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PRIVACY SIGNALING SYSTEM

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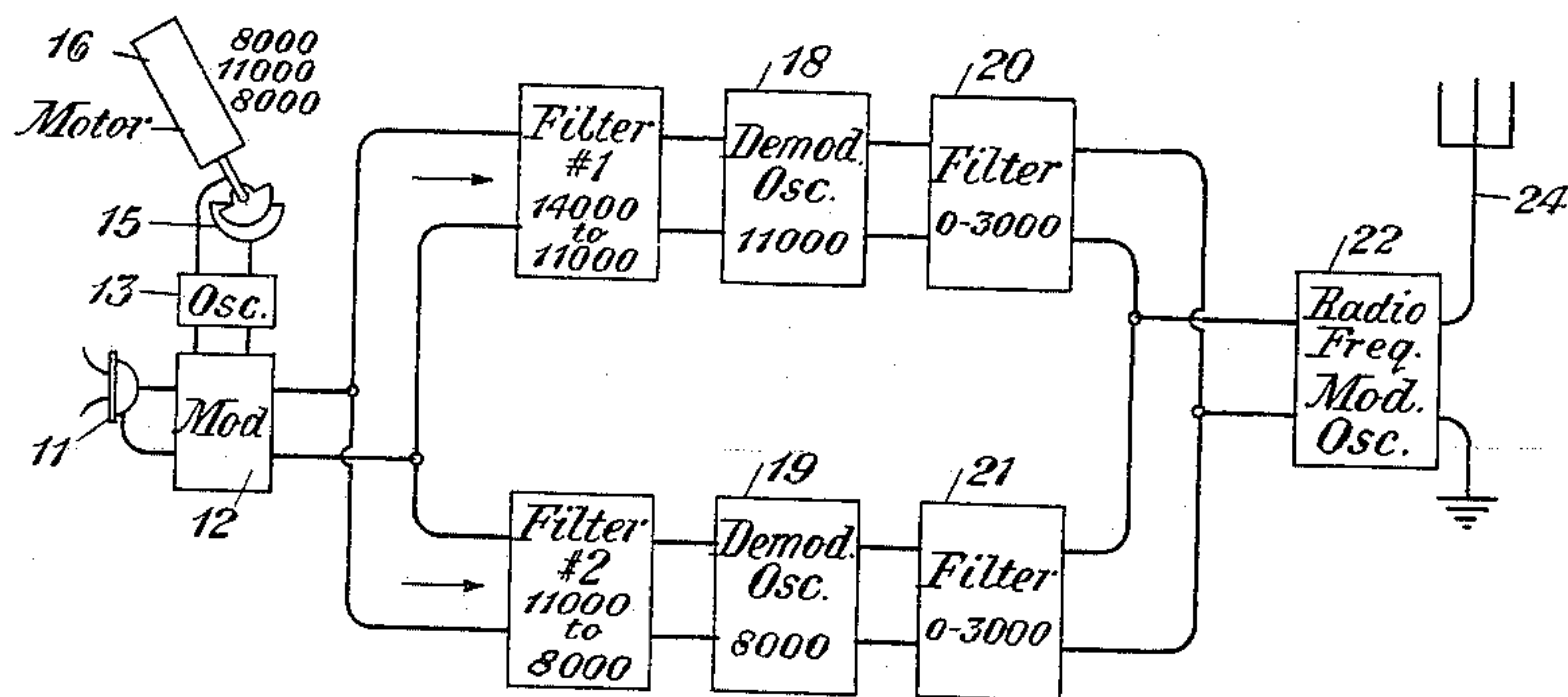


