

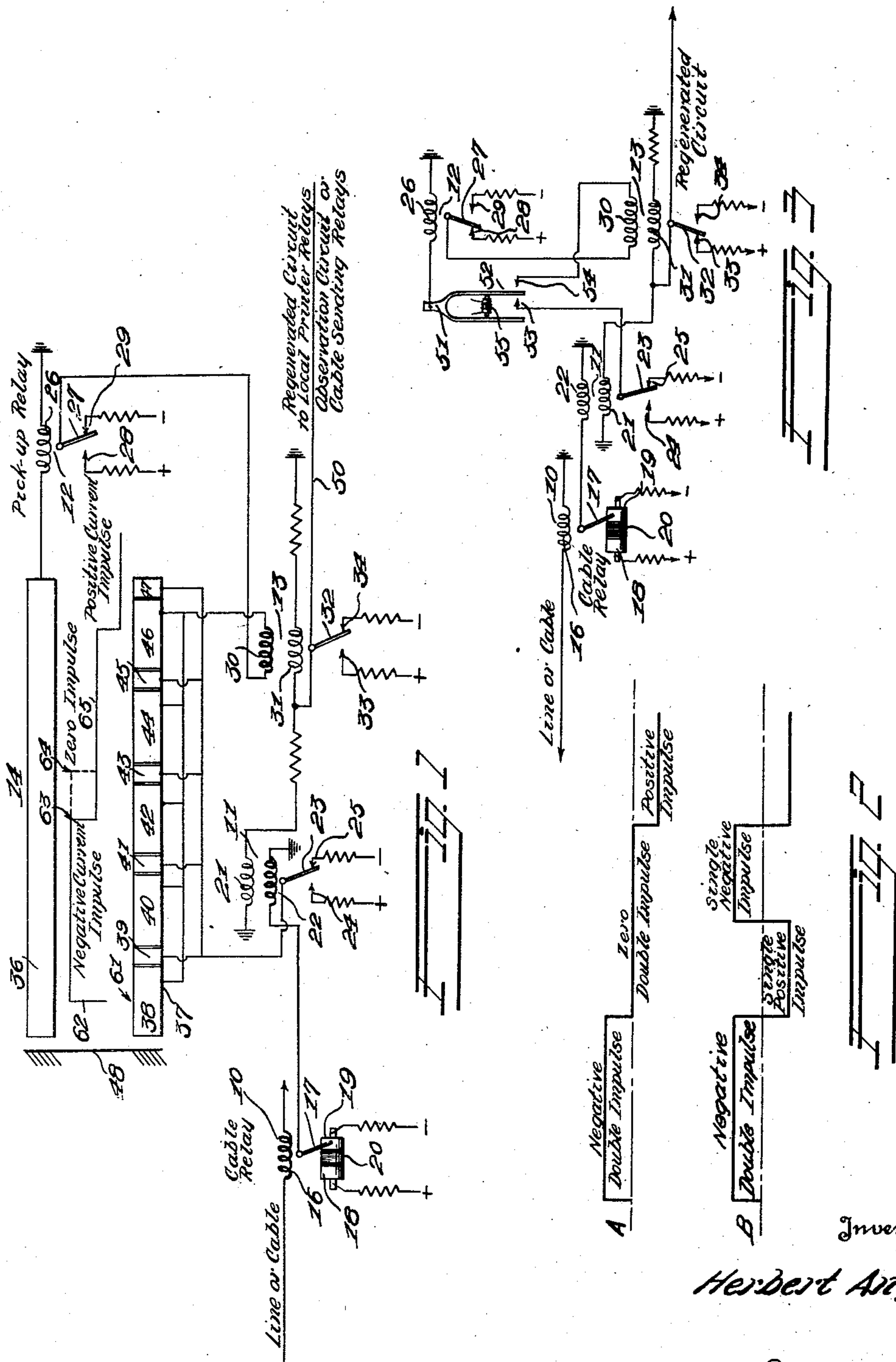
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CORRECTING DISTORTION AND INTERPOLATING IMPULSES IN CABLE TELEGRAPHY

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CORRECTING DISTORTION AND INTERPOLATING IMPULSES IN CABLE TELEGRAPHY

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This invention relates to telegraph systems and particularly to means for regenerating and translating signal impulses received at the end of ocean cables or land lines having the characteristics of ocean cables.

