April 18, 1933. E. T. BURTON 1,904,618

TELEGRAPH SYSTEM

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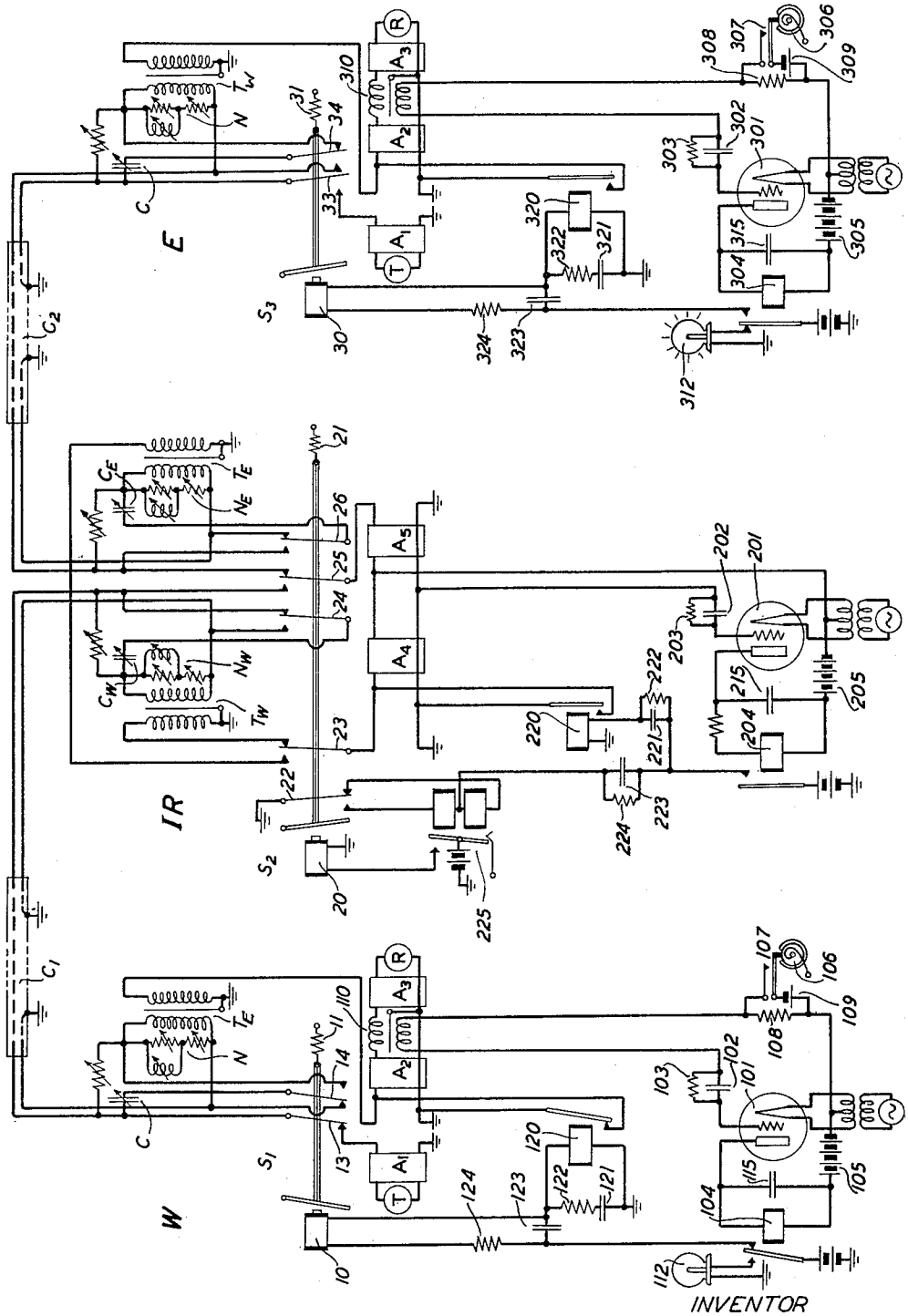

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UNITED STATES PATENT OFFICE

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TELEGRAPH SYSTEM

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This invention relates to telegraph systems and more particularly to the type of telegraph system known as "single Morse circuit" in which signals are transmitted over the line in only one direction at one time and in which the direction of transmission may be reversed, whenever desired, by means of a special reversing condition or signal impressed upon the line.

