

Dec. 1, 1925.

1,563,326

R. BOWN

SECRET COMMUNICATION SYSTEM

Filed Nov. 8, 1921

2 Sheets-Sheet 1

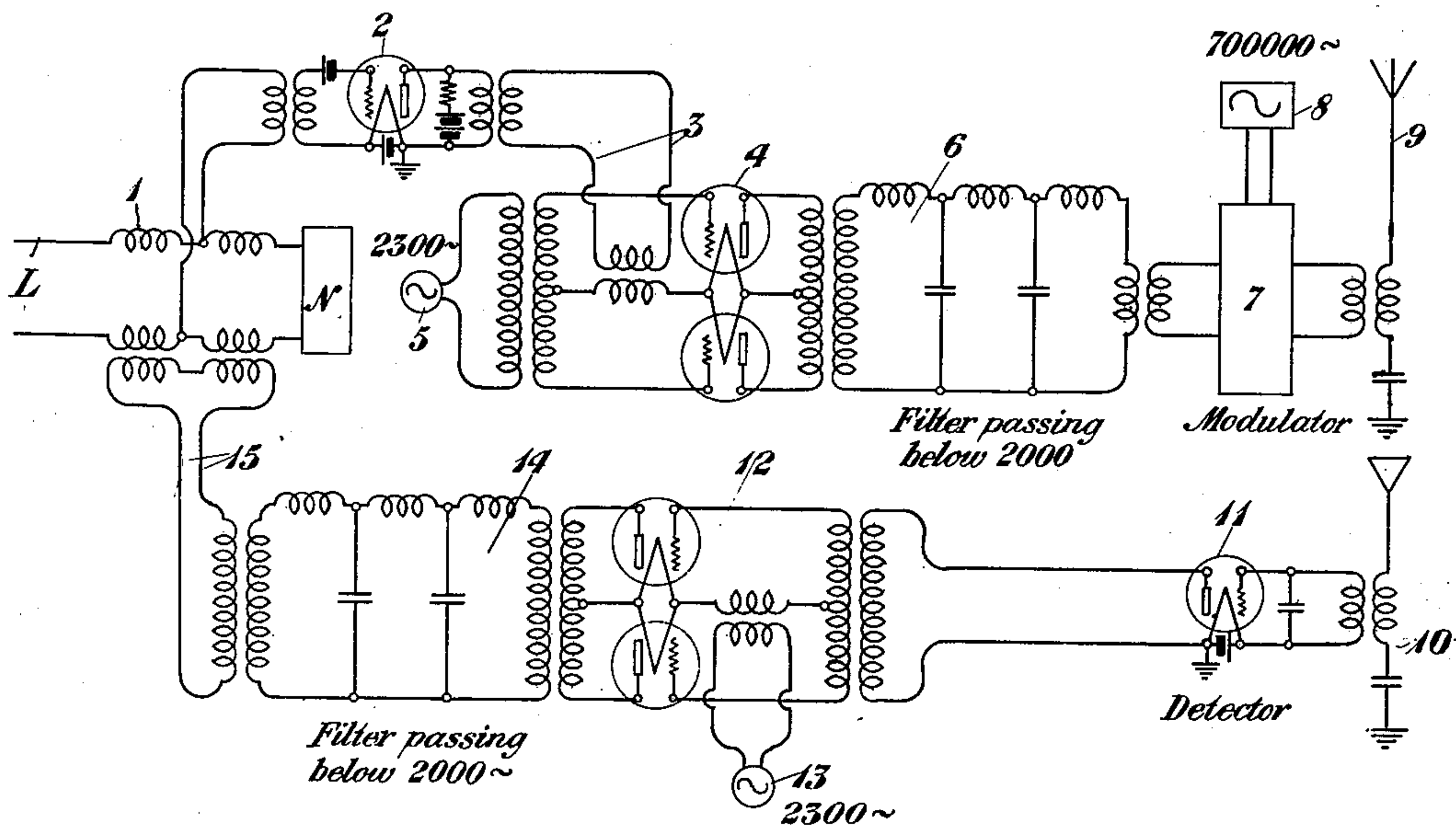


Fig. 1

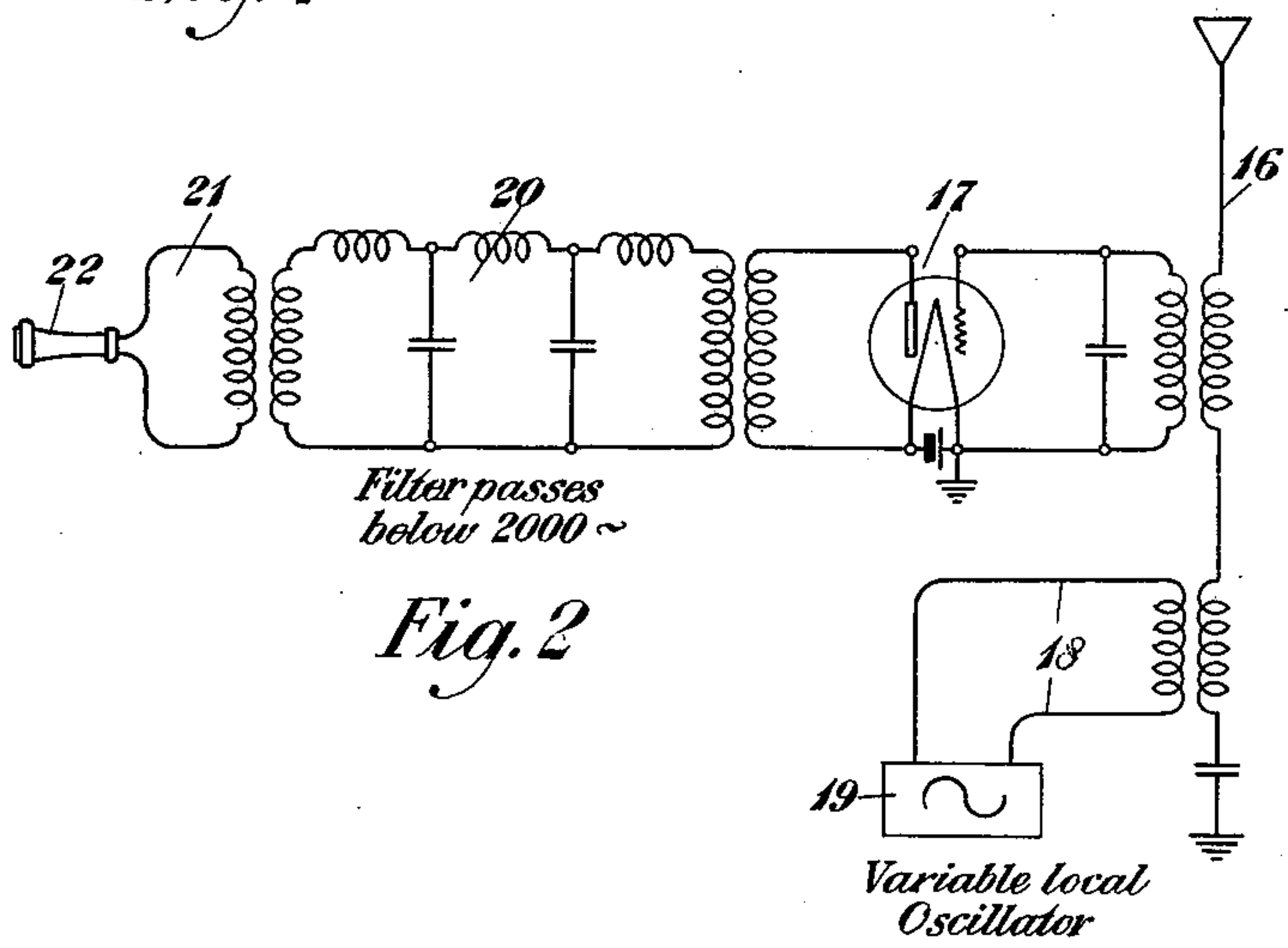


Fig. 2

