Oct. 5, 1926. 1,601,941

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SUBMARINE TELEGRAPH SYSTEM

Filed Oct. 4, 1922 2 Sheets-Sheet 1

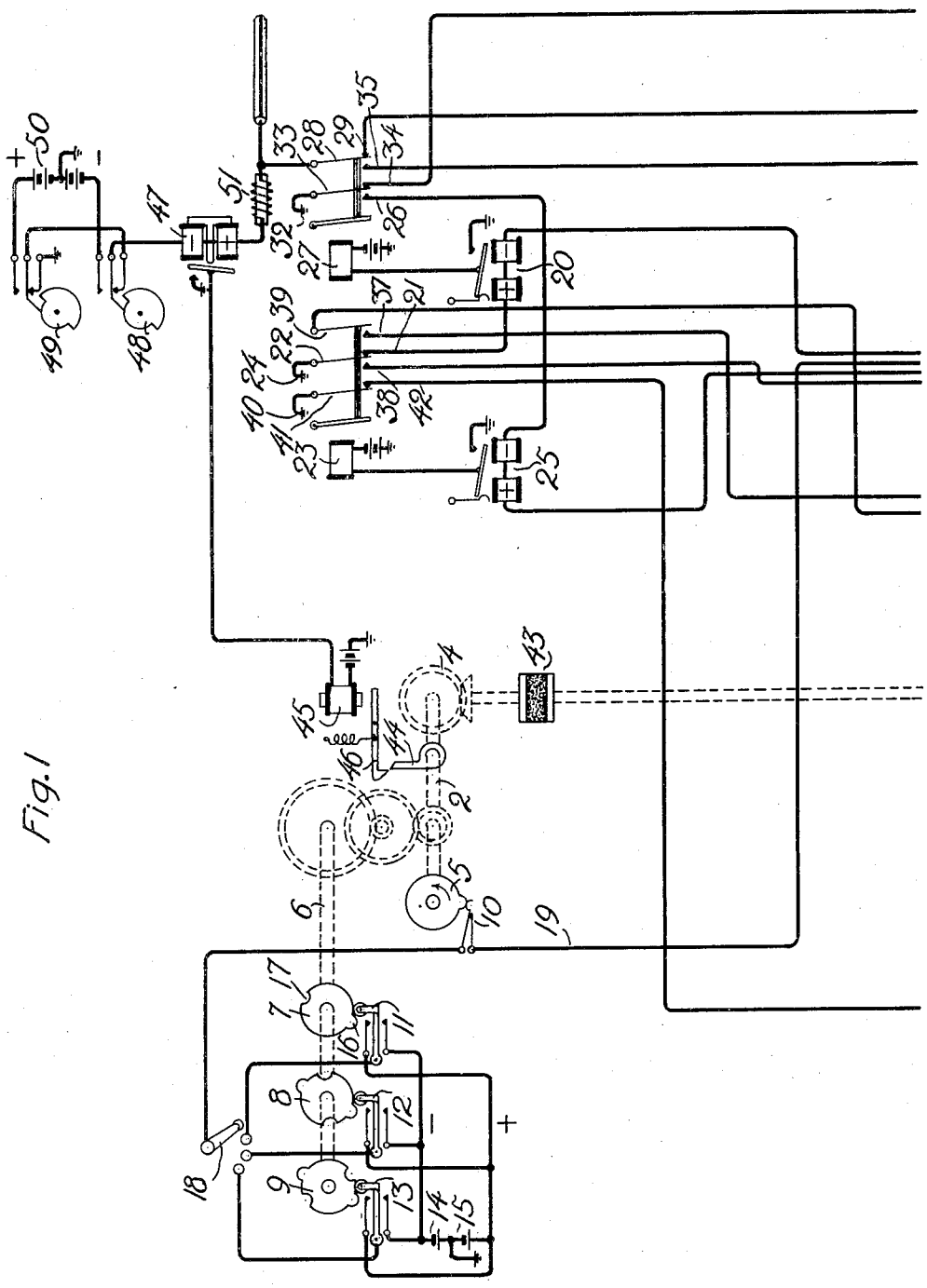

Fig. 1

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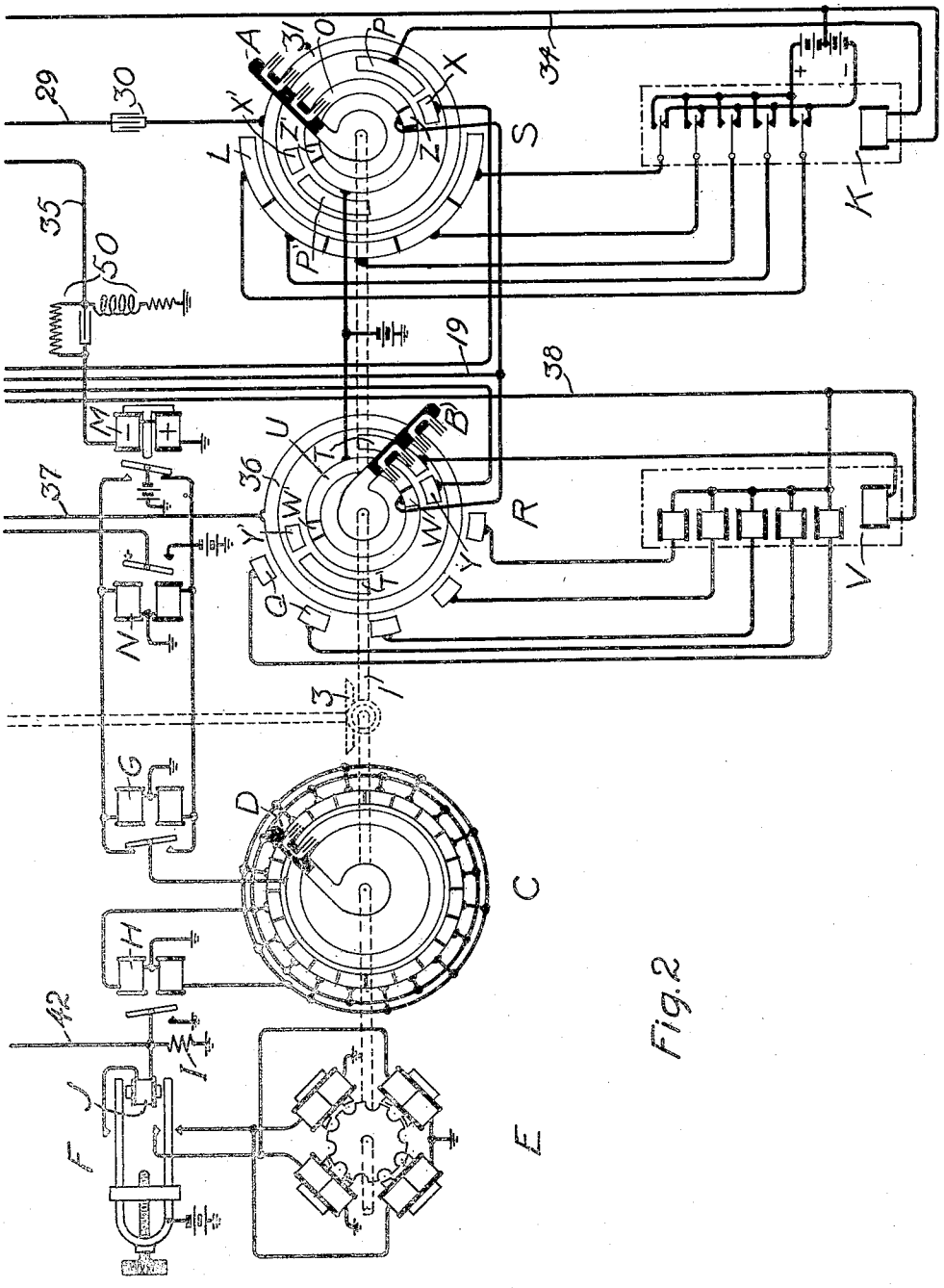

Fig. 2

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Patented Oct. 5, 1926.

1,601,941

UNITED STATES PATENT OFFICE.

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SUBMARINE TELEGRAPH SYSTEM.

Application filed October 4, 1922. Serial No. 592,216.

This invention relates to automatic signaling over transmission lines and particularly to telegraphic signaling over submarine cables.

The principal object of the invention is to provide a method and means for changing at desired times the direction of signal transmission over a line or cable over which messages are transmitted in one direction only at one time.

