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CARRIER SIGNALING SYSTEM

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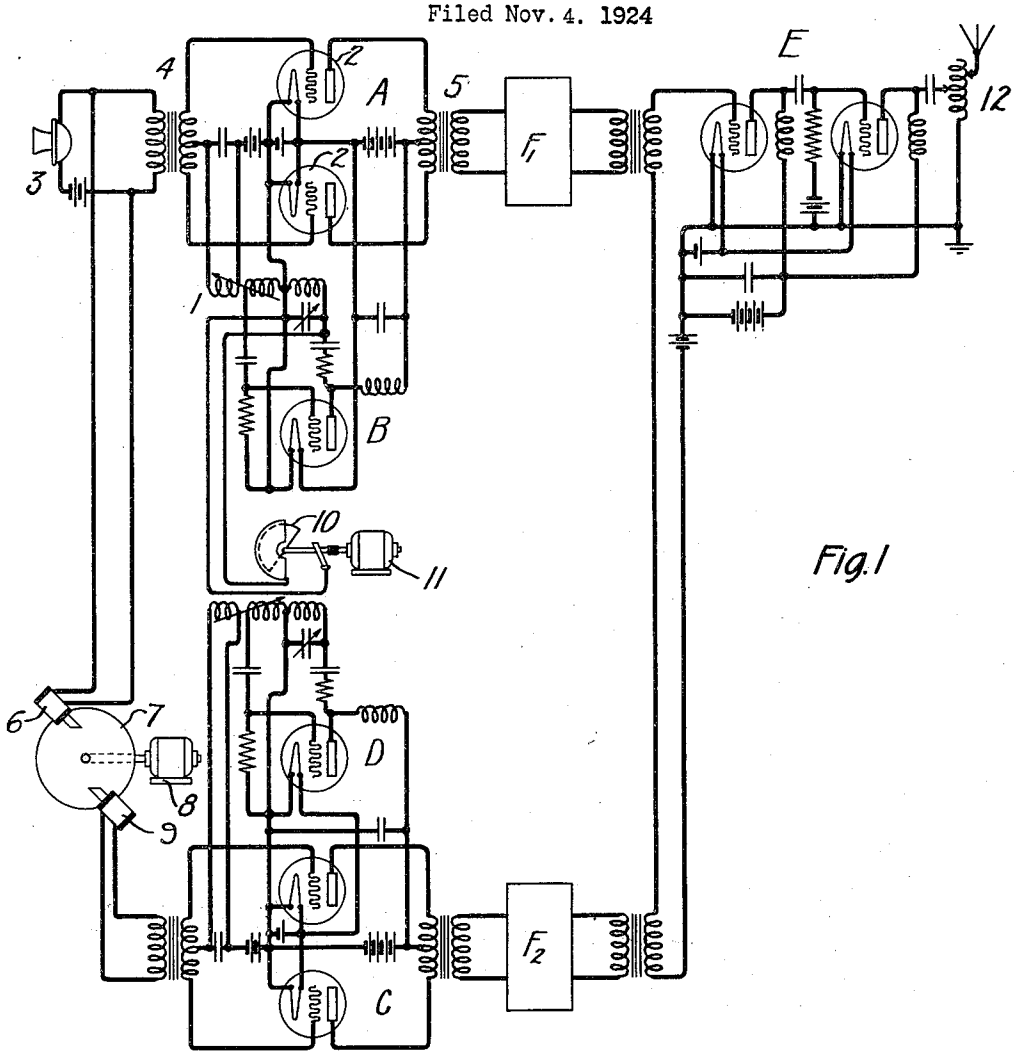



Fig. 1

Fig. 3

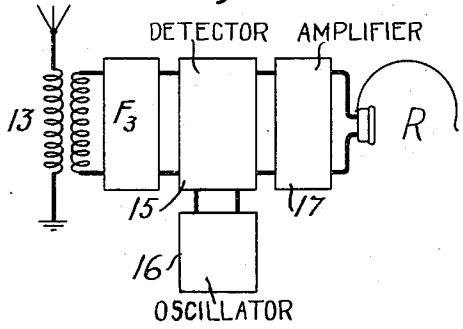
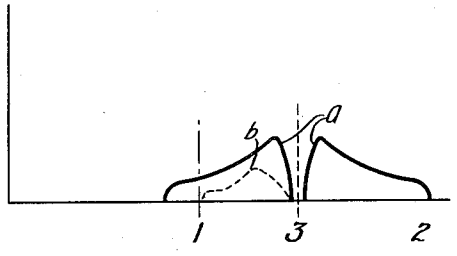



Fig. 2

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# UNITED STATES PATENT OFFICE.