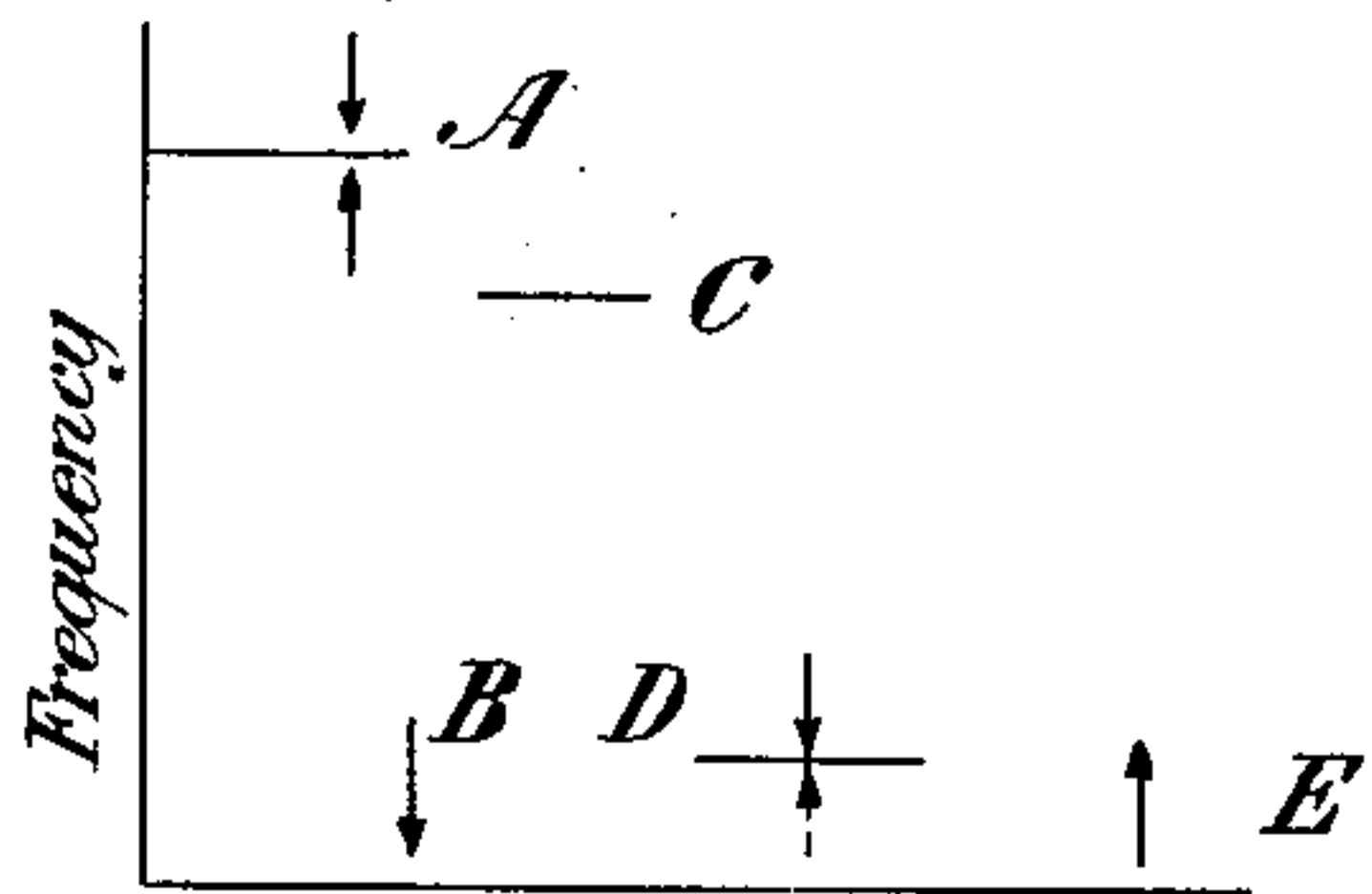


Fig. 3

INVENTOR

R. Bown

BY

ATTORNEY

Dec. 1, 1925.

