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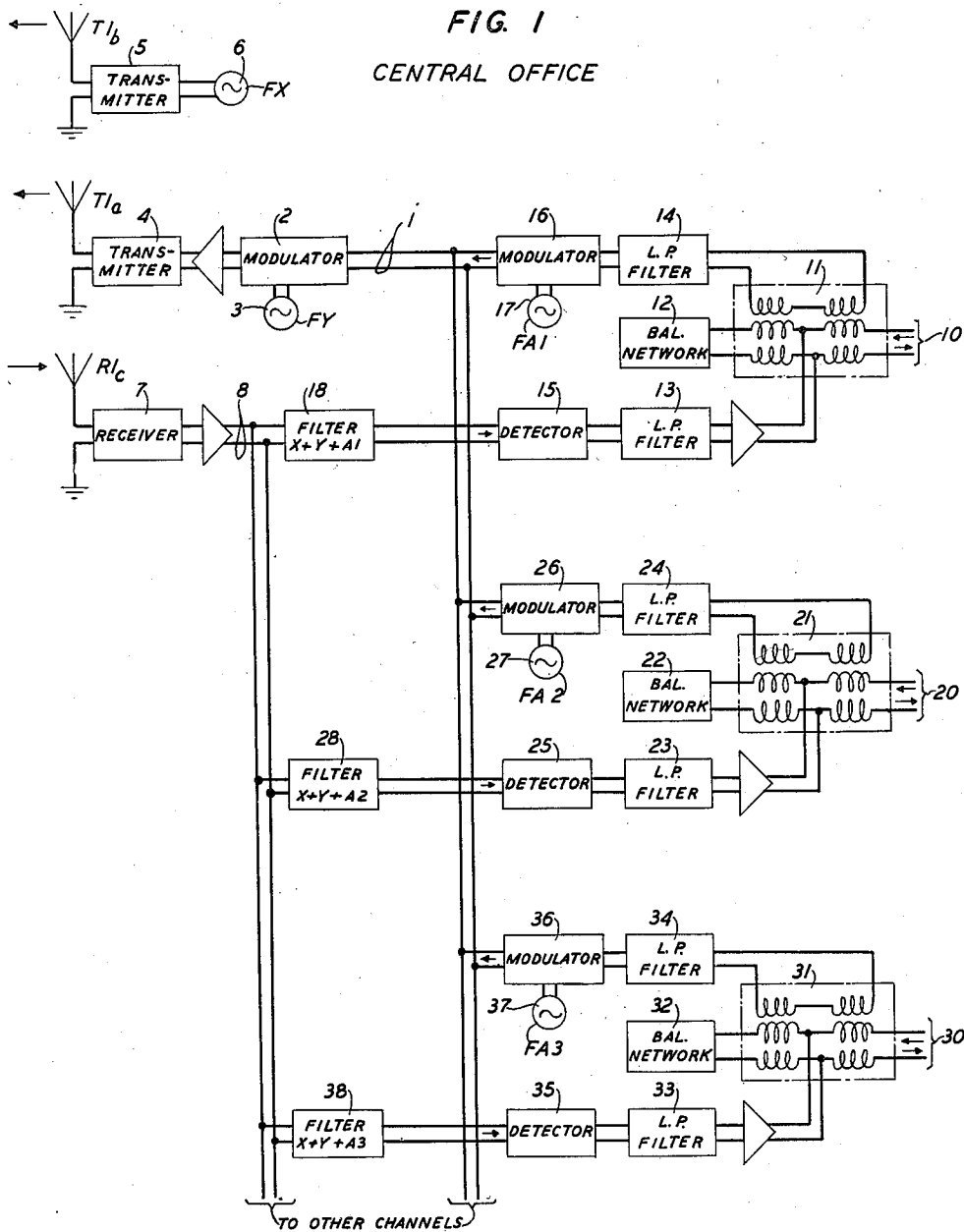
R. C. CORDERMAN

