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CARRIER WAVE TRANSMISSION

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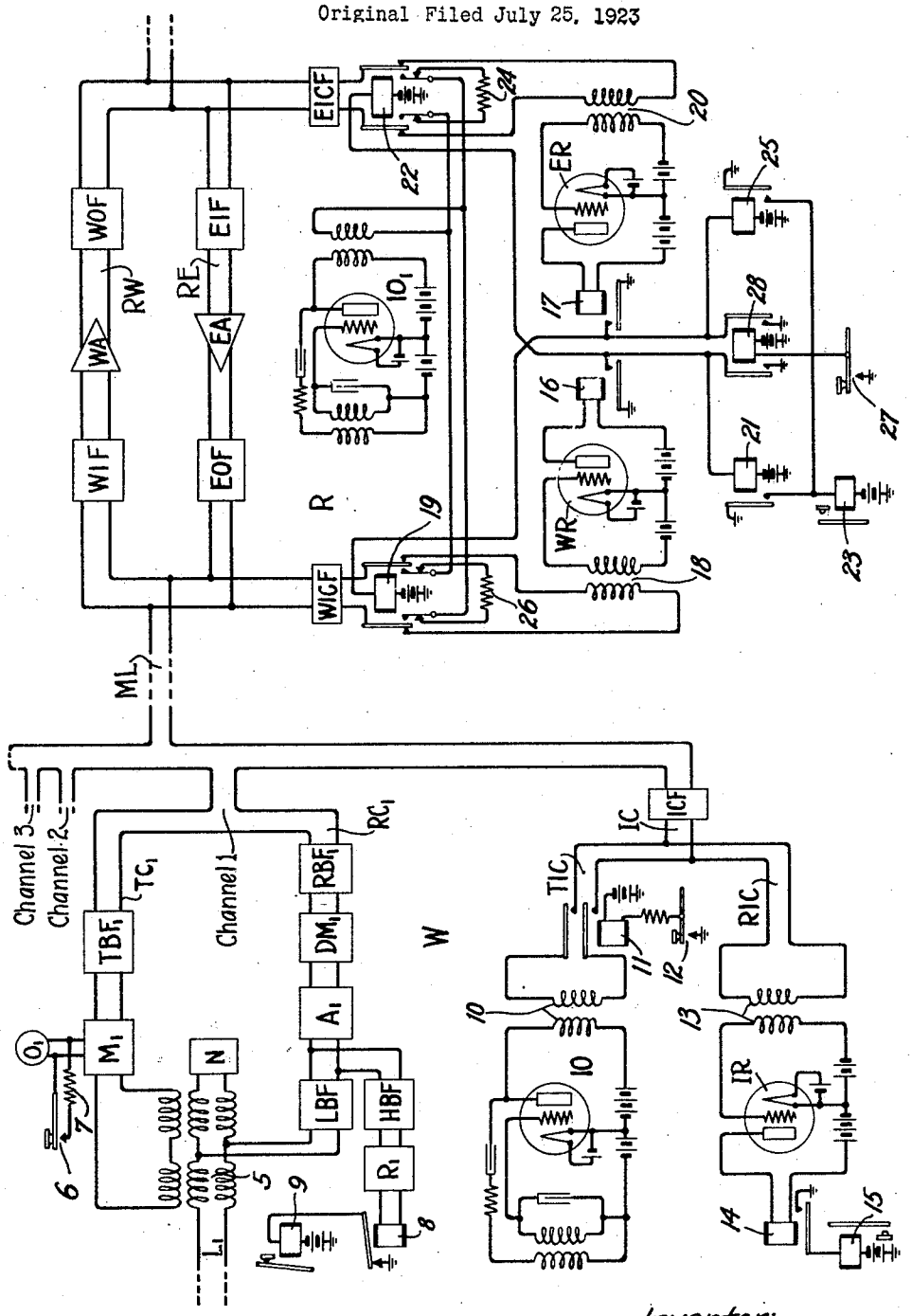

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UNITED STATES PATENT OFFICE.

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CARRIER-WAVE TRANSMISSION.

Original application filed July 25, 1923, Serial No. 653,629, patented December 21, 1926, No. 1,611,350. Divided and this application filed November 20, 1926. Serial No. 149,780.

This invention relates to carrier wave transmission, and is a division of application, Serial No. 653,629, filed July 25, 1923, patented December 21, 1926, No. 1,611,350.

An object of the invention is to provide in a multiplex carrier signaling system efficient intercommunicating means between the terminal and repeater stations.

Another object of the invention is to provide intercommunicating means between the terminal and repeater stations of a transmission system which will in no wise be affected by or affect the operation of the repeaters.