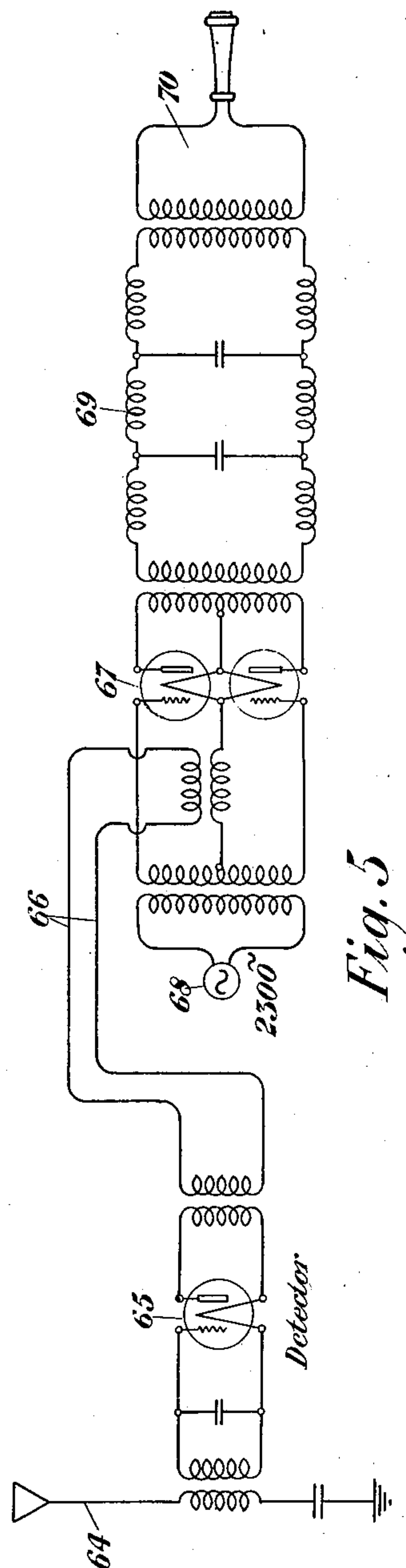
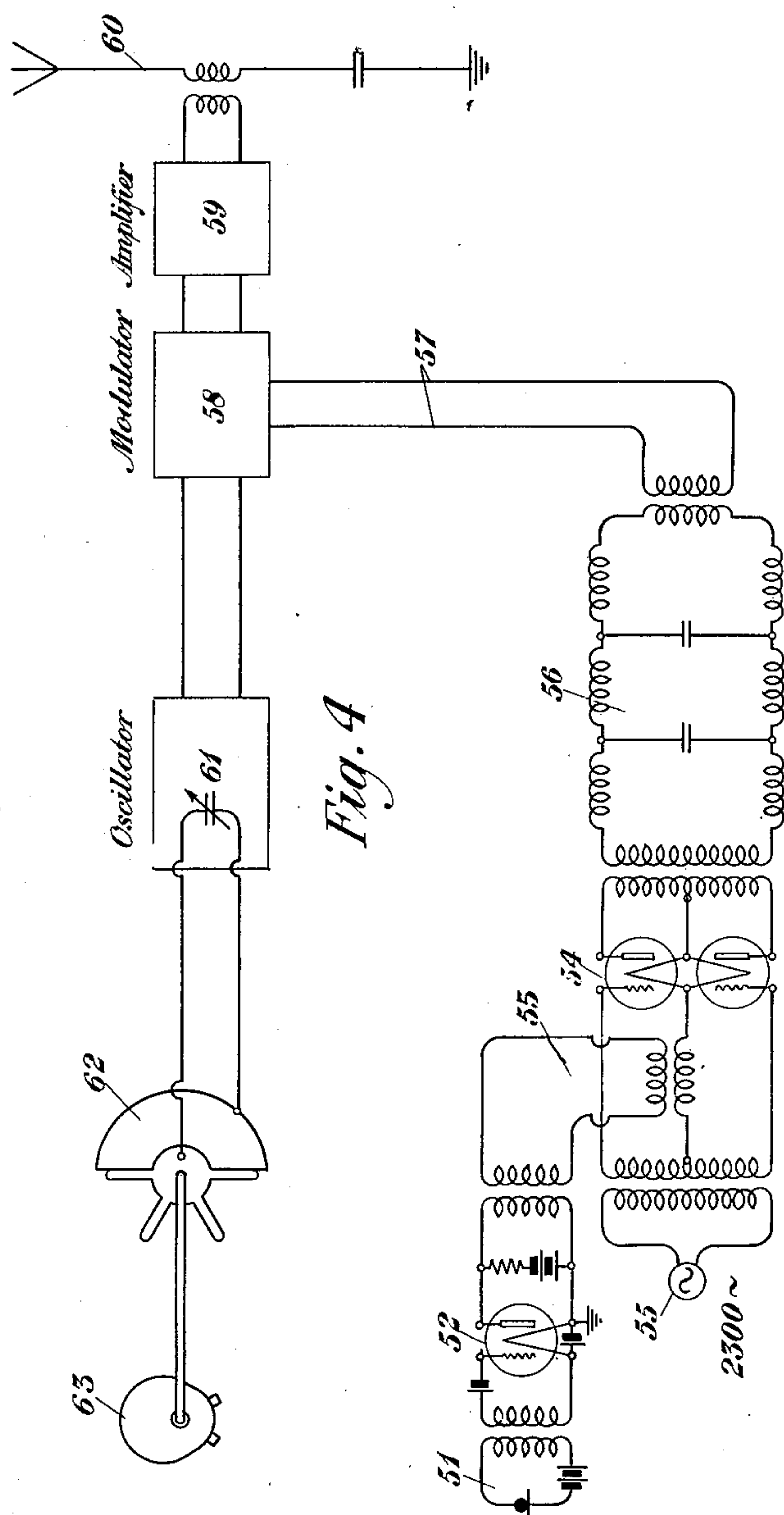
1,563,326