As is well known, the signal impulses sent over an ocean cable are considerably attenuated at the receiving end, due to the electrical characteristics of the cable such as its capacity and its impedance and the cable must therefore be operated more slowly than the land lines, the signal impulses being proportionately longer. If the current impulses are too short or are sent into the cable too rapidly they will be practically absorbed or lost and will not reach the receiving end. To overcome this difficulty it has been proposed to transmit single code unit impulses at such a high rate of speed that they will not affect the relay at the receiving end. Consequently single impulses will produce no effect at the distant end of the cable, while impulses having a duration of two or more single impulses will actuate the cable relay. By providing at the distant or receiving end an organization of apparatus which interpolates all of the missing impulses, the printer magnets are operated in accordance with every impulse indicated in the code characters as they are perforated in the sending tape and pass through the transmitter.

The systems heretofore employed for regenerating and translating signals transmitted over an ocean cable have been found to be unreliable in that they do not record the code signals accurately. This is due mainly to the fact that the signals received over the cable shift their position with respect to the segmented ring of the distributor, in some cases the shift of the signal with respect to the distributor being as much as fifty per cent of the length of the distributor segment. In the systems heretofore used, the interpolation of a zero signal is arranged to occur at a predetermined instant in an impulse interval and accordingly when the impulse is displaced, the interpolation may be lost.

Accordingly the main object of this invention is to provide an improved means for regenerating and translating signal impulses

whereby distorted signal impulses will be accurately translated.

A further object of my invention is to provide means for regenerating and interpolating received distorted cable impulses irrespective of the extent of signal shift within an impulse interval.

Still a further object of my invention is to provide means for maintaining interpolating means in condition for interpolating distorted cable impulses during the entire impulse interval.

There are other objects of my invention which together with the foregoing will appear in the detailed description to follow.

In the following description, reference will be made to the accompanying drawings in which only so much of the telegraph equipment has been shown as will be necessary to a clear understanding of the invention.

Figure 1 is a diagrammatic illustration of one embodiment of the invention and shows the apparatus at the receiving station.

Figure 2 is a diagram illustrating the current impulses as they are received and as they appear after translation by the receiving apparatus, and

Figure 3 is a diagrammatic illustration showing a modification of the apparatus shown in Figure 1.

In general, I provide circuit arrangements such that the interpolating relay is effective for interpolating impulses over a substantial portion of the impulse intervals so that even a fifty per cent displacement of the signal will not result in a loss of the signal impulse.

In Figure 2, curve A represents the current impulses as they are received by the receiving apparatus at the end of a cable or long land line. The negative impulse shown in curve A comprises two single negative impulses. The next two impulses, a single positive impulse followed by a single negative impulse are received as two zero impulse intervals. Curve B represents current impulses as they appear after they have been translated by the apparatus of my invention. As will be seen, the negative double impulse of curve A has not been altered but the zero double

impulse of curve A has been resolved into its components; namely, a single positive impulse and a single negative impulse.

Referring now to Figure 1, the receiving apparatus comprises a cable or line relay 10, an operating relay 11, a pick-up relay 12, a translating relay 13 and a distributor 14. The cable relay 10 comprises a winding 16 and an armature 17 adapted to co-operate with a spacing contact 18, a marking contact 19 or an intermediate insulated portion 20. Winding 16 operates in response to received line signals to move armature 17 to either contact.

The operating relay 11 comprises two windings 21 and 22 and an armature 23 adapted to co-operate with a spacing contact 24 or a marking contact 25. When current of the same polarity flows through these two windings their magnetic effects are opposed, but the turns of winding 22 are so chosen as to predominate sufficiently to operate and hold armature 23 in accordance with the current therethrough. As will appear hereinafter, relay 11 is the interpolating relay, the winding 21 being effective when no signals are received to operate armature 23 from one of its contacts to the other contact.