According to the invention, the terminal and repeater stations of a carrier wave signaling system are provided with sending and receiving apparatus for affording intercommunication between any two or all of said stations. Such intercommunicating apparatus operates with carrier current of a frequency different from that employed in the usual signaling channels and entirely independently of the repeaters and the carrier wave transmission apparatus of the usual channels of the system. Other features and aspects of the invention are described hereinafter.

The invention will be described as applied to a multiplex carrier wave transmission system, although it will be understood that it is not limited to such a system since some of the features thereof may find application in other forms of signaling systems and in other fields.

The drawing is a diagrammatic illustration of a multiplex carrier telephone and telegraph system embodying the invention.

The system shown in the drawing comprises in general a main high frequency transmission line ML extending between the west terminal and one or more repeater stations R. The usual east terminal, which is identical to the west terminal shown in the drawing, is omitted for the sake of simplifying the showing.

The telephone channels employ different carrier frequencies, those used for transmission in one direction being grouped in a different frequency range from those employed for transmission in the opposite direction. The telegraph channels are superimposed upon the telephone channels in the manner disclosed and claimed in my copending application, Serial No. 149,779, filed November 20, 1926, the telegraph channels employing the same carrier frequencies.

An intercommunicating channel IC for communication between the repeater and terminal stations is associated with the multiplex carrier telephone and telegraph system. This intercommunicating system employs but one carrier frequency, which is different from that on any of the telephone and telegraph channel frequencies. Preferably, the intercommunicating channel frequency is higher than that of any of the telephone and telegraph channel frequencies.

There are provided at the terminal station, three telephone channels, 1, 2 and 3 and an intercommunicating channel IC, all of which are connected to the main line ML. Telephone channel No. 1 includes a transmitting channel TC_1 and a receiving channel RC_1 which are conjugately related to a low frequency line L_1 by means of a transformer 5 and a balancing network N. The telephone line L_1 usually extends to and terminates at a telephone switchboard (not shown).

The transmitting channel TC_1 includes a modulator M_1 and a transmitting band filter TBF_1. Carrier current of the frequency assigned to this channel is supplied to the modulator M_1 from a high frequency source O_1. Band filter TBF_1 is designed to pass currents of the carrier frequency assigned to this channel and currents of frequencies within either the upper or lower side band thereof and to suppress currents of all other frequencies.

In order that the telegraph channel may be superimposed upon this telephone channel, there is associated therewith a telegraph transmitting key 6 which, during the operation thereof, is adapted to intermittently shunt an impedance element 7, which may take the form of a non-inductive resistance, across the leads from the source of high frequency current O_1. Thus, during the intermittent operation of the transmitting key 6, the amplitude of the carrier current supplied to the modulator M_1 is alter-

nately reduced from and restored to its normal value. Consequently, the telephone signal modulated carrier current output from the modulator M_1 is intermittently changed in amplitude during the transmission of telegraph signals.

The receiving channel RC_1 includes a receiving band filter RBF_1, a demodulator DM_1, an amplifier A_1, a low frequency band filter LBF, a high frequency band filter HBF, a rectifier R_1, and a telegraph receiving relay 8 which controls the usual telegraph sounder 9. The receiving band filter RBF_1 is designed to pass currents of the carrier frequency assigned to this channel and of the frequencies within either the upper or lower side band thereof and to suppress currents of all other frequencies.

The low frequency band filter LBF is designed to pass currents within the voice range between about 200 and 2000 cycles frequency and to suppress currents of higher frequencies as well as the telegraph signals below 200 cycles. The high frequency band filter HPF is designed to pass currents of the carrier frequency assinged to this channel and of frequencies within both or one of the telegraph side bands and to suppress currents of all other frequencies. Thus, these two filters separate the received telephone and telegraph signals.

The operation of the system in so far as transmission and reception of telephone signals are concerned is well known. Therefore, no description thereof will be given. The operation of the telegraph channel superimposed upon the telephone channel, which is disclosed and claimed in my copending application mentioned above, will be referred to briefly.

When the telegraph key 6 is open, the normal amount of carrier current is flowing to the line and the amount of rectified current through the telegraph receiving relay 8 at the distant station is sufficient to hold its contact closed, thereby maintaining the circuit of the sounder 9 closed. When the telegraph key 6 is closed, the amout of carrier current fed to the line is reduced and the amount of rectified current through the receiving relay 8 at the distant station is reduced to such an extent that the relay can no longer hold up its armature. The circuit of the sounder 9 is therefore opened. When the telegraph key 6 is again opened, the amount of rectified current through the receiving relay 8 at the distant terminal increases and it thereupon closes its contact, causing the energization of the sounder 9.

