

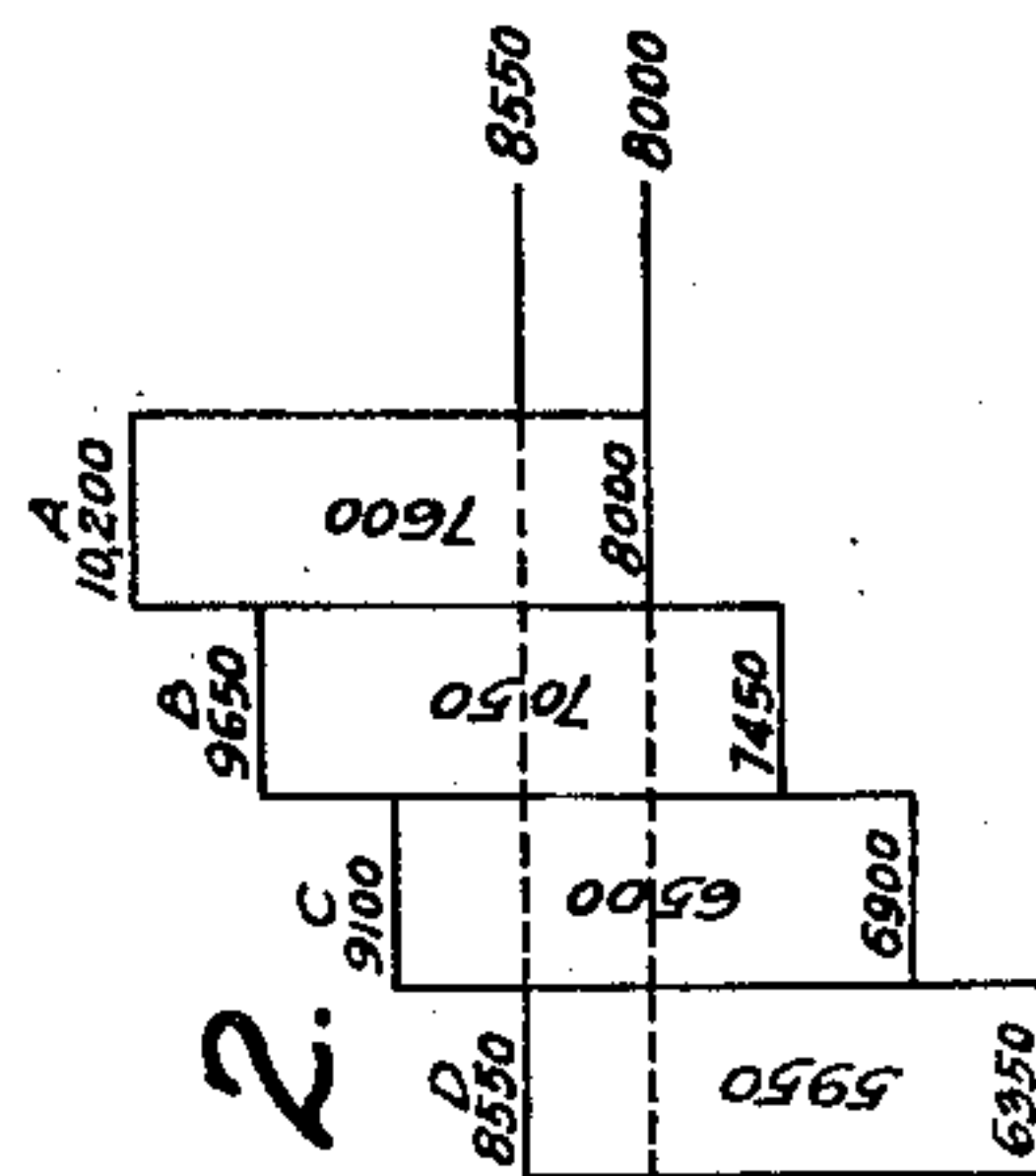
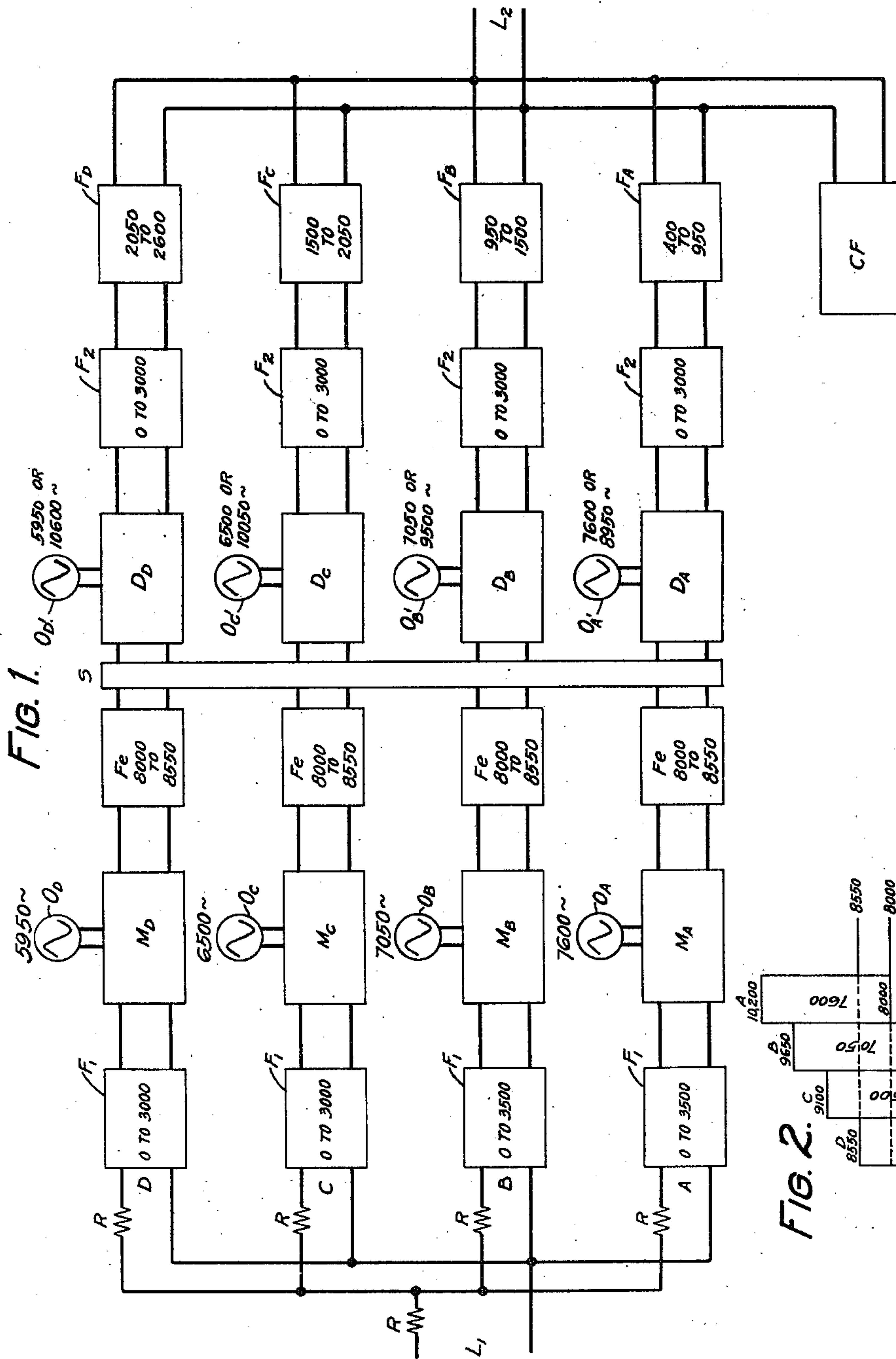
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SECRET COMMUNICATION SYSTEM

