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CARRIER TELEGRAPH SYSTEM

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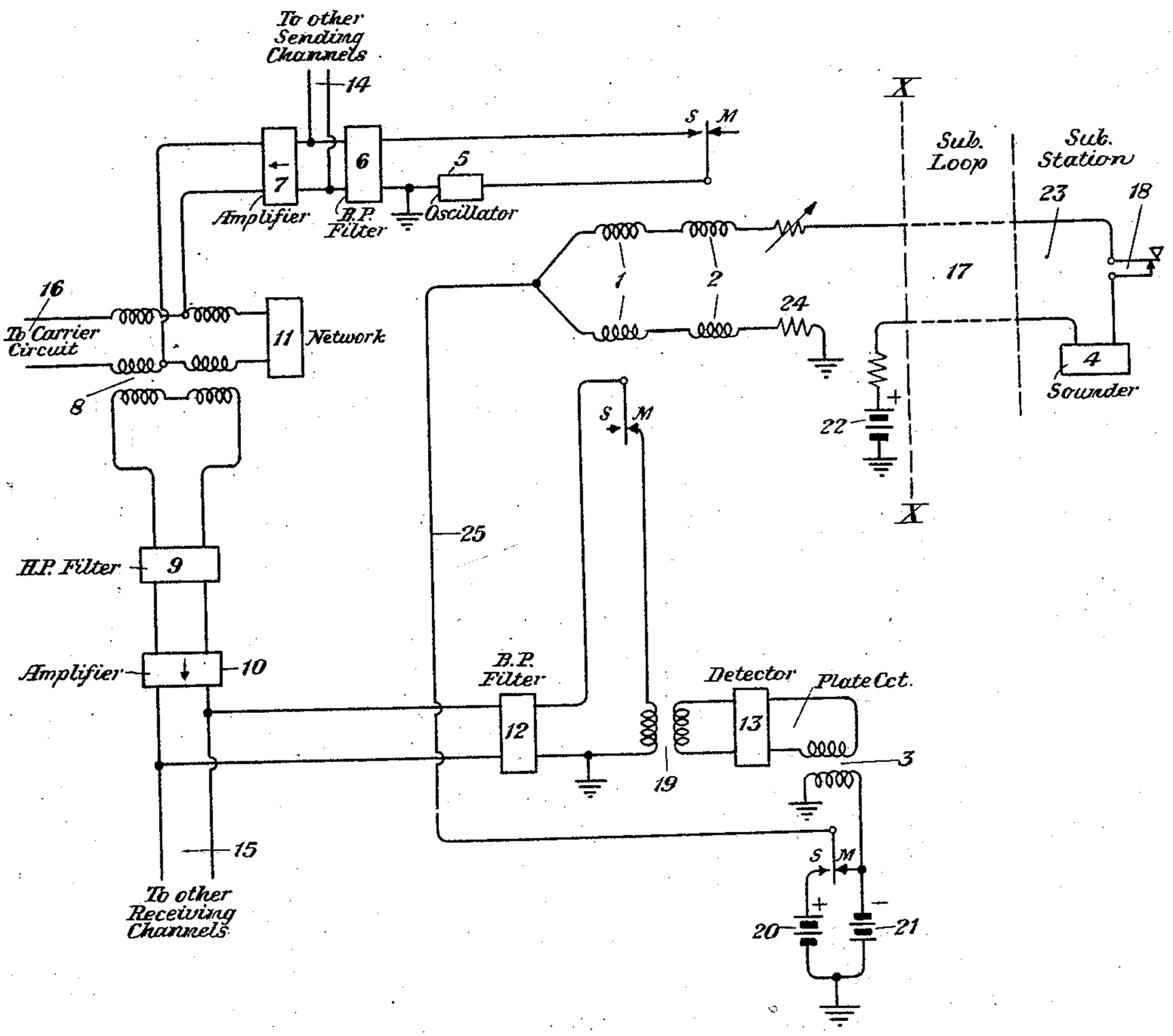

INVENTOR
V. P. Thorpe

BY

ATTORNEY

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VAUGHN P. THORP, OF RIVER EDGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

CARRIER TELEGRAPH SYSTEM

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This invention relates to the art of telegraph communication, and discloses a half duplex carrier telegraph system in which the same carrier frequency is utilized for the transmission of signals in both directions over a given carrier channel.

