Jan. 7, 1936. H. CHIREIX ET AL 2,026,613

SECRECY SYSTEM

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Fig. 1

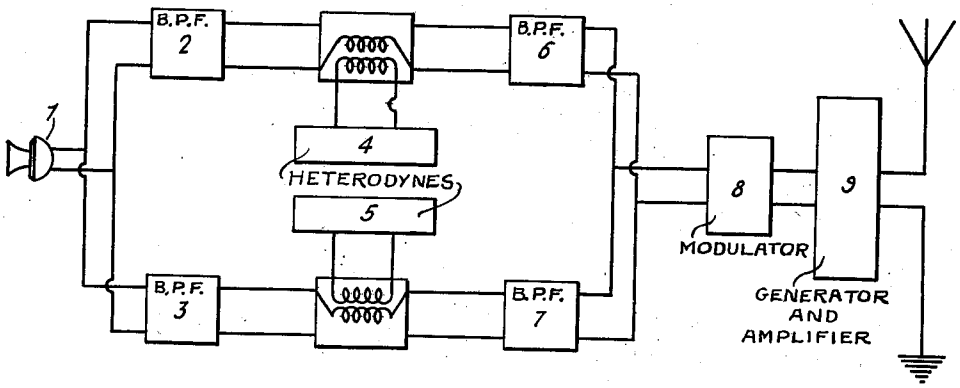


Fig. 3

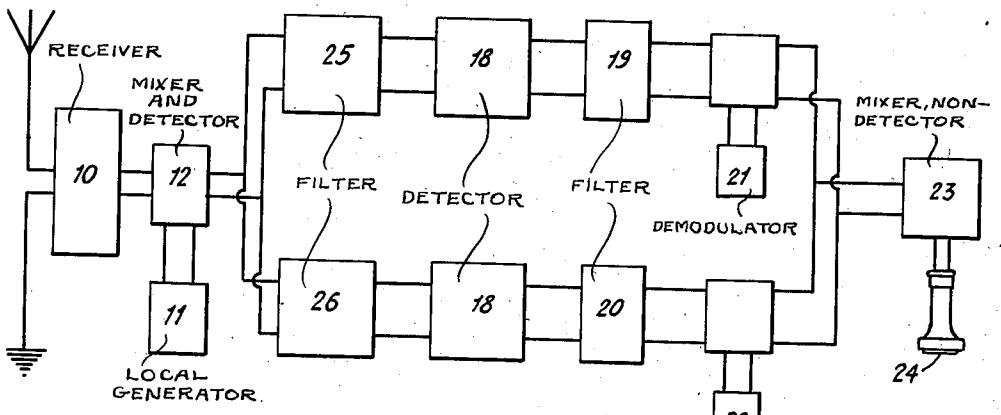
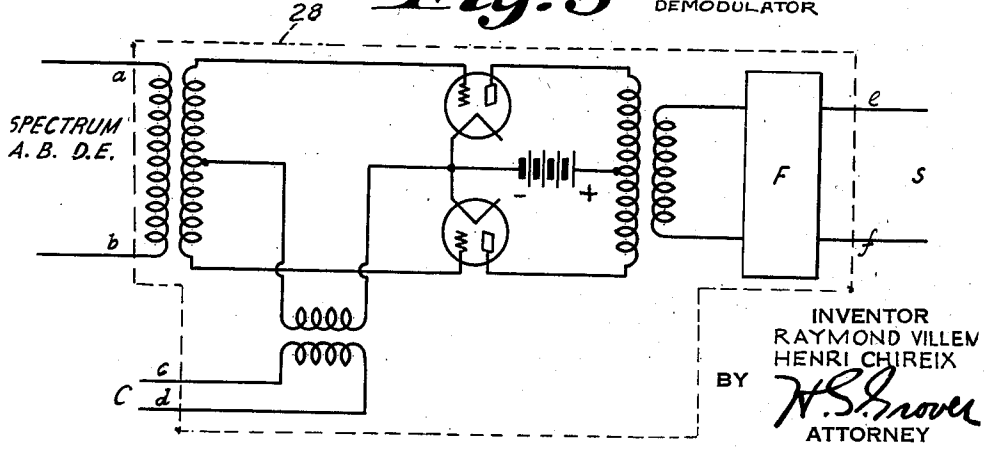