Fig. 1

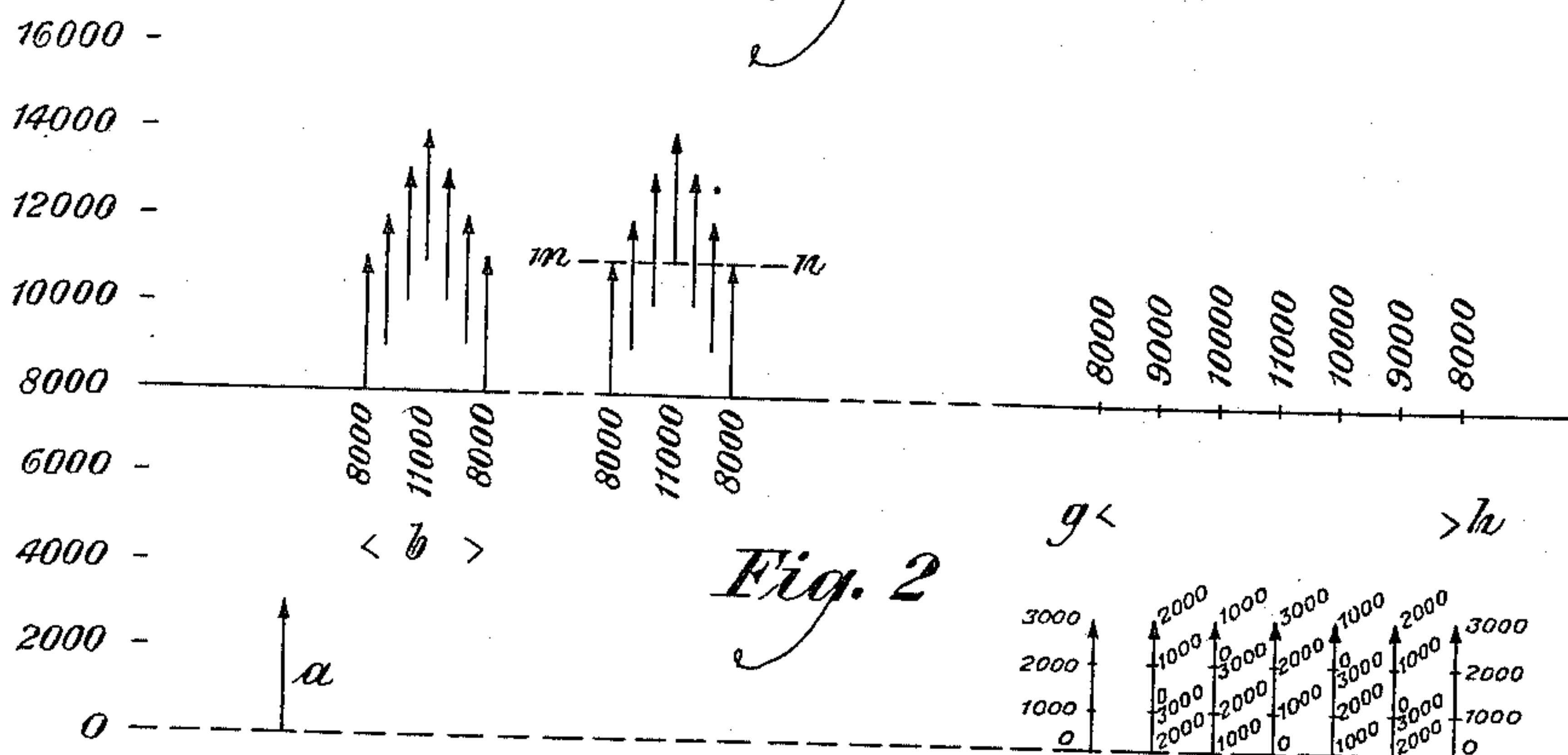


Fig. 2

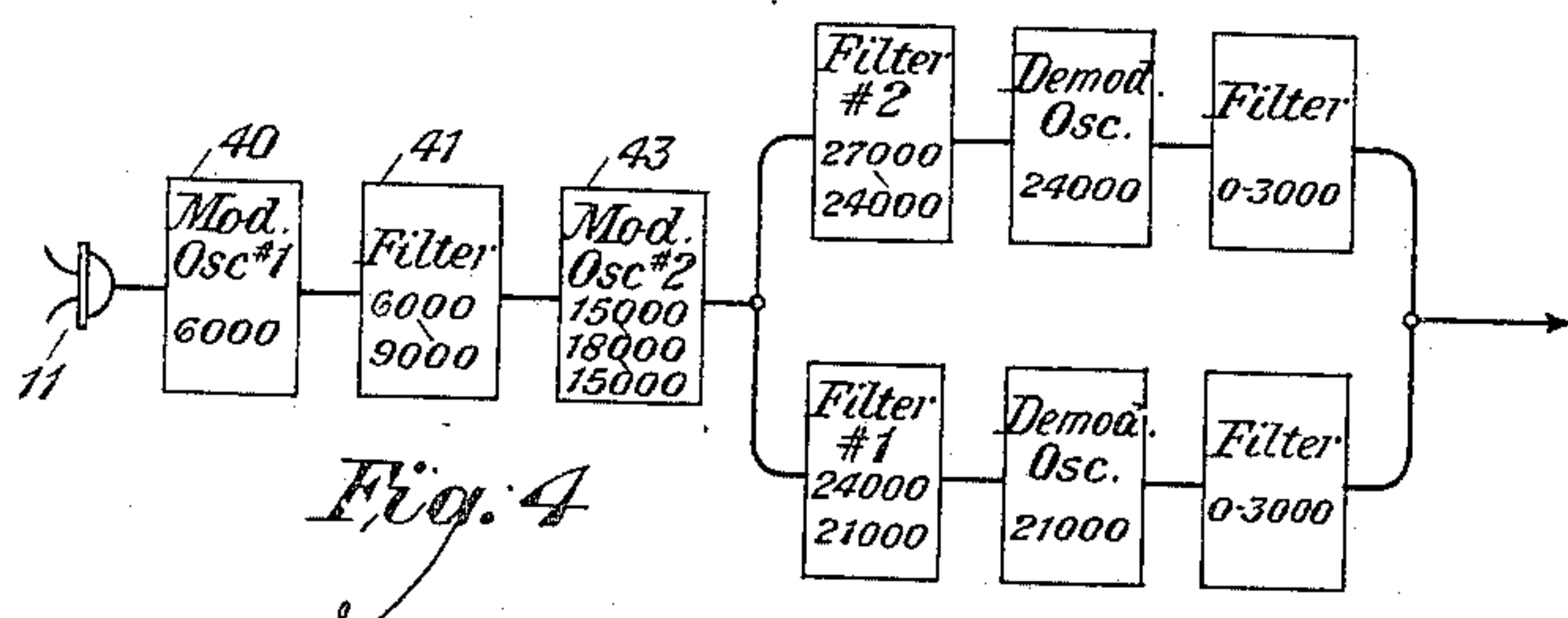


Fig. 4

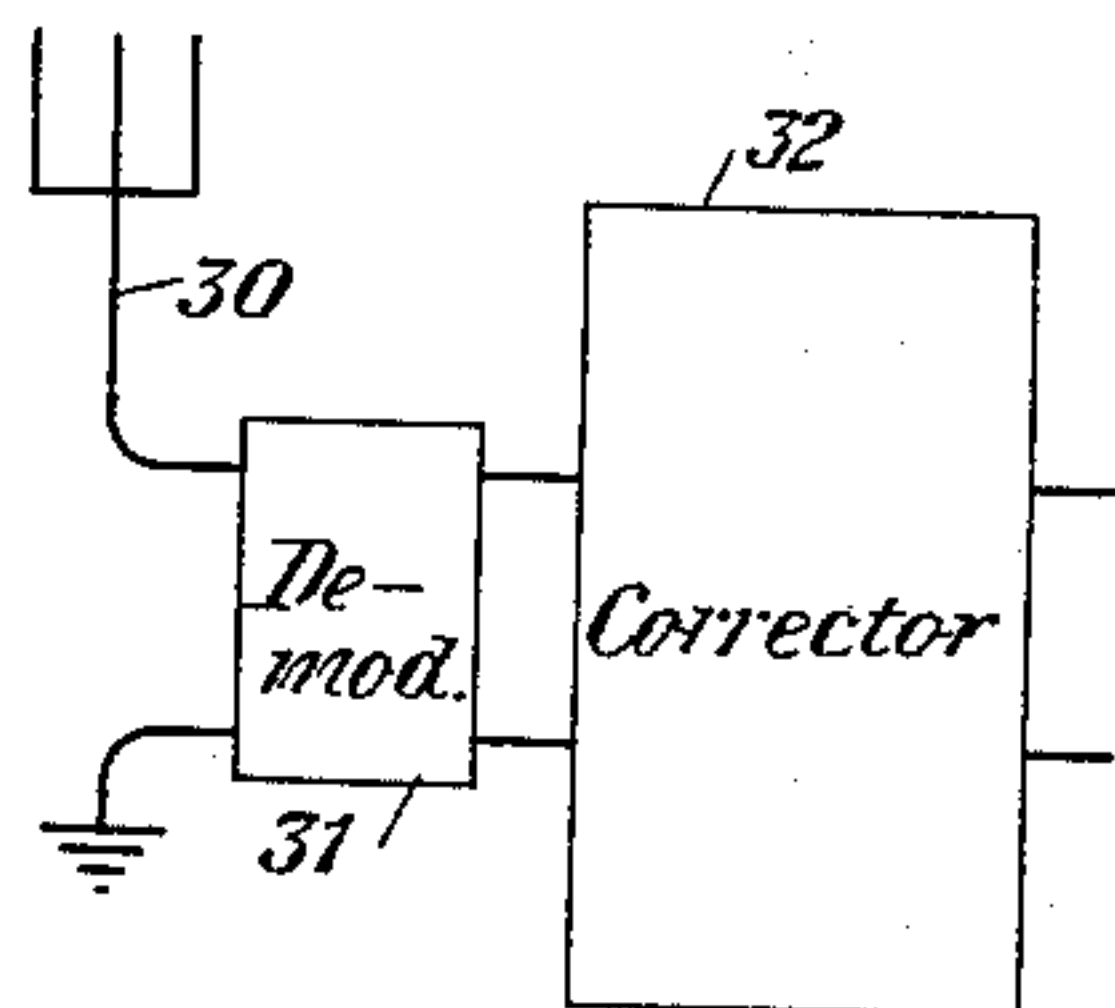


Fig. 3

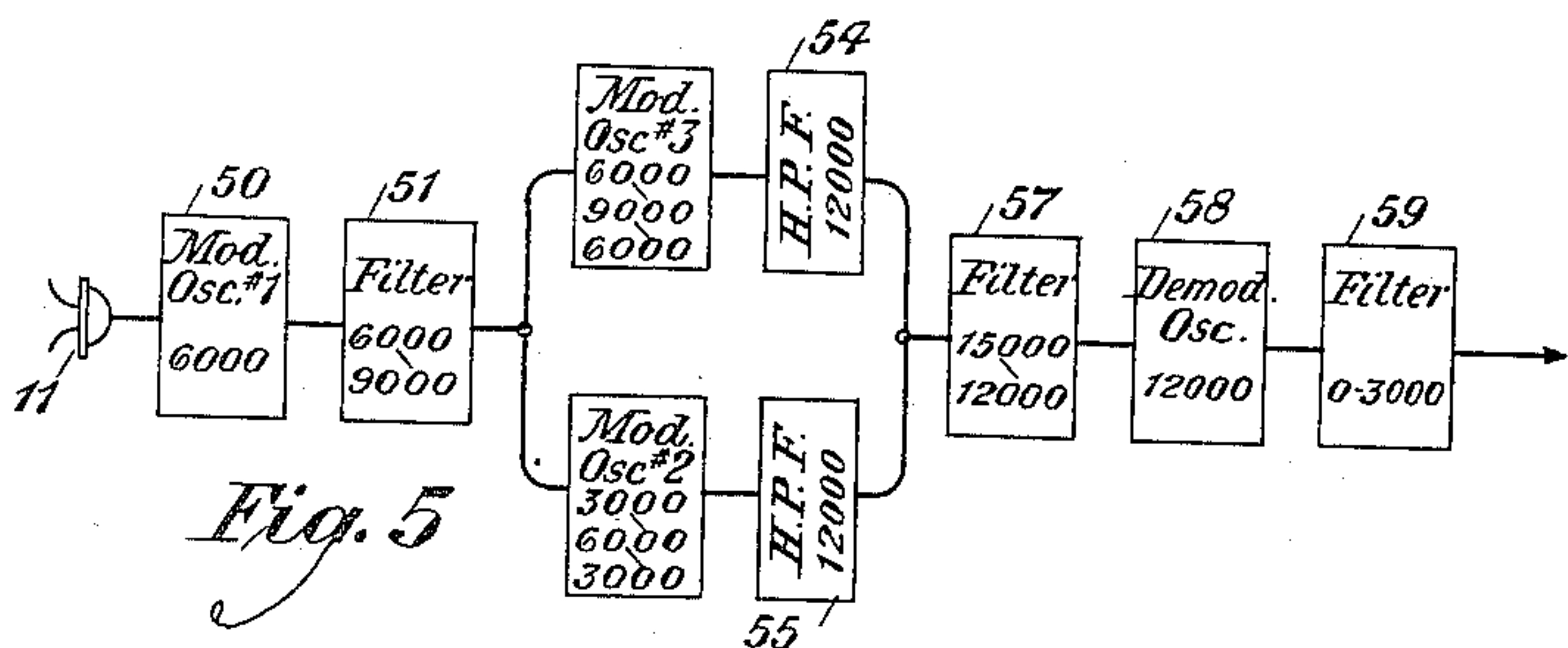


Fig. 5

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PRIVACY SIGNALING SYSTEM

Application filed November 1, 1929. Serial No. 404,138.

This invention relates to a privacy signaling system, and its purpose is to render more complete than heretofore the secrecy which may be attached to radio communication.

5 Heretofore it has been proposed in case of speech to obtain secrecy by splitting the voice frequency band into a number of sub-bands, which are then rearranged with respect to
10 are transmitted to remote stations. It has further been proposed to change this arrangement from time to time to make more difficult the unauthorized de-coding of the message. Certain disadvantages are inherent
15 in such an arrangement, among others being the effects arising from the sudden changing from one arrangement to another.

In our invention we rearrange the voice frequency band and change the configuration
20 of the arrangement smoothly and continuously. More specifically, the speech band is translated back and forth over the frequency spectrum without increasing the frequency band width. As the speech band shifts, the
