

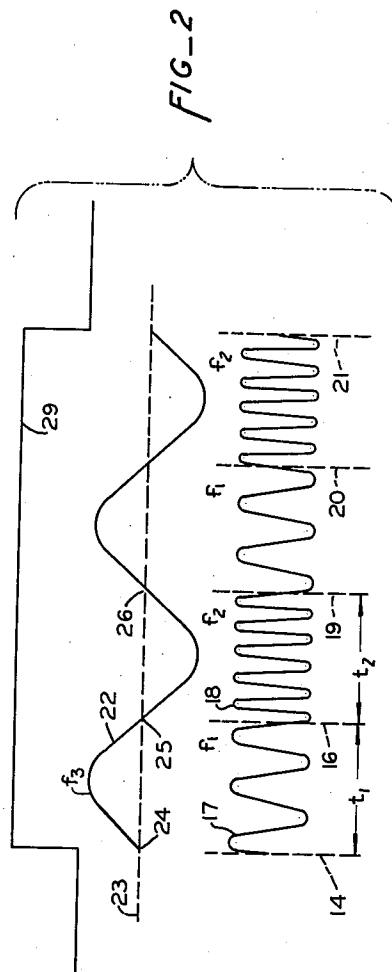
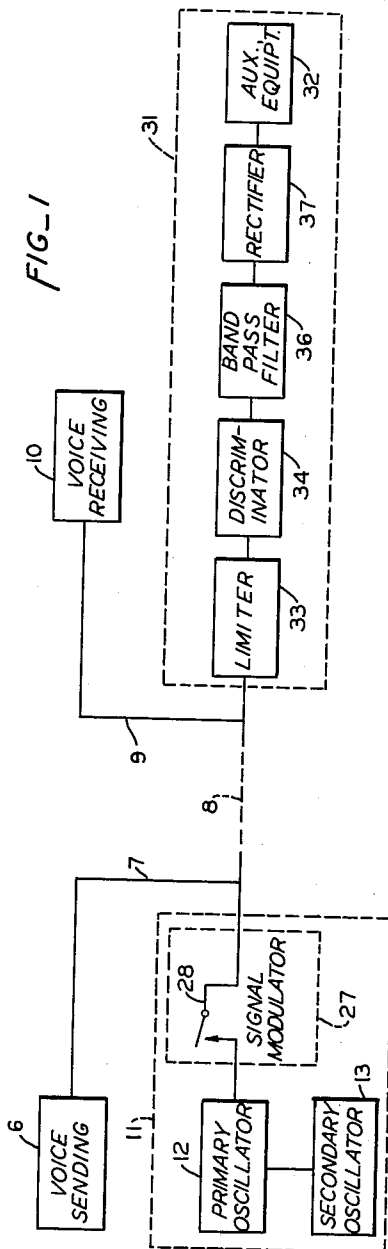
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W. E. NOLLER

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INBAND SIGNALLING SYSTEM

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INVENTOR.
WALTER E. NOLLER
BY *Lothrop & West*
ATTORNEYS

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INBAND SIGNALLING SYSTEM

Walter E. Noller, Berkeley, Calif., assignor to Lynch Carrier Systems, Inc., a corporation
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My invention relates to the art of communication and is especially concerned with an electro-magnetic system in which intelligence substantially at voice frequency is transmitted from a sending station to a receiving station. In such a system, it is customary to have at the receiving station not only equipment which is designed to render audible the received voice frequencies but also other equipment actuated by means of various energizing impulses. This auxiliary equipment may be dialing or ringing mechanism, for example. It is customary to provide the energizing impulses at some frequency other than the voice frequencies normally transmitted and to have such impulses remotely spaced in the frequency spectrum from the voice frequencies.

If the auxiliary equipment were responsive to voice frequencies, then normal conversation over the communications circuit would from time to time and in unwanted instances actuate the auxiliary equipment. To avoid unwanted or inadvertent, random actuation of auxiliary equipment it has been necessary heretofore to resort to various means involving departure from the voice spectrum for handling the impulses for uniquely energizing the auxiliary equipment. There is an increasing necessity to utilize as narrow a frequency spectrum as possible for direct communication and also for auxiliary equipment, and so it is highly desirable to reduce the frequency spectrum required for all purposes.

