impulse. This is not the case in actual practice, however, for the cable code transmitter is not connected to the multiplex distributor but is driven independently.

Because of this fact, therefore, the cable code transmitter will drift out of phase with the distributor. Advantage is taken of this drifting feature for making it possible to vary the cable code transmission speed without requiring a corresponding change in the speed of the multiplex distributor.

For practical purposes it is not desirable that the speed of the cable code transmitter be below that of the comparative speed of the cable code channel of the distributor, and hence the speed of the cable code transmitter is adjusted to run faster than the distributor speed, with enough margin to prevent it from drifting backwards, due to any temperature changes which may affect the speed of the driving forks of the distributor and transmitter.

The brushes of the multiplex distributors MSD and MRD at the transmitting and receiving ends of the line respectively are driven synchronously with the speed of transmission of the multiplex channels, such as by fork-controlled La Cour motors maintained in synchronism by means of converting circuits in the manner well understood.

With a multiplex distributor running at 360 revolutions per minute, which as already stated provides a cable code channel with a minimum speed of 600 tape centerholes, the cable code transmitter should run about $1\frac{1}{2}\%$ faster to ensure a good working speed margin between the transmitter XTR and distributor MSD.

Since the cable code transmitter is then running faster than the speed which corresponds to three segments of the distributor for each cable code transmitter centerhole or impulse, a unit impulse of cable code will not always span three segments of the distributor, but will sometimes span two segments. Obviously, the faster the cable code transmitter is speeded up the greater will be the number of two-segment cable code units in any given number of units. That is, if the

cable code transmitter is running faster than the speed at which each cable code unit spans exactly three segments of the distributor, each unit of the message will span either two segments or three segments and the faster the cable code transmitter is speeded up the more two-segment cable code units and the fewer three segment units there will be in a given transmission. Consequently as the speed of the cable code transmitter is increased, without however increasing the speed of the multiplex distributor into one channel of which the cable code transmitter transmits, the greater will be the number of cable code units transmitted over the line in a given time.

At the receiving end, the two-segment units and the three-segment units are picked up on a standard cable code rotary regenerator, and regardless of whether the received signal is a two-segment signal or a three-segment signal, the rotary regenerator regenerates the signals into their original three element shape.

The operation of the system whereby the three-element cable code comprising positive current, negative current and no-current elements is converted into the two-element code comprising only positive current and negative current elements will now be described, the signal to be transmitted and converted being taken as the cable code character "A", which is dot, dash, space (.-).

Let it be assumed that the comparative speeds of the cable code transmitter and channels of the multiplex distributor are exactly alike. Under the conditions, assumed a unit of cable code spans three segments of the distributor.

Upon the closing of the transmitter dot contact, the sending converting relay SCR moves to its spacing contact, and the sending brush b_1 of the multiplex distributor MSD in wiping over segments 1, 2, 3 of ring R_1 operates relays SPR_1 , SPR_2 and SPR_3 to their spacing contacts. These three relays in turn set up positive potential on the sending segments 1, 2, 3 of sending ring R_2 . When the sending brush b_2 thereafter wipes over these last mentioned segments 1, 2, 3, a positive impulse three segments in length is transmitted into line L, corresponding to the original dot cable code signal transmitted from the cable code transmitter XTR.

When the transmitter XTR closes its dash contact, the sending converting relay SCR operates to its marking or negative contact, and polar relays SPR_4 , SPR_5 , SPR_1 will be operated to their marking or negative contacts by closure of circuits from negative battery over tongue 14 of relay SCR and the segments 45 and 1 of converting ring R_2 . Operation of relays SPR_4 , SPR_5 and SPR_1 , sets up negative potential on sending segments

4, 5, 1 in advance of the wiping of the sending brush b_1 .

