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CARRIER CURRENT SIGNALING SYSTEM

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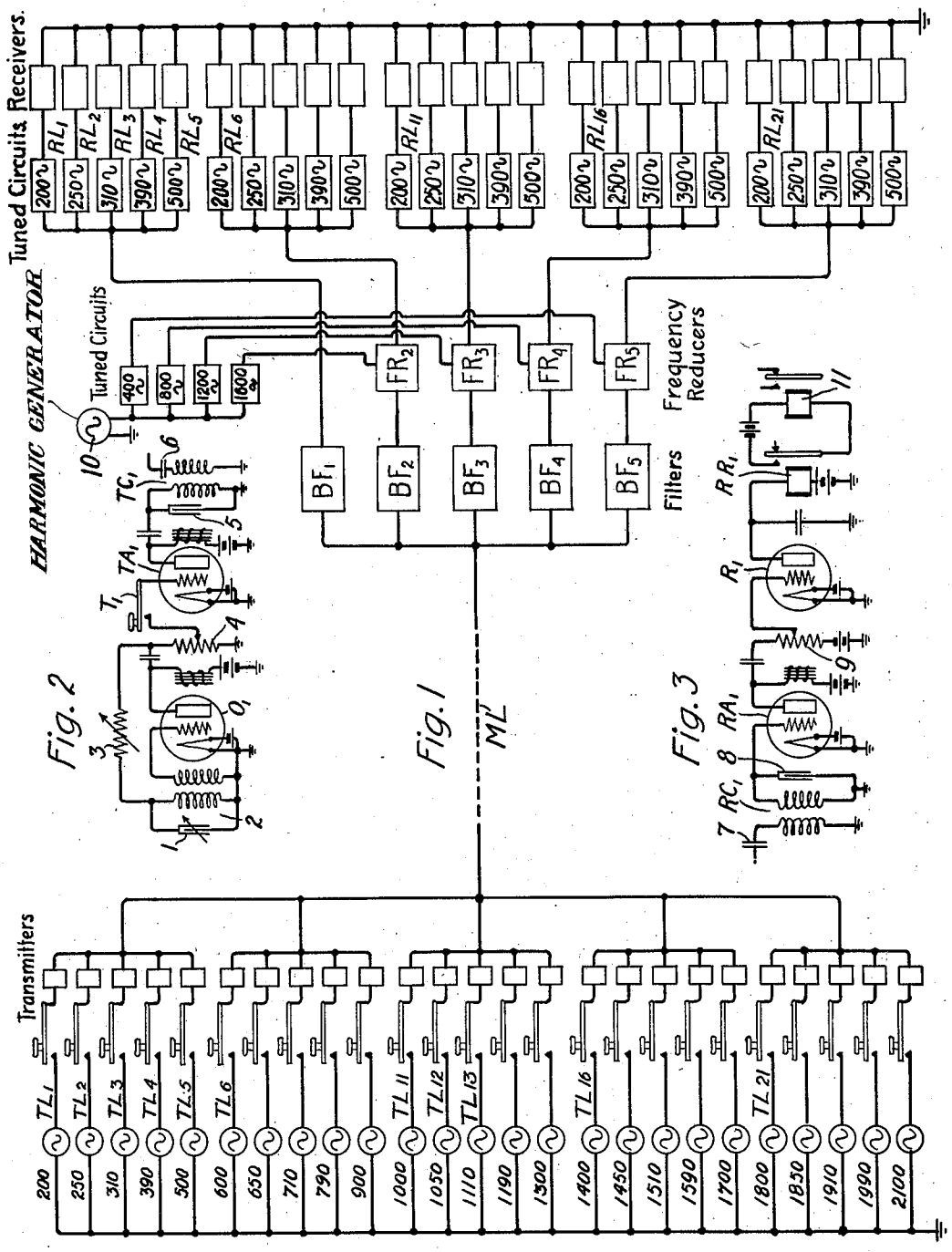


Fig. 2

Fig. 1

Fig. 3

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CARRIER-CURRENT SIGNALING SYSTEM.