25 frequencies which pass beyond the upper limit of the frequency band reappear at the lower part of the frequency range just vacated, until finally the speech band occupies its original position. The process is then re-
30 versed in that the speech band passes beyond range at the lower end of the spectrum and reappears at the top, thus yielding a continuous but periodically changing arrangement of the portions of the original speech signal.

35 The apparatus for correcting the signal at a receiving station is the same as that at the transmitting end, the difference in operation being that as the frequency of a modulator-oscillator at one terminal is increasing,
40 the frequency of the corresponding modulator-oscillator at the other terminal is decreasing, and vice versa. The effect produced is similar to but more effective than wobbling the radio carrier frequency for it does
45 not require a widening of the transmission band, an increase which is inherent where the carrier itself is wobbled.

The invention will be better understood from the following specification taken in
50 connection with the accompanying drawing,

in which Figure 1 shows a radio transmitting station in which the rearrangement and continual shifting of the speech signal to be transmitted is accomplished; Fig. 2 is a
55 diagram illustrating the shifting of the speech signal band as it passes through the apparatus of Fig. 1; Fig. 3 shows schematically the circuit at the receiving station; and Figs. 4 and 5 show modifications of the
60 arrangement of Fig. 1.

Referring more specifically to Fig. 1, there is shown a source of speech signals 11 which will yield a band of frequencies extending from a low value, say of about 200, to a value
65 which might be in the neighborhood of several thousands, but for the purpose of this description we will assume that the speech signal band extends from zero to 3,000, this upper limit yielding speech of sufficiently
70 good quality for most commercial purposes. This speech signal is then modulated against a carrier of variable frequency in the modulator 12, the oscillator 13 in this case being
75 shown for illustrative purposes as having a frequency which varies continuously from a minimum of 8,000 to a maximum of 11,000 and back again, the variation being cyclical in any suitable period of, say, 15 seconds. There are numerous ways in which such pe-
80 riodic change in the frequency of the oscillator 13 may be obtained, and the figure shows one simple manner which consists in having a motor-driven variable condenser 15 comprising a portion of the tuned circuit of the oscillator 13. The motor 16 may be used for
85 rotating this condenser 15.

The output of the modulator 12 is divided into two paths one of which is shown as containing a filter No. 1 with a transmission
90 band extending from 11,000 to 14,000, followed then by a demodulator the oscillator of which is maintained at a frequency of 11,000. Following this is a filter 20 which passes all frequencies from zero to 3,000, and no others. Similarly, the other branch from the modu-
95 lator 12 comprises a filter No. 2 with a transmission band extending from 11,000 to 8,000 followed by a demodulator whose oscillator is set for 8,000, and in turn followed by a filter 21 passing the band from zero to 3,000. 100

The two paths now come together, and the combined output consists of the original speech message lying in the original frequency range but rearranged to render it secret and unintelligible, the rearrangement changing continuously because of the properties of the circuit. This secret message may now be transmitted to any station over any signaling channel. In particular, we have shown it in Fig. 1, as being impressed on a radio frequency modulator 22 to be transmitted by radio over the antenna 24.