The usual method of telegraphic signaling over lines and cables involves the use of an artificial network which electrically balances the line for outgoing signals with respect to the receiver, so that the latter is unaffected by transmitted current. It is impossible, however, to make an artificial network which exactly simulates the line or cable for all frequencies and the resultant interference with received signals increases with increase of signaling frequency. It has recently been proposed to increase very greatly the speed of signaling over ocean cables by inductively loading the cable by means of a surrounding sheath of a newly discovered alloy of iron and nickel of very high permeability at low magnetizing forces The signaling frequencies obtainable are so high that difficulty is experienced in obtaining an artificial balancing network which simulates the cable with sufficient accuracy to permit duplex operation. An alternative is to adopt simplex operation with periodic reversal of the direction of transmission.

The present invention provides means for simplex operation comprising automatic means for reversing the direction of transmission from time to time in a manner, when necessary, to provide for heavier traffic conditions in one direction than the other. A minimum loss of line or cable time at the periods of reversal is obtained and the occurrence of false or overlapping signals is prevented.

This system has been developed for use with the high speed cable mentioned above, but is adapted for use with either submarine cable or land lines wherein simplex operation is of advantage because of difficulties of obtaining duplex balance or for other reason. Certain features of the invention are obviously not limited to use in simplex systems and this has been borne in mind in drafting the claims attached to the following specification.

The invention is described in detail in the following specification in which reference is made to the accompanying drawing. Figs. 1 and 2 taken together, with Fig. 1 above Fig. 2, show diagrammatically one embodiment of the invention.

Each end of the cable is provided with a distributor comprising a sending face S, a receiving face R and a correcting face C, the brushes A, B, and D associated therewith being driven by an impulse motor E controlled by a driving fork F. The two distributors are maintained in synchronism by means of the electrical correction method which is well known in the art, comprising a leak relay G, a corrector relay H and a resistance I which is in series with the fork driving magnet J. Transmission is accomplished in the usual manner by a perforated-tape controlled transmitter K, operating in conjunction with the segmented sending ring L, local ring O, local segment P, and brush A of the sending face S. The line impulses are received on a line relay M. or any other suitable type of relaying or amplifying device, and repeated into the print relay N which operates in conjunction with the segmented receiving ring Q, local ring U, local segment T, and the brush B of receiving face R to distribute the received impulses to the proper selecting magnets of the printer V, in a manner which is readily understood by those skilled in the art.

A shaft 2, carrying a contact closing cam 5, is driven by the distributor shaft 1 through reduction gear trains 3 and 4, of such ratios as to cause shaft 2 to make approximately one revolution per minute when distributor shaft 1 is rotating at the speed which corresponds to the normal transmission speed of the associated line circuit. Shaft 6, carrying contact closing cams 7, 8, and 9, is driven by shaft 2 through reduction gears to make one complete revolution for each 20 revolutions of the latter shaft, or approximately one revolution in 20 minutes. A cam follower 11 is arranged to be pressed against its negative contact by the raised portion 16, and against its positive contact by the depression 17 in the periphery of cam 7. Contact 10 will be closed once

each minute by the raised portion of cam 5, and as one of these closures of contact 10 will coincide with each operation of cam follower 11, negative battery 14 will be applied through cam follower 11, switch 18 and contact 10 to conductor 19 for a short time in each 20-minute period, and positive battery 15 will similarly be applied to conductor 19 for a short time during each 20-minute period. If the depression 17 of contact closing cam 7 is diametrally opposite the raised portion 16, short pulses alternating in polarity will be applied to conductor 19, once every 10 minutes. Contact cams 8 and 9, with alternating depressions and raised portions in their peripheries representing other time intervals, control cam followers 12 and 13, respectively, in a similar manner, and by means of the switch 18 can be made operative at will. Conductor 19 is connected to a local transmitter control segment Z and local receiving control segment W. Corresponding in position to segment Z, and connected thereto during a brief portion of a revolution of brush A, is segment X, which is connected through a polarized relay 20, contact 21 and armature 22 of the printer control relay 23 to ground at 24. A similar segment Y, on the receiving face of the distributor, is connected through a polarized relay 25 to contact 26 of transmitter control relay 27.

The cable is connected through armature 28 and contact 29 of transmitter control relay 27, sending condenser 30, to the common sending ring 31, and transmitter K is made operative by means of ground 32, applied to it through armature 33 and contact 34 of transmitter control relay 27. The line circuit to the receiving relay M and distortion correction network 50 is disconnected at contact 35 of transmitter control relay 27 and the tongue of printing relay N is disconnected from the receiving common ring 36 by separation of armature 39 from contact 37 of the printer control relay 23. The printer V is made inoperative by the open contact 38 of printer control relay 23, and the speed correction circuit is also made inoperative by a shunt circuit to ground 40 around the contacts of corrector relay H through contact 42 and armature 41 of relay 23.

