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TELEPHONE SYSTEM

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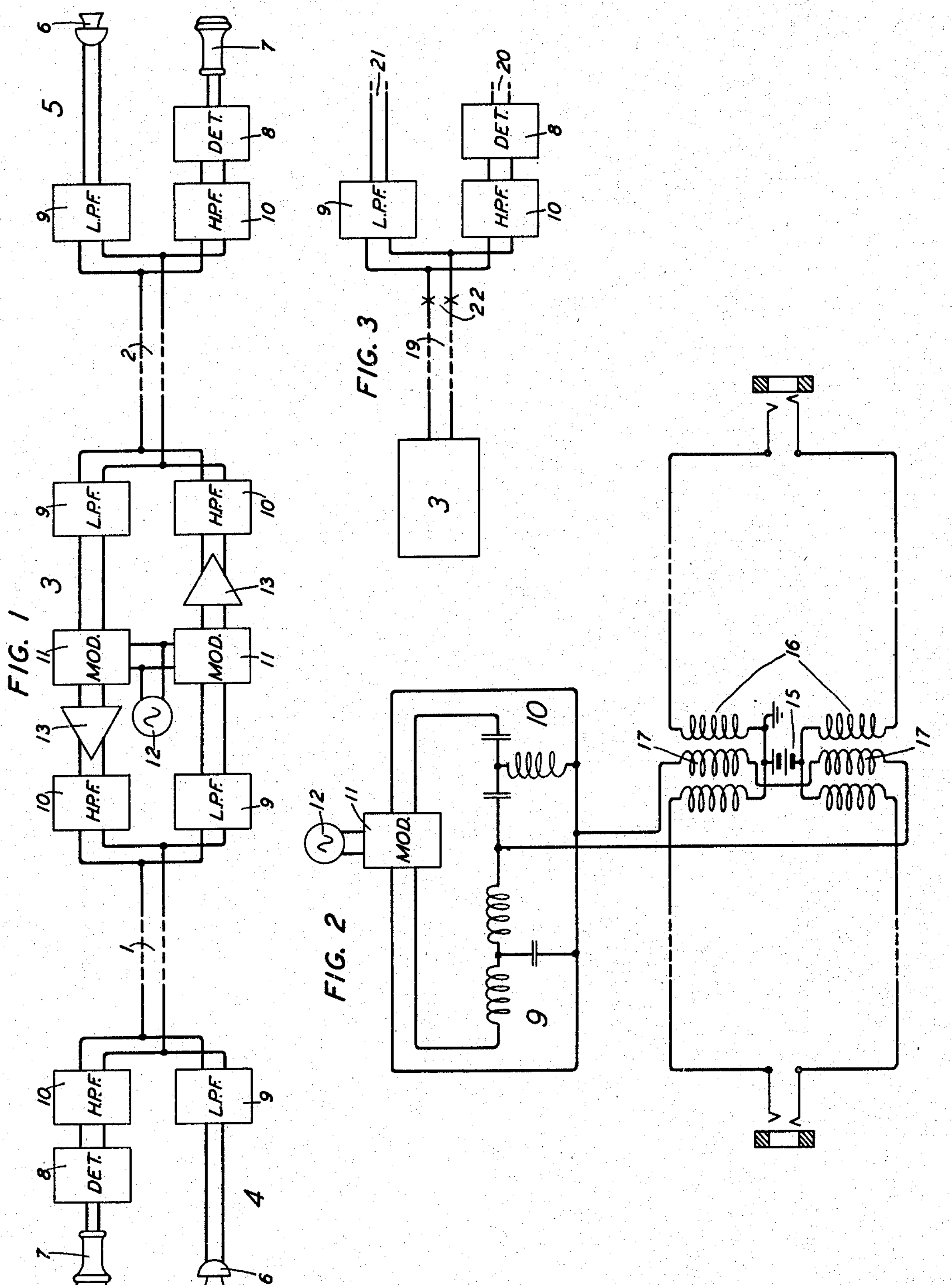

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TELEPHONE SYSTEM

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6 Claims. (Cl. 179—1)

The present invention relates to transmission of waves for signaling purposes, and particularly to transmission over two-wire circuits on a four-wire basis by use of different frequency ranges in the two directions.