The invention, though not limited thereto, is especially adapted for use in telegraph systems operating over lines, such as long submarine cables, having a large attenuation factor; an example of such a system, to which the invention is applicable, is disclosed in Patent No. 1,632,275, issued on June 14, 1927, to A. M. Curtis.

An object of the invention is to avoid the use of mechanical timing devices responsive to the reversing signal for the control of the reversing operations.

A further object of the invention is the prevention of interference with the reversing signal by variations in earth potentials at the cable ends.

Another object is to insure that the reversing equipment responds but once to each reversing signal, thereby preventing the possibility of two stations becoming opposed to each other.

Another object is the reduction of disturbing effects and of delays at the time of reversal of the system due to charges in the cable and to earth currents.

Another object is the protection against overloading of the receiving equipment during reversal operations.

For the attainment of these and other objects which will be apparent from the following description, the invention in its preferred form provides for a system in which there is connected to the line circuit at each station, a leak circuit arranged to differentiate between two line conditions, one characterized by continued signaling and the other by a prolonged absence of signals. This leak circuit includes an electron discharge device or thermionic tube, the input circuit of which is subjected to potential variations from the line. The leak circuit also includes a network capable of storing potentials applied at the frequencies of the ordinary signals, thereby maintaining the electron discharge device in unoperated or paralyzed condition; however, during a prolonged steady condition on the line, the network after a predetermined interval loses its potential, thereby vitalizing the device, which then operates to cause the local reversing switch, associated with its output circuit, to reverse the direction of transmission of the station.

In accordance with the invention the coupling of the leak circuit to the line circuit is such as to prevent the entrance of very low frequency impulses into the input circuit of the electron discharge device, thereby preventing that the slowly varying earth currents interfere during the absence of signals with the operation of the electron discharge device and thus insuring definite control by the transmitting station of the switching of remote stations. The switching control is thus independent of the line potential and depends only upon the frequency of the line current.

The special reversing signal in accordance with the invention is transmitted from that terminal station which at the time is sending and constitutes an interruption of the outgoing signals and a temporary impression of a steady potential, preferably a ground or zero potential, on the cable; for this purpose a manual or automatic switch is preferably provided at each terminal station for conditioning the local electron discharge device to operate its associated reversing switch from its sending to its receiving position. The transmitting circuit of this operation being disconnected from the line and the grounded receiving circuit being substituted therefor, the electron discharge devices at the distant terminal station and at any intermediate station respond to the consequent cessation of signals and operate their associated reversing switches. The reversing switch at a station, under the control of its associated leak circuit, may, according to the requirements, be arranged to respond to the line conditions either by taking one position for signaling condition and the other position for no-sig-

naling condition, or by reversing in either direction under no-signal condition and maintaining its new position under signal conditions. In the latter instance it is necessary to prevent false operation of the switch, which, in a preferred arrangement in accordance with the invention, is accomplished by inserting, in the operating circuit for the switch magnet, a blocking network which prevents the magnet from operating more than once in response to a reversing signal.

Since considerable energy may be stored in the receiving transformer due to earth current flowing in the primary winding thereof, it would take considerable time, at the time of a reversal before the energy could be dissipated at a reasonable rate. In accordance with the invention, at least part of the receiving equipment at a repeater station, including the receiving transformer, is duplicated and one set is switched into the line circuit for transmission in one direction and the other set for transmission in the other direction, thereby permitting each transformer to remain in connection with its associated cable, no matter what the direction of transmission may be, so that it will be in condition for immediate use upon being switched into the line circuit.

For the further protection of the amplifiers in the receiving equipment during switch-over, the line circuit may be bridged and grounded temporarily to divert excessive impulses due to the switching operations and thus prevent overloading, particularly of the later stages of the amplifiers as described in the patent to Curtis, referred to above. In accordance with the invention, this protection is controlled from the leak circuit referred to above and its proper timing is attained by suitable networks.