R. BOWN

SECRET COMMUNICATION SYSTEM

Filed Nov. 8, 1921

2 Sheets-Sheet 2



INVENTOR
R. Bown
BY *Joe Fila*
ATTORNEY

UNITED STATES PATENT OFFICE.

RALPH BOWN, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SECRET COMMUNICATION SYSTEM.

Application filed November 8, 1921. Serial No. 513,744.

To all whom it may concern:

Be it known that I, RALPH BOWN, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain
5 Improvements in Secret-Communication Systems, of which the following is a specification.

This invention relates to systems of communication in which secrecy in the transmission of messages is a cardinal feature.
10 One of the features of the invention consists in providing arrangements in such systems which will further insure secrecy in the transmission of the messages and prevent
15 their interception by well known receiving arrangements.

One of the methods heretofore utilized in providing for secrecy in the transmission of messages, to which the arrangements of this
20 invention are particularly applicable, has been to invert the speech frequency band at the sending station and to transmit the band in its inverted and hence unintelligible shape, and to provide at the receiving station
25 apparatus for reinverting the speech band to render it intelligible. This may be accomplished by modulating an oscillation current at the sending station in accordance with the signal wave and selecting the lower
30 side band of the modulated wave which will be the signal wave with the frequency relation inverted. This lower side band may then be utilized to modulate a carrier wave and thus transmitted to the distant station.
35 At the receiving station the carrier wave would be detected and eliminated thus leaving the lower side band of the modulated signal wave. This lower side band, or inverted frequency band, would then be utilized
40 to modulate an oscillation current similar to that used at the sending station and the lower side band resulting therefrom would be selected. This band would be the signal wave reinverted and restored to its
45 original condition. The above method of obtaining secrecy has been described in detail in the U. S. application, Ser. No. 210,868, filed January 8, 1918, in the name of Hendrik J. Van der Bijl, and reference may be
50 had thereto to a more detailed description of its operation.

The method of receiving the signals in the above described system, it will be seen, com-

prises at least two distinct steps, first the detecting of the carrier waves to receive the inverted speech band, and secondly the reinverting by modulation of the inverted received speech band so as to restore it to intelligible form. In a co-pending application
55 filed in the name of Ralph Bown, Ser. No. 513,743 filed November 8, 1921, there is disclosed an improved and simplified method of receiving for the above referred to communication system in which both of the above
60 steps of detecting and reinverting are accomplished by one single operation. It is pointed out that in the above co-pending application this is accomplished by utilizing a simple heterodyne receiver in place of the detector and the reinverting modulator of
65 former arrangements. In such cases the oscillator of the heterodyne receiver should be adjusted to a frequency equal to the difference between the carrier frequency and the inverting oscillation current frequency
70 utilized at the sending station. With such an arrangement and suitable filtering apparatus the speech band sent out in inverted form may be detected, reinverted, and received with one operation.
75

While such an arrangement may be desirable for certain purposes, it has been found that messages sent out by such systems may with these arrangements be easily intercepted and utilized by those without
80 authority. This may be done by simply varying and adjusting the local oscillator of the heterodyne receiver until the receiving apparatus shows the correct value to have been attained. It has been found exper-
85 mentally in carrying out this method of interception that the frequency difference between the radio carrier and the local oscillator of the heterodyne receiving set must be adjusted and maintained with a very
90 high degree of precision in order to be operative. If the radio carrier is allowed or intentionally caused to vary in frequency by a very small fraction of one per cent, and
95 in an arbitrary or erratic manner, the above described method of intercepting the messages cannot be successfully applied. Accordingly the arrangements of this invention provide means for varying the radio
100 carrier in an arbitrary or erratic manner in order to preclude the above described meth-
105

od of interception of the messages and to further insure the secret transmission of messages in the above referred to type of communication systems. It is pointed out
5 that the variation in the radio carrier will in no way effect the operation of reinverting the frequency and restoring the speech band to intelligible condition by the normal receiving methods of the above referred to
10 systems.