It is the general practice, in carrier current telegraphy, to use distinct frequencies for transmission in the two directions over a given channel. There are a number of reasons for this among which the following may be mentioned as being probably the more important. Where the full duplex method of operation is desired, the terminal apparatus is much simplified by the use of separate frequencies transmitting and receiving since, by the insertion of suitable band pass filters, interference between the transmitting and receiving equipment at the same end of a circuit may be eliminated. The use of separate frequencies transmitting and receiving simplifies the amplification of the telegraph currents at through repeater points located at intermediate points along the telegraph line. In this case, the insertion of suitable band pass filters in series with the repeater elements amplifying in opposite directions eliminates the necessity for inserting hybrid coils in the circuit at the repeater point for purposes of balance in order to eliminate singing. A third instance making desirable the use of distinct frequencies for transmitting and receiving over a carrier channel, occurs where two similar carrier systems are operating over conductor pairs of open wire line located on the same pole line. Under these conditions, if the same frequency were used for transmitting and receiving, the signals transmitted from one terminal over conductor pair A, say, would get over into conductor pair B and affect the carrier equipment at the terminal in question operating at the same frequency over the latter conductor pair.

Although for the reasons outlined above it is, in general, desirable to use separate frequencies for transmitting and receiving over a given carrier telegraph channel, instances occur in which the above difficulties are not encountered, and hence in such cases the use of separate frequencies transmitting and receiving is not required. For example, where it is desired to operate only by the half duplex method over a circuit which requires no repeaters, and having adjacent thereto no similar carrier system which would give rise to the possibility of interference with the first system. A short section of submarine cable containing only one pair of conductors for use in carrier current telegraphy would offer an example of a situation where the two latter difficulties would be eliminated.

A carrier current telegraph system adapted to utilize the same frequency for transmitting and receiving over a given channel is disclosed in the present invention, for use where practicable. The system is best understood by reference to the drawing, which shows in schematic form the terminal equipment at a given office both transmitting and receiving for a single channel, together with a subscriber's loop extending to a subscriber's station with control equipment at the subscriber's station for transmitting and receiving the signals.

Referring to the drawing, the equipment located to the left of the vertical line *xx* is located at the central office. This equipment is associated with the carrier circuit 16 which extends to the distant point. At the subscriber's station 23 is located a sending key 18 for controlling the transmission of carrier impulses to the distant point, and the sounder mechanism 4 operating under control of the carrier signals received from the distant point. The subscriber's station is connected to the equipment at the central office over the loop 17. It is understood, of course, that a printing telegraph transmitting and receiving set or other D. C. telegraph means could be used instead of the sending key 18 and sounder 4 which are indicated at station 23.

At the central office the equipment for transmitting signals to the distant point comprises the oscillator 5 for generating a single frequency carrier current, a band pass filter 6 for passing the generated current and an amplifier 7 for amplifying the same. The signal modulated carrier current is applied to the carrier line 16 through hybrid coil 8. The

balancing network 11 matches the impedance of the line 16 to prevent the transmitted current from entering the receiving equipment located at the same central office.

The receiving equipment is associated with the lowest winding of coil 8 and comprises the high pass filter 9 which serves to prevent the voice frequency telephone currents on the same line circuit from entering the receiving equipment, amplifier 10 to amplify the received carrier current, a band pass filter 12 to permit the proper frequency to enter the receiving equipment, detector 13 for rectifying the received carrier current and relay 3 operated by the current thus detected.

The circuit operation for the sending signals will first be considered. With key 18 down as shown, relays 1 and 2 are operated against their marking contacts M. This occurs as a result of current flowing from plus battery 22 over the lower conductor of loop 17, through sounder 4, sending key 18, upper conductor of loop 17, upper or line windings of polar relays 2 and 1 in series, over lead 25, through the marking contact M of relay 3 to ground through minus battery 21. This current, in flowing through the line windings of relays 1 and 2, holds the armatures thereof against the marking contact M. A second current, which flows from grounded negative battery 21, through the marking contact of relay 3, over lead 25, through the auxiliary or lower windings of relays 1 and 2 in series, through resistance 24 to ground, tends to operate relays 1 and 2 against their spacing contacts S. This current through the auxiliary windings, however, is smaller than the above described current flowing through the line windings, with the result that, while current flows through the line windings, the relays remain against their marking contacts. When, however, current in the line windings is interrupted, the current in the auxiliary windings causes relays 1 and 2 to move against their spacing contacts.

With key 18 down, as shown, causing the operation of relay 2 against its marking contact, as explained, the circuit containing oscillator 5 is opened at the contacts of relay 2, with the result that no carrier current is transmitted out over the line 16. When key 18 is opened, however, relays 2 and 1 immediately move against their spacing contacts, as explained above. The operation of relay 2 against its spacing contact closes the circuit containing oscillator 5 and thus causes the carrier current to be applied to line 16 through filter 6, amplifier 7 and hybrid coil 8. At the same time, the operation of relay 1 against its spacing contact opens the receiving circuit at the contacts of relay 1, and thus prevents any possibility of the transmitted current getting into and affecting the receiving detector 13. When, of course, key 18 is depressed again, it again completes the circuit through the line windings of relays 1 and 2, permitting current to flow therethrough and reoperate the relays against their marking contacts, in the manner explained.

