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WAVE SIGNALING METHOD AND APPARATUS

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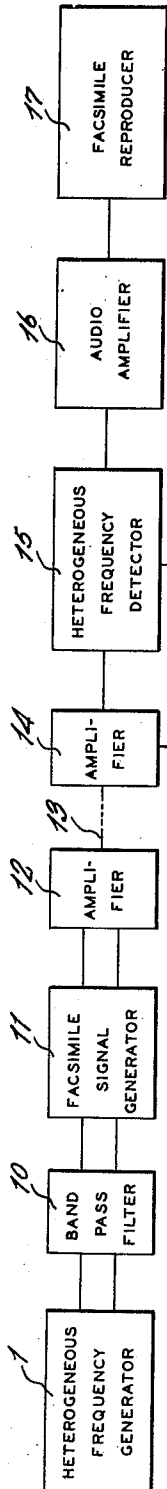


Fig. 1.

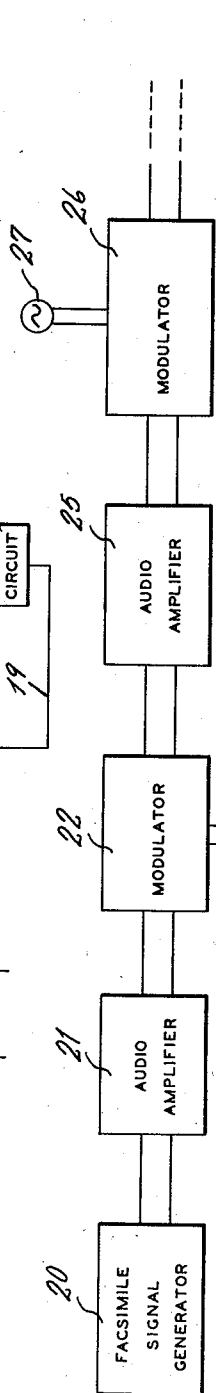


Fig. 2.

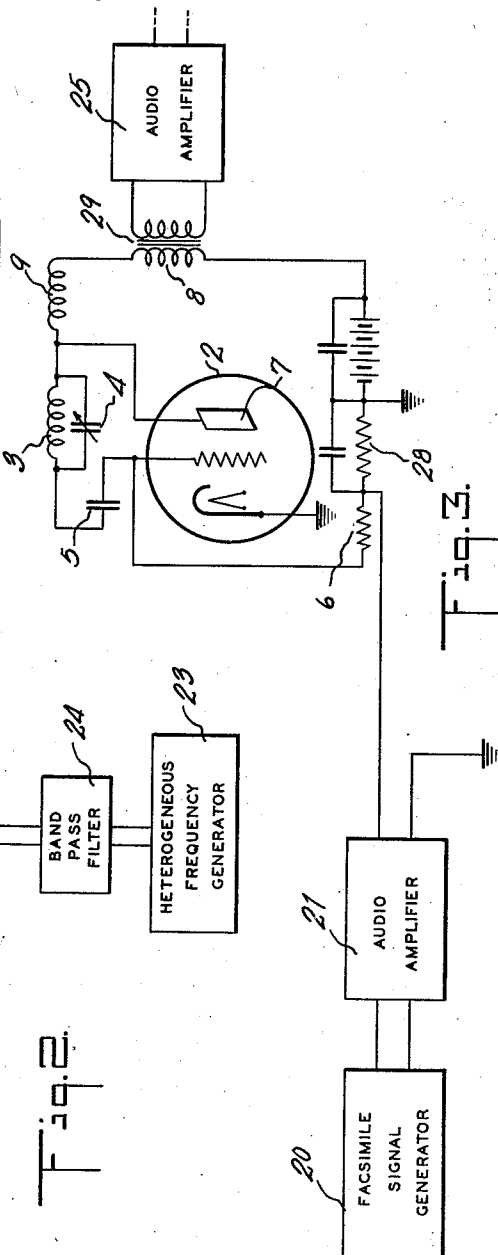


Fig. 3.

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WAVE SIGNALING METHOD AND APPARATUS

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12 Claims. (Cl. 250—6)

This invention relates to wave signaling systems and more especially to methods and apparatus for compensating for level variations in a transmitting medium of the wire or wireless type.

5 A principal object of the invention is to provide an improved method of transmitting signals, such for example as tele-facsimile signals, telegraph signals and the like, so that the selective fading characteristic of the transmitting medium is compensated for.