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## CARRIER SIGNALING SYSTEM.

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This invention relates to carrier signaling systems and more particularly to a method of and means for the secret transmission of signals between stations.

One object of this invention is to provide a signaling system wherein the transmitted signals may be received only by certain authorized stations.

Another object is to provide a secret signaling system wherein a minimum of power is used in long distance transmission.

These objects are accomplished by employing a system of transmission wherein a carrier wave is modulated by signal currents, the unmodulated carrier component is suppressed and the modulated components consisting of the side bands, one of which is rendered incapable of intelligible reception as by means of masking frequencies, are transmitted. The side band is masked by superimposing upon it a side band resulting from modulating a carrier wave by delayed signal currents derived from the original modulating source. To produce the masking side band, energy of the signal currents is stored and, after a definite time interval, is supplied together with a carrier wave to an auxiliary modulator in which they are combined. The signal is made intelligible at a receiving station by suppressing the masked side band and combining a wave of carrier frequency with the undistorted incoming wave component.

The invention will be hereafter described as applied to a radio system, but it is to be understood that this invention may be used in a carrier system employing a line for guiding the waves.

The novel features which are believed to be characteristic of this invention will be pointed out with particularity in the claims appended hereto. The invention itself, however, as to its objects and advantages, the details of its organization and its mode of operation will be better understood by referring to the following description taken in connection with the accompanying drawing in which:

Fig. 1 illustrates a transmitting system embodying this invention;

Fig. 2 shows a series of curves to be used in explaining the operation of the system shown in Fig. 1; and

Fig. 3 is a schematic representation of a system adapted to receive waves transmitted by the apparatus shown in Fig. 1.

Referring now to Fig. 1 there is shown a balanced modulator A which may be of any type adapted to produce both side bands and suppress the unmodulated component of carrier frequency. A suitable system which may be used for this purpose is shown and described in U. S. Patent 1,343,307, June 15, 1920, to Carson. A wave of carrier frequency supplied by an oscillator B is impressed upon the common input circuit of the modulator A by means of coil 1. Speech currents produced in the microphone circuit 3 are impressed upon the filament-grid circuit of the modulator A through transformer 4. The oscillator B is of any type adapted to produce radio frequency oscillations. A suitable system which may be employed for this purpose, if desired, is shown and described in detail in U. S. Patent 1,356,763, October 26, 1920, to Hartley.

In double side band transmission it is impossible to intelligibly receive signals unless the supplied carrier is of the exact frequency and phase of the suppressed carrier. If one side band is suppressed, however, the supplied carrier may vary considerably and still produce intelligible signals. By transmitting a portion of the second side band this feature is taken advantage of and the difficulty of reception is increased.

To assist in preventing an unauthorized station from being able to intelligibly receive the message being transmitted a carrier wave of constantly varying frequency should preferably be used. For this purpose a variable auxiliary condenser 10 of small capacity, included in the frequency determining circuit of the oscillator B, has its movable element continuously driven by a motor 11.

The modulation products resulting from the operation of the modulator A, consisting solely of the modulated components of the carrier wave, i. e., both side bands, are impressed upon filter $F_1$ which is designed to suppress a portion of one of the side bands and transmit only the remainder of this side band and all of the other side band. These transmitted side bands are represented by the curves "a" in Fig. 2. The portion transmitted through filter $F_1$ is the portion be-

tween points 1 and 2. This is impressed upon the input circuit of an amplifier E, which may consist of any number of stages.

Signals from source 3 are also supplied to the electromagnet 6 which acts upon a telegraphone disc 7 operated by motor 8 to produce variations in the magnetic properties of the disc. These magnetic variations induce corresponding current variations in an electromagnet 9 which is in spaced relation to electromagnet 6. The current variations produced in the magnet 9 will have a time lag depending upon the spacing of the two elctromagnets and the speed of rotation of the disc. Delayed signal currents from electromagnet 9 are impressed upon balanced modulator C, upon which a carrier wave is impressed by oscillator D. Oscillator D and modulator C operate in the same manner as the arrangement described above comprising the modulator A and oscillator B, to produce side band components only. These side bands will be hereinafter termed the delayed side bands.