It should be noted here that when key 18 is opened, operating relays 1 and 2 against their spacing contacts, the receiving circuit is opened at the contacts of relay 1 before the sending circuit is closed at the contacts of relay 2. Again, when key 18 is later depressed, reoperating relays 1 and 2 against their marking contacts, the operation of relay 2 opens the circuit for transmitting the carrier current before the receiving circuit is closed by the operation of relay 1. It will thus be seen that there is a certain operating margin which insures that the receiving circuit will always be open while carrier current is being transmitted from oscillator 5, thus insuring that the signaling current transmitted from a given office will not affect the receiving equipment at such office.

For the reception of signals from the distant point, key 18 is left closed continuously. The carrier signals incoming over circuit 16 flow through hybrid coil 8, through the high pass filter 9, through the amplifier 10, through the band pass filter 12, transformer 19 and detector 13. The receiving circuit is, of course, completed through the contacts of relay 1 since this relay is operated against its marking contact while key 18 is down, as explained. The incoming carrier signals operate relay 3 against its spacing contact S. Normally, with no incoming signaling currents this relay is held against its marking contact by current from grounded battery 21 through the lower or auxiliary winding of relay 3 to ground. The grid of detector 13 is so biased that normally no current flows in the upper or line winding of relay 3. When, however, carrier current is impressed upon the detector, a sufficient plate current flows in the line winding of relay 3 and in proper direction to operate it against its spacing contact. Relay 3 thus follows the incoming carrier signals and is operated against its spacing contact while carrier current is being received. These incoming carrier signals cause the operation of sounder 4 at subscriber's station 23 as follows. With no carrier current incoming, current flows from positive grounded battery 22, over the lower conductor of loop 17, through sounder 4, key 18, upper conductor of loop 17, line windings of relays 2 and 1 in series, over lead 25, through the marking contact of relay 3 to ground through negative battery 21 as explained. This current holds the sounder 4 operated to its marking position. When, now, a carrier signal incoming over the line 16 affects detector 13 and causes relay 3 to operate against its spacing contact, positive battery 20 is substituted for negative battery

21. This positive battery 20 is opposed to positive battery 22, and thus prevents the further flow of current through sounder 4. Sounder 4 is thus released and under spring biasing tension is operated against its spacing contact. Sounder 4 thus follows the incoming carrier current signals.

The circuit is arranged to transmit a "break" signal from the distant point during transmission of signals thereto from the near end. To show how the "break" feature operates, assume for the present that the break signal is transmitted while key 18 is down. In this case the transmitting circuit will be arranged as shown in the drawing. The break signal which is, of course, a spacing signal incoming over line 16, will flow through the receiving equipment and cause relay 3 to be operated against its spacing contact. The operation of relay 3, as was explained above, substitutes positive battery 20 for negative battery 21. The positive battery 20 opposes the positive battery 22 and thus prevents current flowing through sounder 4, causing the same to be operated against its spacing contact. Also, the opposing batteries prevent current from flowing through the line windings of relays 1 and 2. These relays are not operated against their spacing contacts in this instance, however, due to the fact that the direction of current flow through the auxiliary windings has been reversed, due to the substitution of positive battery 20 for negative battery 21. The negative battery 21, it will be remembered from the above explanation, normally supplies current through the auxiliary windings of relays 1 and 2, which tends to move these relays against their spacing contacts, and will do so when the current in the line windings is interrupted. In the present instance, however, current through the auxiliary windings is supplied from positive battery 20 which reverses the direction of normal current flow through the auxiliary windings and thus tends to hold these relays against their marking contacts, and will do so when, as in the present instance, no current flows in the line windings. Thus, it will be seen that, due to the substitution of battery 20 for battery 21 in the manner explained, the operation of the sending circuit is no longer under control of station 23, due to the fact that with key 18 either open or closed, no current flows in the subscriber's loop 17 and hence relays 1 and 2 and sounder 4 remain inoperative and do not follow the further operations of key 18.

Had key 18 been open when the break signal was transmitted from the distant point, relay 1 would, of course, have been operated against its spacing contact, thus opening the receiving circuit and preventing the break signal from affecting the detector 13 or relay 3. The break signal would be, therefore, ineffective until key 18 was closed, at which time the sequence of operations described in the immediately preceding paragraph would take place.

