Aug. 24, 1943. W. H. T. HOLDEN 2,327,711

COMMUNICATION SYSTEM

Filed Oct. 31, 1941

FIG. 1

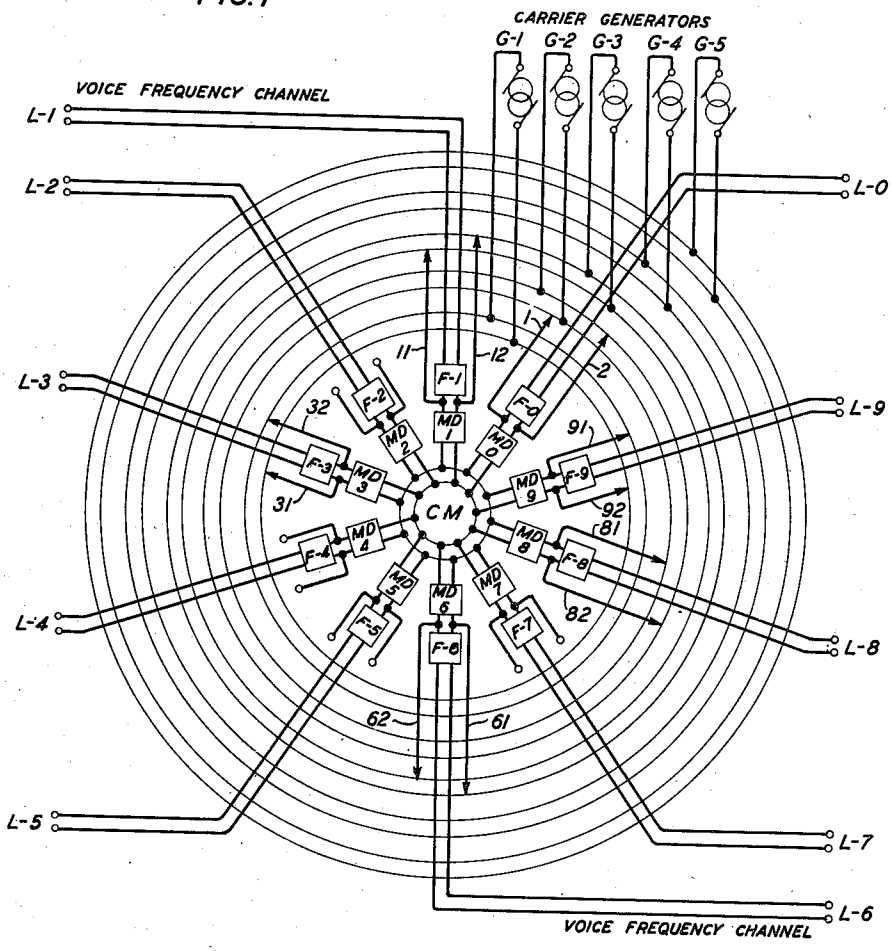
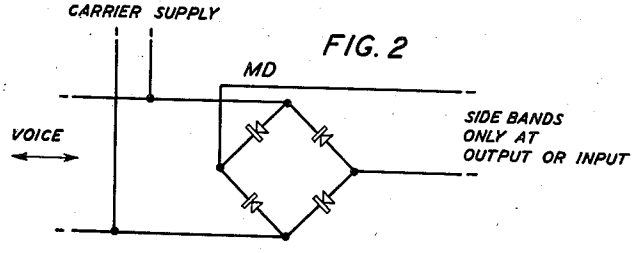



FIG. 2

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2,327,711

## COMMUNICATION SYSTEM

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Application October 31, 1941, Serial No. 417,323

4 Claims. (Cl. 179—15)

This invention relates to communication systems and particularly to systems employing a broad-band high-frequency transmission medium constituting a plurality of channels for use in establishing desired communication connections.

Objects of the invention are an increase in efficiency in the utilization of broad-band high-frequency transmission media in establishing communication connections, prevention of interference between channels, and simplification of the equipment needed for establishing two-way connections through the channels of such media, the carrier channel frequency limits and spacing being effective to prevent interference between channels without providing individual high frequency channel filters.

