July 21, 1925. 1,546,439

L. ESPENSCHIED

SECRET TELEPHONE SYSTEM

Original Filed Jan. 8, 1920 3 Sheets-Sheet 1

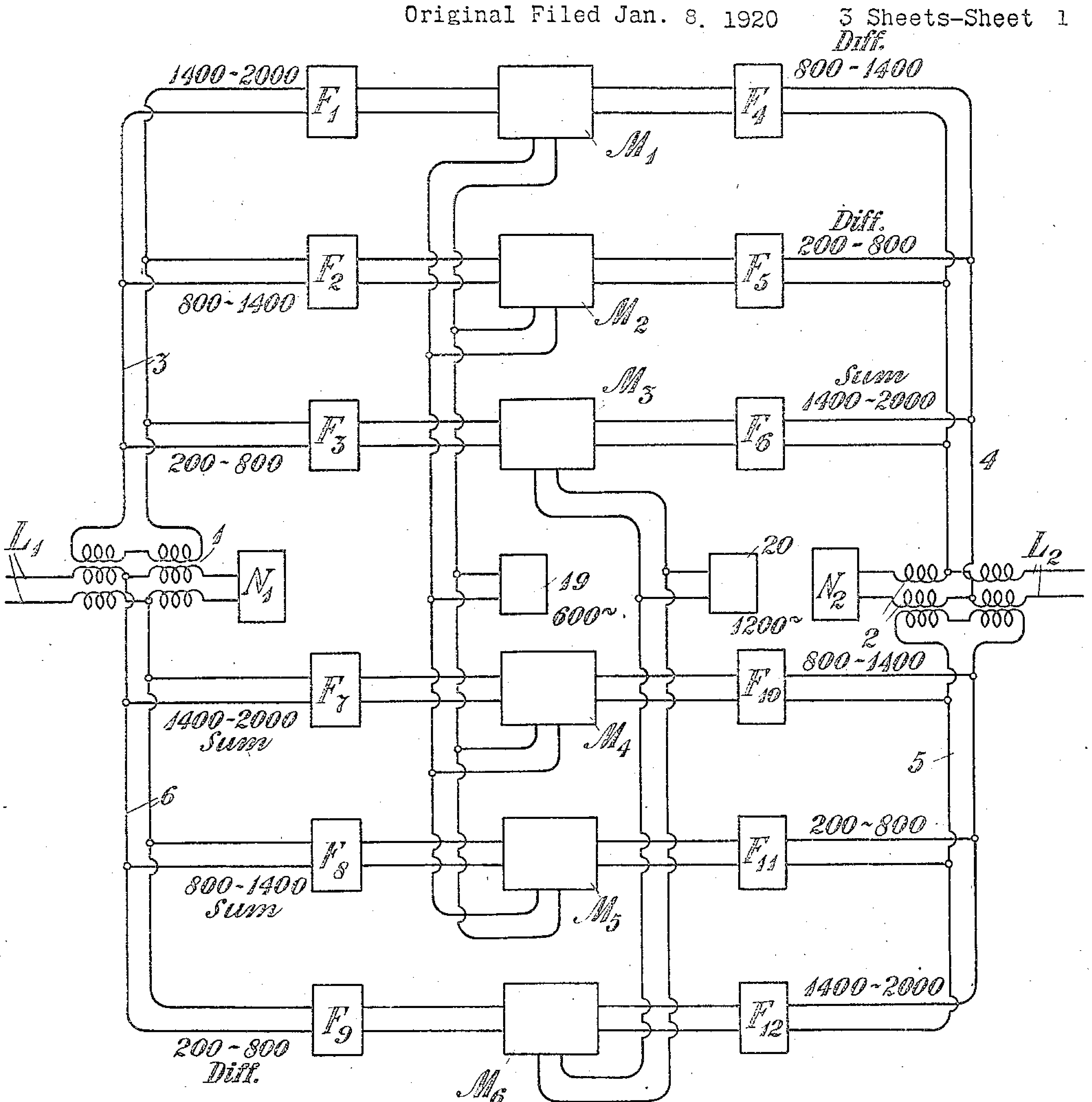

Fig 2

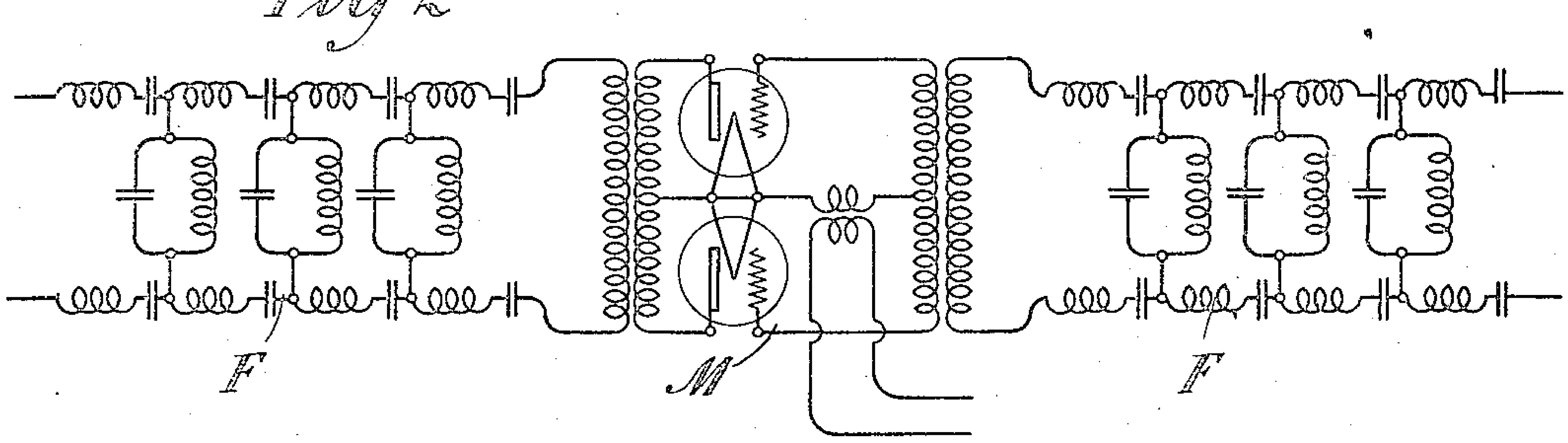

Fig. 1

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Original Filed Jan. 8, 1920 3 Sheets-Sheet 2