The pick-up relay 12 comprises a single winding 26 and an armature 27 adapted to co-operate with a spacing contact 28 or a marking contact 29. Relay 12 is controlled through distributor 14 for timing the operation of the interpolating and translating relays. The translating relay 13 comprises two winds 30 and 31 and an armature 32 adapted to co-operate with a spacing contact 33 or a marking contact 34. Winding 30 is so chosen with respect to 31 that it predominates when their fluxes are opposing, winding 31 functioning as a locking winding thereafter to hold its armature 32 locked.

Each of the spacing contacts 18, 24, 28 and 33 is connected to positive battery and each of the marking contacts 19, 25, 29 and 34 is connected to negative battery.

The receiving distributor 14, which for the sake of clearness is shown developed, comprises a solid ring 36 and a segmented ring 37, the latter consisting of segments 38, 39, 40, 41, 42, 43, 44, 45, 46 and 47 suitably insulated from each other. The rings 36 and 37 are adapted to be bridged by a brush 48 which is carried by an arm (not shown) arranged to be continuously rotated by means of a motor (also not shown) and which is maintained in synchronism with a transmitting distributor at the opposite end of the cable by any well known means the phase displacement of which may be corrected either mechanically or electrically.

The even numbered segments 38, 40, 42, 44 and 46, of the ring 37 are connected together and the entire group is connected to one terminal of the winding 30 of the translating relay 13. The other terminal of the winding 30 is

connected to the armature 27 of the pick-up relay 12. The odd numbered segments 39, 41, 43, 45 and 47 of the ring 37 are connected together and the entire group is connected to the armature 23 of the operating relay 11. The solid ring 36 is connected to one terminal of the winding 26 of the pick-up relay 12, the other terminal of the winding 26 being connected to ground.

The armature 17 of the cable relay 10 is connected to one terminal of the winding 22 of the operating relay 11, the other terminal of the winding 22 being connected to ground. The winding 21 of the operating relay 11 has one of its terminals connected to ground and the other terminal connected with one terminal of the winding 31 of the translating relay 13, the other terminal of the winding 31 being connected to ground. The armature 32 of the translating relay 13 may be connected by means of conductor 50 to the local printer relays or to cable sending relays (not shown) for retransmitting the regenerated signals.

For a clear understanding of the invention, the operation thereof will be given. Normally an impulse such, for example, as the negative double impulse shown in curve A of Figure 2 arrives to energize the cable relay winding 16 at the moment that brush 48 is on segment 38 at the point 61 as indicated in Figure 1 by curve 62. The negative current flowing through winding 16 of the cable relay 10 operates the armature 17 of this relay to engage its marking contact 19. A circuit is thus established for the operating relay 11 from negative battery, over contact 19, armature 17 and through winding 22 of operating relay 11, to ground. The negative current flowing through winding 22 moves armature 23 into engagement with its marking contact 25 thereby extending negative potential over contact 25 and armature 23 to the odd numbered segments 39, 41, 43, 45 and 47.

When now the brush 48 reaches and wipes over segment 39, the negative potential on segment 39 is extended over the brush 48, ring 36 to winding 26 of pick-up relay 12 and thence to ground. The negative current flowing through winding 26 moves the armature 27 into engagement with its marking contact 29 thereby extending negative potential over contact 29, armature 27 and through winding 30 of the translating relay 13 to the even numbered segments 38, 40, 42, 44 and 46. As the brush 48 wipes over the segment 40, the negative potential on segment 40 is extended over the brush 48, ring 36 and through winding 26 of pick-up relay 12 to ground. Pick-up relay 12 is thus locked with its armature 27 in engagement with its marking contact 29 during the interval while brush 48 wipes over segment 40. The negative current flowing through winding 30 of the trans-

lating relay 13 moves its armature 32 into engagement with its marking contact 34 thereby extending a negative impulse over the line 50. At the same time, a locking circuit for the translating relay 13 is established from negative battery over marking contact 34, armature 32, locking winding 31 to ground. This locking circuit maintains armature 32 of the translating relay 13 in engagement with its marking contact 34 until the translating relay 13 is unlocked by positive current flowing through the winding 30 thereof, as will be described hereinafter.