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SECRET COMMUNICATION SYSTEM.

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The present invention relates to the transmission and reception with secrecy of signal waves comprising a range of frequencies such, for example, as speech or radio broadcast.

5 An object of the invention is to secure a high degree of secrecy of transmission and reception while at the same time realizing good articulation and high quality.

10 This invention is in the nature of an improvement on the secrecy system and method disclosed in an application of C. L. Weis, jr., Serial No. 203,703, filed July 6, 1927, for secret communicating system. In the system of the Weis application waves to be transmitted with secrecy are subdivided into a number of relatively narrow frequency bands which are impressed upon frequency shifting circuits and transposed to other than their normal frequency positions before transmission to the distant station to be communicated with. The same apparatus for sub-dividing the transmitted waves and transposing their frequencies may also serve for restoring the received transposed frequency waves to their normal relations to render them understandable. As disclosed in the Weis application referred to it is advantageous in effecting the frequency transpositions, first to reduce all of the sub-divided frequency bands to a common frequency level so that there results a plurality of circuits each carrying waves of the same frequencies selected, however, from different portions of the normal speech band. These resultant bands of the same frequencies may then readily and conveniently be interchanged among a corresponding plurality of frequency shifting circuits to convert the bands of waves into bands occupying different levels in the speech range from the normal speech frequency relations. Conversely, if the waves initially impressed on the system (as at a receiving point) are different from normal speech frequency relations the final output wave is restored to the normal speech frequency relations by identically the same steps.

50 One of the difficulties involved in any system in which filters are used to sub-divide the speech and to dovetail together again different bands of frequencies by placing them adjacent one another, to make up a composite band of speech frequency width, is that a

certain amount of distortion is likely to occur from the variations of impedance in the filters at their band edges which makes them transmit frequencies near the edges of the band at a different phase or amplitude (or both) relation from frequencies occurring well within the band. Where, as in the Weis system sub-dividing filters are used at the input and other filters are used at the output identical with those at the input, the distortion or disturbance due to the band edge effects of one set of filters is added to that occasioned by the other set.

Applicant has discovered that the initial sub-dividing filters disclosed in the Weis application can be omitted and that the sub-dividing action can be accomplished after the first frequency shifting operation.

According to the invention the initial sub-dividing action on the speech waves is dispensed with; the speech is directed into a number of branch circuits leading to the frequency shifting modulators in which the entire speech band is shifted by a different frequency interval in each modulator. Assuming that the speech is to be sub-divided into four bands as in the Weis application there are four frequency shifting modulator circuits. The frequency shifting operation results in the production of four bands each of speech frequency width in the respective modulator output circuits, but each occupying a different frequency position such that each band overlaps in frequency the adjacent band by three-fourths of its width. These bands are applied to four filters of identical transmission band, which transmit identically the same frequencies and whose band width is one-fourth of the range of the speech to be transmitted. The different speech bands having been shifted in frequency, as described, i. e., each having been displaced to a greater extent than the preceding by an extent equal to one-fourth of the total band width, it will be seen that these identical filters select from one circuit the quarter band corresponding to the lowermost speech frequencies, the next filter selects the quarter band of next higher frequencies, etc. These sub-bands selected from different portions of the speech range may then be interchanged and manipulated in various manners as disclosed in the Weis

application and may be fitted together again in order to put the outgoing waves in proper condition for transmission or reception, as described.

5 By thus shifting the entire speech band and thereafter selecting the components that are to be used rather than first sub-dividing the speech band and shifting the sub-divided portions to secure the desired frequency relations, applicant avoids the distortion or disturbances produced in the initial sub-dividing filters, while at the same time securing as effective sub-division of the speech as would be obtained from using the initial sub-dividing filters prior to frequency shifting.

10 A better understanding of the invention will be had from the detailed description to follow, in connection with the attached drawings forming a part of this specification in which

20 Fig. 1 is a schematic representation of a secrecy unit or circuit which can be substituted for the secrecy unit disclosed in the Weis application or which can be used in other systems than that illustrated in the Weis application wherever secrecy is to be obtained by sub-dividing signal waves and transposing the sub-divided portions, and

30 Fig. 2 is a diagram which will be referred to in describing the method of the invention for first shifting the speech bands in frequency and thereafter selecting from the shifted bands the frequency portions that are to be utilized.