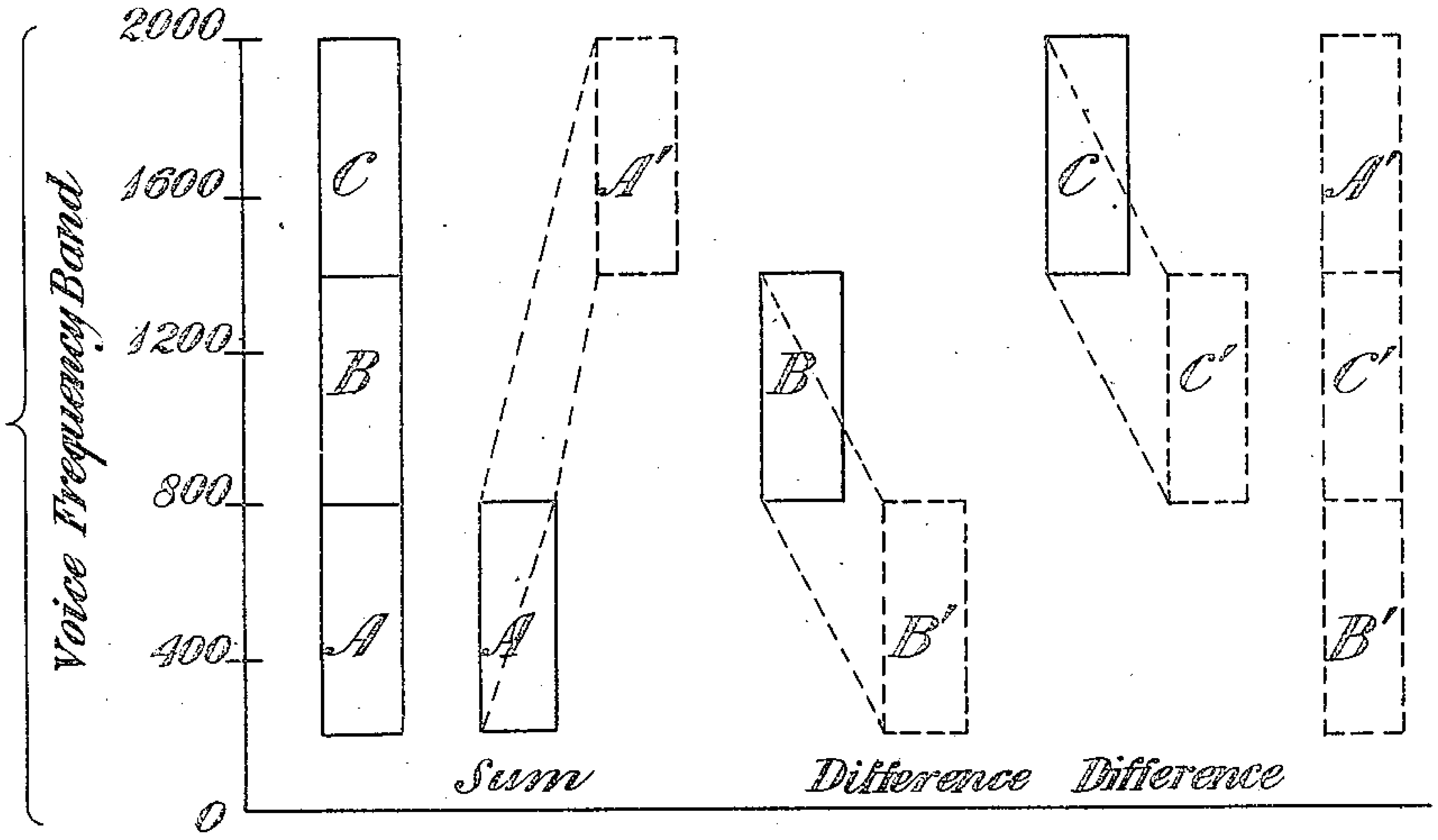

Fig. 3

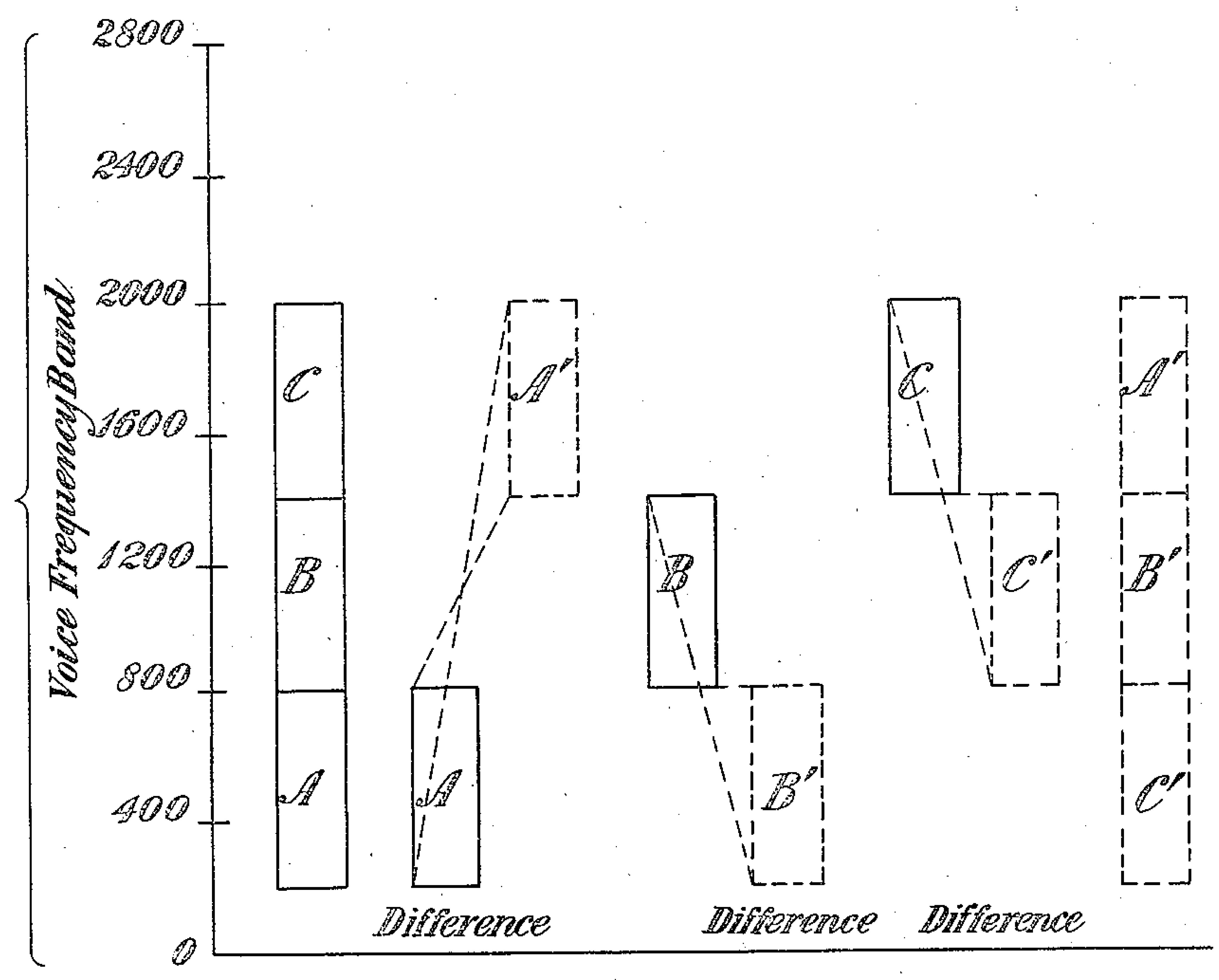

Fig. 4

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SECRET TELEPHONE SYSTEM

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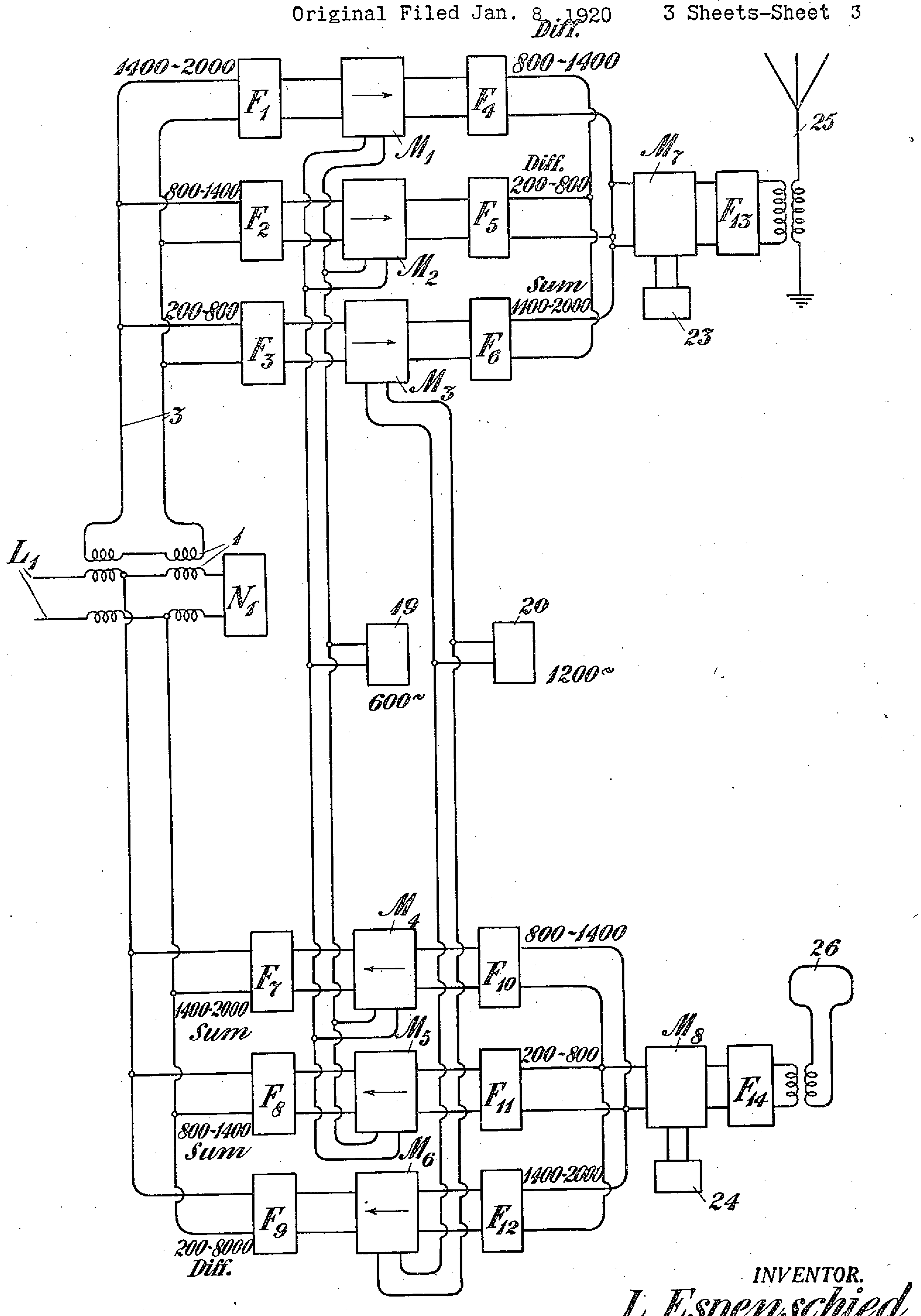

Fig. 5

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Patented July 21, 1925. **1,546,439**

UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF QUEENS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SECRET TELEPHONE SYSTEM.

Application filed January 3, 1920, Serial No. 350,125. Renewed May 15, 1925.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Queens, in the county of Queens and State of New York, have invented certain Improvements in Secret Telephone Systems, of which the following is a specification.

This invention relates to transmission systems and more particularly to a method of and means for providing secrecy in the transmission of messages over such systems.

In general it is the object of the invention to provide a system of communication over which messages, such as telephonic messages, may be transmitted in such a manner that it will be practically impossible for unauthorized persons who might have access to the medium through or over which the messages are transmitted to obtain the information contained therein. It is furthermore a feature of the arrangements of the invention that they are applicable both to systems of communication employing metallic conductors as the medium of transmission and to radio systems. Other objects and features of the invention will appear more fully from the detailed description hereinafter given.