Operation of armature 32 into engagement with its marking contact 34 also extends negative potential over marking contact 34, armature 32 and through the interpolating winding 21 of operating relay 11, to ground. The negative current flowing through the interpolating winding 21 is in such a direction that it tends to throw armature 23 into engagement with its spacing contact 24 but is not effective at this time due to the current in winding 22, which, as described above, is in such a direction as to hold armature 23 in engagement with contact 25, it being understood that the ampere turns of windings 21 and 22 are so chosen that with current in winding 22, it always prevails over winding 21. If, however, the armature 17 of the cable relay 10 is deflected to its neutral position 20 when the negative impulse coming in over the cable terminates or drops to zero, the circuit for winding 22 is opened, this relay winding is deenergized and the current in winding 21 becomes effective to operate armature 23 to contact 24.

It will now be assumed that the incoming negative double impulse instead of terminating or dropping to zero at point 63 (see Figure 1) is unduly distorted and shifted from normal so that it persists on the cable beyond the point 63 and to point 64 at which point brush 48 is wiping over segment 43, as shown in dotted lines in Figure 1. When the brush 48 reaches the segment 43, armature 17 of the cable relay 10 will still be in engagement with its marking contact due to the signal persisting and armature 23 of operating relay 11 will still be in engagement with its marking contact 25. Therefore negative potential will be extended over contact 25, armature 23, segment 43, brush 48, ring 36, winding 26 of pick-up relay 12, to ground. Pick-up relay 12 will maintain its armature 27 in engagement with its marking contact 29.

When the negative double impulse belatedly terminates or drops to zero in the next impulse interval at 64, as shown by dotted lines in Figure 1, armature 17 moves to its neutral point 20 thereby deenergizing the winding 22 of the operating relay 11. When this occurs the continuous negative current flowing over

marking contact 34, armature 32 and through interpolating winding 21 immediately becomes effective and moves armature 23 into engagement with its spacing contact 24. This is due to the fact that, as shown, current for reversing the position of armature 23 flows continuously in winding 21 directly from armature 32 and independently of the position of the distributor brush 48 of positive polarity now.

Operation of armature 23 to contact 24 extends positive potential over contact 24, armature 23, segment 43 and over brush 48, as it passes over the last half of the segment 43, to ring 36 and through winding 26 to ground.

The positive current flowing through winding 26 operates the armature 27 into engagement with its spacing contact 28 thereby extending positive potential over spacing contact 28, armature 27 and through winding 30 to segment 44. When now the brush 48 in its continued rotation wipes over the segment 44, the positive potential on segment 44 is extended over brush 48, ring 36 and through winding 26 of pick-up relay 12 to ground. Pick-up relay 12 is thus locked in its operated position with its armature 27 in engagement with its spacing contact 28.

The magnetic effect of the positive current flowing through winding 30 of translating relay 13 predominates over and is opposed to that of the negative current flowing through the locking winding 31 and is sufficient to move armature 32 into engagement with its spacing contact 33 thereby extending a positive impulse over the line 50. This impulse is indicated in curve B of Figure 2 as the single positive impulse.

As shown in curve A, Figure 2 and at 65 Figure 1, the zero condition now continues while the brush 48 is passing over the segment 44. Accordingly armature 17 is still maintained at its neutral point 20 and winding 22 is still deenergized. The interpolating winding 21 of the operating relay 11 is at this time energized by positive current flowing from positive battery over spacing contact 33 and armature 32 of translating relay 13. It will be noted that the current in winding 21 is now reversed from that described above and causes armature 23 of operating relay 11 to move into engagement with its negative or marking contact 25 again extending negative potential to the odd numbered segments so that when the brush 48 reaches the segment 45 the winding 26 of the pick-up relay 12 will be reenergized by negative current and will reoperate its armature 27 into engagement with its marking contact 29.