The invention will now be described more in detail, both in regard to its operation and its objects, in connection with a telegraph system for transmission over long submarine cables. In this description reference will be made to the accompanying drawing, which shows a preferred form of the invention as applied to a telegraph system having terminal stations and an intermediate repeater station interconnected by means of long submarine cables.

In the drawing there is a schematic representation of a terminal station W, a similar terminal station E, and an intermediate repeater station IR, only enough apparatus being shown in detail at each of these stations to give a clear understanding of the invention and how it may be incorporated in a commercial system. Station W may, for example, be located at New York and is connected through a submarine cable C_1 to the intermediate repeater station IR, which may be located at the Azores and in turn is connected through the submarine cable C_2 to the terminal station E, which may be located in some European city, such as Rome.

The equipment in this system for sending and reception of commercial messages may correspond in all details to the system disclosed in the patent to Curtis 1,632,275, referred to above, and is shown in the drawing in a schematic form, and the equipment for synchronization of the two terminal stations may be similar to that disclosed in Patent 1,670,461 issued on May 22, 1928, to G. A. Locke or to that disclosed in application Serial No. 354,954 filed on April 13, 1929, by W. A. Knoop, and issued as Patent No. 1,848,180, on March 8, 1932, according to which disclosures the synchronization is under the control of the terminal station which is transmitting at the moment. Thus, at station W, the transmitting device T is of any well known type for sending of the ordinary signals; with this device is associated the necessary amplification equipment A_1 for impressing signals of sufficient strength onto the cable C_1, the signals usually being made up of plus and minus impulses in various combinations. Signals incoming from the cable C_1 to station W will be impressed upon the receiving equipment which comprises a shaping network N, amplifiers A_2 and A_3, and the receiving translating device R. Terminal station E may be identically equipped. At the intermediate station IR incoming signals from either one of the cables are switched into a receiving amplifier A_4 and then passed through the sending amplifier A_5 and thus will be repeated into the other cable. Networks N_W and N_E for shaping and phasing of the incoming signals, as shown in the patent to Curtis referred to above, are inserted between the cables C_1 and C_2, respectively, and the receiving amplifier A_4.

For the purpose of reversing the direction of transmission, each station is provided with an electromagnetically operated multi-contact switching device or gang switch; thus at station W the switching device S_1 comprises an operating magnet 10 having an armature for operation of the contact springs 13 and 14 against the return action of spring 11. At station IR the switch S_2 comprises the magnet 20 with its armature for operation of contact springs 23, 24, 25, 26 against the return spring 21; and at station E the switch S_3 comprises the magnet 30 with its armature for operation of contact springs 33 and 34 against the return spring 31. When the magnets of switches S_1 and S_3 are deenergized, the contact springs engage corresponding contacts toward the right to condition the main signaling equipment for reception of signals, at the same time disconnecting the transmitting circuit from the cable; whereas when the magnets are energized their respective contact springs will engage contacts toward the left, thereby con-

necting the transmitting circuit to the cable and disabling the receiving circuit. At the repeater station IR the contact springs of the switch S_2, when its magnet 20 is deenergized, will engage contacts toward the right for reception and retransmission of signals from W to E, whereas when the magnet 20 is energized, the contact springs engage contacts toward the left for the reception and retransmission of signals from E to W.

Assuming now the condition shown in the drawing, according to which the circuits at all three stations by means of the switches S_1, S_2 and S_3 are connected for transmission of signals from W to E, signals from transmitter T at station W pass through amplifier A_1 and contacts 11 of the switch S_1 into the cable C_1. At station IR the signals arrive in a greatly attenuated condition and pass over contacts 24 through receiving condenser C_W, shaping network N_W, receiving transformer T_W, closed contacts 23 and are then impressed upon the receiving amplifier A_4, then upon the sending amplifier A_5, whence they continue over closed contacts 25 of the switch S_2 into the cable C_2. At station E the attenuated signals are received from the cable and pass over receiving condenser C, closed contacts 34 of switch S_3 through shaping network N and receiving transformer T_W and then are impressed upon the receiving amplifiers A_2 and A_3 and the receiving translating device R. It will be noted that the switch S_1 for transmission from W to E is held operated, whereas the switches S_2 and S_3 are in released position.