The method of operation of the arrangements of this invention consists in separating by selective circuits the normal telephone frequency band into a plurality of sub-bands and of altering the normal frequency relation between these sub-bands and transmitting the frequency bands in such altered relation, thereby rendering the transmission unintelligible to ordinary instruments. At the receiving end of the system, the normal frequency relation between these sub-bands is restored, and the normal telephone frequency band is then received in the usual manner.

The invention may be more fully understood from the following description together with the accompanying drawing in the Figures 1, 2, 3, 4 and 5 of which are illustrated arrangements embodying the invention. In Fig. 2 is illustrated a translating station in a transmission system employing metallic conductors, including both sending and receiving apparatus for altering the normal frequency relation of the sub-bands of the outgoing message currents and for restoring the normal frequency relation of the sub-bands of the incoming currents. Fig. 1 illustrates in detail specific elements shown schematically in Fig. 2. In Fig. 5 is illustrated a translating station, substantially similar to that illustrated in Fig. 1, applicable to a radio system. In Figs. 3 and 4 are graphic representations of the methods of altering the normal frequency relation existing between the sub-bands.

Referring to Fig. 3, a graphic representation of the ordinary telephonic or voice frequency band is illustrated, which band extends approximately from 200 to 2000 cycles. This telephone band is divided up into a plurality of sub-bands, which sub-bands are then juxtaposed in the original telephone frequency band. The breaking up of the original telephone band is accomplished by selective circuits of the band filter type; the juxtaposing or shifting of the sub-bands is accomplished by modulation. The sub-bands as thus rearranged in the frequency scale are combined upon a common circuit and transmitted in their reassigned position. There is thus made available for transmission a new frequency spectrum with the colors shifted, as it were, but occupying no greater overall range of frequencies than the original band. This new and artificial frequency spectrum is transmitted to the distant receiver as the original frequency band of approximately 2000 cycles, that is, over an ordinary telephone circuit, or else, may be transmitted at a higher carrier frequency by being modulated upon a carrier current in the usual way. After modulation, the carrier channel may be transmitted either by wire or radio. This new and artificial frequency spectrum will be unintelligible to ordinary receiving instruments and accordingly secrecy may be provided for in transmitting messages with the above described method.

In the arrangement illustrated in Fig. 3 the voice frequency band is divided up into three equal sub-bands, such as A, B, and C, of 600 cycles each. Sub-band A, extending from 200 to 800 cycles, is selected out by means of a band filter, is modulated by being "beaten" by a carrier current of 1200 cycles, and of the resultant frequency bands produced thereby the sum term of the modulation is selected out by a band filter, thus shifting the 200 to 800 cycle band to its new position in the broader range, namely, 1400 to 2000 cycles. Sub-band B, extending from

800 to 1400 cycles, is shifted to the position originally occupied by A, 200 to 800 cycles, by being modulated with 600 cycles and selecting the difference frequency band (to the exclusion of the sum frequency band). Similarly, the sub-band C is shifted to the 800 to 1400 cycle position by being "beaten" with a carrier current of 600 cycles and the lower side band selected. The sub-bands as thus shifted, B′, C′ and A′, are then collected as indicated to form the new telephone band for transmission.

The arrangements for carrying out the above described method of secret transmission of messages may be understood more readily from reference to Fig. 2 in which is shown a transmission line, including the line sections L_1 and L_2. Line sections L_1 and L_2 are balanced by networks N_1 and N_2, respectively, and include windings of the three-winding transformers 1 and 2. In transmitting from line L_1, in which the voice frequency spectrum is normal, to line L_2, in which the frequency spectrum is recast, the voice currents are divided up by means of selective devices, such as filters F_1, F_2 and F_3, into individual circuits corresponding to the sub-bands A, B and C of the original voice frequency band heretofore mentioned. In other words filter F_3 will transmit sub-band A of 200 to 800 cycles, filter F_2 will transmit sub-band B of 800 to 1400 cycles, and filter F_1 will transmit sub-band C of 1400 to 2000 cycles. The sub-bands C and B will be transmitted to the modulating devices M_1 and M_2 where they will be modulated by a current from source 19 of 600 cycles. The difference in the resultant frequency bands will then be selected in each case by the selective devices, such as filters F_4 and F_5. In other words filter F_4 will transmit 800 to 1400 cycles and filter F_5 will transmit 200 to 800 cycles. The sub-band A will be transmitted to the modulator M_3 where it will be modulated by a current from source 20 of 1200 cycles. The sum term of modulation will then be selected out by the filter F_6, which would be 1400 to 2000 cycles. The sub-bands as rearranged in their new frequency relation of B′, C′, A′, will then be recombined on circuit 4, and thence be transmitted out over line L_2.