The use of modulated carrier waves for transmission over toll lines, in which different frequency bands are used in opposite directions is common. The present invention is more especially concerned with securing so-called equivalent four-wire transmission in the local plant, that is, on subscribers' lines and trunk circuits.

Such transmission is effected, in accordance with the present invention, with simplified apparatus by transmitting at speech frequency in one direction (specifically from the substation) and at carrier frequency in the opposite direction (toward the substation). This requires no special modulating apparatus at the substations. A simple type demodulator such as a copper oxide type may be used at the substations. All modulators and sources of carrier current are located at central offices so that the unmodulated carrier does not need to be sent to the substations for modulating purposes.

A better understanding of the invention may be gained from the following description in connection with the drawing.

In Fig. 1 there is shown a schematic diagram of a complete connection between two subscribers' stations;

Fig. 2 shows a simplified type of cord circuit capable of use with the specially equipped subsets of the invention as well as with the ordinary subsets; and

Fig. 3 shows the manner of connection to a physical four-wire toll line.

In Fig. 1, subscribers' lines 1 and 2 lead from central office 3 to subscribers' stations 4 and 5. The subscribers' stations are both alike and each comprises an ordinary transmitter 6, our ordinary receiver 7, a detector 8, which may be a copper oxide rectifier of simple type, a low pass filter 9 and a high pass filter 10.

At central office 3, there is shown a cord circuit for interconnecting subsets 4 and 5, consisting of filters 9 and 10 of the same type as the corresponding filters at the substation, modulators 11 and a source of carrier waves 12. Amplifiers, such as 13, will be provided wherever needed.

It will be understood that carrier source 12 is common to the exchange and may be an oscillator or machine generator wired to all of the cord circuits. The cord circuit shown may be used to connect any pair of subscribers' lines of the types shown. Filters 9 and 10 may comprise the necessary number of sections of filter network comprising inductance and capacity to give the required frequency discrimination between the ranges utilized in the opposite directions of transmission. The cord circuit may be provided with a repeating coil on each side and the usual central office battery for supplying operating current to the microphones at the substations.

When the subscriber at station 4 talks, his speech from transmitter 6 passes through filter 9 to line 1. This filter may have a pass range of 200 to 3000 cycles, for example, while filter 10 may have a pass range of 4500 to 7500 cycles. The speech from line 1 arriving at the central station passes through filter 9 to modulator 11 where it combines with the carrier wave from source 12 to produce a carrier and sideband lying in the pass range of filter 10 so that the resulting waves go out over line 2 to station 5 where they enter filter 10, are detected at 8 and rendered capable of being heard in receiver 7.

Waves in the opposite direction from station 5 to station 4 are transmitted in entirely analogous manner.

Filters 9 and 10 at the subscriber's station and the other apparatus thereat are designed to give full coupling efficiency between the transmitter and receiver, respectively, and the line 1 within the respective filter pass ranges. The modulators 11 may be copper-oxide or other simple type or they may comprise space discharge devices.

In local connections between offices, a cord circuit such as is shown at 3 in Fig. 1 may be used at the originating office while an ordinary type of cord circuit may be used to extend the connection at the other office or offices, these latter cord circuits passing the currents along without frequency translation.

The equivalent four-wire transmission such as is described above and illustrated in Fig. 1 may be extended to toll circuits. While its use is mainly concerned with the local plant, it is not, therefore, to be considered as limited to local plant. For example, in toll circuits generally considered too short to be operated on physical four-wire basis, equivalent four-wire operation may be secured by the method of the invention.