2,388,906

COMMUNICATION SYSTEM

Filed Sept. 9, 1944

2 Sheets-Sheet 1



INVENTOR
R. C. CORDERMAN
BY
R. O. Covell
ATTORNEY

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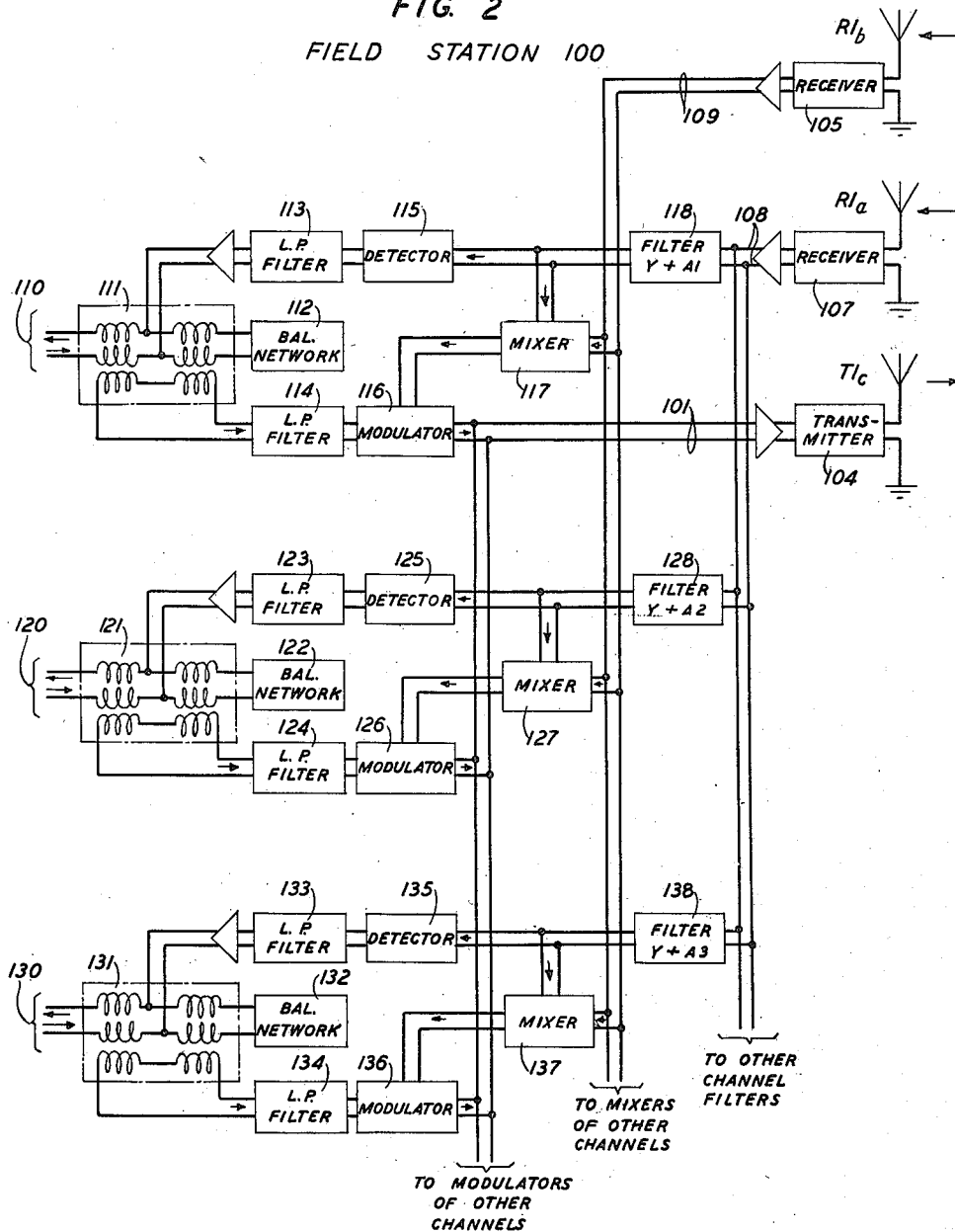
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FIG. 2
FIELD STATION 100



INVENTOR
R. C. CORDERMAN
BY
R. O. Covell
ATTORNEY

UNITED STATES PATENT OFFICE

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COMMUNICATION SYSTEM

Roy C. Corderman, Maplewood, N. J., assignor to
Western Electric Company, Incorporated, New
York, N. Y., a corporation of New York

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5 Claims. (Cl. 250—9)

This invention relates to communication systems and particularly to multiplex carrier telephone systems.