Negative potential is again extended over contact 29, armature 27, through winding 30 of the translating relay 13 to the even numbered segments so that when the brush 48 reaches the segment 46 the winding 26 of the

pick-up relay 12 will be locked in its operated position with the armature 27 in engagement with the marking contact 29. The negative current flowing through the winding 30 will move the armature 32 into engagement with the marking contact 34 thereby again extending a negative impulse over the line 50. This impulse is indicated in curve B of Figure 2 as the single negative impulse.

The next received impulse being the first of a double positive impulse, the current through winding 16 will throw armature 17 to the left in engagement with contact 18. Positive current will then flow through winding 22, throwing armature 23 to the left in engagement with contact 24 and a circuit will be prepared at armature 23 for pick-up relay 12 which is completed when the brush 48 moves to the next odd numbered segment. Relay 12, upon energization, operates armature 27 to engage contact 28 preparing an energizing circuit for winding 30 which is completed when the brush 48 moves over the next even numbered segment. Armature 32 is thrown to engage contact 33 completing an energizing circuit for winding 21 which tends to throw armature 23 to engage contact 25.

As explained above, the current through winding 22 predominates over winding 21 so that armature 23 remains in engagement with contact 24 as long as winding 22 receives current over the circuit from armature 17. This condition is therefore maintained for the next impulse interval which is the second of the double positive impulses.

As will now be clear from the above description, the interpolating relay 11 throughout each impulse interval tends to throw its armature 23 to the opposite contact from that with which it is in engagement at the time. This condition is, as stated, continuous practically for at least the latter portion of each impulse interval due to the direct circuit provided for winding 21 over armature 32, which in turn is operated at some time in the impulse interval through segments on the distributor.

Accordingly although an impulse is through distortion or otherwise displaced with respect to the distributor operation almost all of an impulse interval, the interpolating relay 11 will still be effective.

In the modified embodiment of the invention shown in Figure 3, a tuning fork 51 is substituted for the rotary distributor 35 employed in the embodiment shown in Figure 1. In other respects, the apparatus of Figure 3 is the same as that shown in Figure 1 and the same reference numerals have been applied to the corresponding parts. The tine 52 of the fork 51 takes the place of the solid ring 36 of the distributor 35 and the contacts 53 and 54 take the place of the odd numbered segments and even numbered segments, re-

spectively, of the distributor ring 37. The tine 52 is vibrated by an electromagnet 55 in synchronism with the incoming impulses, any well known means being used to maintain synchronism.

The remaining apparatus is of the same construction as in Figure 1, comprising the line relay 10, interpolating relay 11, regenerating relay 13 and pick-up relay 12.

In operation, let it be assumed that the negative double impulse, shown in curve A of Figure 2, begins at the moment that the tine 52 of the tuning fork 51 is midway between the contacts 53 and 54 and is moving toward contact 53. The negative current flowing through winding 16 of the cable relay 10 operates the armature 17 of this relay to engage the marking contact 19. A circuit is thus established for the operating relay 11 from negative battery, over contact 19, armature 17, through the winding 22 of operating relay 11 to ground. The negative current flowing through the winding 22 moves armature 23 into engagement with its marking contact 25, thereby extending negative potential over contact 25 and armature 23 to the contact 53 of the tuning fork.

When the tine 52 comes into engagement with the contact 53, the negative potential on the contact 53 is extended over the tine 52 and through the winding 26 of the pick-up relay 12 to ground. The negative current flowing through the winding 26 moves the armature 27 into engagement with its marking contact 29, thereby extending negative potential over contact 29, armature 27 and through winding 30 of the translating relay 13 to the contact 54 of the tuning fork. When the tine 52 comes into engagement with the contact 54, the negative potential on the contact 54 is extended over the tine 52 and through the winding 26 of pick-up relay 12 to ground. Pick-up relay 12 is thus locked with its armature 27 in engagement with its marking contact 29. The negative current flowing through the winding 30 of the translating relay 13 moves the armature 32 into engagement with its marking contact 34 thereby extending a negative impulse over the line 50. At the same time a locking circuit for the translating relay 13 is established from negative battery over marking contact 34, armature 32, locking winding 31 to ground. This locking circuit maintains armature 32 of the translating relay 13 in engagement with its marking contact 34 until the translating relay 13 is unlocked by positive current flowing through the winding thereof, as will be described hereinafter.