In order to secure satisfactory operation of a synchronous system, the distributor brushes at opposite ends of the cable must be rotating at the same angular velocity and the angular displacement of the receiving brush with respect to the distant sending brush must represent at any instant the time required for a transmitted signal to traverse the entire length of the line plus the time required for the receiving relay to respond to an incoming signal.

When the distributors at opposite ends of the cable are thus rotating in synchronism and the sending and receiving brushes are in the proper phase relation, the printer at the station shown will remain inoperative, and the transmitter will continue to apply signaling impulses to the line until the coincident closure of cam follower 11 against its negative contact, circuit closer 10, and the gap between control segments Z and X of the transmitting face by the brush connections causes negative battery to be applied to the winding of polarized relay 20, thus reversing the position of its armature, and causing the magnet of transmitter control relay 27 to be energized. The attraction of the armature of relay 27 causes the cable connection to be transferred from the common sending ring 31 to the winding of line relay M, and simultaneously removes ground 32 from transmitter K and applies it through armature 33 and contact 26 of transmitter control relay 27 to the winding of polarized relay 25. Thus the transmitter circuit is made inoperative and if segments Z and X are properly positioned, this operation occurs after brush A has completed the transmission of a five-unit combination, but before it has started upon the transmission of the next succeeding combination set up on the transmitter associated with the adjacent channel. As brush B, associated with the receiving face, continues to rotate, connection between local control segments W and Y will be established and as contact 10 still remains closed and cam follower 11 remains against the negative contact during this brief interval, negative battery will therefore be applied to the winding of the polarized relay 25, which has been made operative through the engagement of armature 33 with contact 26 of transmitter control relay 27, thus reversing the position of the armature of relay 25 and causing the magnet of printer control relay 23 to be energized. As the armature of relay 23 is attracted, ground 24 is removed from the polarized relay 20 by the opening of contact between armature 22 and contact 21, thus making relay 20 inoperative. Ground 24 is simultaneously applied to the printer local through contact 38 of relay 23, and the armature circuit of printing relay N is connected through armature 39 and contact 37 of relay 23 to the common receiving ring 36, thus making the printer responsive to receive line impulses. The operation of relay 23 also opens the connection between its armature 41 and contact 42, thus removing the ground 40 from the resistance I in the correcting circuit of the driving fork F, thus placing the speed correction of the fork under control of the corrector relay H. Should brush B complete several revolutions before contact 10 is opened by cam 5, the direction of transmission will not be af-

fected, because the additional pulses applied to the winding of polarized relay 25 through segment Y, brush B and segment W of the receiving face R, contact 10, switch 18, cam follower 11, and battery 14, will be in the same direction as the initial controlling pulse so that the position of the armature of relay 25 will remain unchanged. As the distributors at the two ends of the circuit are assumed to be operating in synchronism and the brushes to be in the proper phase relationship, the same operations will occur at the proper time at the distant or receiving end, but in the reverse order, so that the distant end, therefore, becomes the transmitting station, and the direction of the transmission is reversed.

The distant station will now continue to transmit signals into the line and received line impulses will continue to operate printer V, until the distributor shaft 1 has made a sufficient number of revolutions to cause depression 17 in cam 7 to come opposite the end of cam follower 11 and permit the latter to be pressed against its positive contact. As previously explained, contact 10, will, at this time, be closed by the raised portion of cam 5, and upon the next passage of brush B over segments W and Y of the receiving face R, positive battery will be applied to the winding of relay 25, thus reversing the position of its armature and causing the magnet of relay 23 to become deenergized. As the armatures of relay 23 return to their original positions against their back contacts, the speed control resistance I, in the driving circuit of fork F is short circuited by ground 40, which is applied through armature 41 and contact 42, thus converting the station from the corrected to the pace-setting station. Simultaneously, ground 24 is removed from the printer local on contact 38 and is applied to the winding of polarized relay 20 at contact 21, and the opening of the printing relay armature circuit at armature 39 and contact 37 of relay 23 results in making the printer V inoperative. The next succeeding passage of brush A over segments Z and X of sending face S causes positive battery to be applied to the winding of relay 20, which reverses the position of its armature and causes the winding of relay 27 to become deenergized. The return of the armatures of relay 27 to their original positions against their back contacts causes the cable to be disconnected from the winding of line relay M at contact 35 and to be connected through armature 28 and contact 29 to the sending condenser 30 and the common sending ring 31 of the sending face S. The local circuit of transmitter K is made operative by the connection to ground at 32 established between armature 33 and contact 34, while the polarized relay 25 is made inoperative when the ground 32 on armature 33 is removed from contact 26. The distributors at opposite ends of the line are in synchronism and the passage of brush B over the control segments W and Y of the receiving face R occurs at such time with respect to the passage of the sending brush over control segments corresponding to segments Z and X on the sending face at the distant or transmitting end as to cause the local and line connections at that station to be changed from the transmitting to the receiving position at the instant of arrival of signal impulses or just prior thereto.