In Fig. 2 the usual central office battery 15 and cord circuit repeating coil 16 are shown, but the latter is provided with an extra winding 17 which is connected to the junction of filters 9 and 10 in the circuit of modulator 11.

When the cord circuit of Fig. 2 is used to interconnect two ordinary subsets, the speech is repeated by coil 16 in the usual manner. Speech currents are also sent into the input of the modulator 11 via winding 17 and filter 9, and as a result a high frequency side band is produced and reapplied to the cord circuit through filter 10 and winding 17. In the case of ordinary subsets, however, this action has no effect except to reduce the efficiency of transmission to a certain extent.

When the cord circuit is connected to a subset of the type shown in Fig. 1, however, these side band currents along with some carrier are received as in the case of Fig. 1. The voice frequency waves sent through the repeating coil 16 direct are, in that case, of no effect. Thus the cord circuit of Fig. 2 may be used during a change-over period while ordinary types of substations and substations in accordance with this invention are both present in the system.

If the output of the cord circuit of Fig. 1 is to be applied to a physical four-wire toll circuit, the connecting circuit of Fig. 3 may be used. In this figure the central office is shown at 3 connected by trunk 19 with the four-wire circuit comprising transmitting branch 20 and receiving branch 21. High pass filter 10 and detector 8 translate the carrier frequency side band to the voice frequency level for transmission over line 20 to the ordinary voice-frequency apparatus at the distant end. In the return circuit 21, filter 9 allows the received speech waves to be sent over circuit 19 to the office 3, but prevents the high frequency oppositely directed waves from entering circuit 21. In the case of ordinary two-wire to four-wire connections, balance and echo difficulties sometimes make it advantageous to perform switching operations in the four-wire portion 20, 21. These difficulties are so far removed by the equivalent four-wire operation of the invention, however, as to enable the switching to be done in the two-wire line 19, e. g. at point 22.

What is claimed is:

1. The method of obtaining equivalent four-wire transmission on subscribers' loops comprising transmitting from the several subscribers' stations to the central office at voice frequency, translating from voice frequency to carrier frequency at the central office and transmitting at carrier frequency from the central office to the said several subscribers' stations.

2. The combination of a subscriber's station capable of transmitting at voice frequency and including a detector for receiving carrier frequency waves and converting them to voice frequencies, and a bilateral cord circuit for interconnecting subscribers' lines and comprising means to translate voice frequency waves from either of two lines to carrier frequency waves for transmission to the opposite line.

3. A subscriber's station comprising a transmitting branch including a transmitter and a voice filter, and a receiving branch including a filter for passing modulated carrier waves, a detector and a receiver, a two-wire line from said subscriber's station to a central office, and a four-wire cord circuit connectible between said line and other similar lines individually and comprising in each side a voice filter, a modulator for translating voice waves to modulated carrier waves, and a carrier frequency filter, in the order named, the opposite sides of said four-wire cord circuit transmitting in opposite directions.

4. The combination with subscribers' lines comprising subscribers' stations each capable of transmitting voice frequency waves and receiving and detecting carrier frequency waves, of a cord circuit including a modulator connectible to said lines, whereby incoming voice waves from a connected line are converted into modulated carrier waves for transmission to another connected line.

5. A telephone system comprising a central station and lines radiating therefrom, a source of carrier waves and modulating means located only at said central station, means for transmitting speech over each of said lines to said central station at voice frequencies, and means including said source of carrier waves and said modulating means for transmitting from said central station over any of said lines carrier waves modulated by the voice waves received over another line.

6. The combination with subscribers' lines comprising subscribers' stations capable of transmitting at voice frequencies and receiving and detecting voice-modulated carrier waves, of a cord circuit connectible to said lines comprising a source of carrier waves, a modulator and a pair of filters, one passing speech currents and the other passing modulated carrier waves, connected between said modulator and the ends of said cord circuit whereby voice waves received over either of two connected lines are converted to modulated carrier waves for transmission to the other line.

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