For the zero or no-current portion of the character "A" both contacts of transmitter XTR are open and the sending converting relay SCR is not operated by winding 11. However, the previous establishment of a path from negative battery through the tongue 14 of relay SCR served to charge condenser 16 and when brush b_1 has left segment 1 the condenser discharges through winding 10 and resistance 15 in a direction to operate relay SCR to its spacing or positive contact, thus causing transmission of positive current through segment 2 to sending polar relay SPR₂. The current through winding 10 will reverse three times during the no-current condition in relay SCR so that the sending converting brush b_1 in passing over the segments 2, 3 and 4 of ring R₁ will close operating circuits for the relays SPR₂, SPR₃ and SPR₄, which will in turn set up positive, negative, and positive potential respectively on the sending segments 2, 3, 4 of sending ring R₂. When therefore the sending brush b_2 wipes over the last mentioned segments 2, 3, 4 of ring R₂, the space portion of the character "A" is transmitted into line L as a series of three single element reversals, as shown in Fig. 3, instead of in its original no-current form, three elements in length as shown in Fig. 2.

Up to this point the character "A" which originated at the cable code transmitter XTR in the form shown in Fig. 2 has been transmitted over the line L in the form shown in Fig. 3. At the receiving end of line L it is received on the receiving segments 1, 2, 3, 4, 5 of one channel of R₃ of the multiplex receiving distributor MRD which operate into the five receiving polar relays RPR₁ to RPR₅ inclusive, similar to the relays SPR₁ to SPR₅ inclusive in the transmitting circuit. The five receiving polar relays are operated in succession to their spacing or marking contacts according as the successive incoming current impulses operate the tongue 25 of the receiving relay 23 to its spacing or marking contacts. The polar relays RPR in turn store up the incoming impulses on the equally spaced segments 1, 2, 3, 4, 5 of the receiving converting ring R₄ of the multiplex receiving distributor in advance of the wiping of the receiving converting brush b_4 .

The signals of Figure 3 now have to be converted so that the space portion of the signals resembles the original zero current of Figure 2. To do this all single element reversals are converted into zero elements by means of a staggered relay arrangement which causes the receiving converting relays RCR¹, RCR², RCR³ to transmit zero current into conductor 45 for the space portion of Fig. 2. Each time the receiving converting brush b_4 wipes over one of the pick-up segments 1, 2, 3, 4, 5

of ring R₄, the receiving converting relays RCR₁ and RCR₂ operate according to the polarity set up on a segment, and remain in operated position until they may be reversed from a succeeding pick-up segment. This reconstructs the signals received from segments 1, 2, 3, 4, 5 of ring R₃ into equally spaced signals from ring R₄ which in turn operate relays RCR₁, RCR₂ so that they repeat the signals in the form shown in Figure 3.

As previously explained all single reversals are suppressed or converted into zero or no-current elements through the medium of relay RCR₃ which follows the movements of RCR₁ and repeats the incoming signals but repeats them one whole impulse out of phase with respect to relays RCR₁ and RCR₂. The manner in which this arrangement converts the two element signals back into the original three element signals has been previously described.

The above description explains the operation of the invention with the comparative speeds of the cable code transmitter and the multiplex cable code channel exactly the same. As previously stated, however, in actual practice the cable code transmitter is driven at a slightly faster speed than the multiplex cable code channel speed, and because of this difference in speed the transmitter will drift ahead, so to speak, causing an out-of-phase condition between it and the multiplex cable code channel as of a result of which a cable code unit is sometimes transmitted as a two-segment length signal instead of as a three-segment length signal. The speed of the transmitter, however, should not be increased to such an extent that a cable code unit is transmitted shorter than a two-segment length.

When this out-of-phase condition exists, the conversion of the sending signals and their reception is similar to that already described. However, due to the fact that the speed of the cable code transmitter has been increased, the current impulses transmitted to the winding 11 of the sending converting relay SCR are somewhat shortened, and the change in polarity when tongue 14 moves from spacing to marking contact, or vice versa, may occur at an instant when the sending converting brush b_1 is passing over the ring R₁, at a point between two conducting segments.

