

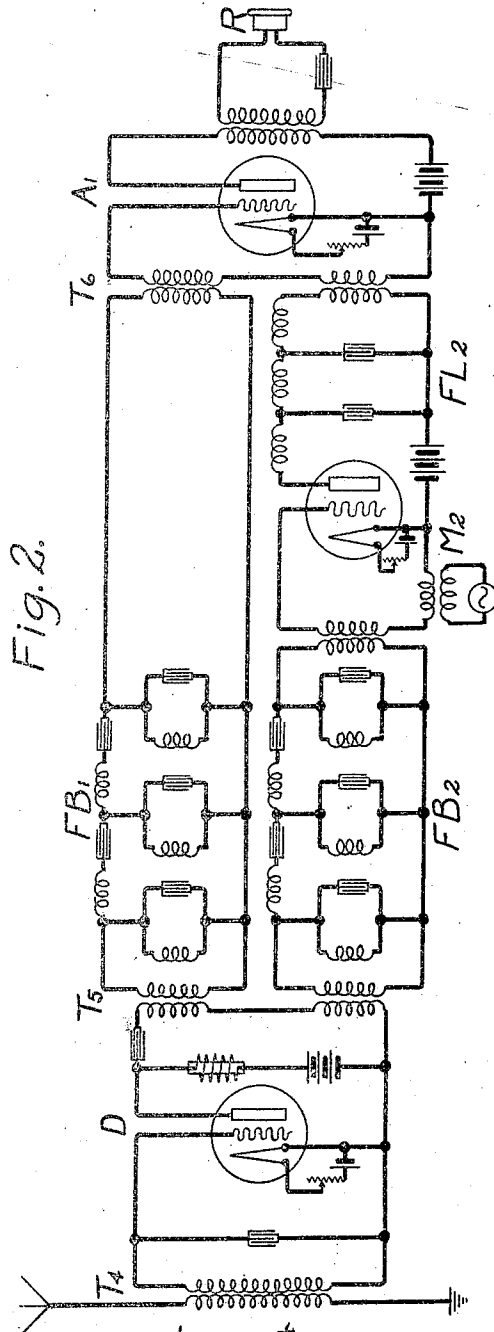
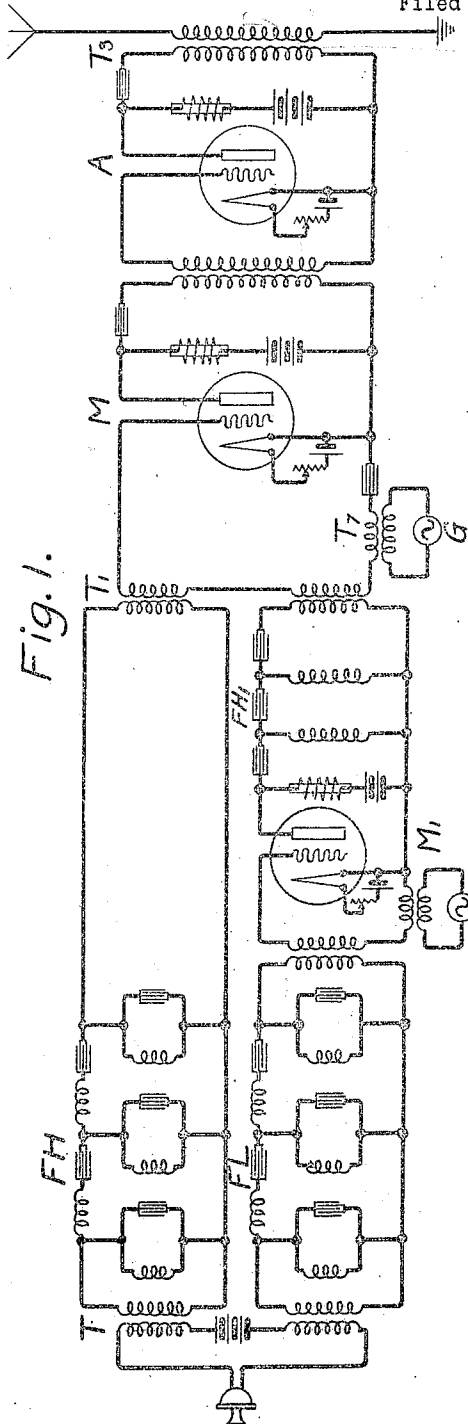
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H. W. NICHOLS

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SECRET SIGNALING

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UNITED STATES PATENT OFFICE.

