Feb. 18, 1930. R. C. MATHES 1,747,835

TWO-WAY SIGNALING SYSTEM

Filed Dec. 6, 1927

FIG. 1

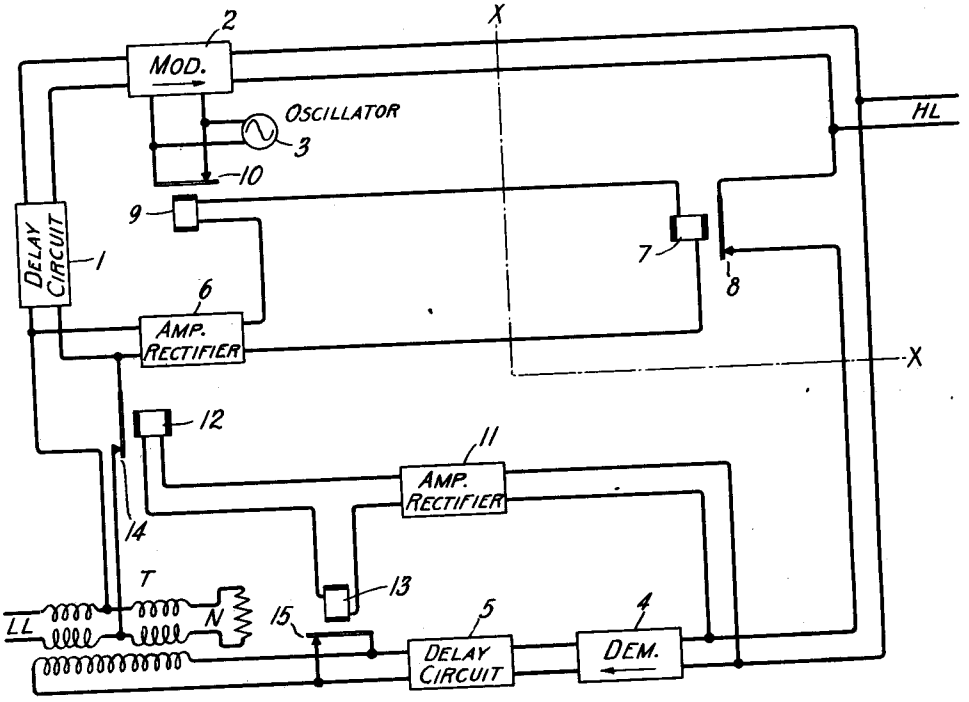
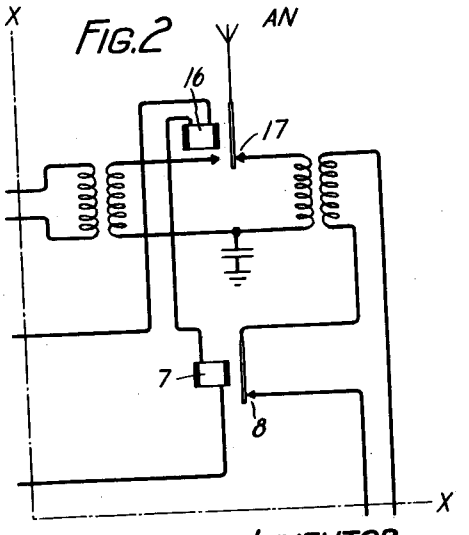



FIG. 2

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# UNITED STATES PATENT OFFICE

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## TWO-WAY SIGNALING SYSTEM

Application filed December 6, 1927. Serial No. 238,046.

This invention relates to signaling systems and methods of operation and more particularly to two-way signaling systems employing preferably waves of the same carrier frequency for transmission in both directions.

Arrangements have heretofore been proposed for operating signaling systems in both directions in which voice operated relays control the sending and receiving apparatus. There is disclosed in U. S. Patent 1,691,076 issued November 13, 1928, to me, a voice operated control system for two-way radio signaling systems in which the relays controlling the sending and receiving circuits are energized by voice currents.

An object of the invention is to provide improved methods of and apparatus for operating a two-directional carrier transmission system in which the same carrier frequency is used for transmission in both directions.

Another object of the invention is to provide switching means which are operated under control of the signals and which are positive in their operation and are of simplified and relatively inexpensive construction.

A feature of the invention is that the carrier wave from the sending station is utilized to energize the switching means at the receiving station. This use of the carrier wave provides the maximum initial energy for operating a switch at the receiving end as compared with the slowly rising energy which would be supplied by some types of signals especially speech as delivered by the demodulator.