The recast and unintelligible voice frequency spectrum will be transmitted over the line L_2 to a distant station which will include apparatus similar to that illustrated in Fig. 2 and to which reference will now be made. The recast and unintelligible voice frequency spectrum transmitted over line L_2 will be transmitted through transformer 2 and over circuit 5. Associated with circuit 5 are the selective devices, such as filters F_{10}, F_{11} and F_{12}, which will separate the voice frequency band into the sub-bands as rearranged at the distant station. For example filter F_{10} will transmit sub-band C′ of 800 to 1400 cycles, filter F_{11} will transmit sub-band B′ of 200 to 800 cycles, and filter F_{12} will transmit sub-band A′ of 1400 to 2000 cycles. Sub-bands C′ and B′ will then be transmitted to the demodulating devices M_4 and M_5 where they will be "beaten" by a current from source 19 of 600 cycles. The sum term of modulation will in each case be selected out by filters F_7 and F_8, which will restore the sub-bands C′ and B′ to their original frequency relation of 1400 to 2000 and 800 to 1400 cycles, respectively. Sub-band A′ will be transmitted to the modulating device M_6 and will be "beaten" by a current from source 20 of 1200 cycles and the difference selected out by filter F_9, which will be 200 to 800 cycles, thereby restoring sub-band A′ to its original frequency relation of A. The sub-bands A, B and C are thus restored to their normal frequency relation and when thus recombined on circuit 6 are transmitted over line L_1 to receiving apparatus in intelligible form.

In Fig. 1 is illustrated in detail a form of modulating and demodulating device M and the band filters F, which elements have been heretofore referred to and illustrated schematically in Fig. 2. The modulating and demodulating device M is shown as of the duplex vacuum bulb type, illustrated in the U. S. Patent No. 1,343,307 issued June 15, 1920, to J. R. Carson. The band filters may be of the types illustrated in the U. S. Patents Nos. 1,227,113 and 1,227,114 to George A. Campbell, although other selective means might be employed if desired. It is desirable to utilize the duplex type of vacuum bulb modulator for the following reasons: The carrier frequencies involved in forming the frequency shifting operation may be themselves in the telephone range of frequencies, in the case illustrated being 600 cycles and 1200 cycles. These modulating currents are prevented from being transmitted beyond the modulators by the use of the duplex type of modulator circuit illustrated, which suppresses by balance between the two tube output circuits, the component which remains unmodulated. While this type of modulating device is desirable, it is pointed out that it is not essential and that other types may be employed.

An important application of such a secrecy system as has been described is in a radio telephone transmission system, where because of the broad-cast nature of the usual radio transmission, it is especially desirable to render unintelligible the transmitted energy. Accordingly in Fig. 5 there has been illustrated an arrangement of the secrecy system of this invention as applied to a radio telephone transmission system. Similar reference characters have been used to denote like parts in Figs. 2 and 5. The circuit arrangement of Fig. 5 is substantially similar to that of Fig. 2, the essential distinction being that the two one-way branches of the secrecy line of Fig. 2 are replaced in Fig. 5 by a sending antenna 25 and a receiving antenna 26. Between the modulating and selecting portions of the secrecy system and the respective antenna, there are provided radio frequency modulating devices M_7 and M_8 and selective circuit elements, such as filters F_{13} and F_{14} whereby in sending, the recast telephone frequency band is stepped up to the radio frequency, and whereby, in receiving, this band is stepped down from the radio to the audio frequency range. Interference with the incoming channel by the outgoing channel is prevented by employing a loop receiving antenna 26 balanced with respect to transmitting antenna 25 and by using where necessary or desired, different frequencies for sending and receiving as generated by 23 and 24 respectively. As in other respects the arrangements and operation of the radio system of Fig. 5 are substantially the same as that already described with respect to the arrangements of Fig. 2, no further description thereof will be given.

In Fig. 4 of the drawing is illustrated a case where the sub-bands A, B and C are not only shifted to different positions in the frequency spectrum, but in being so shifted are also turned upside down, as indicated by the dotted lines. This constitutes another element tending to "garble" and render unintelligible the telephone frequency band, particularly when transmission of the message takes place over a wire line at telephone frequencies. The turning over of the sub-bands is accomplished by so choosing the modulating frequency that the desired new position of a sub-band in the frequency range is represented by the component of modulation representing the difference between the sub-band and the modulating frequencies. There are required in the case illustrated three modulating currents of different frequencies. These modulating frequencies are illustrated as 2200 cycles for sub-band A, 1600 cycles for sub-band B, and 2800 cycles for sub-band C. These modulating frequencies are outside of the frequency range of their respective sub-bands which facilitates excluding, by the use of selective circuits, the modulating frequencies from interfering with the transmission circuit proper. The circuit arrangements for carrying out the above outlined method of changing the voice frequency spectrum are substantially similar to those already described and further description thereof will be omitted.