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SECRET SIGNALING.

Application filed December 13, 1920. Serial No. 430,403.

To all whom it may concern:

Be it known that I, HAROLD W. NICHOLS, a citizen of the United States, residing at Maplewood, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Secret Signaling, of which the following is a full, clear, concise, and exact description.

This invention relates to secret signaling, and in particular to a secret signaling system wherein the signals are transmitted in the form of a complex wave which can be resolved into a series of waves having frequencies comprised within a given range.

An object of the invention is to so transmit a signal as to render it incapable of intelligible reception by ordinary means.

In accordance with a feature of the invention, the transmitted signal is confused by the transposition of portions of the signal wave at the transmitting station and is restored to its initial condition at the receiving station.

The system to which the invention is applied may be classed with those secret systems wherein the transmitted signal is confused, as distinguished from those systems wherein means are provided for effectually preventing the reception of the signal impulses.

It is readily apparent from a study of the record traced by the voice actuated vibrations of a telephone diaphragm that the vibrations making up the complex wave form of a voice wave obey no regular or systematic sequence. They are indeed so confused and intermingled that if the vibrations comprised within a relatively small portion of the total frequency range used are eliminated the effect is found to be repeated in many parts of the record with attendant decrease in clearness of received voice signals in the case that the voice variations are transmitted and received by any of the known means. If the vibrations are transmitted as electromagnetic impulses and passed through a telephone receiver, unintelligible signals would accordingly result. It is essentially in this feature that the element of secrecy inheres in the present invention, as well as in the examples given. In one known system, the signal range is divided into two

parts, either of which alone is incapable of effecting intelligible signals. The two parts of the signal wave are separately transmitted as modulations of carrier wave which may have the same or different frequencies. In another system, the essential principle is preserved by effecting a systematic change of each frequency by subtracting the voice frequencies from a frequency larger than any component frequency of the voice wave, the effect being in the nature of a reversal of frequencies, the greatest frequency becoming the smallest, etc., the median frequency remaining unchanged.

According to the present invention, the frequencies corresponding to a definite portion of the speech frequency band or spectrum are transposed to frequencies which may be outside the range of audition, or two portions may be transposed as a whole so that each occupies the range previously occupied by the other. In either case the resulting wave is used to modulate a single carrier wave as in the usual system as will be described later. The signal is transmitted by means of voice modulated carrier waves as in the usual case, but the voice currents are impressed on the input circuit of the modulating device in two or more parts to each of which is confined the currents of frequencies corresponding to a definite and predetermined portion of the frequency range used. There is also provided a means such, for example, as a frequency converter or translator for changing each of the voice frequencies transmitted through the circuit by a predetermined amount. In the particular case in which the voice currents are transmitted to the modulator through two circuits the frequencies corresponding to one circuit may be increased or decreased, depending on which circuit contains the means mentioned, by a predetermined amount. This change would be sufficient to cause the frequencies so changed to occupy a band or portion of the voice frequency range adjacent to and at the remote side of the band or portion occupied by the frequency components transmitted in the other circuit. The voice frequency components would occupy the same range as before but would be displaced from their former frequencies by a

definite amount and would be combined with the carrier wave and transmitted exactly as in the usual case. An interceptor, however, who attempted to receive the wave and detect it in the ordinary manner would derive a wave form identical with the wave impressed on the input circuit of the modulator, which wave could not produce an intelligible signal when caused to actuate the diaphragm of a telephone receiver. The result would be similar if a portion of the frequency range was transposed to such a position that the resulting frequency band was not continuous or of the same width as the original voice frequency band. If the voice currents were transmitted to the modulator through more than two circuits and transposition were effected in more than one circuit, a confusion would also ensue, although the result obtained in this case probably would not justify the elaborate means required.