What is claimed is:

1. In a carrier current telegraph system in combination, a line extending from a first to a second office, a loop extending from the first office to a local subscriber's station and terminated in telegraph sending and receiving means thereat, sending relay means associated with said loop at the first office responsive to said subscriber's sending means, a sending circuit controlled in accordance with the operation of said sending relay means, an oscillator circuit individual to and associated with said sending circuit for applying thereto pulses of signaling current of a predetermined frequency for transmission over said line to the second office, filter means individual to said sending circuit, means at the first office associated with said line for receiving from the second office pulses of signaling current of said predetermined frequency comprising, a filter for passing current of said frequency, a detector associated therewith for rectifying the same, receiving relay means in the detector output responsive to said rectified current pulses for applying alternately plus and minus battery to the loop to operate said subscriber's receiving means, and means controlled by said sending relay means for opening the receiving circuit at the first office while signaling current of said frequency is being transmitted therefrom, and means for preventing the operation of said sending relay means at the first office and said subscriber's receiving means while steady signaling current is being received from the second office.

2. In a carrier current telegraph system in combination, a line extending from a certain point to a central office, a balancing network associated with the line at said office, a hybrid coil having input and output terminals interposed between the line and network, a loop extending from said office to a subscriber's station, a telegraph sending key and sounder associated with the loop thereat, polar sending and control relays associated with the loop at the central office responsive to said sending key operation, a sending circuit associated with the input terminal of said hybrid coil and controlled by said sending relay, an oscillator and an oscillator circuit individual to and associated with said sending circuit for applying thereto pulses of signaling current of a predetermined frequency for transmission over said line to said certain point, a filter circuit connected to said hybrid coil output terminals for passing pulses of signaling current of said predetermined frequency transmitted from said certain point, detector means connected to said filter for rectifying said current pulses, a receiving re-

lay in the detector output responsive to said rectified current for applying alternately plus and minus battery to said loop to operate said telegraph sounder, means for applying one of said batteries to the windings of said sending and control relays and to said sounder to prevent their operation while steady signaling current is received from said certain point, and means controlled by said control relay to prevent operation of the receiving relay by current transmitted from said oscillator.

3. In a carrier current telegraph system in combination, a line extending from a first to a second office, associated with said line at each said office the following: a balancing network to simulate the line impedance, a hybrid coil with input and output terminals interposed between line and network, a subscriber's loop extending from the central office to a subscriber's station, telegraph sending and receiving means associated with the loop thereat, a sending relay associated with the loop at the central office responsive to said subscriber's sending means, means controlled in accordance with the operation of said sending relay for applying to said hybrid coil input terminal pulses of signaling current of a predetermined frequency for transmission to the distant office, a receiving circuit connected to the hybrid coil output terminals comprising a filter for passing signaling current of said predetermined frequency transmitted from the distant office, a detector connected to said filter for rectifying said current, a receiving relay in the detector output responsive to said rectified current, and means controlled thereby for applying alternately plus and minus battery to said loop to operate said subscriber's receiving means, relay means associated with said loop responsive to said subscriber's sending means for opening said receiving circuit at a given office while signaling current is being transmitted from such office, and means controlled by the receiving circuit at a given office to hold the sending and control relays at such office and the receiving means at the subscriber's station connected thereto inoperative, while steady signaling current is received from the distant office.

4. In a telegraph system, in combination, a telegraph circuit extending from a first point to a second point, a sending key and a receiver at each of said points, a sending circuit at each of said points adapted to be effectively associated with said telegraph circuit in accordance with the operation of the sending key, a generator circuit individual to and associated with said sending circuit for applying to said sending circuit pulses of signaling current of a predetermined frequency for transmission to the other point, filter means individual to said sending circuit, a receiving system at each of said points for receiving the signaling current of said predetermined frequency, and means at each of said points controlled by the operation of the sending key thereat for rendering the receiving circuit thereat non-responsive to the transmitted signaling current while signaling current of said predetermined frequency is being transmitted therefrom.

5. In a telegraph system, in combination, a telegraph circuit terminating at a telegraph station, balancing means associated with said telegraph circuit, a sending key and a receiver at said station, a sending circuit at said station controlled in accordance with the operation of said sending key, a generator circuit individual to and associated with said sending circuit for applying to said telegraph circuit pulses of signaling current of a predetermined frequency for transmission to a distant point, a receiving circuit at said station for receiving signaling current of said predetermined frequency, and means at said station controlled by the operation of said sending key for rendering said receiving circuit non-responsive to the transmitted signaling current while signaling current of said predetermined frequency is being transmitted from said station.