For transmission from E to W the switch S_3 at station E will be energized, thereby connecting the transmitting equipment to the cable C_2 and disabling the receiving equipment; the switch S_2 at station IR will be energized, thereby connecting the receiving condenser C_E, shaping network N_E and receiving transformer T_E between the cable C_2 and the amplifiers A_4 and A_5, which in turn will be connected to the cable C_1, at the same time disabling the receiving condenser C_W with its associated network N_W and transformer T_W; and the switch S_1 at the station W will be deenergized, thereby disconnecting the transmitting equipment from the cable C_1 and connecting the receiving equipment, including transformer T_E, receiving amplifiers A_2 and A_3, and the receiving translating device R, to the cable. The circuit for transmission of messages under these conditions may readily be traced similar to the circuit traced above for transmission from W to E.

The equipment provided in accordance with the invention, for the proper switching of the stations, when it becomes desirable to reverse the direction of transmission, and for the protection of the receiving amplifiers during the switching operations, will now be described. For the purpose of this description the system will again be assumed to be in the condition shown in the drawing for transmission from W to E.

At station W there is provided a three element thermionic vacuum tube 101 for the detection of incoming signals in the receiving circuit of that station. The input circuit of the tube includes a high resistance 108, the secondary winding of transformer 110 and the condenser 102 with its leak resistance 103, which, when no signals are being received through the transformer 110 applies a zero potential to the grid of the tube with respect to the filament; the output circuit of the tube 101 includes the plate battery 105 and winding of relay 104. Under the assumed conditions the zero grid potential causes a plate current to flow, sufficient for the energization of relay 104, which by its front contact applies battery to a circuit through the winding of magnet 10 of the switch S_1 and the winding of shorting relay 120 to ground. The magnet 10 consequently holds the switch S_1 operated, thereby connecting the transmitting equipment to the cable and grounding over contacts 14 the receiving condenser C, thus disabling the receiving equipment and in turn maintaining a zero potential on the grid of vacuum tube 101. As long as these conditions prevail, the relay 120 in its operated condition places a grounded short circuit across the input circuit of receiving amplifier A_2, thereby effectively preventing excessive impulses, due to switching, from overloading the receiving equipment.

At the intermediate repeater station IR there is provided equipment similar to that described for station W and comprising the three electrode vacuum tube detector 201 including in its grid circuit the grid condenser 202 and leak resistance 203, and in its output circuit plate battery 205 and relay 204. The input circuit of the detector is shown connected directly across the output circuit of receiving amplifier A_4: however, this connection may be in the nature of an inductive coupling similar to the transformer 110 shown at station W. As long as impulses from amplifier A_4 are being impressed upon the input circuit of the detector 201, a charge will be maintained on the grid condenser 202 which will apply a negative potential to the grid, thereby reducing the plate current sufficiently to prevent the operation of relay 204.

At station E there is also provided a detector circuit similar to that described for station W and including the vacuum tube detector 301 with grid condenser 302 and leak resistance 303, the input circuit of which is connected through transformer 310 to the output of receiving amplifier A_2; the plate circuit of the tube 301 includes the relay 304 and battery 305. As described for station IR impulses from amplifier A_2 are impressed

upon the grid circuit of the tube 301 placing a charge on condenser 302 so that the negative potential on the grid will reduce the plate current sufficiently to prevent the operation of relay 304. With relay 304 deenergized, battery is disconnected from magnet 30 of the switch S_3 and from shorting relay 320, which consequently both remain deenergized. In this position of switch S_3 the transmitter T is disconnected from the cable and signals are received over condenser C, closed contacts 34, shaping network N, transformer T_W, into the receiving equipment A_2, A_3 and R, the short circuit across the input of amplifier A_2 being open at the contacts of relay 320.