According to this invention a desired number of two-way non-interfering channels are provided in a broad-band high-frequency transmission medium without the use of channel filters by providing means for connecting carrier generators of the same frequency to the low-frequency circuit units to be interconnected. A feature of the invention is the provision of two-way modulator-demodulator units individual to the lines or other low-frequency circuits to be interconnected. A further feature is an allotment of carrier frequencies to the required number of channels such that a total band of less than one octave is utilized for all channels and so that the separation between carrier frequencies is not less than three times the voice band to be transmitted, whereby interference between channels due to intermodulation is prevented.

A clear and complete understanding of the invention will be facilitated by consideration of a system embodying the features of the invention, one such system being represented schematically in the drawing which forms a part of this specification. The invention is, however, not limited in its application to the specific arrangements shown in the drawing but is generally applicable to systems employing broad-band high-frequency transmission media.

Referring to the drawing:

Fig. 1 discloses ten telephone lines L—1 to L—0, inclusive, connected by individual low-frequency filters F—1 to F—0, inclusive, and individual two-way modulator-demodulator units MD—1 to MD—0 to a common broad-band high-frequency transmission medium CM, generators G—1 to G—5, inclusive, being provided each for connection to any pair of modulator-demodulator units between which it is desired to establish communication; and

Fig. 2 shows a modulator-demodulator unit MD.

The lines L—1 to L—0, inclusive, may be subscribers' lines or trunks used in establishing desired telephone connections. Each of the carrier sources G—1 to G—5, inclusive, may be any known type of alternating current source. An alternating generator of the thermionic type is disclosed in the patent to E. H. Colpitts No. 1,624,537 of April 13, 1927. Each of the low-frequency filters F—1 to F——0, inclusive, is adapted to pass a voice-frequency band from 0 to 3,000 cycles. Reference may be had to the patent to G. A. Campbell No. 1,227,113, granted May 22, 1917, for disclosure of filters tuned to pass a desired band of frequencies. Each of the modulator-demodulator units MD—1 to MD—0, inclusive, may be similar to the modulator-demodulator unit MD shown in Fig. 2, which comprises a full wave rectifier consisting of dry type rectifying elements, for instance, copper oxide discs. The patent to Black No. 1,983,528, December 11, 1934 discloses a modulator-demodulator unit similar to MD and the patent to Griggs No. 1,559,867, November 3, 1925 discloses other modulator-demodulator units which might be used in practicing my invention. The aforementioned patent to Black also shows the filter unit required between the modulator-demodulator and the voice-frequency line.

Referring to Fig. 1, the conductors of transmission medium CM are connected to each of the modulator-demodulator units MD—1 to MD—0. When a carrier source of the same frequency is connected to any two of the lines L—1 to L—0, a two-way communication path is established between the two lines. As shown in the drawing, the modulator-demodulator MD—1 of line L—1 is connected by conductors 11 and 12 to carrier source G—3 and the modulator-demodulator MD—6 of line L—6 is connected by conductors 61 and 62 to carrier source G—3, thereby establishing two-way communication between lines L—1 and L—6. The filters F—1 and F—6 prevent the transmission of carrier-frequency currents over the lines L—1 and L—6. Modulator-demodulator units MD—3 and MD—9 are connected, by conductors 31 and 32 and conductors 91 and 92 to carrier source G—1 thereby establishing two-way communication between lines L—3 and L—9. And modulator-demodulator units MD—8 and MD—0 are connected, by conductors 81 and 82 and conductors 1 and 2 to carrier source G—2 thereby establishing two-way communication between lines L—8 and L—0. Other connections may be established in like

manner, as many simultaneous connections being possible as there are carrier sources of different frequencies.