10 Another object is to provide a system of tele-facsimile transmission wherein the facsimile signals are simultaneously transmitted on a band of heterogeneous carrier or sub-carrier frequencies having predetermined lower and upper frequency limits.

15 Another object is to provide a system of automatic gain control for a receiving amplifier which utilizes the average amplitude of a received heterogeneous frequency band for level control, thus avoiding the drawbacks incident to the use of a single level control frequency. In accordance with this object, instead of transmitting the signals as a modulation of a single fundamental frequency carrier or as a modulation of a plurality of simultaneous carriers of one or more dominant or fundamental frequencies, the signals are transmitted as modulations of a "noise band" carrier, that is one wherein a large number of frequencies are generated but without any dominant frequency. An example of such a "heterogeneous frequency" band may be mentioned the "noise" currents which are generated when an oscillating circuit is suddenly quenched at a lower frequency, of which a super-regenerative oscillator of any known type is typical. I have found that this ordinarily undesirable "noise" or hissing can be practically utilized as a carrier or sub-carrier for signals such as facsimile signals or the like, and that it has highly advantageous results when used for automatic level control at a receiving station.

20 Accordingly a feature of the invention relates to a signaling system wherein a "noise" generator of a "heterogeneous frequency" band is employed as a carrier or sub-carrier of message signals such as telegraph signals, facsimile signals and the like.

25 Another feature relates to a signal transmission system wherein a "heterogeneous" carrier frequency band is employed so as to produce a smooth noise or hiss over a relatively wide portion of the audio-frequency spectrum, the amplitude of the band being modulated in accordance with signals to be transmitted.

A further feature relates to the novel organization, arrangement and relative interconnection of parts which cooperate to produce a signaling system which is singularly free from the effects of fading or level variation in the transmitting medium whether of the wire or wireless type.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

10 Inasmuch as the invention in its broad aspects is concerned with the method and apparatus of generating and utilizing a carrier or sub-carrier of the "heterogeneous frequency" band type, only those parts of a signaling system are shown as will enable the inventive concept to be understood and practised. Accordingly, apparatus and connections which are old or well-known in the art will be illustrated in the drawing in simplified or diagrammatic form.

15 Fig. 1 shows in schematic form a transmission system embodying features of the invention.

Fig. 2 is a modification of Fig. 1.

20 Fig. 3 is a more detailed diagram of connections of the system of Fig. 2 showing the "heterogeneous frequency" generator that may also be used in the system of Fig. 1.

25 It can be shown by mathematical analysis that "noise" generated by the excitation or quenching of an oscillating circuit by means of other waves of steep wave front, consists of innumerable frequency components. Thus where the excitation or quenching is by means of a square wave pulse, the frequencies are theoretically infinite in number. It is known that by using a grid-controlled vacuum tube and exciting it with square front waves, that a series of separate frequencies are produced in the output circuit, however these frequencies are generated on a regularly continuous time basis and successively higher frequencies are regularly recurrent as far as the time axis is concerned. Such an arrangement is quite commonly used in carrier telephone systems. In contradistinction to this known type of harmonic or "homogeneous frequency generator," the present invention contemplates the generation and utilization of the innumerable component frequencies which are generated on a random time axis and will be referred to herein as a "heterogeneous frequency" band generator. 30 It is possible by proper excitation of a grid-controlled vacuum tube to generate such "heterogeneous frequency" bands so that the recurrence of the individual frequencies of the band is not on a harmonic basis, and the frequency recur-

rence of any given wave or waves is fortuitous. When such "heterogeneous" frequencies are generated in the audio frequency band they are evident to the ear as a smooth hissing in which no particular frequency is outstanding or dominant. In accordance with the present invention, a predetermined portion of the spectrum of such a "heterogeneous frequency" generator is selected for example by band filters or the like, and this band is used as a carrier or sub-carrier of signals to be transmitted over a wire channel or a wireless channel. Consequently since at any given instant at the receiver a signal is represented by an innumerable number of individual heterogeneous carrier or sub-carrier frequencies, the effects of selective fading can be materially reduced at the receiver. One manner of utilizing this "heterogeneous frequency" band is to apply it to control the generation of an automatic volume control signal for application to a receiving amplifier. Thus where the signals are transmitted over a radio channel, it is well-known that individual frequencies are very often subjected to selective or non-uniform fading. Consequently two frequencies separated by a small fraction of a percent will not always fade simultaneously and to the same extent. In the usual system of amplitude-modulated carrier transmission where the transmission is carried out by means of a sub-carrier usually of audio frequency, only a single sub-carrier is employed for the signals. Consequently at any given instant at the receiver, there will be present the sub-carrier frequency and its upper and lower side-band frequencies. It is the usual practice in applying A. V. C. signals at the receiver, to generate such A. V. C. signals in accordance with the received carrier or sub-carrier frequency alone, and the side-band frequencies may fade in and out irregularly with respect to the carrier or sub-carrier although the latter may be held quite constant. In accordance with the present invention, by using sub-carrier frequencies of the "heterogeneous frequency" band type and utilizing these "heterogeneous frequencies" for A. V. C. control purposes there is assured at all times a considerable number of frequencies for the A. V. C. control. Consequently even if some frequencies are actually missing as a result of selective fading, there will be sufficient remaining to prevent a complete loss of the receiver output.