Assume for example, that in transmitting the character "A" the cable code transmitter is so adjusted that it moves to its spacing contact, to send a dot impulse, just after the sending converting brush b_1 has passed beyond the conducting segment 2. Positive potential will be applied to brush b_1 the tongue 14 moves to its negative or marking contact. Because of the slightly increased speed of the cable code transmitter, the

tongue 14 will swing to its negative or marking contact just before the brush b_1 wipes over contact 5. Accordingly, during the transmission of the dot impulse, the brush b_1 has wiped over only two segments, 3 and 4, and therefore only two relays SPR_3 and SPR_4 are operated to apply positive potential to the segments 3 and 4 of the ring R_2 . Thus the positive or dot unit in this case is only two segments long.

Since the tongue 14 swings to its negative or marking contact just before brush b_1 reached segment 5, the brush b_1 will wipe over three segments 5, 1, 2 while the tongue is on its negative or marking contact. The three corresponding polar relays SPR_5 , SPR_1 , SPR_2 are then operated and the negative or dash unit transmitted to line L is three segments long.

As pointed out above in order to increase the relative number of two-segment units as compared to three-segment units, the speed of the cable code transmitter may be increased. The fact that the cable code transmitter is driven independently allows it to be varied in speed independent of the fixed speed of the multiplex distributor, so that it is possible and practicable to change the speed of the transmitter from say 160 letters per minute to 170 letters or more without requiring a corresponding change in the multiplex distributor speed.

At the receiving end, the two-segment length signals and the three-segment length signals received from ring R_4 are repeated into a cable code regenerator in the usual way, the regenerator being phased to properly pick up the shortest or displaced signal. The rotary regenerator in effect ignores the differences in length of the two-segment and three-segment units, and regenerates the signals into their original three-current shape.

Since the cable code transmitter XTR is driven by an independent driving motor, and is not controlled by the local segments of the multiplex distributor, it is obvious that regulation of the speed of the cable code transmitter does not affect the operation of the multiplex distributor MSD. Accordingly utilization of one channel of the multiplex circuit for recorder code operation in accordance with this invention, does not interfere with the use of the other channels of the multiplex circuit in the usual manner. It is obvious also that although this invention is shown applied only to one channel of the multiplex circuit, one or more other channels may be used in a similar manner.

I claim:

1. In a telegraph system, a code transmitter, a multiplex distributor connected thereto, means for driving said distributor, means for driving said code transmitter, and means for adjusting to unequal speeds the driving

means for said distributor and said code transmitter.

2. In a system comprising a code transmitter feeding into a channel of a multiplex distributor, the method of increasing the speed of code transmission which comprises increasing the speed at which the code transmitter is driven with respect to the speed of the distributor.

3. In a system comprising a code transmitter feeding into one channel of a multiplex distributor, the method of varying the speed of code transmission which comprises varying the speed at which the code transmitter is driven while maintaining the speed of the distributor constant.

4. In a telegraph system, code transmitter, a multiplex distributor connected to the line, means between said transmitter and said distributor for transmitting marking and spacing conditions only to line when marking, spacing and no-current or zero signals are received from said code transmitter, means for driving said distributor, and means for driving said code transmitter independently of said distributor.

5. In a telegraph system, a code transmitter, a multiplex distributor connected to the line, means between said transmitter and said distributor for transmitting marking and spacing conditions only to the line in response to marking, spacing and no-current or zero conditions from said code transmitter, means for driving said code transmitter independently of said distributor, and means for adjusting the speed of said code transmitter while maintaining the speed of the distributor constant.

6. In a telegraph system, a code transmitter, a multiplex distributor connected to the line, means for converting marking, spacing and no-current signal conditions transmitted from said code transmitter into marking and spacing conditions only and means for transmitting said converted signal conditions to the line through said distributor in the form of code units having a length equal to the time interval of three segments of said distributor.

7. In a telegraph system, a code transmitter, a multiplex distributor connected to the line, means for converting marking, spacing and no-current signal conditions transmitted from said transmitter into marking and spacing conditions only, means for transmitting said converted signal conditions to the line through said distributor in the form of code units having a length equal to the time interval of three segments of said distributor and means for changing the length of some of the code-units to two-segment length.