It is therefore an object of my invention to provide a signalling system for use with voice frequency intelligence transmission in which the impulses for actuating auxiliary equipment are within the voice frequency spectrum, yet in which the voice itself does not inadvertently or at random actuate the auxiliary equipment.

Another object of the invention is to provide an inband signalling system in which impulses for actuating auxiliary equipment are transmitted effectively at frequencies within the voice spectrum yet in which the voice itself does not produce unwanted actuation of the auxiliary equipment.

Another object of the invention is to provide a simple and straightforward means for distinguishing, within a voice frequency spectrum, signals for actuating auxiliary equipment.

Another object of the invention is to provide auxiliary equipment responsive to signals within the voice frequency spectrum but not substantially actuated by the voice.

Another object of the invention is, in general, to improve communication signalling systems.

A still further object of the invention is to provide a practical inband signalling system of a relatively simple, effective nature.

An additional object of the invention is to provide an inband signalling system not dependent upon complex guard circuits, band elimination and elaborate filter combinations.

Other objects, together with the foregoing, are attained in the embodiment of the invention described in the accompanying description and illustrated in the accompanying drawings, in which—

FIGURE 1 is a block diagram of an inband signalling system arranged in accordance with the invention.

FIGURE 2 is a diagram showing the relationship of various signal plots in the inband signalling system.

While the inband signalling system of the invention

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can be utilized in connection with various means of transmitting intelligence and can be adapted directly or by analogue to widely variant forms of such means, it has successfully been commercially embodied substantially as illustrated herein. In this arrangement, there is provided a voice sending station 6 of any recognized sort in which the energy of the human voice at its customary speech frequencies is translated into electro-magnetic impulses impressed on a conductor 7 and transmitted over a transmission path 8. This path may be with or without metallic conductors and is especially designed for the efficient and effective carriage of the intelligence impressed at the sending station 6. One example of the transmission path 8 is a carrier telephone circuit. The path 8 extends to a conductor 9 ending at a voice receiving station 10 at which the electro-magnetic energy is translated into a reasonable reproduction of the sound impressed at the sending station 6. The frequency spectrum of the reproduced energy at the receiving station 10 is approximately the same as the frequency spectrum of the energy impressed upon the sending station 6.

Pursuant to the invention, there is provided in connection with the sending station 6 and usually, although not necessarily at the physical location of the sending station 6 or adjacent thereto, a means (enclosed by the broken line 11) comprising elements effective to send a special inband signal over the transmission path 8. While the special signal is well within the frequency spectrum of the voice sending station 6, it also has certain characteristics largely distinguishing it from the voice. For that reason, included in the signal sending means 11 is apparatus for amplitude modulating two alternately occurring carriers of different frequency. Part of the apparatus is a primary oscillator 12. This oscillator is of any convenient kind and has no special characteristics except that it is operable or tunable to operate at either one of two selected frequencies. The first selected or predetermined frequency is well within the voice spectrum and the second predetermined or selected frequency, although of a different value and separated from the first frequency by a significant amount, is itself still within the frequency spectrum of the voice.

The primary oscillator 12 is arranged to be operated at one of the selected frequencies for a given interval of time and then at the other of the selected frequencies for a given interval of time so that the frequencies follow or alternate with each other at given or predetermined times. It is possible to have more than two predetermined frequencies of operation of the oscillator 12 and three or more such frequencies are referred to as a sequence or series of such frequencies. In the event there are more than two, then the different frequencies are arranged to follow each other at intervals of time and in a sequence which is predetermined. The term "alternating" is therefore intended to apply not only to two frequencies which succeed each other but also to a plurality of distinct frequencies which follow each other in selected order and for chosen individual duration times.