6. In a telegraph system, in combination, a telegraph circuit extending from a first station to a second station, a telegraph receiver located at each station, a sending circuit at each station controlled by the operation of a sending key, an oscillator circuit individual to and associated with said sending circuit for applying to said sending circuit pulses of signaling current of a predetermined frequency for transmission to the other station, a filter individual to said sending circuit, a receiving circuit at each station adapted to receive signaling current of said predetermined frequency from the other station, and means at each station for rendering the sending circuit thereat ineffective for the transmission of signals and for preventing the operation of the receiver thereat while steady signaling current of said predetermined frequency is being received from the other station.

7. In a telegraph system, in combination, a telegraph circuit extending from a first station to a second station, a telegraph receiver located at each station, a sending circuit at each station controlled by the operation of a sending key, an oscillator and an oscillator circuit individual to and associated with said sending circuit for applying to said sending circuit spacing signals of a predetermined frequency for transmission over said telegraph circuit to the other station, a receiving circuit at each station adapted to receive spacing signals of said predetermined frequency from the other station, said receiving circuit being balanced with respect to said sending circuit, means at each station controlled by the operation of the sending key

thereat for rendering the receiving circuit thereat nonresponsive to signaling current while spacing signals of said predetermined frequency are being transmitted therefrom, and means at each station for rendering the sending circuit thereat ineffective for the transmission of signals and for preventing the operation of the receiver thereat while steady spacing current of said predetermined frequency is being received from the other station.

8. In a telegraph system a telegraph circuit extending to a telegraph station, a sending key and a receiver at said station, a sending circuit at said station adapted to be effectively associated with said telegraph circuit in accordance with the operation of said sending key, a generator circuit individual to and associated with said sending circuit for applying signaling current to said sending circuit for transmission to a distant point, a filter individual to said sending circuit, a receiving circuit at said station for receiving signaling current, and means at said station controlled by the operation of said sending key for rendering said receiving circuit non-responsive to the transmitted signaling current while signaling current is being transmitted from said station.

9. In a telegraph system a telegraph circuit extending from a first station to a second station, balancing means associated with said telegraph circuit at each station, a telegraph receiver located at each station, a sending circuit at each station controlled by the operation of a sending key, a generator circuit individual to and associated with said sending circuit for applying signaling current to said telegraph circuit for transmission to the other station, a receiving circuit at each station adapted to receive signaling current from the other station, and means at each station for rendering the sending circuit thereat ineffective for the transmission of signals and for preventing the operation of the receiver thereat while steady signaling current is being received from the other station.

10. In a telegraph system a telegraph circuit extending from a first station to a second station, a telegraph receiver located at each station, a sending circuit at each station controlled by the operation of a sending key, an oscillator and an oscillator circuit individual to and associated with said sending circuit for applying spacing signals to said sending circuit for transmission over said telegraph circuit to the other station, a filter individual to said sending circuit, a receiving circuit at each station adapted to receive spacing signals from the other station, means at each station controlled by the operation of the sending key thereat for rendering the receiving circuit thereat non-responsive to the transmitted signaling current while spacing signals are being transmitted therefrom, and means at each station for rendering the sending circuit thereat ineffective for the transmission of signals and for preventing the operation of the receiver thereat while steady spacing current is being received from the other station.

11. In a telegraph system a telegraph circuit extending to a telegraph station, sending means and a receiver at each station, relay means at said station controlled in accordance with the operation of said sending means, a sending circuit controlled in accordance with the operation of said relay means for applying signaling current to said telegraph circuit for transmission to a distant point, a filter circuit individual to said sending circuit, a receiving circuit at said station for receiving signaling current, means for preventing the signaling current in said sending circuit from being transmitted to said receiving circuit, and means controlled in accordance with the operation of said relay means for rendering said receiving circuit non-responsive to the transmitted signaling current while signaling current is being transmitted from said station.

12. In a telegraph system a telegraph circuit extending between two stations, a sending circuit at each station adapted to be associated with said telegraph circuit, a source of signaling current and a circuit therefor individual to and associated with said sending circuit at each station, filter means individual to said sending circuit, sending means and a receiver at each station, a receiving circuit associated with said telegraph circuit at each station, and means at each station controlled in accordance with the operation of the sending means thereat for rendering the receiving circuit thereat non-responsive to signaling current and after a predetermined interval of time for associating the sending circuit thereat with said telegraph circuit, said means also being adapted to dis-associate said sending circuit from said telegraph circuit in response to the further operation of said sending means and after a predetermined interval of time to render said receiving circuit responsive to the signaling current.

In testimony whereof, I have signed my name to this specification this 8th day of August 1928.

VAUGHN P. THORP.