In order to make the system as described effective for transmission of intelligible signals to a desired station, a particular means must be employed at the receiving station to recast the confused signal wave received at the said station into an intelligible form. This recasting means is preferably similar to the means employed at the transmitting station to confuse the signal and in effect acts on the received signal wave in an inverse sense so as to restore the transposed portion of the frequency band to its original frequency position. Accordingly the receiving circuit resembles the transmitting circuit in that it has the same number of similarly related elements although the sequence of operations is in general in inverse order. The modulated carrier wave is demodulated in the usual manner, the resulting wave of substantially audible frequency being unintelligible. This wave is transmitted to an amplifier and to the detecting device in two or more channels or circuits in one or more of which is a frequency changing means, such, for example, as a frequency converter or translator which restores the different frequency components to their initial frequency relation, the combined or resultant wave being identical with the original voice wave and capable of reproduction as an acoustic wave in the usual telephone receiver.

For further details of the specific features of the invention, reference is made to the following description which, taken in connection with the drawing, discloses the invention in a preferred embodiment. In the drawing Fig. 1 shows the transmitting circuits and Fig. 2 shows the receiving circuits of a system embodying the invention. Similar parts are indicated by similar reference symbols, the particular parts being differentiated by subscripts. The ordinals used have been chosen so as to indicate the

device or circuit designated. For example, modulators are shown by the letter M, detectors by D, high pass filters by FH, etc.

Referring to Fig. 1, M designates a modulator, shown here as a three element tube, although any one of the many alternative circuits for accomplishing the modulating function, or even a mechanical modulating means, may equally well be used. This modulator serves to combine waves corresponding to speech frequency with the high frequency carrier wave. The carrier waves are impressed on the input circuit of the modulator by means of the high frequency carrier source G through transformer T₁. The waves of voice frequency are impressed on the input circuit by transformer T₂ in two distinct portions which are derived in common from transformer T and traverse separate circuits to transformer T₁, one portion passing through high pass filter FH and the other through low pass filter FL, modulator M, and high pass filter FH₁. The high pass filter FH is designed to pass currents of frequencies above a predetermined frequency, while low pass filter FL is designed to pass currents of frequencies below the same frequency. For example, the filter FH may transmit currents of frequencies above 1000 cycles, while filter FL may transmit below 1000 cycles. Although these filters have been described as high and low pass filters, they may as well be band filters designed to transmit currents of frequencies between the median value stated and substantially the highest and lowest voice frequency respectively. As will more fully appear later an advantage accrues from causing the filter FH to have an upper cut-off limit although there is no similar advantage in an analogous use of filter FL. Filters of the general type shown are described in Campbell Patent No. 1,227,111. The terms "high pass filter," "low pass filter" and "band filter" are here used to describe respectively, a filter which is designed to transmit only currents having frequencies above a predetermined limiting frequency called the "cut-off frequency," a filter which is designed to transmit frequencies below the predetermined cut-off frequency, and a filter so designed as to transmit currents having frequencies between upper and lower cut-off frequencies.

The currents of frequencies transmitted through filter FL are changed, either decreased or increased, by a fixed amount by means of a device here shown as frequency translator or modulator M₁, although other means, such, for example, as an induction generator, may be used. Its function is to transpose the frequencies of the waves transmitted thereto to a different frequency in order to confuse or distort the speech signal waves impressed on modulator M and trans-

mitted to the receiving station as side bands of the carrier frequency. It would not be sufficient to transpose these frequencies to the frequency range occupied by the frequencies in the other or another circuit, since this would cause an inextricable confusion of signals from which it would be difficult or impossible by any arrangement of circuits to obtain an intelligible signal at the receiving station. In order that such intermingling or overlapping of signals shall not occur, it is of advantage to have the filter FH transmit currents of frequencies substantially up to the upper limit of voice frequency, for example 3000 cycles, and to increase the frequencies in the other portion by 3000 cycles. Although in the system shown the lower frequencies are increased by a fixed amount, it would be possible to transpose the frequencies included in a relatively narrow part of a frequency range to a frequency below the audible range, but this would obviously be a less efficient arrangement than that shown. Instead of this a transposing means could be placed in each of the circuits shown and a complete reversal of frequencies effected, an arrangement which would increase the confusion of transmitted signals but which would probably not justify the increased expense and complication made necessary.