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To all whom it may concern:

Be it known that I, ELMER V. GRIGGS, a citizen of the United States of America, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Carrier-Current Signaling Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to a carrier current signaling system, and more particularly to a multiplex carrier current telegraph system employing speech frequency carrier currents.

An object of the invention is to increase the number of channels within a given frequency range.

Another object is to simplify the apparatus required in such a system.

Other objects and advantages will hereinafter appear.

According to the invention, the channels of a multiplex carrier telegraph system employing different frequencies are separated in groups by filters at the receiving terminal, the channels of one group then being separated by selective circuits, and the channel frequencies of each of the other groups first being reduced to produce frequencies corresponding to those of the first mentioned group and then separated by selective circuits like those employed in the first group.

One of the advantages of a system embodying the invention is simplification of the receiving apparatus wherein the number of different kinds of selective circuits is reduced to the number of channels in one group.

The factor limiting the number of channels of multiplex carrier waves which may be successfully applied to a circuit of given frequency transmission range is the spacing or percentage frequency difference required between adjacent frequencies to avoid interference. Features of the present invention are, substantially uniform percentage difference between adjacent frequencies which are to be separated, a decrease in the number of different designs of selecting circuits required and an increase in the number of available channels encompassed within a given frequency range.

While the invention is illustrated as applied to a multiplex carrier telegraph system employing carrier currents of speech frequency, it will be understood that it may also be applied to multiplex carrier signaling systems employing carrier currents of other frequencies of audio or higher than audio frequencies.

It is, of course not essential that the system have a ground return, for a full metallic circuit may be employed.

In the drawings,

Fig. 1 shows diagrammatically a multiplex carrier telegraph system employing carrier currents of audio frequencies.

Fig. 2 shows in detail one of the transmitting channels.

Fig. 3 shows in detail one of the receiving channels.

As shown in Fig. 1, the multiplex carrier telegraph system comprises a plurality of transmitting channels TL_1, TL_2, TL_3, etc. located at one terminal and coupled to a main line ML, and a plurality of receiving channels RL_1, RL_2, RL_3, etc. located at the other terminal and coupled to the main line ML.

As illustrated, there are twenty-five transmitting channels and a corresponding number of receiving channels.

These channels may be divided into five groups, carrier frequencies of 200, 250, 310, 390 and 500 cycles being assigned to the transmitting channels of the first group. The carrier frequencies assigned to the transmitting channels of each of the other groups are respectively 400, 800, 1200 and 1600 cycles higher than those assigned to the channels of the first group.

Each transmitting channel as shown in Fig. 2 includes an oscillation generator O_1 or other source of carrier current of the frequency assigned thereto, a signal transmitting element T_1, an amplier TA_1, and a transmitting selective circuit TC_1.

The oscillation generator O_1, of any well known type, such as a vacuum type oscillator supplies the carrier current for the channel. The frequency of the generated carrier current may be changed by a variable condenser 1 in the oscillator frequency determining circuit 2. Variable resistance 3 determines the amplitude of the oscillations fed back from the oscillator output to input circuit.

The output circuit of the oscillator O_1 is coupled by means of a potentiometer 4 to the work circuit containing the signal trans-

mitting element or key T_1. One contact of key T_1 is connected to the control electrode of the amplifier TA_1 which may be of any well known type such as, for example, a vacuum tube amplifier.

The transmitting selecting circuit TC_1, coupling the amplifier output circuit to the main line ML, comprises a transformer whose primary and secondary windings through the cooperation of condensers 5 and 6 are tuned to the carrier frequency assigned to the channel.

The receiving channels are coupled to the main line ML by band filters and frequency reducers.