In the specific embodiment of this invention herein shown and described a voice operated control system similar to that disclosed in the copending application referred to above is used except that the receiving channel is put in operative condition by the carrier currents which are transmitted along with the side band energy due to the voice currents. Part of the voice currents at the sending end of the line are transmitted through an amplifier-rectifier to operate a relay which disables the receiving apparatus at the sending end and also to operate another relay which renders operative the carrier current oscillator, permitting the oscillater current to pass through the modulator and over the line to the receiving station. At the receiving station this carrier current passes through an amplifier-rectifier and operates a relay which disables the transmitting apparatus in the receiving station and also operates a second relay which renders operative the receiving circuit at the receiving station. The two stations are then in condition to signal in one direction only. The rest of the voice currents from the sending end pass through a delay filter to the modulator, thus inducing side band currents which pass out over the line along with the carrier. This delay filter insures that the various switching functions at the sending end are completed and that the sending circuit as a whole is prepared for one-way transmission at or before the instant when the first part of the signal reaches the modulator. An additional delay circuit may be used in the receiving circuit to insure that the relays which disable the transmitting apparatus at the receiving end and render operative the receiving apparatus have operated before the signals reach the receiving apparatus and thus insure that the received signal is not "clipped".

This second delay circuit need not, however, be as elaborate as those commonly used for performing similar functions and in some cases may be omitted altogether since in accordance with the invention the carrier is used to operate the switching apparatus at the receiving end and the voice currents may be delayed at the sending end for a sufficient time after the carrier has been transmitted to insure the proper operation of the relays at the receiving station before side band currents reach the demodulator.

The invention will be better understood by reference to the following specification and accompanying drawings in which:

Fig. 1 represents in diagrammatic form the circuits of a two-way carrier current station;

Fig. 2 represents a radio antenna circuit which may be substituted for that portion of the current of Fig. 1 to the right of lines X—X.

Since the terminal stations may be identical

in construction it has been deemed sufficient to illustrate only one terminal, and in the following description the manner in which signals are received at and transmitted from a distant station will be clear from reference to the single station shown.

In the particular system illustrated in Fig. 1 the transmitting system comprises the low frequency line LL, the delay circuit 1, the modulator 2, the oscillator 3 and the high frequency line HL, by which combination the signals from the low frequency line LL are used to modulate the current from oscillator 3, after which the modulated signal is transmitted over the high frequency line HL.

The delay circuit 1 may be a low pass filter as shown at 1*g* in Fig. 11 of U. S. patent to Campbell No. 1,227,114, granted May 22, 1917, although a delay circuit is not required to have the characteristics of a filter, or it may be of the type shown in U. S. patent to Arnold No. 1,565,302, granted December 15, 1925.

The modulator 2 is of the type well known in the art from which some of the unmodulated carrier component is transmitted along with the side bands.

The receiving system comprises the high frequency line HL, the demodulator 4, the delay circuit 5 and the low frequency line LL by means of which the received signal waves from the high frequency line HL are detected to reproduce a signal frequency current which is transmitted through the delay circuit to the low frequency line LL. The delay circuit 5 may be like delay circuit 1 or it may be different and as explained later in connection with the switching system disclosed, delay circuit 5 may in some cases be omitted.

The low frequency portions of the transmitting circuit are connected to the common line LL, through a three-winding transformer T and network N by means of which the connection may be made substantially conjugate.

The operation of the switching system is as follows: When the signal currents pass from the low frequency line LL, through transformer T, part of the signal current is shunted through an amplifier-rectifier 6 by a connection made at points in advance of delay circuit 1. The currents transmitted through this amplifier-rectifier operate relays 7 and 9. Relay 7 actuates switch 8 which is normally biased to the circuit closing position. Relay 9 actuates switch 10 away from its normal position as shown, removing the short circuit from oscillator 3 and allowing the carrier wave to pass through modulator 2 and over the high frequency line HL. Preferably, relay 7 is adjusted to operate before relay 9 in order to disable the receiving circuit before the transmitting circuit is in condition to transmit the carrier currents. The signal currents which pass through delay circuit 1, due to the time constant of this circuit, do not reach the modulator 2 until after relays 7 and 9 have operated.