The intercommunicating channel IC is connected to the main line ML through a selective circuit ICF, which may be either an ordinary tuned circuit comprising capacity and inductance or a band filter of the type disclosed in United States patents to Campbell Nos. 1,227,113 and 1,227,114, issued May 22, 1917. If the selective circuit is a band filter it should be designed to pass currents of the frequency assigned to this channel and currents of the frequencies within one or both side bands thereof and to suppress currents of all other frequencies.

The intercommunicating channel IC has associated therewith at each terminal station a transmitting channel TIC and a receiving channel RIC. The transmitting channel TIC includes a high frequency source, such as an oscillator 10, supplying current of the carrier frequency assigned to this channel. The output circuit of the oscillator is connected to the primary of a transformer 10 whose secondary terminates in normally open contacts. The connection of the oscillator 10 to the main line is controlled by a relay 11 having in its operating circuit a normally open transmitting key 12.

The receiving channel RIC includes an input transformer 13, a rectifier IR, and a receiving relay 14 which controls the operation of a sounder 15.

Each repeating station R is provided with a repeater having two asymmetric repeating channels RW and RE for repeating currents in opposite directions, and the transmitting and receiving apparatus for the intercommunicating channel.

The repeater per se, which forms no part of the present invention, may be of the type disclosed in United States patent to Raibourn No 1,413.357, April 18, 1922, or of the type disclosed in my copending application, Serial No. 640,643, filed May 22, 1923.

Each of the repeating channels includes an input filter, an amplifier, and an outpunt filter, for further details of which reference should be made to either the Raibourn patent or to my said copending application, Serial No. 640,643, filed May 22, 1923.

The transmitting and receiving apparatus for the intercommunicating channel is connected in shunt with the repeating channels through selective circuits WICF and EICF so as not to be affected by or affect the operation of the repeater. Apparatus is provided for receiving signals from either direction over the line. Thus, signals transmitted over the intercommunicating channel from the west line section are received by a rectifier WR, having a relay 16 in its output circuit, and the signals incoming from the east line section are received by a rectifier ER which has in its output circuit a relay 17. The rectifier WR is connected to the main line ML through input transformer 18, normally closed contacts of relay 19 and selective circuit WICF. Likewise, rectifier ER is connected to the main line through input transformer 20, normally closed contacts of relay 22 and selective circuit EICF. The selective circuits WICF

and EICF are similar to the selective circuit ICF described in connection with the terminal apparatus and perform the same functions.

The operation of the receiving relay 16 causes the operation of relays 21 and 22. The operation of the relay 21 causes the operation of the telegraph sounder 23. The operation of relay 22 disconnects the rectifier ER from the east line section, and connects to this line section a source of high frequency current 10, of the carrier frequency assigned to the intercommunicating channel.

When the receiving relay 17 operates it causes the operation of relays 25 and 19. Relay 25 controls the operation of the sounder 23. The operation of relay 19 disconnects the rectifier WR from the line, and connects to the line the high frequency source 10_1. The load on the oscillator 10_1 is always constant due to the provision of resistances 24 and 26 connected through closed contacts of relays 22 and 19, respectively, to the oscillator. When either relay operates, its associated resistance is disconnected from the oscillator and one of the line sections substituted therefor.

The apparatus for the intercommunicating channel at each repeater station includes also a telegraph key 27 and a relay 28, whose actuation causes the energization of relays 19 and 22 whereby the source of high frequency current 10_1 is connected to both sections of the transmission line outgoing from the repeater station.

The attendant at the west terminal station desiring to communicate with the attendant at any or all of the repeater stations or with the attendant at the distant terminal station may do so by actuating transmitting key 12 to transmit a carrier wave modulated in accordance with a telegraph signal. Upon the closure of the key, relay 11 operates, connecting the source of high frequency currents 10 to the main line through the selective circuit ICF. The currents so impressed upon the line are selected at the first repeater station by the selective circuit WICF, and pass through the primary winding of transformer 18. The resulting induced currents in the secondary of this transformer are impressed upon the rectifier WR and the rectified current in the output circuit thereof causes the operation of relay 16. Relay 16, in operating, causes the energization of relay 21 which operates the sounder 23. Relay 22 also operates, disconnecting rectifier ER from the line section and connecting thereto the source of high frequency currents 10_1. Current so impressed upon the line section from the source 10_1 is selected by the selective circuit WICF at the next repeater station on the line where the apparatus functions in the manner previously described. Thus, the telegraph signals are relayed from station to station and cause the operation of the sounder at each of the repeater stations and the sounder at the distant terminal station corresponding to the sounder 15 at the west terminal station shown in the drawing. Any one of the repeater attendants may likewise communicate with the other repeater attendants and terminal attendants by actuating key 27 to transmit the intercommunicating channel frequency modulated in accordance with telegraph signals.