The operations for reversal of the direction of transmission will now be described. For this purpose the terminal stations W and E are provided with keys 106 and 306, respectively, connected in the input circuit of the detectors 101 and 301. Referring particularly to station W, the key 106 is in the nature of a mechanical timing device, which may be manually operated, as for example, by the winding of a spring, to initiate the rotation of a cam adapted to close a set of contacts 107 for a predetermined length of time. The key 106 may be operated, for example, at a time when station W has completed the transmission of a message or the key may be automatically operated at certain definite intervals, for the reversal of transmission.

The closure of contacts 107 serves to insert in the grid circuit of the tube 101, the battery 109 thereby applying negative potential to the grid; the plate current thus is reduced sufficiently to cause the relay 104 to release. The release of relay 104 disconnects battery from magnet 10 and relay 120, thereby first deenergizing the magnet 10 for the release of switch S_1 and next releasing relay 120 for the removal of the short circuit across the input of receiving amplifier A_2 after the switching operation of switch S_1 has been completed. The sequential release of magnet 10 and relay 120 is secured by means of a network in multiple to relay 120 and consisting of condenser 121 and resistance 122, whereby the charge on the condenser 121, due to its previous inclusion in the operating circuit, is dissipated through the winding of relay 120 at a rate determined by resistance 122 to delay the release of relay 120; the condenser 123 bridged across the winding of magnet 10 is not of sufficient size to appreciably delay the release of magnet 10. The release of relay 104 causes the lamp 112 to light, indicating to the operator that the station is in condition for reception of signals.

Immediately upon the release of switch S_1, signals cease to flow out over the cable circuit and, considering first the station IR, the effect upon the detector tube 101 of the cessation of impulses from receiving amplifier 4 is, that the charge on condenser 202 during a predetermined time will be dissipated through the resistance 203, with the result that the grid receives zero potential and the plate current increases sufficiently to operate relay 204.

The operation of relay 204 places battery on the operating circuits of the two-position relay 225 and relay 220, the first circuit to be traced over condenser 223 and lower winding of double relay 225, closed contact 22 to ground and the other circuit to be traced over condenser 221, winding of relay 220 to ground. As will be readily understood by those skilled in the art the relay 225 may be a polarized relay, for which purpose a simple rearrangement of its operating circuit would be required. The lower winding of relay 225 attracts the armature, thereby connecting battery to magnet 20 which operates the contact springs of switch S_2 to connect with their left-hand contacts. Simultaneous with the operation of relay 225 and before the reversal of switch S_2 the relay 220 operates to place a temporary short circuit across the input of receiving amplifier A_4 thereby protecting the amplifier against excessive impulses due to the subsequent operation of switch S_2. The condenser 221 after a predetermined length of time, adjustable by means of leak resistance 222, becomes sufficiently charged to cause the release of relay 220 and the opening of the short circuit across the amplifier A_4 which takes place shortly after the completion of the reversal operation of switch S_2. The condenser 223 also assumes a charge which, by the time when the reversal of switch S_2 has been completed, is sufficiently high to prevent the operation of the upper winding of double relay 225 over the left-hand contact of spring 22; the armature of relay 225 is mechanically locked in both positions to stay put after the windings have become deenergized. Thus battery will be applied to magnet 20 until a new reversal is required, for which case a circuit is prepared in the new position of spring 22 for the operation of the upper winding of relay 225 which again will disconnect battery from magnet 20. The station IR is now ready for retransmission from E to W.