Fig. 5



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Fig. 2

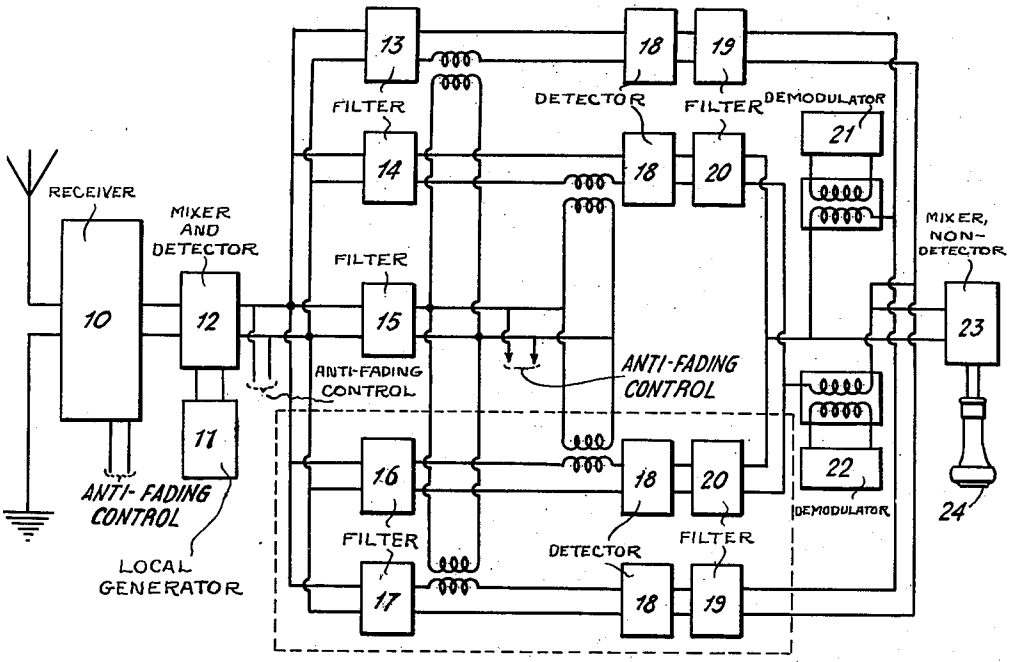
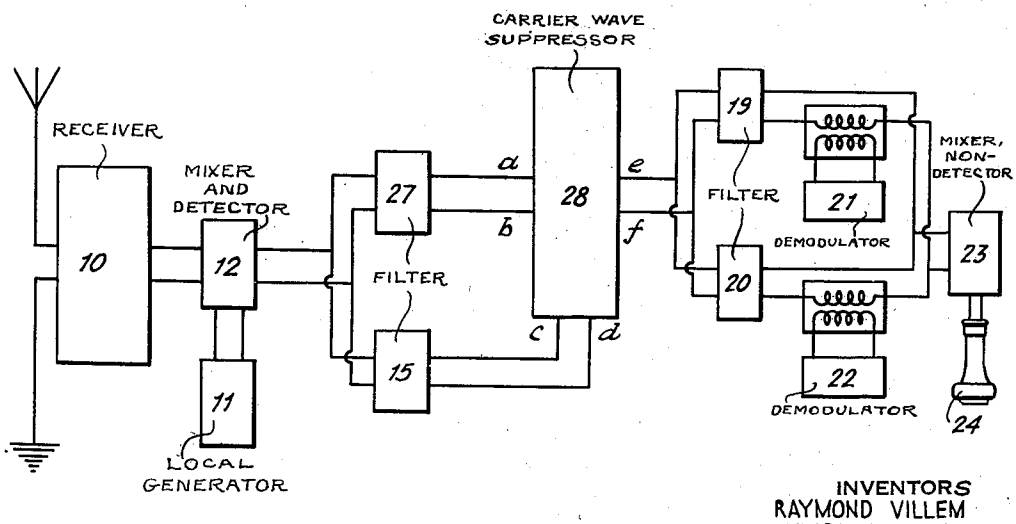