No channel band filters are provided, interference between channels being prevented by a proper allocation of the carrier frequencies. The maximum carrier frequency is less than twice the minimum carrier frequency and the spacing between frequencies may be equal to but not less than three times the voice band passed by the low-frequency filters. Assuming that the voice band is 4 kilocycles in width, the spacing between carrier frequencies is 12 kilocycles, the minimum carrier frequency becoming 12 *n* kilocycles, if *n* is the number of channels required. With a minimum channel frequency of 150 kilocycles, the frequencies of carrier sources G—1, G—2, G—3, G—4 and G—5 for the first five channels would be 150, 162, 174, 186 and 198 kilocycles, respectively. With modulator-demodulator units MD—3 and MD—9 connected to carrier source G—1, side bands of from 146 to 154 kilocycles are transmitted through medium CM during conversation between lines L—3 and L—9. With modulator-demodulator units MD—8 and MD—0 connected to carrier source G—2, side bands of from 158 to 166 kilocycles are transmitted through medium CM; and with modulator-demodulator units MD—1 and MD—6 connected to carrier source G—3, side bands of from 170 to 178 kilocycles are transmitted through medium CM. Interchannel modulation effects will be of a frequency above 4 kilocycles and will, therefore, not pass into the voice-frequency lines.

In applying the invention to central office switching, a large number of channels are required and reference may be had to the patent to N. Monk No. 2,231,634 February 11, 1941 for disclosure of arrangements for providing and connecting carrier sources of desired frequency to modulator and demodulator units being used in establishing connections between lines.

Various modifications may be made without departing from the spirit of the invention. For instance the modulator-demodulator units may be of two types, each of the units of one type having fixed carrier frequencies and the units of the other type being adapted to be connected to a carrier source of any desired frequency. Thus the units of one type may be associated with incoming lines or trunks and units of the other type may be associated with outgoing lines or trunks.

What is claimed is:

1. In a telephone system, a multichannel transmission medium, a plurality of two-way modulator-demodulator units connected to said medium, a plurality of carrier sources, and means connecting the same carrier source to any two of said units between which communication is desired, there being as many conversational channels possible at one time as there are carrier sources of different frequencies, the highest frequency of the carrier sources being less than twice the lowest frequency of the carrier sources and the spacing between carrier frequencies being not less than three times the voice band.

2. In a telephone system, lines, two-way modulator-demodulator units, band-pass filters each adapted to pass voice-frequency currents individually connecting said lines to said units, a broad-band high-frequency transmission medium constituting a plurality of carrier channels common to said units, carrier sources of different frequencies, one for each channel, and means for connecting each of said units to a carrier source of any desired frequency, the connection of each of any two of said units to a carrier source of the same frequency being effective to establish a two-way communication between the lines to which said two units are connected, the range of frequencies used for said channels being less than an octave and the spacing between carrier frequencies being not less than three times the width of the band passed by each of said filters.

3. In a telephone system, lines, two-way modulator-demodulator units, one for each of said lines, a broad-band high-frequency transmission medium constituting a plurality of carrier channels common to said units, band-pass filters each adapted to pass voice-frequency currents, each filter individually connecting one of said units to one of said lines, carrier sources of different frequencies, and means for connecting a carrier source of any desired frequency to any of said units, the allocation of frequencies being such that the maximum carrier frequency is less than twice the minimum carrier frequency and so that the difference between carrier frequencies is not less than three times the band passed by each of said filters, said allocation and spacing being effective to prevent interference between channels without providing high-pass channel filters.

4. In a telephone system, lines, two-way modulator-demodulator units one for each of said lines, each of said units comprising a full-wave dry type rectifier, a broad-band high-frequency transmission medium common to said units, band-pass filters each adapted to pass voice-frequency currents said filters individually connecting said units to said lines, carrier sources of different frequencies, and means for connecting each of said units to a desired one of said sources, the connection of any two of said units to sources of the same frequency being effective to establish a two-way channel between the lines with which said two units are associated, the allocation of carrier frequencies being such as to make the provision of channel filters unnecessary, the maximum carrier frequency being more than twice the minimum carrier frequency and the spacing between carrier frequencies being not less than three times the band passed by each of said filters.

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