The operation of the system as thus far described will be better understood by reference to Fig. 2, taken in connection with Fig. 1. In this Fig. 2 there is shown a frequency plot indicating the position and nature of the frequency band at different places along the circuit. For example, at the microphone 11 there is produced the speech band shown at *a* in Fig. 2 as extending from zero to 3,000. In the output of the modulator 12 there will appear a side band which shifts in the frequency level according as the frequency of the modulator carrier changes. The position of such a side band is shown at *b* of Fig. 2 for successive values of the oscillator from 8,000 to 11,000 and back to 8,000 this representing one complete cycle in the variation of the oscillator frequency. It will be noted that in general a portion of each one of these bands passes through the filters No. 1 and No. 2. More particularly, the portion which passes through the filter No. 1 is that shown in Fig. 2 as lying above the dotted line *mn*, and the portion which passes through the filter No. 2 is that which lies below the line *mn* and above the 8,000 frequency line. If, now, the portions above the line *mn* are demodulated against a carrier of 11,000 as shown in Fig. 1, they will be shifted downwards to the zero frequency level, all other demodulator products being suppressed by the filter 20. Similarly, the portions lying below the line *mn* will be shifted downwards by the demodulator 19, and when the two paths are united there will appear at the common output a signal the character of which from moment to moment is indicated in Fig. 2 in the portion extending from *g* to *h*, this portion covering the changes which occur in one complete period of the rotation of the condenser 15. Thus we are able to obtain a secret message in which not only is there a rearrangement of the signal but a continuous change in that rearrangement, the change consisting in causing the speech band to move across its own width, the portion which moves beyond the range at one side of the band reappearing at the other edge of the band which was vacated until the band occupies its original position, whereupon the reverse process takes place.

In Fig. 3 there is shown a receiving antenna 30 associated with a demodulator 31

and a correcting circuit 32 which, in turn, is connected to any receiving device, such as a telephone receiver. The corrector 32 performs the reverse operation of that described in Fig. 1 and the circuit is the same, element for element, the only change being that as the frequency of the oscillator 13 rises, the frequency of the corresponding oscillator at the receiving station falls, and vice versa. This is a condition which can be readily attained by having the condenser at one terminal at its maximum when the other is at its minimum. It should be emphasized that close synchronism between the motors for changing the condensers is required, and any suitable means for accomplishing this may be used, such as accurately driven clock motors or tuning fork motors.

Fig. 4 shows a modification of the circuit of Fig. 1 and for simplicity in description this Fig. 4 as well as Fig. 5 are shown as one-line diagrams, it being understood that one line stands for a pair of wires. Also, in these figures the oscillators are not shown as separate units, it being understood that every modulator or demodulator has associated with it an oscillator to supply a carrier frequency of the appropriate value. Fig. 4 differs from Fig. 1 in that a modulator-oscillator of constant carrier frequency is introduced immediately following the original source of speech signals, here shown as the microphone 11. In this figure the carrier frequency for this modulator is shown as 6,000, and there will result two side bands one of which extends from 6,000 to 9,000. This band is selected to the exclusion of all other frequencies by means of a filter 41, and this side band is now impressed upon the modulator of variable carrier frequency, the remainder of the circuit operating in precisely the same manner as that indicated in Fig. 1. In this Fig. 4 this variable modulator is shown as having a carrier frequency changing from 15,000 to 18,000 cycles, but it is to be understood that these, as well as all other frequencies mentioned throughout this specification, are for illustrative purposes only. In this case, however, we have shown the frequency of the modulator 43 as being substantially removed from the signal band extending from 6,000 to 9,000, which is coming from the filter 41. This particular choice of frequencies is made in order that there shall be no danger of the carrier frequency or the other side band being transmitted through the filters No. 1 and No. 2 of Fig. 4 whose transmission bands, respectively, cover the bands 24,000 to 27,000 and 21,000 to 24,000. The specific function of the modulator 40 is to place the signal band at such a frequency level that there will be no difficulty in separating the side bands in the output of the modulator 43.