Each band filter is of the type shown in Fig. 14 of the article by Colpitts and Blackwell entitled "Carrier current telephony and telegraphy" appearing in Transactions of American Institute of Electrical Engineers vol. 40, 1921. When used in the present system, one of the input terminals of each of the band filters is grounded.

The band filters separate the channels into five groups corresponding to the frequency grouping of the channels at the transmitting terminal.

Each of the band filters is designed to pass carrier currents of the frequencies assigned to the channels of a particular group and the side band frequencies thereof and to suppress currents of all other frequencies.

Thus band filter BF_1 is designed to pass only the carrier currents of 200, 250, 310, 390 and 500 cycles assigned to the five channels of the first group and currents of frequencies within the side bands of these carrier frequencies.

The frequency reducers FR_2, FR_3, FR_4 and FR_5 reduce the frequencies of the incoming signal currents transmitted from the channels of groups 2 to 5, so that the signal currents passing to the receiving channels of each of these groups are of the same frequencies as those passing to the receiving channels of the first group.

Each frequency reducer may be of any well known type such as, for example, the vacuum tube frequency reducer D_1 disclosed in U. S. Patent 1,361,487 granted December 7, 1920 to H. S. Osborne.

Incoming signaling currents of the frequencies selected by a band filter are impressed upon its associated frequency reducer wherein they react with locally supplied oscillations and produce currents of frequencies which are the difference between the frequencies of the incoming and the locally supplied currents.

The locally supplied currents may be furnished from a harmonic generator 10 or any other suitable source or sources.

The harmonic generator or producer 10 may be of any well known type, such as, for example, a vacuum tube harmonic producer like that shown in Fig. 49 of the Colpitts and Blackwell article, supra.

The generator 10 may have a base frequency of 100 cycles, the fourth, eighth, twelfth and sixteenth harmonics thereof being selected by selective circuits and supplied to the respective frequency reducers FR_2, FR_3, FR_4 and FR_5.

Each of these selective circuits may be simple series tuned circuits composed of capacity and inductance proportioned to tune the circuit to currents of the frequency to be selected and supplied to its associated frequency reducer.

Each of the receiving channels contains a selective circuit RC_1, an amplifier RA_1, a rectifier R_1, and a receiving relay RR_1.

Each selecting circuit RC_1 comprises a transformer whose primary and secondary windings through the cooperation of condensers 7 and 8 are tuned to currents of the frequency to be received by the receiving channel with which it is associated. The transformers and their associated condensers form a tuned coupling between the main line and the respective receiving channels.

The currents of the frequencies selected by the selecting circuit RC_1 are impressed upon the amplifier RA_1 coupled to the rectifier R_1 by means of a potentiometer 9 for regulating the magnitude of the amplified currents delivered to the rectifier.

The receiving relay RR_1 in the output circuit of the rectifier R_1 is responsive to the rectified currents and controls a sounder 11 or other signaling device.

The operation of the system is as follows:

Assuming that the transmitting key T_1 of transmitting channel TL_1 is operated to form and transmit marking and spacing signals, 200 cycle currents are impressed upon amplifier TA_1 each time that key T_1 is closed. The amplified currents pass through the tuned coupling TC_1 to the main line.

The transmitted signal currents having originated in a transmitting channel of the first group, such currents incoming at the receiving terminal are selected by the band filter BF_1. These signal currents after passing through the band filter BF_1 are selected by the tuned coupling RC_1 of receiving channel RL_1. The signal currents so selected are impressed upon amplifier RA_1, and the amplified currents therefrom are then impressed upon the rectifier R_1. Receiving relay RR_1 in responding to the rectified currents causes the operation of the associated sounder 11.

If the signals are transmitted from a transmitting channel of any group other than the first group, for example, from transmitting channel TL_{13} of the third group, the signal currents incoming at the receiving terminal are selected by the band filter BF_3. The selected currents passing through the

band filter BF_3 are impressed upon the frequency reducer FR_3, wherein the 1100 cycle signal currents interact with the locally supplied 800 cycle currents and produce 310 cycle currents. The difference frequency 310 cycle currents are selected by the selective circuit RC_{13} of the receiving channel RL_3.