The frequency of oscillator D may be the same as that of oscillator B or it may vary therefrom by 50 or 100 cycles. If the frequency is taken so that the upper side band from modulator C is superimposed on the lower side band from modulator A the disturbing wave after detection will not merely be delayed words but will be inverted to also effectively constitute noise. As words have a greater disturbing effect it is preferable to so choose the frequency of oscillator D that the lower side bands from the two modulators will coincide.

The output energy of the modulator C is impressed upon filter $F_2$ which is designed to transmit a portion of one side band only, such as that represented by curve *b* between the points 1 and 3 of Fig. 2. This delayed side band is impressed upon the input circuit of the amplifier E and superimposed upon the side bands transmitted through the filter $F_1$. The superposed side bands consisting of those transmitted through the filter $F_1$, one of which is masked by the delayed side band passed by the filter $F_2$ and the other of which comprises the undisturbed side band component, after being amplified by the amplifier E, are supplied to and radiated from the antenna 12.

Filters $F_1$ and $F_2$ are band pass filters of any suitable type, such as, for example, those disclosed in U. S. Patent 1,227,114, May 22, 1917 to Campbell.

Figure 3 shows an arrangement adapted to receive the waves transmitted by the system shown in Figure 1.

The waves radiated from the antenna 12 are received by the antenna circuit 13. The received waves are impressed upon a band pass filter $F_3$ which is designed to suppress the masked side band component and transmit only the undisturbed side band component, corresponding to the portion represented by curve "*a*", between points 3 and 2 in Fig. 2. The undisturbed side band component is supplied to a detector 15. An oscillator 16 supplies oscillations of carrier wave frequency to this detector in which they are combined with the undisturbed side band to yield the signal currents. These currents after being amplified by the amplifier 17, consisting of any number of stages desired, are used to actuate a receiving device R, which may be a telephone receiver or a loud speaker.

In secrecy systems heretofore proposed continuously supplied noise currents are used to modulate the carrier wave with the result that an operator after listening in for a period of time and becoming accustomed to the disturbing noises may be able to disregard them and hence distinguish the desired signal from the disturbances.

In the present system, however, the disturbing noises occur only during the signaling intervals, they are of substantially the same pitch as the signals, and hence are much more effective in masking the signal than in the systems referred to above.

If in an unauthorized receiving station a local oscillator is used which supplies oscillations of exactly the same frequency as the suppressed carrier it would be possible to receive the incoming signals more or less intelligibly without suppressing the masked side band. However, by slightly varying the frequency of the carrier supplied at the transmission station it will be impossible for an unauthorized receiving station to reproduce the suppressed carrier with the result that the signal will be unintelligible unless the masked side band is suppressed.

If desired, the oscillator D may also have its frequency varied slightly in a manner similar to that described above with reference to oscillator B, to further increase the difficulty of reception.

In secrecy transmission systems it is of prime importance to keep the power used to produce a disturbing signal as low as possible. This is especially true in long distance transmission, where high power must necessarily be used both for the desired signal and the superimposed masking signal. As pointed out above, since the disturbing noises are especially effective in masking the signals and they are only transmitted during signaling intervals, the energy required to produce them is considerably less than in the systems in which noise currents are continuously transmitted. Hence, under similar conditions, the amount of power required to transmit a signal to a distant station is considerably less than in systems heretofore known.

Although the invention has been described as applied to a radio telephone system, it is to be understood that by continuously actuating the microphone to produce a modulating current, or substituting a suitable modulating current source therefor, and using a key to control the current supplied to both the signal and distortion producing modulators in accordance with any code, this invention may be applied to the transmission of telegraph signals.

What is claimed is:

1. In a carrier signaling system comprising means for producing a carrier wave modulated in accordance with signaling currents, means for rendering one of said side bands incapable of intelligible reception, by waves derived from the signal source, and means for transmitting only the side band components of said wave.

2. In a carrier signaling system comprising means for producing a carrier wave modulated in accordance with variable frequency signaling currents, means for masking one of said side bands by a superimposed wave derived from the signal source, and means for transmitting the side band components of said wave while suppressing the unmodulated carrier component.