It will be understood that the secrecy system of this invention is not limited to any particular division of the voice frequency range into sub-bands and furthermore the modulating frequencies may be varied widely. While in the cases illustrated the normal voice frequency range has been divided into three sub-bands of equal frequency ranges, these sub-bands may be of any desired number and not necessarily equal in frequency widths. Furthermore, the sub-bands, when transmitted from station to station, may either be widely separated in the broad frequency range or may be kept close together and confined as much as possible to the overall frequency band as has been illustrated. Accordingly, while the invention has been disclosed in certain specific arrangements which have been deemed desirable, it is understood it is capable of embodiment in many and widely varied arrangements without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. The method of transmitting messages secretly which consists in dividing the original frequency band of the message into simultaneously existing sub-bands, shifting said sub-bands from their normal positions in the frequency scale to produce a new band having substantially the same width as the original signal band, transmitting said sub-bands in their shifted positions, and in restoring said shifted sub-bands to their normal positions in the frequency scale.

2. The method of secret telephony which consists in arbitrarily dividing the speech wave into unintelligible fragments, recombining said fragments by modulation with other frequencies to form an unintelligible wave having substantially the same width of frequency range as the original signal wave, and transmitting said wave to a distant station, dividing said transmitted wave into its component fragments, and recombining said fragments by modulation with other frequencies to form said original speech wave.

3. The method of secret signaling which comprises dividing a signal wave into its frequency components, recombining said components by modulation with other frequencies in an unintelligible manner to produce a wave having substantially the same width of frequency range as the original signal wave, transmitting said components as recombined, and restoring said components by modulation with other frequencies at a receiving station to their original relation to form the original signal wave.

4. A transmission line including two line sections, two one-way circuits transmitting in opposite directions interconnecting said line sections, selective devices associated with each of said two circuits for separating the incoming frequency band into sub-bands, and means in each of said two circuits for

changing the normal frequency relation of said sub-bands with respect to each other to produce a wave having substantially the same width of frequency range as the original signal wave.

5. In a transmission system including a sending station and a receiving station, a plurality of selective devices at said sending station for separating the message frequency band into sub-bands, means for modulating said sub-bands to alter their original frequency relation with respect to each other, means for recombining said sub-bands in said altered relation to produce a wave having substantially the same width of frequency range as the original signal wave, a plurality of selective devices at said receiving station for separating said recombined message band into its component sub-bands, means at said receiving station, for modulating said sub-bands so as to restore said sub-bands to their original frequency relation with respect to each other, and means for recombining said sub-bands to form said original message frequency band.

6. In a system of signaling in which signals are transmitted as modulated side bands of a carrier current wave, the method of attaining secrecy which consists in transmitting a side band having substantially the same width of range as the original message band, but with the individual frequencies of the band rearranged with respect to their counterparts in the original band.

7. In a system of signaling in which signals are transmitted as modulated side bands of a carrier current wave, the method of attaining secrecy which consists in transmitting a side band having substantially the same width of range as the original message band, but with the individual frequencies of the band rearranged with respect to their counterparts in the original band, demodulating the transmitted wave at the receiving station, and rearranging the components of the resultant signal wave so as to restore them to their original relation.

8. In a system of signaling of the kind in which voice currents are transmitted as modulated side bands of a carrier current wave, the method of secret transmission which comprises transmitting a side band which is substantially the same width of range as the original voice band, but with the individual frequencies rearranged with respect to their counterparts in the original voice band, demodulating the transmitted wave at the receiving station, and rearranging the component frequencies of the resultant signal wave to produce a wave corresponding to the original voice wave.

9. The method of transmission of waves representing a message having a band of frequency components occurring in a characteristic order, which comprises dividing said band into sub-bands, inverting the frequency order of the components within certain sub-bands, recombining said sub-bands in their altered condition to produce a wave having substantially the same frequency width as the original message band, and transmitting said sub-bands as recombined to a distant station.

10. The method of providing secrecy in the transmission of a message in a system of communication which comprises dividing a voice frequency band into sub-bands, inverting the normal order of frequencies within at least one sub-band, recombining said sub-bands in their altered condition to produce a wave within the voice frequency range, and transmitting all of said sub-bands as recombined to a distant station.

11. The method of providing secrecy in the transmission of a message which comprises dividing a message frequency band into sub-bands, inverting the frequency order within at least one sub-band, shifting at least one sub-band into a different position in the frequency scale with respect to the other sub-bands, recombining said sub-bands in their altered condition and relation to produce a wave having substantially the same frequency width as the original message wave, and transmitting all of the sub-bands as recombined to a distant station.

12. The method of receiving a band of frequencies representing a message in which certain sub-bands have the component frequencies in inverted order which comprises restoring the frequencies of the inverted sub-bands to the normal order and utilizing the restored sub-bands in connection with the other sub-bands to reproduce the message.