Fig. 4



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SECRECY SYSTEM

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Application August 1, 1933, Serial No. 683,124
In France August 12, 1932

2 Claims. (Cl. 179—1.5)

When a plurality of transmissions are sent off from one and the same transmitter apparatus simultaneously, or only one transmission characterized by modulation by a frequency spectrum, it is advantageous, particularly in short wave communication to preclude interference between the various modulation frequencies which may occur as a result of certain phenomena occurring in propagation.

In the case of multiplex transmission, interference of this sort results in diaphony (cross-talk) between the different channels.

In the case of telephonic transmission, stray frequencies are produced and these result in distortion causing an impairment in intelligibility.

In the case of uncoded telephonic communication these stray frequencies are harmonics of those of the initial spectrum and their amplitude is liable to reach considerable proportions. In the case of secret telephony transmission systems the situation is no longer the same. In these transmissions, the voice spectrum is cut up into several parts which may be inversed or transposed at the sending end so as to result in a jammed or garbed spectrum.

The different channels produced by such decomposition of the voice are thus similar to those in multiplex transmissions.

The garbled spectrum is fed to the modulation circuit of the transmitter and after having passed through the usual radio frequency and medium frequency circuits it is integrally fed to a detector whereafter selector means and transposing means are rendered operative so as to restore the initial spectrum.

Experience has shown that the sending systems mentioned above, particularly short wave systems, are inapplicable and unserviceable in the case of communication over long distances.

In fact, the conditions of propagation of short waves are such that inside the transmitted spectrum certain frequencies will be especially weakened; it frequently happens that the carrier wave is weakened, while the side bands preserve their large amplitudes.

If it is kept in mind that the spectrum of correct reproduction is obtained by interference between side bands and carrier wave and that, on the contrary, those factors causative of distortion are the result of interference between the side bands, it will readily be seen that in the case of impairment of the carrier wave the stray factors (distortion for telephony and diaphony (cross-talk) in telegraphic work) appear especially with a very large amplitude in reference to the signals of correct of reconstitution. In other words, the beats between the side band frequencies become abnormally large relative to the desired signal which is produced as a result of beats between the carrier and the various side band frequencies.

Moreover, if parts of the voice or speech spectrum have experienced inversions or transpositions, unless these latter are considerable and result as a consequence in the transmission of a radio frequency spectrum of a length incompatible with that of channels admissible in practice, it is found that the distortions introduced by Hertzian propagation are such that, at the receiving end, they will hardly ever allow of satisfactory clearness after re-constitution.

Now, the present invention has as its object ways and means adapted to secure multiplex transmission and secret telephony transmission without causing at the receiving end distortions introduced by propagation and without requiring any appreciable enlargement of the transmitted radio frequency spectrum.

The essential feature of the system consists in operating and effecting selection at the receiving station prior to detection and in causing the separately treated carrier wave to act upon the totality of the side bands, or separately upon each part of these latter, or even upon an assembly of these parts conveniently grouped together.

For a better understanding of the system there shall be given a concrete example of secret telephony which, as shall be shown, may be regarded as a multiplex transmission. In this example the voice spectrum shall be considered as having been divided into two parts, though it will be quite evident that the invention applies equally to the case where the voice spectrum is divided into a greater number of subdivisions.

In the drawings Figure 1 illustrates a transmitter and Figures 2 to 4 various embodiments according to the principles of the present invention. Fig. 5 illustrates in detail the carrier wave suppressor of Fig. 4.

Let us consider, for instance, a voice spectrum having a frequency range extending from

$$\Sigma f = 300\text{–}2400 \text{ cps. (cycles per; second)}$$

and let us assume this range to be divided by the aid of filters into two spectra

$$\Sigma f1 = 300\text{–}1200$$

and $f2 = 1200$ to 2400 cps. (the symbol

$$\Sigma$$

does not by any means indicate here any arithmetic operation, but it serves simply to designate

a band inside which the frequencies under consideration are confined).