The oscillator 12 can be switched between the two (or more) frequencies by any convenient means including mechanical or other switching and, in fact, can be substituted for by a pair (not illustrated) of individual oscillators each of which has one of the predetermined frequencies of operation, with the switching being done between them. Preferably, the primary oscillator 12 (or the primary oscillators) has the function of giving out energy at different frequencies within the voice spectrum under the control of a secondary oscillator 13. The frequency of oscillation of the oscillator 13 is likewise well within the voice spectrum. The secondary oscillator 13 is utilized as a switching oscillator. This can conveniently be done by

connecting the output of the secondary oscillator 13 to switch the output of the primary oscillator 12 so that the two (or more) selected frequencies of the primary oscillator 12 alternate at the selected switching frequency of the secondary oscillator 13.

This condition is represented in FIGURE 2 by the sine sequence between the lines 14 and 16 showing an oscillation plot 17 of a set amplitude and modulated at a selected frequency designed f_1 and having a time duration t_1 and by the sinusoidal oscillation plot 18 between the lines 16 and 19. The plot 18 is at the set amplitude of the first oscillation f_1 but is modulated at a significantly greater frequency represented in the figure as f_2 and extending over a time interval t_2 which, although not necessarily so is illustrated as equal in length to the time interval t_1 . As indicated by the plots between the lines 14, 16, 19, 20 and 21, the various oscillations at different frequencies succeed each other repeatedly.

Also as illustrated in FIGURE 2, the alternations between the primary oscillator frequencies f_1 and f_2 can be represented by a sinusoidal plot 22 of fixed amplitude and frequency extending either side of its axis 23. When on the positive side of the axis, the plot 22 represents production of the frequency f_1 during the time interval t_1 and when on the negative side of the axis 22, the plot 22 represents the production of the frequency f_2 for an equal time interval t_2 . The undulations of the plot 22 represent the frequency of alternation impressed by the secondary oscillator 13 upon the primary oscillator 12 so that the curve 22 represents the frequency f_3 . The points such as 24 and 25 and 26 at which the plot 22 crosses the axis 23 are spaced to represent the times at which the frequency changes.

The curve 22 representing the frequency f_3 need not be sinusoidal but can be of any shape so long as it alternates on opposite sides of the axis 23 and crosses the axis at the points 24, 25 and 26 at the times of frequency switch. Thus, in any case, FIGURE 2 represents the operation of the secondary oscillator 13 and of the primary oscillator 12 to generate continuously a signal made up of voice frequency modulations and comprised of at least two primary oscillations or two tones each at a voice frequency different from the other and themselves alternated at a set frequency; that is, modulated at the voice frequency or third tone of the secondary oscillator. The term "tri-tone" is conveniently applied to the system.

While the production of the three tones or compound voice frequency signal from the primary and secondary oscillators may be continuous, it is not impressed continuously upon the transmission path 8. Rather, this signal as generated is itself governed by an amplitude modulator 27. This modulator can be of any convenient kind effective to vary the amplitude with which the compound oscillator signal is impressed upon the transmission path 8. For example, the modulator 27 may include a switch 28 which opens the conductor interposed between the oscillators 12 and 13 and the transmission path 8. The switch 28 can be opened and closed so that when the path is continuous the impulse from the oscillators 12 and 13 travels over the transmission path 8 and when the switch 28 is open there is no transmission of the signal impulse over the transmission path 8. The closure of the switch 28 is represented by the amplitude modulated curve 29 in FIGURE 2.

In sum, at or adjacent to the sending station 6 there is afforded a means for impressing upon the transmission path 8 for conduction thereover a compound or complex signal impulse which is comprised of individual oscillations, each at a different voice frequency rapidly following each other at a distinct voice frequency, constituting three tones. The transmission path 8 thus can carry sequentially but within the same band not only the voice frequencies from the sending station 6 but also when the

switch 28 is closed the three tone signal energy from the signal means 11.