Considering next station E, the effect upon the detector circuit of the cessation of signals in the line circuit is similar to that described for station IR and results in the energization of relay 304 which connects battery to the operating circuit of magnet 30 of switch S_3 and relay 320, at the same time extinguishing lamp 312 to indicate to the operator that the station is in condition for transmission. For the purpose of securing the proper sequence of operation of the magnet 30 and relay 320, there is provided a network consisting of con-

denser 321 and resistance 322 forming a by-path for relay 320, similar to that described for relay 120, and a condenser 323 forming a by-path for magnet 30 similar to that described for magnet 10; whereas the condenser 323 is not of sufficient size to delay the release of the switch, as described in connection with the release of switch S_1, the condenser is sufficiently large to take an initial charge, when relay 304 operates, to delay the energization of magnet 30, which delay may be timed by the adjustment of resistance 324; and whereas condenser 323, similar to condenser 121, in discharging serves to delay the release of relay 320, the by-path for relay 320, including also resistance 322, is not of sufficiently low impedance to delay the energization of relay 320. The consequence is that relay 320 operates quickly to place a short circuit across the receiving amplifier A_2 for protection of the amplifier during the subsequent switching operation, and magnet 30 operates after a short predetermined time to connect the transmitting equipment over contact 33 to the cable, and to disconnect at contacts 34 the receiving condenser C from receiving transformer T_W and ground the condenser. During the following period of transmission by station E, the detector 301 will receive no impulses and consequently will cause the relay 304 to remain energized, thereby maintaining the station in condition for transmission.

The connection at station E of the transmitter T and amplifier A_1 to the line circuit will, in a commercial system, immediately cause the transmitter T to send and the effect of signals arriving at station IR upon the detector 201 is, that the condenser 202 will again be charged, thereby applying a negative paralyzing potential to the detector and thus reducing the plate current sufficiently for the release of relay 204. After the removal of battery by relay 204 from the operating circuits of relays 220 and 225, the charges on condensers 221 and 223 will be dissipated through resistances 222 and 224, respectively, thus preparing these relays for the next reversal of switch S_2. It will thus be seen that it is necessary for station IR to receive a series of signals in the new reversed direction before another reversal can be made, and that the series of signals must be of sufficient length to build up a charge on condenser 202 for the release of relay 204.

Referring now to station W, the signals arriving from station E are received over receiving condenser C, closed contacts 14, shaping network N and receiving transformer T_E and are impressed upon the amplifiers A_2 and A_3 and recorder R. The signals in the output circuit of amplifier A_2 are impressed, through the transformer 110, upon the input circuit of detector 101 thereby charging the condenser 102 to impress a negative potential on the grid circuit, temporarily aiding the negative potential of battery 109, which still is included in the grid circuit by the continued operation of key 106. Relay 104 remains deenergized, and after a short time the contacts 107 are restored to their open condition, thereby removing the battery 109 from the grid circuit which now is maintained negative under the influence of incoming signals, thus insuring that the switch S_1 remains released as long as signals are being received. The reversal of all three stations for transmission from E to W is thus completed.

For the purpose of again reversing the transmission to the direction from W to E the timing device 306 at station E is operated to close contacts 307, thereby releasing relay 304 and operating switch S_3 in the manner described for the corresponding equipment of station W. The cessation of signals at the repeater station IR again causes the operation of relay 204 which extends battery over the circuit through upper winding of relay 225, prepared at contact 22 at the time of the last reversal. Relay 225 operates to disconnect battery from magnet 20 of switch S_2, which now reverses and at contact 22 again prepares an operating circuit for the lower winding of relay 225 which, however, is prevented from energizing due to a charge built up in the meantime on condenser 223. Shorting relay 220 is operated, as described above, and the release of relay 204 and discharge of condensers 222 and 223, when signals commence to arrive from station W, take place as described above. The reversing operations at station W are exactly like those described for station E.

It will be observed that the reversal of transmission is always under control of the transmitting station and that a reversing signal is started by the cessation of signals from the transmitting station and continues until the remote terminal station commences to transmit.

In order that the operation of relays 104, 204 and 304 due to the loss of charge on the grid condensers 102, 202 and 302, respectively, in the absence of signals shall not be affected by disturbing currents of low frequencies, such as earth currents, the coupling of the input circuits of the detectors 101, 201 and 301 to the respective receiving circuits is such as not to pass impulses of low frequency into the input circuits. Thus by the connection of the leak circuit to a point beyond the first stage of the receiving amplifier the lower frequencies received from the cable have been discriminated against by a transformer in that stage, the transformer in a commercial system having low efficiency at the low frequency range. However by the insertion of a separate transformer, such as 110 at sta-

tion W in the coupling, additional frequency discrimination may be attained.