Let us suppose, also for the sake of argument

$$\Sigma f1$$

transposed from 1400 cps., and

$$\Sigma f2$$

inversed and transposed by the aid of a modulator to 2700 cps. After the action of the modulators, and after filtering to eliminate the lower band for

$$\Sigma f1$$

and the upper band for

$$\Sigma f2,$$

the spectra become

$$\Sigma' f1 = 1700\text{–}2600 \text{ cps.},$$

and

$$\Sigma' f2 = 1500\text{–}300 \text{ cps.}$$

The transmitter is modulated at the same time by

$$\Sigma' f1$$

and

$$\Sigma' f2$$

An arrangement for such a transmitter is illustrated in Figure 1 wherein

(1) Microphone
(2) Band pass filter for 300 to 1200 cycles
(3) Band pass filter for 1200 to 2400 cycles
(4) Modulator or heterodyne of 1400 cycles
(5) Modulator or heterodyne of 2700 cycles
(6) Band pass filter for 1700 to 2600 cycles
(7) Band pass filter for 300 to 1500 cycles
(8) Modulator for transmission
(9) Carrier wave generator including high frequency amplification.

At the receiving end, the aggregate spectrum that has been picked up is passed through the selection and amplifying means of the kind customarily employed, but the receiver terminates in frequency changer means wherein selection according to the method hereinafter to be indicated is effected. This is indicated in Figure 2.

This reception, in general, is facilitated by insuring a frequency change at relatively low frequency, say, 10,000 cps. As a result of such frequency conversion the incoming spectrum becomes

$$10{,}000 \text{ cps.} \pm \Sigma' f2,\ 10{,}000 \text{ cps.} \pm \Sigma' f1,$$

in other words:

$$\overbrace{7.400 \text{ to } 8.300 \text{ c. p. s.}}^{A} — \overbrace{8.500 \text{ to } 9.700 \text{ p. p. s.}}^{B}$$

$$\overbrace{10.00 \text{ p. p. s.}}^{C} — \overbrace{10.300 \text{ to } 11.500 \text{ p. p. s.}}^{D}$$

$$\overbrace{11.700 \text{ to } 12.600 \text{ p. p. s.}}^{E}$$

After such frequency conversion there are provided filters designed so as to transmit separately ranges A, B, C, D, and E. After each of these filters four detectors are operated, each thereof being fed with the bands A, B, D, or E and the component C.

It will be seen that as a result of these detectors there are obtained A±C, B±C, D±C, E±C and after filtering of the upper undesirable bands there are finally obtained:

$$A-C=\Sigma'_{f1} \quad B-C=\Sigma'_{f2} \quad D-C=\Sigma'_{f2}$$

2600 to 1700 pps.—15,000 to 300 pps.—300 to 1500 pps.

$$E-C=\Sigma'_{f1}\ 1700 \text{ to } 2600 \text{ pps.}$$

By causing modulators of frequencies 1400 cps. and 2700 cps., respectively, to act upon

$$\Sigma' f1 \text{ and } \Sigma' f2.$$

there are obtained, after suitable filtering of the new modulation bands thus obtained, following spectra:

$$\Sigma f1 = 300 \text{ to } 1.200 \text{ p. p. s.}$$

and

$$\Sigma f2 = 1.200 \text{ to } 2.400 \text{ p. p. s.}$$

which are fed to the grid of a mixing non-detecting tube or to a common circuit so as to obtain the initial a. f. band

$$\Sigma f.$$

According to one of the feasible modifications of the invention the wave C, indicated by way of example to be equal to 10,000 cps., may be furnished with an amplitude regulator system independent of the amplitude regulator which may be provided for the aggregate spectrum passed through the first stages of the receiver equipment.