Referring to Fig. 1, the numeral 1 represents a device for generating a "heterogeneous" frequency wave spectrum wherein the individual frequencies are generated fortuitously or at random so far as timing is concerned. For example there is shown in Fig. 3, one typical generator comprising a grid-controlled vacuum tube 2 having its input and output circuits connected in feedback relation through the tuned oscillatory circuit 3, 4, so as to generate super-audible oscillations which are interrupted at a super-audible rate under control of the grid condenser 5 and grid leak resistance 6, it being understood that the D. C. voltage for plate 7 is applied through the output transformer winding 8 in series with the high frequency choke coil 9. This generator is therefore of the well-known super-regenerative type and any other well-known form of such generator may be employed. As is well-known in the art, the output of such a generator produces a steady "hissing" or smooth noise which is free from any one dominant or regularly recurrent frequency component.

The audio-frequency or hissing output of de-

vice 1 (Fig. 1) is then passed through a suitable band-pass filter 10 of known design whereby a predetermined section of the audio-frequency spectrum of the "noise" currents is passed to the signal generating device 11. Device 11 may be any well-known form of telegraph transmitter such for example as a telegraph keying apparatus whereby the currents from the filter 10 are keyed in accordance with message signals. If desired, the device 11 may be of any well-known form of tele-facsimile signal generator including means for optically scanning a representation to convert it into corresponding electric signals. The output of filter 10 is applied to the facsimile scanning equipment so that the output of device 11 consists of the "heterogeneous frequency" sub-carrier of audio-frequency modulated in accordance with the instantaneous facsimile signals. The modulated heterogeneous frequency sub-carrier can then be amplified in any suitable amplifier 12 and impressed upon the transmission link 13 which may be a wire channel or a radio channel.

At the receiving station, to which the channel 13 is connected, the received waves are amplified in a suitable amplifier 14 including preferably a stage employing a grid-controlled amplifier tube (not shown) which is arranged in the usual way to have its gain controlled by an A. V. C. signal. After amplification the heterogeneous frequency sub-carrier is detected in any well-known detector whereby the original signals are also detected and applied to the audio-frequency amplifier 16 the output of which is applied to any well-known form of signal reproducer 17. A portion of the detected sub-carrier heterogeneous frequencies from device 15 are applied to any well-known form of A. V. C. circuit 18 whereby there is produced a D. C. signal representative of the average amplitude of the heterogeneous carrier frequencies as actually received from the link 14. These A. V. C. signals are then applied in the usual way over the A. V. C. conductor 19 to control the gain of the receiving amplifier 14.

Referring to Fig. 3, there is shown a slightly modified form of the invention. The signals from the facsimile or telegraph signal source 20 are amplified in amplifier 21 and are applied to any well-known form of modulator network 22 which is fed with a "heterogeneous frequency" band sub-carrier from the generator 23 through the band-pass filter 24. After amplification in the audio-frequency amplifier 25 the signal modulated sub-carrier is applied to the modulation network 26 of any well-known form of carrier transmitter the carrier generator of which is represented by the device 27. The doubly modulated carrier wave is then transmitted to the receiving station where after suitable amplification it is subjected to double demodulation to detect the "heterogeneous frequency" sub-carrier in order to generate the local A. V. C. signal as described in connection with Fig. 1, and to detect from the sub-carrier the original signals to be reproduced.