Objects of the invention are the stabilization of carrier frequencies used in multiplex carrier telephone systems and particularly in systems employing ultra-high frequency carrier currents, an efficient assignment of channel frequencies between a central office and outlying stations, and the provision of circuit arrangements which provide the desired carrier supply for the maximum number of channels without interference between channels.

The invention is a multiplex carrier telephone system comprising a plurality of offices or stations, ultra-high carrier frequencies being employed for transmission in both directions between the voice channels in one office or station and the voice channels in another office or station. Either a wireless or a wave guide transmission medium may be used.

A feature of the invention is a system in which the carrier frequency produced at one terminal of a circuit between two offices or stations is used as a source of stabilized frequency, for the transmission from the other terminal, by combining this frequency with an additional stabilized frequency which also originates at the first-mentioned terminal.

According to the invention two ultra-high frequency carriers are transmitted from one office or station of a system to another office or station of the system, one carrier being transmitted without modulation and the other being modulated by the voice modulated carriers of a plurality of channels, the unmodulated carrier being combined at the other station with the incoming voice modulated carrier of each channel to constitute the carrier supply for transmission in the opposite direction.

The invention will be better understood from the following description of a system arranged in accordance with the above-mentioned features as shown in the drawings which form a part of this specification. The drawings, which consist of two figures, show schematically a central station and a field station of a multiplex carrier telephone system which may include a plurality of field stations.

The system shown in the drawings comprises a transmitting antenna T1A at the central station associated with a transmitter 4 for transmitting signaling energy to a receiving antenna R1A and receiver 107 at field station 100; comprises a transmitting antenna T1B at the cen-

tral station associated with the transmitter 5 for transmitting a stabilizer carrier to a receiving antenna R1B and receiver 105 at field station 100; and comprises a transmitting antenna T1C at the field station 100 for transmitting signaling energy to a receiving antenna R1C and receiver 7 at the central station. There are a plurality of two-way voice channels 10, 20, 30 at the central station and a corresponding plurality of two-way voice channels 110, 120, 130 at the field station 100. The system is arranged so that channels 10 and 110 are connected for communication, channels 20 and 120 are connected for communication and channels 30 and 130 are connected for communication. Each other field station has an antenna and receiver for receiving the stabilizing carrier from the central station, an antenna and receiver for receiving signal energy from the central station, and a transmitter and antenna for transmitting signaling energy to a receiving antenna and receiver associated with a group of voice channels at the central station corresponding to the voice channels of the field station.

In the central office, the two-way voice channels 10, 20 and 30 are individually connected to hybrid coils 11, 21 and 31 and are balanced by the balancing networks 12, 22 and 32, respectively. Voice currents from channels 10, 20 and 30 are passed through the associated hybrid coils and through low-pass filters 14, 24 and 34, respectively, to modulators 16, 26 and 36, respectively. Each of the modulators is provided with a carrier source of a different frequency, the carrier current source 17 of modulator 16 being of a frequency A1, the carrier current source 27 of modulator 26 being of a frequency A2, and the carrier current source 37 of modulator 36 being of a frequency A3. The output of each of modulators 16, 26 and 36 and the modulators of other channels provided for communication with field station 100 is connected by conductors 1 to a group modulator 2. The carrier source 3 associated with modulator 2 is of an ultra-high frequency Y, and the carrier current from this source is modulated by the output of each of modulators 16, 26 and 36. The output of modulator 2 is applied through an amplifier to the input side of the transmitter 4 associated with the directional antenna T1A; and this antenna is aimed at the antenna R1A at field station 100 so that signal energy from each of the voice channels associated with group modulator 2 is transmitted to field station 100.