Referring more particularly to Figure 2 which shows this arrangement:

(10) Receiver including high frequency amplification and anti-fading control
(11) Local generator including amplitude regulator
(12) Mixer and detector
(13) Band pass filter for 7,400 to 8,300 cycles
(14) Band pass filter for 8,500 to 9,700 cycles
(15) Band pass filter for 10,000 cycles
(16) Band pass filter for 10,300 to 11,500 cycles
(17) Band pass filter for 11,700 to 12,600 cycles
(18) Detectors
(19) Band pass filter for 1700 to 2600 cycles.
(20) Band pass filter for 300 to 1500 cycles.
(21) Demodulator at 1400 cycles.
(22) Demodulator at 2700 cycles.
(23) Mixer, non-detector.
(24) Telephone.

According to another modified scheme indicated in Figure 3, the components A, B, C, D, E, may be filtered through two three-band filters allowing of the transmission of A, C, and E, in the case of the first, and of B, C, D, in the second one.

Next there are mounted two detectors which are worked upon by the respective two filters mentioned. Above the said detectors there are obtained $<f1$ and $f2$ which are thereupon fed into a joint circuit.

In Figure 3

(25) Filter for 3 bands for 10,000, 7,400 to 8,300 and 11,700 to 12,600 cycles.
(26) Filter for 3 bands for 10,000, 8,500 to 9,700 and 10,300 to 11,500 cycles.

It will be obvious that the system is similarly applicable quite readily to transmission systems generally known as "single-hem" systems (with one side band). In such an instance, as a result of frequency conversion at 10,000 cps. there are obtained only C, D, E, or A, B, C.

The filtering means are simplified, and in lieu of four detectors two need to be provided only, and to one of these are fed bands A and C, and to the other one bands B and C.

The system is similarly useful in connection with transmissions without carrier wave, with or without pilot wave, the latter being of any desired amplitude at all, this circuit arrangement being obtained by omitting in Figure 2 the elements numbered 16, 17, 18, 19 and 20, shown schematically in the dotted line rectangle.

In all of these arrangements the restitution of the carrier wave at the receiving end may be effected in synchronism with the sending wave, and in case there is a pilot wave the same could be used for the purpose of regulating the intermediate frequency C.

According to a modification of the invention indicated in Figure 4, cross-modulation or intermodulation between the side bands may be precluded by causing to act together under symmetric conditions upon a balanced detector (Figure 5) the side bands hereinbefore designated by A, B, C, D and E and in parallel the wave C treated and filtered separately.

After this detector, and after being fed into a filter F, there results at the output terminals the assembly of the spectra A—C, B—C, D—C, E—C which for the purpose of re-constitution are handled as hereinbefore suggested.

In Figure 4

(27) Filter for 4 bands for 7,400 to 8,300, 8,500 to 9,700, 10,300 to 11,500 cycles.

(28) Rectangle containing the scheme of Figure 5.

We claim:

1. Method of secret radio communication consisting of dividing the modulator spectrum into several channels, filtering a determined band in each of these channels, separately transposing the filtered bands, separating new bands determined after transposition, combining these latter bands, modulating the transmission by the combined spectrum, changing the frequency of the received modulated transmission, selecting different bands of the modulating frequency and carrier wave in the spectrum resulting from the changing, applying the carrier wave to the other selected bands, detecting the obtained bands, eliminating undesirable parts of these bands after detection, changing the frequency in order to reconstitute the parts of the original spectrum and recombining these parts in order to obtain the entire spectrum.

2. A system for secret radio communication having, in combination, a transmitter comprising a source of modulator spectrum, filters for dividing the spectrum into several channels and to obtain a predetermined band in each of these channels, frequency changers for separately transposing the filtered bands, filtering means eliminating the undesirable parts of the transposed bands, means for combining the transposed and filtered bands, a modulator operated by the entire combination of bands and a source radiating the high frequency modulated by this modulator, and a receiver comprising a wave collector, means for amplifying the received energy, a local generator, means for superposing the energy of the generator with the received energy so as to change the carrier frequency, means for separately selecting the changed carrier wave and different parts of the modulator spectrum, means for superposing the carrier wave with said parts of the spectrum, detecting means for the superposed waves, means for removing the detected waves of the parts necessary in order to reconstitute the original spectrum, means for changing the frequency and recombining the removed parts so as to obtain the original spectrum and indicating means actuated by this spectrum.

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