Although not necessarily so located, there is conveniently provided at or adjacent the receiving station 10 an impulse receiver, generally designated 31, which includes certain auxiliary equipment 32 designed to be appropriately actuated in connection with the transmission of the intelligence. In a telephone installation, for example, the mechanism 32 might be a ringing device. The receiving means 31 is connected to the transmission path 8 and preferably includes a signal limiter 33. The limiter in effect reduces amplitude variation of frequencies from voice transmission along the path 8 to a very low value, too low to have an actuating effect upon the auxiliary equipment 32. The relatively strong signal from the modulator 27, being substantially deprived of amplitude variation by the limiter, now appears at the output of 33 substantially as the wave form 17, 18 of FIG. 2. It is passed into a discriminator 34 wherein the frequency f_3 of the secondary oscillator is recovered, and appears at the output thereof substantially in the form shown at 22 in FIG. 2.

The output 22 of the discriminator 34 is fed into a band pass filter 36 designed to block all frequencies other than the frequency f_3 and pass only the frequency f_3 , the frequency at which the secondary oscillator 13 is effective. Since the other frequencies are screened out, only the frequency f_3 is passed to a rectifier 37 in which the signal originally impressed by the amplitude modulator 27 is detected and recreated to substantially the form shown at 29, and so serves as an impulse for actuating the auxiliary device 32. Thus, the three tone signal which is put upon the transmission path 8 at the output of the amplitude modulator 27 is ultimately effective to actuate the auxiliary equipment 32.

Since all of the frequencies utilized in the signalling means 11 and travelling over the transmission path 8 are within the voice frequency spectrum, it might be thought that voice frequencies impressed upon the transmission path at the sending station 6 might themselves travel through the receiving means 31 and be effective to actuate the auxiliary equipment 32. That, however, is not the case in fact, certainly not in a commercial sense. It has been determined by careful study of voice frequency patterns and combinations and by extensive laboratory and commercial experience that the frequencies f_1 and f_2 of the primary oscillator 12 when alternated or utilized in sequence at the frequency f_3 of the oscillator 13 do not occur in voice transmission.

Perhaps it can not be said that such a combination of voice frequencies can never occur in speech, still in laboratory tests and in commercial operation over a protracted period of time, no actuation of auxiliary equipment by such a combination has ever occurred. It certainly can be said that the incidence or production in the voice of the frequencies f_1 and f_2 at the modulation frequency f_3 at all, or for the amplitude modulation interval 29, occurs so seldom in fact and in commercial usage as to be well within the failure expectancy of other items of equipment utilized in the system. For that reason, in the claims herein there is reference to the "substantial" non-occurrence within voice transmission of the frequencies f_1 and f_2 modulated at the frequency f_3 . While it cannot be said that it is impossible for the auxiliary equipment 32 to be actuated by the voice sending equipment 6, yet when the auxiliary equipment 32 is set up with the translating equipment 33, 34, 36 and 37, the statistical probability of any unwanted actuation occurring is so remote that it can be said substantially never to occur. The probability of occurrence of an unwanted actuation is even less than the probability of other failures which occasionally occur in a practical, commercial system.

There has thus been provided, pursuant to the invention, an inband signalling system utilizing two base frequencies or tones alternated or modulated at a third fre-

quency or tone to provide a compound signal amplitude modulated for transmission at voice frequency over a voice frequency transmission path and which at the receiving station is so interpreted that it actuates auxiliary equipment and in which the interpretation equipment substantially never receives from the voice transmission a signal which duplicates the compound signal. Thus, there is provided a practical inband signalling system for a voice transmission path so that auxiliary equipment can be accurately and positively actuated substantially without false actuation and without expanding the necessary frequency spectrum beyond that of the voice. In a commercial installation, it is feasible to provide a differential of 15 to 30 db between unwanted voice and the desired signal and the performance of the system is not materially changed by variation in magnitude of the signal tones from 0 to 20 db below speech.

What is claimed is:

1. An inband signalling system comprising means for receiving over a voice frequency transmitting path a pulse substantially differing from voice frequencies and including an amplitude modulated signal resulting from the transmission of two different voice frequencies alternating at a third voice frequency, said means including in sequence a limiter for substantially limiting amplitude variations of said signal, a discriminator for recovering said third frequency from said signal, a band pass filter for passing substantially only said third frequency, and a detector for recovering said amplitude modulated signal.