35 This secrecy circuit, of course, is a one-way device but may be used in a two-way transmission circuit as shown in the Weis application.

40 The apparatus shown in Fig. 1 in this application may be inserted in the block indicated secrecy circuit of Fig. 1 of the drawings of the Weis application and controlled by the associated apparatus in the drawing of that application.

45 In Fig. 1 is shown a block diagram of the necessary apparatus for the secrecy circuit itself. The voice frequency waves in their normal and understandable arrangement are impressed on the line L_1 while the frequencies within the same range are impressed on the line L_2 in a scrambled condition indistinguishable to persons receiving them on the ordinary type of receiving apparatus. The input circuit L_1 is divided into four circuits or channels designated as A, B, C, and D. To obtain the proper impedance matching between the channel circuits and the line L_1 , resistances R of approximately 360 ohms are used and connected up in a series-parallel arrangement as shown in the drawing. This arrangement provides terminating impedances of approximately 600 ohms for each branch. The voice frequency range is to be considered, for purposes of illustration, as a band from 400 to 2600 cycles per second.

The first elements that the voice frequency band encounters in the channels A, B, C and D are filters F_1 , which are identical low pass filters passing frequencies from 0 to 3000 cycles per second. The purpose of these filters is to prevent leakage carrier current from the modulators immediately following from interfering with the modulation in any of the other channels. The carrier frequencies used in this system are all well above 3000 cycles and the path from one modulator to another includes two of the filters, thus effectively preventing any transfer of these modulating waves between modulators.

Modulators M_A , M_B , M_C , and M_D following the filters F_1 are the same as those employed in the Weis application but according to this invention they modulate the entire range of voice frequencies, that is, the 400 to 2600 cycles band. For instance, in channel A the voice band including frequencies of 400 to 2600 cycles is modulated in modulator M_A with a carrier frequency of 7600 cycles per second producing a side band of frequencies extending from 8000 to 10,200 cycles per second. This modulator is supplied from an oscillator O_A generating 7600 cycles per second. Similarly in channel B modulator M_B produces a side band, by modulation with the carrier frequency of 7050 cycles from oscillator O_B , of 7450 to 9650 cycles per second. In channel C a side band of 6900 to 9100 cycles per second results and in channel D a side band of 6350 to 8050 cycles per second is produced.

These side bands pass into identical filters F_2 which are constructed to pass a band of frequencies ranging from 8000 to 8550 cycles. From these side bands of speech width, a band having only those frequencies lying between the limits of 8000 and 8550 cycles is permitted to pass into the output circuit of each of the filters F_A , F_B , F_C , and F_D . Therefore, each channel now contains a band of frequencies of the same width and same frequency level, obtained from one of the four different portions of the voice frequency range of 400 to 2600 cycles.

These four bands, now pass into a switching arrangement identical with that shown in the Weis disclosure, and represented in this application by the block S. This switching arrangement allows each channel to be connected with any other channel, in the manner disclosed in the Weis application, and permits the bands to pass into demodulators D_A , D_B , D_C and D_D , with the waves from their respective oscillators O'_A , O'_B , O'_C and O'_D , in any desired combination. These oscillators are constructed to produce either of two carrier frequencies and are under the control of the switching circuits as described in the Weis application. As shown, oscillator O'_A generates either 7600 or 8950 cycles per second; oscillator O'_B generates 7050 or 9500 cycles per second; oscillator O'_C

generates 6500 or 10,050 cycles per second; and oscillator O'_D generates 5950 or 10,600 cycles per second. With these eight carrier frequencies to choose from and by demodulating the bands of 8000 to 8550 cycles with certain of them, it is possible to invert and shift the bands to form all possible combinations. For instance, the voice band of 400 to 950 cycles may be shifted to the 2050 to 2600 cycle range by demodulating with the carrier frequency of 5950 cycles located in channel D and using only the upper side band. By using the side band of the demodulation products of the 10,600 cycle frequency, the 400 to 950 cycle band is shifted to the D channel in an inverted position. In an analogous manner, each of the other bands from the filters F_E may be shifted to any one of the other outgoing circuits and its frequencies may be inverted or not, as desired, under control of the switching circuit. These switching circuits and the elements following them and cooperating in building up the final output wave form no part of the present invention but are being illustrated and described herein for the purpose of disclosing the several steps occurring in the process of sub-dividing the speech and rearranging the component sub-bands to form the output wave.