Operation of armature 32 into engagement with its marking contact 34 also extends negative potential over marking contact 34, armature 32 and through the interpolating winding 21 of operating relay 11, to ground.

The negative current flowing through the interpolating winding 21 has no effect at this time due to the current in winding 22, but will operate to move the armature 23 into engagement with its spacing contact 24 at the moment when the armature 17 of the cable relay 10 is deflected to its neutral position 20 which deflection occurs when the negative impulse coming in over the cable terminates and drops to zero.

It will now be assumed that the incoming negative double impulse becomes distorted and persists on the cable until time 52 comes into engagement with the contact 53. When the time 52 comes into engagement with the contact 53, armature 17 of cable relay 10 will still be in engagement with its marking contact 19 and armature 23 of operating relay 11 will still be in engagement with its marking contact 25. Therefore negative potential will be extended over contact 25, armature 23, contact 53, time 52 of tuning fork 51, winding 26 of pick-up relay 12, to ground. Pickup relay 12 will maintain its armature 27 in engagement with its marking contact 29. When the negative double impulse terminates or drops to zero armature 17 moves to its neutral point 20 thereby de-energizing the winding 22 of the operating relay 11. When this occurs the continuous negative current flowing over marking contact 34, armature 32 and through interpolating winding 21 takes effect and moves armature 23 into engagement with its spacing contact 24 thereby extending positive potential over contact 24, armature 23, contact 53, time 52 of the tuning fork and through winding 26 to ground. The positive current flowing through winding 26 operates the armature 27 into engagement with its spacing contact 28 thereby extending positive potential over spacing contact 28, armature 27 and through winding 30 of translating relay 13 to contact 54 of the tuning fork 51. When the time 52 of the tuning fork 51 comes into engagement with the contact 54, the positive potential on the contact 54 is extended over the time 52 and through the winding 26 of the pick-up relay 12 to ground. Pick-up relay 12 is thus locked in its operated position with its armature 27 in engagement with its spacing contact 28. The magnetic effect of the positive current flowing through the winding 30 of the translating relay 13 predominates over that of the negative current flowing through the locking winding 31 and moves armature 32 into engagement with its spacing contact 33 thereby extending a positive impulse over the line 50. This impulse is indicated in curve B of Figure 2 as the single positive impulse.

During the time that the time 52 of the tuning fork 51 is in engagement with the contact 54, the interpolating winding 21 of the operating relay 11 is energized by positive current flowing from positive battery over

spacing contact 33 and armature 32 of translating relay 13. This causes armature 23 of operating relay 11 to move into engagement with its negative or marking contact 25 extending negative potential to contact 53 of the tuning fork 51 so that when the time 52 comes into engagement with the contact 53 the winding 26 of the pick-up relay 12 will be energized by negative current and will operate its armature 27 into engagement with its marking contact 29. Negative potential is thus extended over contact 29, armature 27, through winding 30 of the translating relay 13 to the contact 54 of the tuning fork 51 so that when the time 52 comes into engagement with the contact 54, the winding 26 of the pick-up relay 12 will be locked in its operated position with the armature 27 in engagement with the marking contact 29. The negative current flowing through the winding 30 will move the armature 32 into engagement with the marking contact 34, thereby extending a negative impulse over the line 50. This impulse is indicated in curve B of Figure 2 as the single negative impulse.

As long as the impulse is displaced not more than half an impulse interval so that it drops to zero when fork 52 engages contact 53, the received impulses will be interpolated correctly. My system accordingly provides for a more accurate operation than has heretofore been obtainable.

Although, I have disclosed my invention in connection with a specific adaptation thereof, other forms thereof will be evident to those skilled in the art and I accordingly do not wish to limit myself except insofar as set forth in the appended claims.

I claim:

1. In a signalling system, an incoming line over which negative, zero and positive current conditions are received, a receiver associated with said line for translating the zero conditions into alternate negative and positive signals, and means including circuit connections so arranged that the receiver will invariably interpolate said negative and positive signals regardless of the duration of an impulse interval caused by any displacement from normal in the received signal.