2. An inband signalling system comprising a sending station, a receiving station, means for transmitting intelligence at voice frequencies between said stations, means located at said sending station for impressing upon said transmitting means an amplitude modulated signal including a pair of different frequencies alternating at a third frequency, means located at said receiving station for limiting the amplitude of said signal, means located at said receiving station for discriminating said third frequency in said signal, means located at said receiving station for filtering out all but said third frequency from said signal, and means located at said receiving station for detecting the amplitude modulation of said third frequency remaining in said signal.

3. An inband signalling system comprising a sending station, a receiving station, means for transmitting intelligence at voice frequencies between said stations, means located at said sending station for impressing upon said transmitting means a signal resulting from the amplitude modulation of two different frequencies alternating at a third frequency, means located at said receiving station for limiting voice amplitude modulations of said signal, means located at said receiving station for discriminating to recover said third frequency of said signal, means located at said receiving station for passing substantially only said third frequency, and means located at said receiving station for detecting said amplitude modulation of said third frequency remaining in said signal.

4. System for transmitting a control signal over an audio frequency transmission system and employing audio frequencies to effect said control, comprising: a transmission system, audio means for applying to said transmission system transmission signals covering a range of audio frequencies, means for producing a control signal residing in the audio frequency range, means for frequency modulating said control signal at a predetermined modulating frequency also residing in the audio frequency range, means for applying said frequency modulated control signal to said transmission system, means for selectively amplitude modulating the control signal applied to said transmission system, means for receiving from said transmission system the transmission signals applied to said transmission system by said audio means,

means for receiving from said transmission system said control signal, demodulating means for frequency demodulating said received control signal to substantially recreate said predetermined modulating frequency, filter means for receiving the output of said demodulating means and for passing only a narrow band of frequencies centered substantially at said predetermined frequency, and a responding mechanism effective to respond to signal passed by said filter means during the sustaining of said frequency modulated control signal, thereby to respond and thus recreate substantially the selective amplitude modulation applied to said control signal.

5. System for transmitting a control signal over an audio frequency transmission system and employing audio frequencies to effect said control, comprising: a transmission system, audio means for applying to said transmission system transmission signals covering a range of audio frequencies, means for producing a control signal residing in the audio frequency range, means for frequency modulating said control signal at a predetermined modulating frequency also residing in the audio frequency range, means for applying said frequency modulated control signal to said transmission system, means for selectively amplitude modulating the control signal applied to said transmission system, means for receiving from said transmission system the transmission signals applied to said transmission system by said audio means, means for receiving from said transmission system said control signal, means for frequency demodulating said received control signal to substantially recreate said predetermined modulating frequency, and a responding mechanism selectively responsive only to a narrow band of frequencies centered substantially at said predetermined frequency and effective to respond during the sustaining of said frequency modulated control signal, thereby to respond and thus create substantially the selective amplitude modulation applied to said control signal.

6. Inband signalling system for transmitting and receiving audio frequency signal and a control signal, all significant frequencies of said signals lying in the audio range, comprising: a transmission system, means for applying to said transmission system audio frequency signals covering a range of audio frequencies, means for applying to said transmission system a control signal, means for successively alternating the carrier frequency of said control signal between two different frequencies at a third predetermined alternation frequency, means for selectively applying said control signal to said transmission system, means for receiving said audio signals from said transmission system, means selectively responsive to the carrier frequencies of said control signal for receiving said control signal from said transmission system, means for demodulating the output of said last name receiving means to create a signal of said predetermined frequency, filter means selectively responsive to a narrow band of frequencies centered substantially at said predetermined frequency for delivering an output in response to application thereto of said narrow band of frequencies, and means responsive to the output of said filter means for responding to said control signal whenever the same is applied to said transmission system by said applying means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,299,821	Horton	Oct. 27, 1942
2,461,956	Beckwith	Feb. 15, 1949
2,495,452	Grove	Jan. 24, 1950
2,535,104	Van Mierlo	Dec. 26, 1950
2,547,024	Noble	Apr. 3, 1951
2,871,463	Beckwith	Jan. 27, 1959