The device which may be used to increase the frequencies by a fixed amount may be any combining device in which the currents of voice frequencies may be combined with an input frequency wave in such a manner that the resultant wave has a frequency equal to the sum or difference component of the frequencies.

Any modulating device, as far as known, will accomplish this function and there is shown a representative type of modulator tube for accomplishing this purpose. As is well known, the output product of a modulator is a wave which can conveniently be resolved into three waves comprising waves of the unmodulated component frequency and sum and difference frequencies. For example, if the combining frequency in tube M_1 is 3000 cycles, there will be an unmodulated component wave of 3000 cycles, a lower side band of frequency 3000 less the voice frequency below 1000 cycles, and an upper band having frequencies of 3000 plus the voice frequencies of below 1000. The unmodulated component and lower side band are suppressed by high pass filter FH, which is designed to transmit currents of frequencies above approximately 3000 cycles. The confused voice frequency wave impressed on modulator M accordingly contains frequencies varying from approximately 1000 to 4000 cycles.

The output from modulator M is amplified by device A which is of a known type,

after which it may be transmitted to the communicating station by wire or radio transmission. In the system shown, the resulting wave is impressed on a radiating antenna by means of transformer T_2 .

In the system disclosed only the waves corresponding to frequencies between 1000 and 3000 are transmitted with unchanged frequency and would be insufficient to produce an intelligible signal in the telephone receiver of an interceptor. If a transposing means were placed in each of the circuits leading from transformer T and the frequencies therein interchanged, all of the frequencies corresponding to voice signals would be transmitted as audio frequencies, but the received signal would probably be even less intelligible than in the system above described.

Referring now to Fig. 2, there is shown a receiving system by means of which the received unintelligible waves may be detected and caused to produce an intelligible signal in a telephone receiver.

The received wave is transmitted by transformer T_1 to detector D which functions in the usual manner. The output circuits from detector D accordingly contain a current similar in form to the modulating current of tube M, having frequencies varying from 1000 to 4000 cycles in the example given. This output current is impressed by means of transformer T_2 on divided circuits containing band filters FB_1 and FB_2 .

These band filters are of the same general type as the filters shown in Fig. 1, the former being designed to transmit currents of frequencies between 1000 and 3000 cycles and the latter frequencies above 3000 or between 3000 and 4000. The frequencies of currents transmitted by filter FB_2 are decreased by 3000 cycles by means of modulating device M_2 which functions in the same manner as modulator M_1 to the extent that the combining frequency from the source shown is the same, 3000 cycles. The low pass filter FL_2 may be designed to transmit only currents of frequencies below 1000 cycles and accordingly suppresses the unmodulated and upper side band frequency components. It is seen that device M_2 , with low pass filter FL_2 , in effect restores the transposed portion of the voice wave to its initial relation to other portions of the wave and that the current flowing in the secondary of transformer T_3 has the characteristic wave form of speech signal current and is capable of reacting in a telephone receiver to produce intelligible signals.

The telephone receiver is shown in the output circuit of amplifier A, which may be used if necessary to amplify voice current circulating in the transformer T_4 .

The invention set forth herein is not limited to a system wherein the signal is trans-

mitted as a series of vibrations within a range of frequencies, but is applicable to speech transmission in a system wherein other types of signals may be transmitted.

It should also be understood that the invention in its broadest aspect resides in the transposition of a portion, or portions, of the vibrations corresponding to the signals whether in the sequence of operations before the signal wave has been combined with the wave supplied by generator G or in one of the side bands of the wave resulting from modulation by device M. The receiving circuits may remain unchanged, it being also necessary to suppress the remaining side band at the transmitting station.

What is claimed is:

1. The method of secret carrier current telephony which comprises the steps of dividing the voice wave into two or more portions, changing each of the frequency components included in one or more, but not all, of said portions by a sufficient amount to cause said frequency components to occupy a range of frequencies not previously occupied, transmitting the resultant wave as modulations of a carrier wave, detecting said transmitted wave, and restoring the voice component of the detected wave to its initial condition.