Another group of two-way voice channels is

provided in the central office for each field station with which communication is desired, each such group of voice channels being common to a group modulator similar to the modulator 2, the signal energy from each of the associated voice channels being applied through an amplifier to a transmitter similar to the transmitter 4 and transmitted from an antenna which is aimed at a receiving antenna of the field station in question. Each of the modulators of each such group of voice channels is provided with a carrier source of a different frequency, the carrier frequencies of the modulators of voice channels for a second field station being designated B1, B2, B3, etc., the carrier frequencies of the modulators of voice channels for a third field station being designated C1, C2, C3, etc., and so on. The frequency separation, between successive channel frequencies A1, A2, A3, etc., used in communicating with the same field station, is such as to enable the use of channel filters of simple and economical structure. Since the transmission between the central station and each field station is effected by an ultra-high frequency carrier with directional antenna, the channel frequencies B1, C1, etc., one for each other field station, may lie between the frequencies A1 and A2 of channels for a first field station; the channel frequencies B2, C2, etc., one for each other field station, may lie between the frequencies A2 and A3 of channels for a first field station; the channel frequencies B3, C3, etc., one for each other field station, may lie between the frequencies A3 and A4 of channels for a first field station; and so on, thereby permitting utilization of all of the available spectrum in which the carrier frequencies of the system may be assigned.

The carrier source 6 associated with the transmitter 5 at the central station is also of an ultra-high frequency and a stabilizing carrier of this frequency is transmitted from the transmitting antenna T1B to the receiving antenna R1B at field station 100. A separate transmitting antenna may be provided for transmitting the stabilizing carrier to a similar receiving antenna at each other field station, or a single transmitting antenna may be provided if designed to effectively transmit the stabilizing carrier to each field station.

In the field station 100, the two-way voice channels 110, 120 and 130 are individually connected through hybrid coils 111, 121 and 131, respectively, to the corresponding one of balancing networks 112, 122 and 132 to the corresponding one of the detectors 115, 125 and 135, respectively, and to the corresponding one of modulators 116, 126 and 136, respectively. The signal energy received by antenna R1A and radio receiver 107 at the field station 100 is amplified and selectively transmitted through conductors 108 and each of the channel filters 118, 128 and 138 to detectors 115, 125 and 135, respectively, and also to mixers 117, 127 and 137, respectively, each of the detectors and each of the mixers being individually associated with one of the voice channels 110, 120 and 130 of field station 100. Filter 118 is tuned to pass the voice modulated current of frequency $Y+A1$; filter 128 is tuned to pass the voice modulated current of frequency $Y+A2$ and filter 138 is tuned to pass the voice modulated current of frequency $Y+A3$. The voice current output of each of detectors 115, 125 and 135 is passed through a low-pass filter 113, 123 and 133, respectively, and the associated one of hybrid coils 111, 121 and 131 to voice channels 110, 120 and 130, respectively.

Voice currents from channels 110, 120 and 130

are passed through the associated hybrid coils and through low-pass filters 114, 124 and 134 respectively, to modulators 116, 126 and 136 respectively. The stabilized carrier received by antenna R1B and receiver 105 is amplified and transmitted through conductors 109 to mixers 117, 127 and 137, in parallel, for combination with the current passed through the associated one of filters 118, 128 and 138 to constitute the carrier supply for each of modulators 116, 126 and 136 respectively. The voice modulated current of frequency $Y+A1$ passing through channel filter 118 is combined in mixer 117 with current of frequency X from receiver 105 to supply a stabilized carrier for modulator 116; the voice modulated current of frequency $Y+A2$ passing through filter 128 is combined in mixer 127 with current of frequency X from receiver 105 to supply a stabilized carrier for modulator 126; and the voice modulated current of frequency $Y+A3$ passing through filter 138 is combined in mixer 137 with current of frequency X from receiver 105 to supply a stabilized carrier for modulator 136. The voice modulated carrier output of each of modulators 116, 126 and 136 is transmitted through conductors 101 to transmitter 104; and the signal energy from all of the channels of the field station 100 is thereby transmitted from antenna T1C to the receiving antenna R1C at the central station.