In a commercial system of the type described above, the transmitting equipment at each terminal station may be arranged to include a plurality of transmitters, and at such time, when no messages are being transmitted, the transmitters automatically continue to send synchronizing impulses over the line as long as they are connected to the line circuit for the purpose of keeping the distant receiving equipment in synchronism with the local transmitting equipment, and at the same time serving the purpose of maintaining the direction of transmission until either key 106 or 306 is operated.

It should be understood that the scope of the invention is not limited to the arrangement described above and shown in the drawing, but that the invention may be applied to systems of different kinds and may be modified in different manners well known to those skilled in the art without a departure from the principles or objects of the invention.

What is claimed is:

1. A long signaling line, a simplex telegraph station connected to said line and comprising sending and receiving equipments, relay means for alternately conditioning said equipments for operative relation with the line, frequency discriminating means for said relay means to differentiate between impulses of high and low frequencies to change the operative relation of said equipments at the cessation of impulses of one of said frequencies in the line.

2. In a communication system, the arrangement for remote switching control of a signaling station which comprises a long line circuit, a signaling station connected to said circuit, sending and receiving equipments at said station, relay means for alternately switching one and the other of said equipments into operative relation with said line circuit, connecting means between said relay means and said line circuit, and a biasing network included in said connecting means for preventing switching operation by said relay means during signaling and for causing said relay means to switch during a cessation of signaling.

3. A simplex telegraph station comprising sending equipment, receiving equipment, switching means for alternately switching said sending and receiving equipments into service, thermionic control means for said switching means, and biasing means for said control means to differentiate between signal and no-signal conditions on the line thereby rendering said control means responsive for the operation of said switching means.

4. A simplex telegraph station comprising sending equipment, receiving equipment, switching means for alternately conditioning said sending and receiving equipments for service, thermionic control means for said switching means, biasing means for rendering said control means unresponsive to line impulses including a high impedance for reducing the biasing effect of said biasing means upon said control means to render said control means responsive in the absence of line impulses thereby operating said switching means.

5. A simplex telegraph station for transmission of impulses alternately in opposite directions comprising switching means for reversing the direction of transmission of said station, thermionic control means for said switching means and a slow discharge circuit for paralyzing said control means during continued transmission of ordinary signals.

6. A simplex telegraph station for alternately sending and receiving high frequency impulses over a long line having a large attenuation factor, switching means for converting said station from receiving to sending condition, control means for said switching means responsive to a prolonged low frequency condition on said line to cause the conversion of said station and a slow discharge circuit for rendering said control means unresponsive to said low frequency condition between ordinary signals.

7. A simplex telegraph station for transmission of impulses alternately in opposite directions comprising switching means for reversing the direction of transmission of said station, a receiving circuit including a thermionic amplifier, a transmitting circuit, a leak circuit connected to said receiving amplifier and including a thermionic tube and a slow discharge circuit for maintaining a potential in the input circuit of said tube, said potential being supplied by incoming signals through said amplifier, and said tube having a plate circuit for operating said switching means when said slow discharge circuit becomes practically discharged in the absence of incoming signals.

8. A simplex telegraph system for transmission of signal impulses alternately in opposite directions comprising a long line circuit, signaling stations connected at remotely separated points to said line circuit, a ground connection for said circuit at each of said stations, switching means for converting said stations from receiving to sending condition, relay means at each station for operation of said switch means, biasing means for said relay means to differentiate between signal and no-signal conditions on the line thereby rendering said relay means responsive for operation of said switching means and connecting means including inductive coupling means between said line circuit and said biasing means, said inductive coupling having low efficiency at fre-

quencies considerably below the signaling frequency to prevent false operation of said switching means due to earth current variations.