Fig. 5 shows a further modification in

which again the signal band is shifted to a comparatively high level by means of the modulator 50, and one side band only is transmitted through the filter 51. In this figure, instead of having a single variable modulator, two such modulators are shown, one in each of the parallel paths, the one of these indicated as modulator-oscillator No. 2 having a carrier varying from 3,000 to 6,000 and the other indicated as modulator No. 3 having a carrier varying from 6,000 to 9,000. The output of these two modulators is combined and passed through a single band filter 57, passing a band from 12,000 to 15,000, thus eliminating certain portions of the output of modulator No. 2 and certain portions of the output of modulator No. 3. These portions are then shifted in their frequency level by demodulator 58 whose carrier frequency is 12,000, the filter 59 suppressing all but those frequencies lying in the original signal band from zero to 3,000. The final output is of the same form and varies in the same way as described in connection with Fig. 1.

It is seen that in this modification the filters No. 1 and No. 2 of Figs. 1 and 4 have been replaced by a single band filter. The cut-off requirement for any of these filters is severe and therefore they are expensive, and it represents a substantial economy in the circuit to be able to eliminate one of these. In order to avoid interaction between the modulators No. 2 and No. 3 of Fig. 5, it is desirable to isolate these from each other by means of suitable filters, and two such filters 54 and 55 are shown, these being high pass filters having a nominal cut-off of 12,000 for the particular circuit shown. The requirement of sharpness of the cut-off for these filters in their particular location is not severe, and they may therefore be made quite economically. It will be noted that two modulators, each with variable frequency oscillators, are necessary for the circuit of Fig. 5. These may be supplied independently or the second variable frequency may be produced by beating the first variable oscillator against a fixed oscillator. For example, with one oscillator working from 3,000 to 6,000 cycles, a portion of its output could be caused to beat with a 3,000 fixed oscillator and thus a second set of frequencies varying from 3,000 to 9,000 cycles would be obtained.

From all of the description thus far it has been indicated that the upper side bands from the modulators are to be retained. Obviously, the lower side bands might have been retained, and in that case the final secret message would have consisted of "inverted speech," which would lend further secrecy to the system.

In actual operation for two-way signaling it is evident that two sets of apparatus may be used at each terminal, one for transmitting and one for receiving. On the other

hand, a single set of apparatus at each terminal could be used, in which event one system would be switched from the transmitting leg to the receiving leg, or vice versa, by means of voice operated devices or equivalent means.

Numerous variations and modifications of our invention can be made such, for example, as causing the changes to take place in steps rather than continuously as described, but it is to be understood that all such modifications are included in the scope of our invention.

What is claimed is:

1. In a secrecy signaling system, the method which consists in modulating the signal band against a variable carrier frequency, transmitting the frequencies above a certain value along one channel and those below that value along a parallel channel, demodulating in each channel to the same frequency level, and combining the output of the two channels to yield a secret message with portions of the original signal transposed and continually varying in that transposition.

2. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, and means in each path for demodulating to the same frequency range.

3. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, and means in each path for demodulating to the same frequency range with the two portions transposed.

4. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, and means in each path for demodulating to the original frequency range with the two portions adjacent but transposed and continually varying.

5. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, and means in each path for demodulating to the original frequency range with the two portions adjacent but transposed, the line of transposition varying periodically across the frequency band in accordance with the variations in the first named modulating means.

6. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, means in each path for demodulating to the same frequency range with the two portions transposed, and means for modulating the product against a radio carrier frequency.

7. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, means in each path for demodulating to the original frequency range with the two portions transposed, and a remote receiving station and means thereat for performing the reverse process.

8. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, means in each path for demodulating to the original frequency range with the two portions transposed, and a remote receiving station and similar means for decoding the message, said means comprising a demodulator whose oscillation frequency varies in the reverse manner from that at the first station.

9. In a secrecy communication system, a source of speech signal, means for modulating the signal against a varying carrier frequency, a path for transmitting the upper portion of one of the side bands, a second parallel path for transmitting the lower portion of the same side band, means in each path for demodulating to the original frequency range with the two portions transposed, means for modulating the product against a radio carrier frequency, and a remote receiving station and similar means for decoding the message, said means comprising a demodulator whose oscillation frequency varies in the reverse manner from that at the first station.

In testimony whereof, we have signed our names to this specification this 30th day of October, 1929.

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CLIFFORD N. ANDERSON.