The signal energy received at the central station by antenna R1C and receiver 7 is amplified and selectively transmitted through conductors 8 and each of channel filters 18, 28, 38 to detectors 15, 25, 35, respectively. Filter 18 is tuned to pass the voice modulated circuit of frequency $X+Y+A1$; filter 28 is tuned to pass the voice modulated current of frequency $X+Y+A2$; and filter 38 is tuned to pass the voice modulated circuit of frequency $X+Y+A3$. The voice current output of detectors 15, 25, 35 is passed through low-pass filters 13, 23 and 33 respectively, and the associated one of hybrid coils 11, 21, 31 to voice channels 10, 20, 30, respectively. Thus two-way communication is provided between these channels and channels 110, 120, 130 of field station 100.

The transmission of signal energy from the voice channels of each of any other field station to the central station is effected in like manner to that described for field station 100, there being a receiving antenna at the central station for each of the field stations. The signal energy from each other field station is selectively transmitted to each of the voice channels provided for communication with such other field stations; the channel filters being tuned to selectively pass the signal energy to the proper detectors.

What is claimed is:

1. In a telephone system, a first station, a second station, voice channels in said stations, there being a voice channel in each station for communication individually with a particular one of the channels in the other station, a modulator and a channel filter individual to each of said voice channels, a carrier source of a different frequency for each of the modulators in said first station, means including an ultra-high frequency carrier current source common to the modulators in said first station for transmitting signal energy from said modulators to said second station, means including the channel filters in said second station for receiving and selectively transmitting the signal energy incoming from said first station to the corresponding voice channels in said second station, means including a second ultra-high frequency carrier source in said first station for

transmitting a stabilizing carrier to said second station, means in said second station for receiving said stabilizing carrier and for individually mixing said carrier with incoming signal energy passed by each of the channel filters in said second station to constitute a carrier source of a different frequency for each of the modulators in said second station, and means common to the modulators of said second station for transmitting the signal energy from said modulators to said first station.

2. In a telephone system, a first station, a second station, voice channels in said stations, there being a voice channel in each station for communication individually with a particular one of the channels in the other station, a modulator and a channel filter individual to each of said voice channels, a carrier source of a different frequency for each of the modulators in said first station, means including an ultra-high frequency carrier current source common to the modulators in said first station for transmitting signal energy from said modulators to said second station, means including the channel filters in said second station for receiving and selectively transmitting the signal energy incoming from said first station to the corresponding voice channels in said second station, means including a second ultra-high frequency carrier source in said first station for transmitting a stabilizing carrier to said second station, means in said second station for receiving said stabilizing carrier and for individually mixing said carrier with incoming signal energy passed by each of the channel filters in said second station to constitute a carrier source of a different frequency for each of the modulators in said second station, means common to the modulators of said second station for transmitting the signal energy from said modulators to said first station, and means including the channel filters of said first station for receiving and selectively transmitting the signal energy incoming from said second station to the corresponding voice channels in said first station.

3. In a telephone system comprising a central station and a field station, a plurality of voice channels at a field station, a corresponding plurality of voice channels at the central station, a modulator and a detector for each of said channels, channel filters, one for each of said detectors, each of said filters tuned to pass only the voice modulated carrier current of the frequency of the carrier supplied to the modulator of the corresponding voice channel at the other station, a different carrier current source for each modulator in said central station, a modulator common to said channel modulators in said central station, a carrier current source for said common modulator, another carrier current source at the central station, means including antennae at said stations for separately transmitting signal energy from said common modulator and energy from said other carrier current source at said central station to said field station, means including the channel filters and detectors at said field station for selectively transmitting the incoming signal energy to the voice channels of said field station, means for mixing the incoming carrier of each channel of the field station with said other carrier to constitute the carrier current source for the modulator of that channel, means comprising a transmitting antenna at said field station common to the modulators of all of the channels thereat and a receiving antenna at said central station common to the detectors of the channels

of said central station which correspond to the voice channels of said field station for transmitting signal energy from the modulators of said field station to said central station, and means including the channel filters and detectors of the voice channels of the central station for selectively transmitting the incoming signal energy to the voice channels of said central station.