As soon as switch 10 is opened by the operation of relay 9, the carrier currents, unmodulated by the signal currents, are transmitted over high frequency line HL to the receiving station. The action occurring at the receiving station will be understood by considering the receiving side of Fig. 1. Part of the received carrier current, by connection made at points in advance of demodulator 4, is shunted through amplifier 11 to energize relays 12 and 13, thereby actuating switches 14 and 15. Relay 12 is preferably adjusted to operate before relay 13 so that switch 14 will disconnect the sending circuit from transformer T before switch 15 removes the short circuit from the receiver.

The sending and receiving stations are then in condition for transmission in one direction only.

The time of transmission through the delay circuit 1 is so chosen that the signaling currents will not reach the input side of modulator 2 until the means for putting the sending circuit in operative condition have been operated by relays 7 and 9. Similarly, upon the termination of a signal the time lag of the relays may be such that the transmitting station is not rendered inoperative until the last part of the signal has traversed the delay circuit and has been transmitted by the modulator. Likewise, the time of transmission of delay circuit 5 is so chosen that the signaling currents will not reach the input side of transformer T at the receiving station until the means for putting the receiving circuit at the receiving station in operative condition have been operated by relays 12 and 13. The time lag of these relays is so chosen that the receiving station is not rendered inoperative for receiving until the last part of the signal has traversed the delay circuit 5 and transformer T to the low frequency line LL.

Obviously, since the means for putting the receiving circuit at the receiving station are operated by the carrier currents by means of a connection in advance of modulator 4, if delay circuit 1 has a sufficiently large time constant so that the signal modulated currents do not reach the demodulator until after the means for putting the receiving circuit at the receiving station in operative condition have been operated by relays 12 and 13, delay circuit 5 can be omitted.

Since both the sending and receiving stations are never in condition to transmit at the same time singing of the apparatus is impossible and it is also impossible for a signal current being transmitted in one direction to be reflected back to the receiver of the sending station.

Fig. 2 illustrates a radio antenna circuit which may be substituted for that portion of the circuit shown in Fig. 1 to the right of lines X—X for utilizing the invention in connection with a two-way radio signaling system in which the carrier is transmitted along with the side bands. Antenna AN which is normally biased by means, not shown, to its receive position is switched to its transmitting position by relay 16 which actuates switch 17. Relay 16 is in the transmitting control circuit and connected to amplifier-rectifier 6. In the connection shown relay 16 is in the energizing circuits of relays 7 and 9, and is actuated simultaneously with them.

While the one embodiment of the invention has been shown and described in detail, it is to be understood that the invention is generic in character and is not to be construed as limited to this particular embodiment since numerous modifications thereof may be made by persons skilled in the art without departing from the spirit of the applicant's invention, the scope of which is to be determined by the appended claims.

What is claimed is:

1. A two-way signaling system comprising a sending station, a normally inoperative receiving circuit, means at the sending station for transmitting a signal modulated carrier wave, and means operative during the transmission of said wave for rendering said receiving circuit operative to receive, said last means being controlled by the unmodulated carrier wave from the sending station.

2. In a two-way signaling system for transmitting modulated carrier waves of the same frequency in both directions, sending stations and normally inoperative receiving stations, means associated with said system to render said receiving station operative for one way transmission in response to transmitted waves and to restore the system to its normal condition when the transmitted waves cease, said means at the receiving station being responsive to the carrier waves from the sending station, and means to delay the transmission of signals until after the carrier waves have been applied to the sending circuit.

3. In combination, a line, sending and receiving apparatus associated therewith, employing carrier waves for telephonic transmission, voice operated relays for controlling the sending apparatus, and carrier operated relays for controlling the receiving apparatus, said carrier operated relays being rendered operative by the unmodulated carrier currents.

4. A signaling system comprising a plurality of sending and receiving stations, said receiving stations being normally disabled, means at said receiving stations for putting the receiving apparatus in condition to receive, said last means being actuated in response to the unmodulated carrier currents transmitted from a sending station.

5. The method of operating a two way carrier signaling system in which a transmitting and a receiving channel are provided at each of the two intercommunicating stations and the carrier is transmitted from a modulator along with the side band which comprises putting the source of carrier current at one of said stations in condition for transmitting in response to signal currents from said station, delaying the arrival of said signal currents at said modulator, and putting the receiving channel at the other of said stations in condition to receive in response to the unmodulated carrier currents from said first mentioned station before said signal currents from said last mentioned station arrive at said modulator at said first mentioned station.