3. In a carrier signaling system comprising a source of speech waves and a source of carrier waves, a modulator for combining said waves to produce modulated components of said carrier wave while suppressing the unmodulated component, and means for masking one of said components by a superimposed wave derived from the original speech waves source.

4. In a carrier signaling system including a source of signaling waves and a source of carrier waves, a balanced modulator for combining said waves to produce the side band components while suppressing the unmodulated component of said carrier wave, and means for masking one of said side bands by a superimposed wave derived from said signaling source.

5. In a carrier signaling system including a source of signaling currents and a source of carrier waves, a balanced modulator for combining said waves to produce side band components while suppressing the unmodulated component of said carrier wave, and means for masking one of said side band components by a wave modulated by currents from said signaling source.

6. In a carrier signaling system including a source of signaling currents and a source of carrier waves, a balanced modulator for combining said waves to produce side band components while suppressing the unmodulated component of said carrier wave, and means for masking one of said side band components by a wave modulated by a delayed signal current from said signaling source.

7. In a carrier signaling system including a source of signaling current and a carrier wave source, a balanced modulator for combining said wave with the signal current to produce side band components while suppressing the unmodulated component of said carrier wave, a signal storing device, means for supplying signal current to said device, means for masking one of said side bands comprising means for producing a carrier wave modulated by current supplied from said signal storing device and means for superimposing a portion of one of said last mentioned side bands upon the side band produced by said first mentioned modulator, and means supplying said superposed side bands to a transmission circuit.

8. In a carrier signaling system including a source of signaling current and a source supplying a carrier wave of varying frequency, a balanced modulator for combining said wave and current to produce side band components while suppressing the unmodulated component of said carrier wave, a filter adapted to suppress a portion of one of said bands, a telegraphone, means for supplying signal current thereto, a second modulator for combining a carrier wave and current supplied by said telegraphone to produce side band components, a filter adapted to press a portion only of one of said last mentioned side bands, means for combining the transmitted portion of said last mentioned side band with the transmitted portion of said first mentioned side bands and means for supplying said combined side bands to a transmission circuit.

9. A method of carrier wave transmission which comprises combining a carrier wave and a signal wave to produce a modulated wave comprising side band components, masking one of said side bands by a superimposed signal modulated wave, and transmitting the superposed waves.

10. A method of carrier transmission which comprises combining a signal wave and a carrier wave to produce a modulated carrier wave consisting solely of side band components, masking the components corresponding to one side band by superimposing thereupon a wave modulated by delayed current derived from the signal wave and transmitting the superposed waves.

11. A method of carrier transmission which comprises combining a signal wave and a carrier wave to produce a modulated carrier wave consisting solely of side band components, masking one of said side bands by superimposing thereupon a side band produced by modulating a wave by delayed current derived from the signal wave and transmitting said superposed waves.

12. A method of secret carrier transmission which comprises combining a plurality of separate signal waves and a plurality of carrier waves to produce separate sets of side band components, masking one of the side band components of one of said sets by superimposing thereupon at least one of the side band components of the other set, whereby the remaining side band comprises a pure reproduction of the signaling wave.

13. A method of secret carrier transmission which comprises combining signal current and a current derived therefrom with a plurality of carrier waves to produce separate sets of side band components, masking at least a part of one of the side band components of one of said sets by superimposing thereupon components of the other set, whereby one of the side band components of one of said sets comprises a pure reproduction of the signal current.

14. The method of rendering a transmitted signal difficult of intelligible reception which comprises impressing the signal elements upon a transmission channel, causing the impression of the signal elements to impress upon the channel disturbing elements, and leaving the channel free of disturbing elements when no signal elements are impressed.

15. The method which comprises generating a signal wave having at least two portions whose corresponding frequencies are equal, generating a carrier wave, combining the carrier with one portion of the signal wave to produce a modulated wave comprising a pair of side bands, utilizing another portion of the signal wave to produce another pair of signal side bands which at least partially overlap one of the first mentioned side bands, superposing the resultant pairs of side bands, and transmitting the superposed waves.

16. The method recited in claim 15 in which the upper side band of the second mentioned pair of side bands substantially overlaps the lower side band of the first mentioned pair of side bands.

In witness whereof, I hereunto subscribe my name this 23 day of October A. D., 1924.

RAYMOND A. HEISING.