2. The method of secret carrier current telephony which includes the steps of modifying the voice wave by dividing it into two or more parts, changing the frequency components in one or more but not all of said parts by modulating with a frequency component corresponding to the desired change and thereafter suppressing all but one side band of the resultant wave, transmitting the changed and unchanged portions of the voice wave as modulations of the high frequency carrier wave, detecting the transmitted wave, and restoring the voice component thereof to its initial form.

3. The method of secret carrier current telephony which includes the steps of modifying the voice wave by dividing it into two or more parts, changing the frequency components included in one or more, but not all, of said parts by modulating with a frequency component corresponding to the desired change and thereafter suppressing all but one side band of the resultant wave, transmitting the voice wave, including said changed frequency components, as modulations of a high frequency carrier wave, detecting said wave, and restoring the voice component thereof to its initial form by modulating the changed frequency components thereof with a wave having a frequency equal to the said change and retaining the frequency band which contains the initial frequencies.

4. In a secret carrier wave signaling system, means for dividing the signal wave

into two or more parts, means for transposing the frequency components included in one or more, but not all, of said parts, a modulating device for combining the changed and unchanged parts of the signal wave with a high frequency carrier wave, means for transmitting the resultant modulated wave, means for receiving and detecting the transmitted wave, means for selecting the signal component from the product of the detecting means, and means for restoring said signal wave to its initial condition.

5. In a voice frequency signaling system, in combination means for dividing the voice frequency band into a plurality of ranges, means for changing the frequencies in certain of the ranges while maintaining the frequencies of the remaining ranges constant, to produce a resultant band of waves different in character from the original voice range, and means for transmitting energy corresponding to the resultant band.

6. In a secret carrier wave telephone system, means for generating a complex wave having speech characteristics, band filters for dividing said wave into two or more parts, means in circuit with one or more of the band filters for changing by a predetermined amount the frequency components transmitted by said filters, means for modulating a high frequency carrier wave in accordance with the changed and unchanged parts of said complex wave, means for transmitting the resultant modulated wave, means for detecting the transmitted wave, band filters for selecting and transmitting the currents of modulating frequencies resulting from said detection, and means in circuit with one or more of the last mentioned band filters for restoring the modulating current wave to a form similar to that of the original complex wave.

7. The system as defined in claim 6 in which the said means in circuit with said band filters for changing the frequency components and for restoring the modulating current wave consists in each instance of the combination of a modulating device, the modulating frequency of which equals the desired frequency change, with a band filter designed for transmitting a single side band of the output thereof.

8. The method of secret telephony which consists in dividing the voice wave in two or more portions, changing the frequencies in certain of the portions while maintaining the frequencies in other portions constant, to produce a resultant distorted voice wave, and transmitting energy corresponding to the distorted wave.

9. The method of secret telephony which comprises the steps of dividing the voice wave into two portions, operating on the frequency components of that portion which

includes the lower frequencies to cause them to occupy a position in the frequency scale immediately above and adjacent to that occupied by the other portion, transmitting the voice wave so changed, and restoring the frequencies to their initial relation at the receiving station.

10. The method of secret carrier current telephony which comprises the steps of dividing the band of frequencies comprised within the voice wave into two portions, stepping up the frequencies in the lower portion to a corresponding position immediately above the frequencies of the other portion by modulating with a current having a frequency corresponding to the desired change and thereafter retaining only the upper side band, transmitting the voice frequencies so changed, as modulations of a high frequency carrier wave, detecting said

wave, and restoring the voice component of the detecting operation to its initial condition.

11. A signaling system, wherein are to be received speech signals represented by bands of frequencies each divided into sub-bands, the frequencies of certain sub-bands being changed and the frequencies of the remaining sub-bands of a band being unchanged, having in combination means for selecting the changed and unchanged frequency sub-bands, means for restoring the sub-bands to their initial relation within the speech range, and a receiver responsive to such restored frequency sub-bands.

In witness whereof, I hereunto subscribe my name this 1st day of December, A. D. 1920.

HAROLD W. NICHOLS.