The selected 310 cycle currents after being amplified and rectified cause the operation of the receiving relay RR_{13} which in turn operates the sounder associated therewith.

It will be observed that in the system illustrated, it is possible to obtain twenty-five channels with approximately twenty-five percent discrimination in the receiving channels. The selecting circuits of the receiving channels of one group are like those employed in each of the other groups, thereby reducing the number of different receiving channel selecting circuits to five.

The frequency spacing between adjacent groups is 100 cycles. Should it be desired to obtain greater frequency spacing between adjacent groups, the fifth channel of each group may be omitted, thus providing a 210 cycle spacing of adjacent groups.

The invention set forth herein is, of course, susceptible of various other embodiments and adaptations.

The invention claimed is:

1. The method of receiving signals in a multiplex carrier signaling system, which comprises separating the incoming signal oscillations of different carrier frequencies into groups, separating the signal oscillations of one group and impressing them upon signal receivers, reducing the frequency of the signal oscillations of each of the other groups, and separating such signal oscillations of reduced frequency and impressing them upon signal receivers.

2. The method of receiving signals in a multiplex carrier signaling system, which comprises separating the incoming signal oscillations of different carrier frequencies into groups, selecting the signal oscillations of one group and impressing them upon signal receivers, stepping down the frequencies of the signal oscillations of each of the other groups to the frequencies of the first group of signal oscillations, selecting such signal oscillations of stepped down frequencies, and impressing such selected signal oscillations upon signal receivers.

3. In a multiplex carrier signaling system wherein a plurality of receiving channels are coupled to a main line to receive incoming signal oscillations of different frequencies the combination of selective circuits between the main line and the receiving channels to separate the incoming signal oscillations into groups according to the frequency thereof and thereby separating the receiving channels into groups, a selective circuit in each channel of one group to select the incoming signal oscillations of frequencies assigned thereto, a frequency reducer for each of the other groups supplied with local oscillations to step down the frequencies of the incoming signal currents selected by the group selecting circuit associated therewith selective circuits in the channels of each of said last mentioned groups to select the currents of stepped down frequencies, and a signal receiver in each receiving channel responsive to oscillations of the frequency selected by the selecting circuits thereof.

4. In a multiplex carrier signaling system comprising a main line a plurality of transmitting channels employing carrier oscillations of different frequencies located at a terminal station and coupled to the main line, a signal transmitter for each channel, a plurality of receiving channels located at a distant terminal station, a plurality of selective circuits between the main line and the receiving channels to separate the receiving channels into groups according to the carrier frequencies assigned to the transmitting channels, a selective circuit in each receiving channel of one group, a frequency reducer for each of the other groups supplied locally with oscillations whereby the frequencies of the signal currents selected by the group selecting circuit associated therewith are reduced to frequencies corresponding to those of the signal currents received in the channels of the first group, selective circuits like those of the first group of receiving channels for the receiving channels of each of the other groups, and a signal receiver for each receiving channel responsive to currents of the frequency selected by the selective circuit thereof.

5. The combination in a multiplex carrier wave transmission system in which the entire frequency range encompassed is divided into a plurality of groups, the lower frequency group having carrier frequencies such that each differs from its adjacent frequencies by substantially the same percentage that any other differs from its adjacent frequencies and each of the other groups having a set of frequencies differing respectively from those of said lower frequency group by a difference frequency substantially constant for that particular group of means for separating currents into groups corresponding to said frequency groups, and means for modifying the frequencies of currents of a given group to a different and definite relation to the frequencies of another group.

In witness whereof, I hereunto subscribe my name this 27 day of March A. D., 1923.

ELMER V. GRIGGS.