2. In a signalling system, an incoming line over which impulses are received, a line relay associated with said line and responsive to the received impulses, an operating relay having two windings, one of said windings being controlled by the line relay, a pick-up relay controlled by the operating relay, a translating relay controlled by the pick-up relay, the second winding of said operating relay being continuously controlled by the translating relay and caused to reverse at the instant the received impulse ceases.

3. In a signalling system, an incoming line over which impulses are received, a line relay

associated with said line and responsive to said impulses, an operating relay having two windings, one of said windings being controlled by the line relay, a distributor, a pick-up relay controlled by the operating relay through said distributor, a translating relay controlled by the pick-up relay, said translating relay continuously controlling the second winding of the operating relay and causing the latter to reverse at the instant the received line impulse ceases, said translating relay operating to repeat the impulses received over the line.

4. In a signalling system, a line relay responsive to received line impulses, an interpolating relay operated by said line relay, a repeating relay, a distributor interposed between said interpolating relay and said repeating relay for associating said relays during the mid portion of each impulse interval and means for continually maintaining said interpolating relay energized whereby it is effective to operate said repeater relay in accordance with received impulses which are displaced a substantial percentage from normal.

5. In a signalling system, a line relay responsive to received line impulses, an interpolating relay operated by said line relay, a repeating relay, a distributor interposed between said interpolating relay and said repeating relay for associating said relays during the mid portion of each impulse interval and means including circuit connections directly from said repeating relay armature to said interpolating relay for continually maintaining said interpolating relay energized whereby it is effective to operate said repeater relay in accordance with received impulses which are displaced a substantial percentage from normal.

6. The method of interpolating received signal impulses in a system including a receiving relay, interpolating relay, pick-up and repeating relay which comprises normally maintaining the interpolating relay non-effective, operating the interpolating relay in accordance with the line relay to prepare an energizing circuit for the pick-up relay in accordance with the operation of the interpolating relay, thereafter rendering the interpolating relay effective to operate the pick-up relay to prepare a circuit for the repeating relay and completing the prepared repeating relay circuit and simultaneously rendering the interpolating relay non-effective.

7. The method of signalling in a system comprising a line relay, interpolating relay and repeating relay which comprises operating the interpolating relay in accordance with the line relay and alternately rendering the interpolating and repeating relay effective and continually energizing the interpolating relay under control of the repeating relay.

8. The method of signalling in a system

comprising an interpolating relay and a repeating relay which comprises alternately rendering the interpolating relay effective and operating the repeating relay.

9. In a signalling system, an interpolating relay, a repeating relay, a distributor interposed therebetween, means for rendering said interpolating relay effective to operate said repeating relay and means for thereafter conditioning said repeating relay for operating in accordance with the condition of said interpolating relay.

10. In a signalling system, an interpolating relay, a repeating relay, a distributor interposed therebetween, means for rendering said interpolating relay effective to operate said repeating relay, means for thereafter conditioning said repeating relay for operating in accordance with the conditions of said interpolating relay and means for continually energizing said interpolating relay under control of said repeating relay.

11. In a signalling system, an interpolating relay, a repeating relay, a distributor interposed therebetween, means for rendering said interpolating relay effective to operate said repeating relay, means for thereafter conditioning said repeating relay for operating in accordance with the condition of said interpolating relay and means for continually energizing said interpolating relay under control of said repeating relay, a line relay for operating said interpolating relay, said last mentioned means being non-effective when said line relay is operating said interpolating relay.

12. In a signalling system, a vibrating member, a repeater relay, a line relay and an interpolating relay associated with said line relay, said vibrating member periodically associating said interpolating relay with said repeater relay.

13. In a signalling system, a vibrating member, a repeater relay, a line relay and an interpolating relay associated with said line relay, said vibrating member periodically associating said interpolating relay with said repeater relay and a direct connection from said repeating relay to said interpolating relay.

In testimony whereof I affix my signature.
HERBERT ANGEL.