It is necessary that the cams 5 and 7 close at approximately the same time as the corresponding cams at the distant station. This is obtained in the following manner: A friction drive 43 is placed between the distributor shaft 1 and the cam shaft 2, which carries on it a stop arm 44 arranged to prevent the rotation of shaft 2, without affecting shaft 1, when stop magnet 45 is energized and holds latch 46 in engagement with stop arm 44. Stop magnet 45 is under the control of a polarized relay 47, arranged to be controlled by line impulses of low frequency transmitted by rotary selector keys 48 and 49 at either end of the line. The distributors at opposite ends of the line are started and brought into proper phase relation in the usual manner, with shaft 2 held stationary as described above. After transmission in one direction has been established, thus indicating that the transmitting and receiving distributors are rotating in proper phase relation the selector key 48 is operated. This transmits over the cable a single prolonged negative pulse from battery 50 which causes relay 47 and the corresponding relay at the distant end to open the circuits through both stop magnets 45, thus releasing the latches 46 and causing the shaft 2 at both ends of the cable to be set in motion in the proper phase relation, dependent upon the time required for a pulse to traverse the cable. The positive selector key 49 is provided to enable either station to stop the rotation of cams 5 and 7 preparatory to starting them in proper phase relation. The purpose of the inductance 51, which is placed in series with the line and relay 47, is to prevent that relay from being operated by currents of signaling frequencies.

Although by way of example printing telegraph apparatus for one channel only is shown, as many channels may be employed as desired, additional segments in the segmented distributor rings being provided. Additional local and control segments T', Y', W', P', X' and Z' for use if a second channel is added are illustrated.

In the accompanying claims the term "line" is used in a generic sense to include cable and the term "line time" is intended to

designate the time required for a signal pulse to traverse the line or cable and reach the receiver.

What is claimed is:

1. The combination with a transmission line, of signal transmitting means at each terminal, signal receiving means at each terminal, and adjustable control means to vary the connection of said line at predetermined intervals from said transmitting means to said receiving means and vice versa, said control means including manually controlled automatic timing means, whereby the length of said intervals may be varied.

2. The combination with a transmission line, of signal transmitting means at each terminal, signal receiving means at each terminal, and adjustable control means to vary the connection of said line at predetermined intervals from said transmitting means to said receiving means and vice versa, said control means including manually controlled automatic timing means at each terminal, whereby the length of said intervals may be varied.

3. The combination with a transmission line, of signal transmitting means at each terminal, signal receiving means at each terminal, and control means including a line control relay to vary the connection of said line at intervals from said transmitting means to said receiving means and vice versa, said control means including constantly rotating synchronously operating timing means at the terminals, whereby the length of said intervals is determined.

4. The combination with a transmission line, of signal transmitting means at each terminal, signal receiving means at each terminal, and control means including a line control relay to vary the connection of said line at intervals from said transmitting means to said receiving means and vice versa, said control means including synchronously operating timing means at the terminals having a phase relation with respect to each other dependent upon the time required for a signal impulse to traverse the line.

5. Terminal apparatus for a transmission line comprising printing telegraph transmitting and receiving apparatus including constantly rotating distributors, means adapted to connect said transmitting and said receiving apparatus alternately to said line, comprising a switch and an intermittently closing circuit closer separate from said distributor controlling said switch, and a common motive means for constantly driving said circuit closer and the moving elements of said distributors.

6. Terminal apparatus for a transmission line comprising printing telegraph receiving and transmitting apparatus including rotary distributors, a pair of relays for controlling the connection of said apparatus to the line, a second pair of relays each controlling one and controlled by the other one of said first mentioned pair of relays and control means for said second mentioned pair of relays comprising segments on said distributors and means for impressing positive and negative potential alternately.