The invention set forth herein is, of course, susceptible of various other modifications and adaptations not specifically shown but included within the scope of the appended claims.

What is claimed is:

1. A carrier wave transmission system comprising transmission line sections over which carrier waves of different frequencies are transmitted in both directions, a repeater connecting said line sections and including individual paths for repeating waves transmitted in each direction, means for impressing signaling impulses on one of said line sections at a point remote from said repeater, a source of sustained oscillations at said repeater, and means at said repeater responsive to signaling impulses incoming over one of said line sections to connect said source to the other line section to repeat said impulses.

2. A carrier wave transmission system comprising transmission line sections over which speech modulated carrier waves of different frequencies are transmitted in both directions, a repeater connecting said line sections and including individual paths for repeating waves transmitted in each direction, means for impressing telegraph signals on said line sections at points remote from said repeater, means at said repeater for receiving said telegraph signals, a source of sustained oscillations at said repeater, and means at said repeater responsive to telegraph signals incoming over either of said line sections to connect said source to the other line section to repeat said telegraph signals.

3. A carrier wave transmission system comprising transmission line sections over which carrier waves of different frequencies are transmitted in both directions, a repeater connecting said line sections and including individual paths for repeating waves transmitted in each direction, means for impressing signaling impulses on one of said line sections at a point remote from said repeater, a source of sustained oscillations at said repeater, means at said repeater responsive to signaling impulses incoming over one of said line sections to connect said source to the other line section to repeat said impulses, a transmitting device at said repeater, and means operated by said device to connect

said source of oscillations to both line sections.

4. A carrier wave transmission system comprising transmission line sections over which speech modulated carrier waves of different frequencies are transmitted in both directions, a repeater connecting said line sections and including individual paths for repeating waves transmitted in each direction, means for impressing telegraph signals on said line sections at points remote from said repeater, a channel at said repeater for selectively transmitting said telegraph signals, means associated with said channel for receiving said telegraph signals, a source of sustained oscillations of the frequency of said telegraph signaling channel at said repeater, means at said repeater responsive to telegraph signals incoming over either of said line sections to connect said source to the other line section to repeat said telegraph signals, a transmitting device at said repeater, and means operated by said device to connect said source of oscillations to both line sections.

5. A carrier wave transmission system comprising a transmission line section, geographically separated terminal and repeater stations connected to said line sections, two one-way repeating paths at said repeater station including amplifiers for repeating the oppositely directed carrier waves, and means associated with said line sections for communicating between the terminal and repeater stations, said means including a carrier current channel, a source of high frequency current at each station, means at each station for connecting said source to an outgoing line section, a signaling device at said terminal station responsive to current from said source at said repeater station, a signaling device at said repeater station responsive to current transmitted from said terminal station, and means at the repeater station responsive to current incoming over one line section from said terminal station to connect the same source of high frequency current at said repeater station to the other line section.

6. A carrier wave transmission system comprising a terminal station, transmission line sections over which carrier waves of different frequencies are transmitted in both directions, a repeater station connecting said line sections and including individual paths for repeating waves transmitted in each direction, a source of high frequency currents at said terminal station, means at said terminal station for connecting said source to the line section extending therefrom, a source of high frequency current at said repeater station, a signaling device at each station, and means at said repeater station responsive to current incoming over one line section from said terminal station to cause the operation of the signaling device at said repeater station and to connect the source of high frequency current thereat to the other line section.

7. A carrier wave transmission system comprising a terminal station, transmission line sections over which a plurality of carrier waves of different frequencies are transmitted in both directions, a repeater station connecting such line sections and including individual paths for repeating waves transmitted in each direction, an intercommunicating channel associated with said system, a source of high frequency currents for said channel located at each station, means at said terminal station to connect the source of high frequency currents thereat to the line section extending therefrom, a signaling device at each station, means at the repeater station responsive to current transmitted over the intercommunicating channel of one line section from said terminal station for controlling the operation of the repeater station signaling device and the connection of the repeater station current source to the other line section, and means at said terminal station responsive to current incoming from said repeater station for controlling the operation of the associated signaling device.

In witness whereof, I hereunto subscribe my name this 11th day of October A. D., 1926.

JACOB S. JAMMER.