Referring to Fig. 3, there is shown in more detail, one modulating arrangement that is represented by the blocks 22, 23, 24 of Fig. 2. The heterogeneous frequency generator 23 is represented by the grid-controlled vacuum tube 1 which as above described is provided with known circuit connections whereby it acts as a super-regenerative oscillator. Connected in the grid-cathode circuit of the generator is a grid-bias

resistor to which is applied the output of the signal amplifier 21 so that the "noise" current in the output transformer 29 is modulated in accordance with signals from source 20. It will be understood of course that any other suitable way of modulating the "noise" currents of the super-regenerative oscillator to produce the signal-modulated heterogeneous frequency sub-carrier may be employed, and other changes and modifications may be made in the disclosed embodiments without departing from the spirit and scope of the invention. While in the foregoing description reference has been made to the production of a heterogeneous frequency in the audio frequency band, it will be understood of course that the heterogeneous frequencies that are used as the carrier or sub-carrier may be in the super-audible spectrum or in the radio frequency spectrum.

20 What I claim is:

1. The method of signaling which includes the steps of generating a heterogeneous frequency band wherein the frequency recurrence of any given wave or waves is fortuitous, modulating said band by a signal to be transmitted, and applying the modulated band to a transmission channel.

2. The method of signaling which includes the steps of generating a heterogeneous frequency band wherein the frequency recurrence of any given wave or waves is fortuitous, modulating said band by a signal to be transmitted, receiving the modulated band, and detecting from the received band the signal to be transmitted.

3. The method of signaling which includes the steps of generating a "noise" band consisting of heterogeneous frequencies wherein the frequency recurrence of any given wave or waves is fortuitous, modulating said band by a signal to be transmitted, receiving the modulated band to detect the signal therefrom, and deriving from the received heterogeneous frequencies a level control signal.

4. The method of signaling which includes the steps of generating a carrier in the form of a band of heterogeneous audio frequencies wherein the frequency recurrence of any given wave or waves is fortuitous, modulating said band by a signal to be transmitted, receiving and detecting the signal from the band, and controlling the level of the detected signal by generating a level control signal in accordance with the average level of the received heterogeneous frequencies.

5. The method of signaling which includes the steps of exciting an oscillatory circuit by waves of a super-audible frequency to generate a large number of heterogeneous frequencies wherein the frequency recurrence of any given wave or waves is fortuitous, selecting from said frequencies a predetermined band, modulating said selected band by a signal to be transmitted, receiving and amplifying said modulated band, and applying

ing a portion of the received band to control the level of the amplification to compensate for selective fading in the transmission medium.

6. The method of radio signaling which includes the steps of generating a plurality of sub-carrier frequencies of heterogeneous frequencies wherein the frequency recurrence of any given wave or waves is fortuitous, modulating said frequencies by a signal to be transmitted, modulating a radio carrier by said modulated frequencies, receiving the modulated radio carrier and detecting therefrom the sub-carriers, and detecting from the sub-carriers said signal.

7. The method of signaling employing a super-regenerative oscillator which includes the steps of generating a signal to be transmitted, exciting the oscillator to produce heterogeneous waves wherein the frequency recurrence of any given wave or waves is fortuitous, applying said signal to the oscillator to modulate the normal "noise" currents in the output circuit thereof, and transmitting said modulated "noise" currents to a distant receiving station.

8. In a signaling system, means to generate a band of heterogeneous frequencies wherein the frequency recurrence of any given wave or waves is fortuitous, means to modulate said band by a signal to be transmitted, and means to apply said modulated band to a transmission channel.

9. In a signaling system, means to generate a series of heterogeneous frequencies wherein the frequency recurrence of any given wave or waves is fortuitous, the series being free from any dominant or fundamental frequency, means to modulate all said frequencies simultaneously by a signal, and means to transmit said modulated frequencies to a distant receiving station.

10. In a signaling system, a super-regenerative oscillator for generating "noise" currents composed of heterogeneous frequencies wherein the frequency recurrence of any given wave or waves is fortuitous, a band-pass filter for selecting a predetermined band of said frequencies, and means to modulate said selected band by a signal to be transmitted.

11. A signaling system according to claim 10, in which means are provided to receive said modulated band and to detect therefrom the signal being transmitted, and means to derive from the received "noise" currents a level control signal.

12. In combination a grid-controlled vacuum tube, a feed-back circuit between the input and output of said tube for generating super-audible oscillations, means associated with said tube to interrupt said oscillations to generate in the output circuit "noise" currents wherein the frequency recurrence of any given wave or waves is fortuitous, means to apply a signal to be transmitted to said tube to modulate said "noise" currents, and means to apply said modulated noise currents as a carrier to a transmission channel.

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