13. A transmission line over which a message frequency band is transmitted, a plurality of selective circuits associated with said line for dividing said message frequency band into simultaneously existing sub-bands, means associated with said selective circuits for inverting the frequency order of the components within certain of said sub-bands, and means associated with said last mentioned means for recombining said sub-bands in their altered condition to produce a band having substantially the same frequency width as the original message band.

14. A transmission line over which a message frequency band is transmitted, a plurality of filters for dividing said message frequency band into sub-bands, modulators associated with said filters for inverting the frequency order of the components within certain of said sub-bands, and circuit means associated with the modulators for recombining said sub-bands in their altered condition to produce a band having substan-

tially the same frequency width as the original message band.

15. A transmission line over which a message frequency band is transmitted, a plurality of selective circuits associated with said line for dividing said message frequency band into simultaneously existing sub-bands, means associated with said selective circuits for inverting the normal order of frequencies within at least one of said sub-bands, and means associated with said selective circuits for recombining said sub-bands in their altered condition to produce a band having substantially the same frequency width as the original message band, and means for transmitting said last mentioned band to a distant station.

16. A transmission line over which a message frequency band is transmitted, a plurality of selective circuits associated with said line for dividing said message frequency band into simultaneously existing sub-bands, means associated with said selective circuits for inverting the normal order of frequencies within at least one of said sub-bands, means associated with said selective circuits for shifting at least one of said sub-bands into a different position in the frequency scale with respect to the other sub-bands, means associated with said selective circuits for recombining said sub-bands in their altered condition and relation to produce a band having substantially the same frequency width as the original message band, and means for transmitting said last mentioned band to a distant station.

17. In a system of communication for providing secrecy in the transmission of the message by dividing the message frequency band into simultaneously existing sub-bands, inverting the normal order of frequencies within at least one sub-band, recombining said sub-bands in their altered condition to produce a wave having substantially the same frequency width as the original message, and by transmitting said sub-bands as recombined, a receiving station comprising a plurality of selective circuits for dividing the incoming unintelligible message band into sub-bands similar to the sub-bands as recombined and transmitted out from the sending station, means in one of said selective circuits for reinverting the order of frequencies within at least one of said sub-bands, and means for recombining all of said sub-bands to form the original message.

18. In a secret communication system a sending station comprising a plurality of selective circuits for dividing the original message frequency band into simultaneously existing sub-bands, means associated with said selective circuits for shifting certain of said sub-bands from their normal positions in the frequency scale, circuit means for recombining said sub-bands in their altered condition to produce a new band substantially no wider than the original message frequency band, and means for transmitting said new band to a distant station, and a receiving station comprising a receiving circuit for said transmitted band, a plurality of selective circuits associated therewith for dividing said transmitted band into its component sub-bands, means associated with said selective circuits for shifting certain of said component sub-bands back to their original positions in the frequency scale, and circuit means for recombining said sub-bands as reshifted to form said original message frequency band.

19. In a secret communication system, a sending station comprising a plurality of selective circuits for dividing the original message frequency band into simultaneously existing sub-bands, means associated with said selective circuits for shifting certain of said sub-bands from their normal positions in the frequency scale, means associated with said selective circuits for inverting the normal order of frequencies within certain of said sub-bands, means for recombining said sub-bands in their altered condition and relation to produce a new band substantially no wider than the original message frequency band, and means for transmitting said new band to a distant station, and a receiving station comprising a receiving circuit for said transmitted band, a plurality of selective circuits associated therewith for dividing said transmitted band into its component sub-bands, means associated with said selective circuits for shifting certain of said component sub-bands back to their original positions in the frequency scale, means associated with said selective circuits for reinverting the order of frequencies within certain of said sub-bands to restore them to normal, and circuit means for recombining said sub-bands as reshifted and reinverted to form said original message frequency band.

20. A system of secret telephony comprising means for dividing the band of speech frequency components into sub-bands of frequency components, means for changing a characteristic of at least one sub-band so that when it is recombined with the other sub-bands the intelligibility of the resultant wave is materially reduced, means for combining the sub-bands into a band of such reduced intelligibility and of approximately the same width as the original band, and a circuit for transmitting the wave so produced.

21. The method of transmitting with secrecy a message represented by waves having a band of frequencies occurring in a characteristic order, comprising dividing

said frequency band into sub-bands, making alterations in certain of the sub-bands to produce a resultant message band in which the order of occurrence of the frequency components is changed to reduce the intelligibility of the resulting band, and transmitting the altered band of frequency components.

22. The method of secret telephony comprising dividing speech waves into sub-bands each of too small a frequency range to be readily understandable, altering the frequency relations of the frequency components of certain of the sub-bands to make the sub-bands still less understandable, recombining the altered sub-bands to form a wave having substantially the same frequency width as the original speech band, and transmitting the recombined sub-bands to a distance.

In testimony whereof, I have signed my name to this specification this 7th day of January 1920.

LLOYD ESPENSCHIED.