9. A simplex telegraph system for transmission of signal impulses alternately in opposite directions comprising a long line circuit, signaling stations connected at remotely separated points to said line circuit, a ground connection for said line circuit at each of said stations, receiving and sending circuits and switching means at each station for reversing the direction of transmission, one of said stations including a thermionic amplifying device in said receiving circuit, a leak circuit, inductive coupling means between said leak circuit and said device, a signal detecting thermionic tube circuit in said leak circuit for operation of said switching means in the absence of impulses impressed on said leak circuit by said device, said inductive coupling having low efficiency at frequencies considerably below the signaling frequency to prevent earth current variations from entering said leak circuit.

10. A simplex telegraph station comprising sending equipment, receiving equipment, switching means for alternately switching said sending and receiving equipments into operative relation with the line, a thermionic electron discharge tube having an input circuit for reception of signal impulses from said receiving equipment and having an output circuit for control of said switching means, a condenser and a slow discharge circuit therefor in said input circuit for storing of a paralyzing potential for said tube supplied by impulses of signaling frequencies to prevent operation of said switching means and for discharging said paralyzing potential during a prolonged absence of signaling impulses in said receiving circuit to cause the operation of said switching means.

11. A simplex telegraph station comprising sending and receiving equipments, switching means for alternately switching said equipments into service relation with the line, thermionic control means for said switching means, biasing means connected to said control means for differentiating between signal and no-signal conditions on the line to render said control means responsive for the operation of said switching means, relay means interposed between said control means and said switching means for accomplishing the operation of said switching means during the responsive condition of said control means, and energy storing and dissipating means associated with said relay means to prevent operation of said switching means more than once for each responsive condition of said control means.

12. In a signal communication system for alternating transmission in opposite directions, two long cable sections, a repeater station intermediate said sections comprising signal repeating equipments having input and output circuits, automatic means for reversing the connections from said input and output circuits with respect to said cable sections for changing the direction of transmission of said station in response to a change in line conditions, and two sets of receiving circuit means, each continuously connected to its associated cable section, and each including a receiving condenser and a grounded input transformer, said switching means being adapted to render either one of said sets non-responsive to outgoing signals in accordance with the direction of transmission.

13. In a signaling system, a cable for the transmission of signals alternately in opposite directions, a receiving amplifier having an input circuit, switching means for connecting together and disconnecting said amplifier and said cable, control means for operating said switching means in response to a special signal repeated by said amplifier, a normally open shunt path for said input circuit for protection thereof during switching operations, means for temporarily closing said shunt path once in response to each special signal comprising a series circuit including a relay and a condenser and a slow discharge path for said condenser independent of said relay.

14. A communication system for transmission of signals alternately in opposite directions comprising two terminal signaling stations, a long line circuit interconnecting said stations, receiving and sending equipments at each station, switching means at each station for operatively associating said equipments alternately with said line circuit, thermionic control means and frequency discriminating means therefor at each station responsive to differentiate between impulses of signaling frequencies and impulses of longer duration to control said switching means for changing the station from receiving condition to sending condition at the termination of a message, and a source of potential and contact means therefor at each of said stations for temporarily biasing said control means to control the switching means for changing the station from sending to receiving condition.

15. A communication system for transmission of signals alternately in opposite directions comprising terminal and intermediate stations, a line circuit having a high attenuation factor interconnecting said stations, sending and receiving equipments at each station, switching means at each station for alternately connecting said equipments in operative relation to said line circuit for transmission in opposite directions, thermionic control means at each station for said switching means having an input circuit for reception of impulses from said receiving equip-

ment, energy storing and dissipating circuit means included at each station in said input circuit for differentiation between current variations of the signaling frequencies and current variations of longer duration to apply a biasing potential to said control means during a signaling period to prevent operation of said switching means and to discharge said biasing potential upon completion of a signaling period to operate said switching means, a source of continuous biasing potential at each terminal station and contact instrumentalities for temporarily connecting said source into said input circuit to apply said continuous biasing potential to the control means at said terminal stations for operation of said switching means from sending to receiving condition, and energy storing and dissipating circuit means at an intermediate station to prevent the operation of the switching means at said intermediate station more than once for each switching from sending to receiving condition of said terminal stations.

In witness wherof, I hereunto subscribe my name this 21st day of December, 1931.

EVERETT T. BURTON.