8. In a telegraph system, a code transmitter, a multiplex distributor connected to the line, means for converting marking, spacing and no-current signal conditions transmitted

from said transmitter into marking and spacing conditions only, means for transmitting said converted signal conditions to the line through said distributor in the form of code units having a length equal to the time interval of three segments of said distributor, means for increasing the speed at which the code transmitter is driven to change some of the code units to two-segment length while maintaining other units at three-segment length.

9. In a telegraph system, a code transmitter, a multiplex distributor connected to the line, means for converting marking, spacing and no-current signal conditions transmitted from said code transmitter into marking and spacing signals only, means for transmitting said converted signal conditions to line through said distributor in the form of code units having a length equal to the time interval of a plurality of segments of said distributor, means for driving said code transmitter independently of said distributor, means for adjusting the speed at which the code transmitter is driven, a receiving distributor connected at the distant end of the line and means for converting the marking and spacing signal conditions received through said receiving distributor into marking, spacing and no-current or zero conditions corresponding to the original code signals.

10. In a telegraph system, a code transmitter, a multiplex distributor connected to the line, means for converting marking, spacing and no-current signal conditions transmitted from said code transmitter into marking and spacing signals only, means for transmitting said converted signal conditions to the line through said distributor in the form of code units having a length equal to the time interval of a plurality of segments of said distributor, a receiving distributor connected at the distant end of the line, means for converting the marking and spacing signal conditions received through said receiving distributor into a distorted form of the original wave comprising marking, spacing and no-current conditions, and means for regenerating said distorted wave to the shape of the original wave of the signals transmitted from said code transmitter.

11. In a telegraph system a code transmitter, a multiplex distributor connected to the line, means for converting marking, spacing and no-current signal conditions transmitted from said code transmitter into marking and spacing signals only, means for transmitting said converted signal conditions to the line through said distributor in the form of code units having a length equal to the time interval of a plurality of segments of said distributor, a receiving distributor connected at the distant end of the line and means for converting the marking

and spacing signal conditions received through said receiving distributor into marking, spacing and no-current conditions corresponding to the original code.

12. In a telegraph system, a line or cable, a transmitting station, a multiplex distributor at said station comprising a segmented ring for a plurality of channels, a cable code transmitter and a converting relay connected to the segments of one channel of said distributor for sending three-element code signals from said code transmitter to the line in form of two-element three-segment-length signal units.

13. In a telegraph system, a line or cable, a transmitting station, a multiplex distributor at said station comprising a plurality of segments for one channel, a cable code transmitter designed to transmit spacing, marking and no-current conditions, a converting relay connected between said transmitter and said distributor comprising means for changing no-current units from said code transmitter into alternate current reversals and means comprising said distributor and polar relays associated therewith for repeating said spacing, marking and no-current units into the line as segment-length impulses.

14. A telegraph system comprising a cable code transmitter, a sending converting relay, a multiplex sending distributor and associated polar relays therefor, means including said distributor for dividing signal units from said cable code transmitter into segment-length impulses, means including said converting relay for changing three element signal units into two-element units, and means for receiving said two-element units composed of segment-length impulses and reconverting them into three element units of the original code.

15. A telegraph system comprising a cable code transmitter, a sending converting relay, a multiplex sending distributor and associated polar relays therefor, means including said distributor and polar relays for repeating signal units from said cable code transmitter as segment-length impulses, means including said converting relay for changing three-element signal units into two-element units, and means for adjusting the speed of the code transmitter with respect to the speed of the distributor to determine the number of segment-length impulses into which the signal units are divided.