7. The method of simplex transmission which comprises automatically performing in sequence and at the end of intervals which are long in comparison to the line time, the following steps of changing the relation of the line to the terminal transmitters and receivers: the active transmitter from operative to inoperative, the active receiver from operative to inoperative at the instant the last of the transmitted signals is received, the inactive transmitter from inoperative to operative, and the inactive receiver from inoperative to operative at the instant the first of the transmitted signals arrives.

8. The method of simplex transmission which comprises automatically performing in sequence and at the end of intervals which are long in comparison to the line time, the following steps of changing the relation of the line to the terminal transmitters and receivers, the intervals being longer for transmission in one direction than in the other: the active transmitter from operative to inoperative, the active receiver from operative to inoperative at the instant the last of the transmitted signals is received, the inactive transmitter from inoperative to operative, and the inactive receiver from inoperative to operative at the instant the first of the transmitted signal message train of waves arrives.

9. Means for controlling the connection of terminal transmitting and receiving apparatus to a transmission line comprising a circuit closer, a constantly moving means for periodically operating said circuit closer, a second circuit closer and constantly moving means for operating it periodically at a period which bears a multiple relation to the period of said first mentioned circuit closing means, common driving means for said constantly moving means, and a relay responsive to impulses over said line for controlling said driving means.

10. The combination with a transmission line of transmitting and receiving apparatus at each terminal and means for controlling the connection of said transmitting and receiving apparatus to said line comprising a circuit at each terminal, a circuit closer therein, means for periodically closing said circuit closer, sources of positive and negative potential, and a circuit closer for alternately including said sources of potential in said circuit, the intervals between the be-

ginnings of said inclusions bearing a multiple relation to the period of said first mentioned circuit closer.

11. Terminal apparatus for a transmission line comprising a local circuit, a circuit closer in said circuit, means for periodically closing said circuit closer, sources of positive and negative potential, means for alternately including said sources of potential in circuit with said circuit closer, the intervals between the beginnings of the inclusions of the one or the other of said sources of potential bearing a multiple relation to the period of closure of said circuit closer, a polarized relay, and additional circuit closing means for including said relay in said circuit.

12. The combination with a transmission line of a current operated device at each terminal thereof, means at each terminal for impressing currents of either of two characteristics at will upon said line and current operated devices, means at each terminal adapted to periodically close a local circuit closer including a moving element, means at each terminal controlled by said current operated device at that terminal for arresting the movement of said circuit closing means when current of one characteristic passes through said current operated devices, and for releasing said circuit closing means when current having the other characteristic flows through said current operated devices, and means for causing said moving elements at the terminals to operate substantially synchronously.

13. The combination with a transmission line of a polarized relay at each terminal thereof, means at each terminal for impressing either positive or negative potential at will upon said line and polarized relays, means at each terminal adapted to rotate and periodically close a local circuit closer, means at each terminal controlled by the armature of the polarized relay at that terminal for arresting the movement of said rotatable means when current of one polarity passes through said polarized relays, and for releasing said circuit closing means when current of the opposite polarity flows through said polarized relays, rotary distributors at each terminal, a motor at each terminal for driving said rotary distributors, and a friction clutch for transmitting power from said motor to said rotatable means.

14. The combination with a transmission line of terminal transmitting and receiving apparatus including synchronously operated distributors, means for periodically changing the electrical connection of said apparatus to said line whereby transmission takes place first in one direction and then in the other, a motor at each terminal for driving said distributors, electromagnetically driven tuning forks for controlling said motors, a resistance at each terminal adapted to be inserted in the electromagnet circuit, a relay adapted to cause the shortcircuiting of said resistance and controlled by incoming signals, a second relay adapted to short-circuit said resistance, and means for causing operation of said last mentioned relay whenever the direction of transmission is changed.

15. The combination with a transmission line, of transmitting and receiving apparatus at each terminal, means for periodically changing the electrical connection of said apparatus to said line whereby transmission takes place first in one direction and then in the other, moving means at each terminal adapted to have its motion controlled by or to control the movement of similar means at the other terminal, and means for automatically changing said control from said means at one terminal to that at the other whenever the direction of transmission is changed.

16. The combination with a line, of transmitting and receiving apparatus at each terminal of said line and means for periodically changing the electrical connection of said apparatus to said line whereby transmission takes place first in one direction and then in the other, said means comprising timing means at each terminal maintained in synchronism by the message signaling impulses, whereby the interval during which transmission takes place in each direction is determined.

In witness whereof, I hereunto subscribe my name this 30th day of September A. D., 1922.

ALLISON A. CLOKEY.