4. In a communication system, a central station, a plurality of field stations, a plurality of voice channels at each field station, voice channels at said central station, each voice channel of said central station corresponding to a different one of the voice channels of said field stations, a modulator and a detector and a channel filter individual to each voice channel of said central station, a carrier current source of a different frequency for each modulator at said central station, a plurality of group modulators at said central station, each group modulator common to the modulators of voice channels of the central station corresponding to voice channels of the same field station, an ultra-high frequency carrier current source for each of said group modulators, a transmitter and transmitting antenna for each of said group modulators for transmitting to a field station signal energy from the voice channels of the central station corresponding to the voice channels of the field station, a receiving antenna and receiver at each field station for receiving from the corresponding transmitting antenna at the central station signal energy from the voice channels of the central station corresponding to the voice channels of the field station, a modulator and a detector and a channel filter individual to each voice channel of said field stations, the filters of the channels of said field stations being tuned to the frequencies of the carriers of the corresponding channels respectively of the central station, means comprising the detectors and associated filters at the field stations for transmitting to each voice channel respectively the voice frequency signaling energy from the corresponding voice channel of the central station, means comprising an ultra-high-frequency carrier source and transmitter and antenna at said central station for transmitting a stabilizing carrier to all of said field stations, an antenna and a receiver at each of said field stations for receiving the stabilizing carrier from said central station, means individual to each of the modulators at the field stations for combining said stabilizing carrier with incoming voice modulated carrier current transmitted through the channel filter of the associated voice channel to constitute the individual carrier source for each of the modulators of the field stations, means at each field station comprising a transmitter and antenna common to the modulators of said field station for transmitting signal energy from all of the associated voice channels to said central station, means comprising an antenna and a receiver at said central station individual to each of said field stations for receiving signal energy from said field stations respectively, means comprising the channel filters of the voice channels of the central station for transmitting to the detector of each voice channel of the central station signal energy received from the corresponding voice channel of the field stations, each of the channel filters of said central station being tuned to the frequency of the carrier supplied to the modulator of the corresponding voice channel of the field stations, and means comprising each detector at the central station

for transmitting to each voice channel voice frequency signal energy from the corresponding voice channel of the field stations.

5. In a communication system, a central station, a plurality of field stations, a plurality of voice channels at each field station, voice channels at said central station, each voice channel of said central station corresponding to a different one of the voice channels of said field stations, a modulator and a detector and a channel filter individual to each voice channel of said central station, a carrier source of a different frequency for each modulator at said central station, adjacent ones of said carrier frequencies being assigned in succession to the modulators associated with different group modulators, a plurality of group modulators at said central office, each group modulator common to the modulators of the voice channels corresponding to voice channels of the same field station, an ultra-high-frequency carrier source for each of said group modulators, a transmitter and transmitting antenna for each of said group modulators for transmitting to a field station signal energy from the voice channels of the central station corresponding to the voice channels of the field station, a receiving antenna and receiver at each field station for receiving from the corresponding transmitting antenna at the central station signal energy from the voice channels of the central station corresponding to the voice channels of the field station, a modulator and a detector and a channel filter individual to each voice channel of said field stations, the filters of the channels of said field stations being tuned to the frequencies of the carriers of the corresponding channels respectively of the central station, means comprising the detectors and associated filters at the field stations for transmitting to

each voice channel respectively the voice frequency signaling energy from the corresponding voice channel of the central station, means comprising an ultra-high-frequency carrier source and transmitter and antenna at said central station for transmitting a stabilizing carrier to all of said field stations, an antenna and a receiver at each of said field stations for receiving the stabilizing carrier from said central station, means individual to each of the modulators at the field stations for combining said stabilizing carrier with incoming voice modulated carrier current transmitted through the channel filter of the associated voice channel to constitute the individual carrier source for each of the modulators of the field stations, means at each field station comprising a transmitter and antenna common to the modulators of said field station for transmitting signal energy from all of the associated voice channels to said central station, means comprising an antenna and a receiver at said central station individual to each of said field stations for receiving signal energy from said field stations respectively, means comprising the channel filters of the voice channels of the central station for transmitting to the detector of each voice channel of the central station signal energy received from the corresponding voice channel of the field stations, each of the channel filters of said central station being tuned to the frequency of the carrier supplied to the modulator of the corresponding voice channel of the field stations, and means comprising each detector at the central station for transmitting to each voice channel voice frequency signal energy from the corresponding voice channel of the field stations.

ROY C. CORDERMAN.