The products of demodulation now pass through low pass filters F_2 having a zero to 3000 cycle range. These filters are identical with those indicated as F_1 and have the same function. The assembling of the shifted bands to make up the ordinary voice frequency range is accomplished by the voice frequency sub-band filters F_A , F_B , F_C and F_D which discriminate against the products of modulation of their respective channels, except those forming the desired and original voice frequency band. A compensating filter CF may be used to improve the efficiency of the band filters at their cut-off limits. This compensating filter may be of the type disclosed in the Mills Patent #1,616,193 of February 1, 1927.

Fig. 2 illustrates by a diagram the manner of sub-division of speech in accordance with the invention. Reading from right to left the four rectangles lettered A, B, C and D correspond to channels A, B, C and D in Fig. 1. For instance, channel A has a modulating frequency of 7600 cycles and when the voice band of 400 to 2600 cycles is modulated therewith, a side band of 8000 to 10,200 cycles per second is produced. In channel D modulating the voice frequency range with the 7050 cycles shifts the voice range by a frequency interval a quarter width of the voice side band less than band A so that it overlaps the first side band by three-quarters of its width. Channel C modulates with 6500 cycles to produce the band of 6900 to 9100 cycles and, in channel D by modulation with the 5950 cycles

frequency, the 6350 to 8550 cycle range is produced. It is seen from this diagram that each band overlaps the adjacent band by three-quarters of its width while channel A overlaps channel D by only one-quarter of its width or a frequency range of 8000 to 8550 cycles. It is thus evident how a band can be selected from a different part of the speech in each channel by identical sub-dividing filters, these sub-bands all occupying the same frequency limits.

It will be understood, of course, that the method and system of the invention may be employed for sub-dividing waves into any desired number of sub-bands for any purpose, and that the numerical values given by way of illustration are not to be taken as in any wise limiting the invention.

What is claimed is:

1. The method of sub-dividing a band of waves into sub-bands comprising shifting the original band of waves in a plurality of frequency shifting operations to occupy respectively different but overlapping frequency positions and selecting from the respective shifted bands the same frequency components of the shifted bands representing different respective components in the original band.

2. The method of sub-dividing waves into their component frequencies comprising modulating the waves to cause them to occupy a new frequency position, independently modulating the original waves to cause them to occupy a different new position, separately selecting from each of the modulated waves the same range of frequencies corresponding to respectively different components of the original waves, and impressing the selected components on a circuit to cause them to occupy adjacent frequency positions making up a total band width of frequency components in said circuit substantially the same as that of the original waves.

3. A circuit for sub-dividing waves comprising a source of waves to be sub-divided, a plurality of frequency shifting circuits associated with said source, each frequency shifting circuit serving to shift the waves to a respectively different frequency position with the shifted bands of waves overlapping, and filters of identical cut-offs for filtering out of the shifted bands the same frequency components corresponding to respectively different components of the original waves.

4. A frequency transposing system comprising a source of waves occupying a band of frequencies, a plurality of modulators connected in parallel to said source, each modulator serving to shift the original band to a different frequency position, the frequencies of the shifted bands in part overlapping one another, a corresponding plurality of filters each selective of waves between the same frequency limits, each associated with the output

of a respective modulator for selecting from the shifted bands the same frequency components corresponding to respectively different components of the original band, and a
5 second plurality of frequency shifting circuits connected to said filters for shifting the frequency positions of the selected bands to posi-

tions adjacent one another embracing a total range substantially the same as that of the original frequency band. 10

In witness whereof I hereunto subscribe my name this 14th day of December A. D., 1927.

ROY W. CHESNUT.