16. A telegraph system comprising a cable code transmitter, a sending converting relay, a multiplex sending distributor and associated polar relays therefor, means including said distributor and polar relays for repeating signal units from said cable code transmitter as segment-length impulses, means including said converting relay for changing three-element signal units into two-element

- units, and means for adjusting the speed of the code transmitter with respect to the speed of the distributor to determine the number of segment-length impulses into which the signal units are divided, and means for receiving said two-element units composed of segment-length impulses and re-converting them into three-element units of the original code.
17. In a telegraph system, a line, a transmitting station, a multiplex distributor, a cable code transmitter connected to said distributor for sending two-segment and three-segment signal units to line through the segments of one channel of said distributor, and means for controlling the relative numbers of two-segment and three-segment signal units transmitted to the line, said means comprising means to adjust the relative speeds of said distributor and said code transmitter.
18. In a telegraph system a line, a transmitting station, a multiplex distributor, a cable code transmitter connected to said distributor for sending two-segment and three-segment signal units to line through the segments of one channel of said distributor, and means for controlling the relative numbers of two and three segment signal units transmitted to line, said means comprising means to adjust the speed of said code transmitter while maintaining constant the speed of said distributor.
19. In a system for receiving two-element code signals over a circuit and converting them into three-element code signals, a pair of converting relays responsive to the incoming two-element code signals, means under control of one of said relays for repeating said incoming code into an outgoing circuit, means under control of the other of said relays for repeating said incoming code slightly out of phase with the repeated code from said one relay, and means for combining said dephased code transmissions in said outgoing line.
20. In a system for receiving two-element code over a multiplex distributor circuit and converting it into three-element code, a pair of converting relays responsive to the incoming two-element code, means under control of the first of said relays for repeating the incoming code into an outgoing line, a third converting relay having a circuit through segments of said distributor under control of the second of said pair of converting relays, and means under control of said third relay for repeating the incoming code into the outgoing line displaced by the time interval between segments of said distributor.
21. In a system for receiving two-element code over a multiplex distributor circuit and converting it into three-element code, a pair of converting relays responsive to the incoming two-element code, means under control of the first of said relays for repeating the incoming code into an outgoing line, a third converting relay having a circuit through segments of said distributor under control of the second pair of converting relays, means under control of said third relay for repeating the incoming code signals into the outgoing line displaced by the time interval between segments of said distributor, means for combining said displaced code signals in said outgoing line, and a code regenerator connected thereto.
22. In a telegraph receiving system, a multiplex receiving distributor, a staggered relay arrangement connected thereto comprising a pair of converting relays, one of which is connected to repeat into an outgoing line, a third converting relay connected to repeat into said outgoing line, an energizing circuit for said third relay under control of the second of said pair of relays, and means in said energizing circuit for delaying the operation of said third relay.
23. In a telegraph system, the method of converting two-element code into three-element code which comprises repeating the two-element code transmission, producing therefrom a second two-element code transmission dephased with respect to said repeated code transmission and combining the dephased two-element code transmissions to produce a single three-element code transmission.
24. In a telegraph code receiving and converting system, the method of restoring the original no-current or zero element to a two-element code in which the original no-current units of the code signals are represented by alternate current reversals, which comprises repeating said unit having the form of alternated current reversals, producing therefrom a second repeated unit out of phase with said first repeated unit by one current reversal and combining said out of phase repeated units to produce a no-current or zero code unit.
25. A telegraph system comprising a cable code transmitter, a sending converting relay, a multiplex sending distributor and associated polar relays therefor, means including said sending converting relay and polar relays for changing the signal impulses of a three-element code transmitted from said transmitter into two-element code signal impulses, a multiplex receiving distributor and associated receiving polar relays, receiving converting relays, and means comprising said polar relays and receiving converting relays for re-converting said received two-element code signals into three-element code signals.
26. A telegraph system comprising a cable code transmitter, a sending converting relay, a multiplex sending distributor and associated polar relays therefor, means including said sending converting relay and said polar relays for changing signal impulses of a

three-element code transmitted from said transmitter into two-element code signal impulses, a multiplex receiving distributor and associated receiving polar relays, receiving
6 converting relays, means comprising said polar and receiving converting relays for reconverting said received two-element code signals into three-element code signals, and means comprising a code regenerator for re-
10 storing said three-element code transmission to its original shape.

In testimony whereof, I affix my signature.
CRESCENT F. NELSON.

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