6. In combination, a source of electrical impulses, a source of carrier current, means for modulating said carrier current by said electrical impulses, means for delaying the arrival of said electrical impulses at said modulating means, a high frequency line over which said carrier current is transmitted, and regulating means associated with said high frequency line, said last means operated by the unmodulated carrier current before the arrival thereat of said modulated carrier currents.

7. In combination, sending and receiving stations, a low frequency line at the sending station, a carrier current oscillator, means for modulating the current waves from said carrier current oscillator by the currents transmitted over said low frequency line at the sending station, a high frequency line connecting said stations, a low frequency line at the receiving station, and means operated by said unmodulated carrier currents for controlling the effective connection of said low frequency line at the receiving station with said high frequency line.

8. In a two-way signaling system comprising a normally inoperative receiving circuit, means at a sending station for transmitting a signal modulated carrier wave, means at said sending station for delaying the transmission of the signal current to the modulating means, means actuated in response to the unmodulated carrier currents, said means remaining actuated in response to the modulated carrier currents, for rendering said receiving circuit operative to receive, and means for restoring said receiving circuit to its inoperative condition upon the failure of the said carrier current.

9. In a telephone system, the combination of a transmitting device, a receiving device, a high frequency circuit, said transmitting device including a source of carrier current oscillations and a modulator, said transmitting device having associated therewith

means for putting said oscillator in condition for operation in response to voice currents and said receiving device having associated therewith means for putting it in condition to receive in response to said unmodulated carrier currents.

10. In a high frequency signaling system comprising telephone transmitting and receiving stations, said transmitting station comprising a generator of carrier frequency oscillations, means for modulating said carrier oscillations in accordance with said signal oscillations, said receiving station being normally inoperative, means for putting said receiving station in condition for operation, said last means being controlled by the reception of said unmodulated carrier frequency oscillations.

11. In a signaling system, a plurality of terminal stations each comprising a line adapted to transmit telephonic currents, a modulated carrier current telephone transmitting and receiving system associated with said line, and control means, each of said transmitting systems comprising a source of carrier currents, means for modulating said carrier currents in accordance with said telephonic currents, and means for transmitting said modulated and unmodulated oscillations, each of said receiving systems comprising means for receiving the unmodulated and modulated oscillations transmitted from another station and means for demodulating the received modulated oscillations, said control means comprising means actuated in response to the unmodulated oscillations received from said other station for preventing the transmission of oscillations from the local transmitting system while the carrier current oscillations are being received from said other station.

12. In a signaling system, a plurality of terminal stations each comprising a line to transmit telephonic currents, a modulated carrier current telephone transmitting and receiving system associated with said line, and control means, each of said transmitting systems comprising a source of carrier currents, means for modulating said carrier currents in accordance with said telephonic currents, means for transmitting said unmodulated and modulated oscillations, each of said receiving systems comprising means for receiving the modulated oscillations transmitted from another station and means comprising a demodulator for detecting the received modulated oscillations, said control means comprising means responsive to telephonic currents from said line for putting said transmitting system in condition to transmit and for preventing the transmission of oscillations from the local transmitting system to the local receiving system while voice currents are being transmitted from said line to said transmitting system, a delay circuit between said line and said modulating means for delaying the transmission of telephonic currents to said modulating means until said transmitting system is in condition to transmit and said local receiving system disabled, means responsive to unmodulated carrier currents transmitted from another station for putting said receiving system in condition to receive and for preventing the transmission of oscillations from the local transmitting system while carrier current oscillations are being received, from said other station, and a delay circuit between said demodulator and said line for delaying the transmission of telephonic currents from said demodulator to said line until said receiving system is in condition to receive and said local transmitting system disabled.

13. A signal transmission system comprising means to transmit a signal-modulated carrier wave containing an unmodulated carrier component, a normally inoperative receiving station, a signal receiving circuit thereat, means controlled by the unmodulated carrier component for rendering the receiving station operative to receive signals, and signal storing means in advance of the signal receiving circuit for permitting the receiving circuit to be put into operative condition before initial portions of the signal modulated carrier wave are impressed upon said signal receiving circuit.

14. A two-way signaling station for a carrier transmission channel, including a transmitting branch and a receiving branch, both normally inoperative, means responsive to impressed signals for rendering the transmitting branch operative to transmit signal controlled carrier waves over the channel and means responsive to unmodulated carrier wave components received from said channel to render said receiving branch operative to receive signals from said carrier channel.

In witness whereof, I hereunto subscribe my name this 3rd day of December, A. D. 1927.

ROBERT C. MATHES.