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 the invention is illustrated. Fig. 1 shows a transmitting and receiving arrangement for a communication system whereby secrecy is attained by inverting the frequency as disclosed in the aforementioned co-pending application in the name of H. J. Van der Bijl.
15 In Fig. 2 are shown the receiving arrangements whereby messages sent out from the apparatus of Fig. 1 may be intercepted as disclosed in the aforementioned co-pending application in the name of Ralph Bown. Fig. 3 illustrates graphically the principles of operation of Fig. 2. Fig. 4 shows the improved transmitting arrangements of this invention and Fig. 5 shows receiving apparatus adapted to co-operate and receive messages sent out from the arrangements of Fig. 4.

In Fig. 1 is shown a line L with which may be associated the usual type of telephone transmitter and receiver. The line L includes the windings of a hybrid coil 1 and also a balancing network N. Associated with the hybrid coil is an output circuit for the speech currents which may include
25 a vacuum bulb amplifier 2. The output of the amplifier 2 is coupled with a circuit 3 which in turn is coupled to a vacuum bulb modulating device 4, which is well known in the art. Associated with the modulator 4 is a source 5 of current which may be of the nature of 2300 cycles in frequency, the output of the modulator 4 is associated with a band filter 6 of the type illustrated in the U. S. Patent, No. 1,227,113, to G. A. Campbell.
35 The band filter is designed to cut off and extinguish frequencies above a certain limit, such as 2000, and hence will allow the lower side band of the modulated wave to be transmitted therethrough. Associated with the filter 6 is a modulator 7 of any well known type and a source 8 of carrier frequency upon which will be superposed the aforementioned lower side band. The output of modulator 7 is coupled with a radiating antenna 9. The receiving apparatus comprises an antenna 10 with which is coupled a detector 11, which is well known in the art. The detector is connected to a modulating device 12 similar to 4. The
45 modulator 12 is coupled with a band filter

14 similar to 6 and the circuit of filter 14 is connected through a circuit 15 to the hybrid coil 1 and to line L.

The arrangements of Fig. 1 operate in the following manner:

The speech band will be transmitted from line L through the amplifier 2 to the modulator 4. The speech band will then modulate the current from the source 5 of 2300 cycles and the upper and lower side bands will be transmitted to the filter 6. The upper side band and the carrier frequency of 2300 will be shut out by the filter and only the lower side band will be transmitted on. This lower side band consists of the difference between the frequency components of the speech band and the carrier frequency of 2300 and is the ordinary speech band in inverted form. This lower side band will then modulate a carrier frequency, such as 700,000 cycles, at the modulator 7 and there will be radiated from the antenna 9 the carrier frequency of 700,000 and the upper and lower side band resulting from modulation by the original lower side band. If we assume the speech band to have arbitrary limits such as a and b and let $a=300$ and $b=2000$ then upon modulating 2300 by the speech band we will get

$$\begin{matrix} b=4300 \\ a=2600 \end{matrix} \left. \vphantom{\begin{matrix} b=4300 \\ a=2600 \end{matrix}} \right\} \text{upper side band.}$$

$$\begin{matrix} 2300 \\ b=300 \\ a=2000 \end{matrix} \left. \vphantom{\begin{matrix} 2300 \\ b=300 \\ a=2000 \end{matrix}} \right\} \text{lower side band or inverted speech band.}$$

The band filter 6 will cut off all except the lower side band and we will now modulate the carrier of 700,000 with the lower side band values of $b=300$ and $a=2000$ and we will get

$$\begin{matrix} a=702,000 \\ b=700,300 \\ 700,000 \\ b=699,700 \\ a=698,000 \end{matrix}$$

When these values which are radiated from the antenna 9 are detected by detector 11, we will get

$$\begin{matrix} b=300 \\ a=2000 \end{matrix}$$

which is again the original lower side band or the speech band in its inverted shape. The inverted speech band is then used at the modulator 12 to modulate the 2300 cycle current from source 13 and we get

$$\begin{matrix} b=2600 \\ a=4300 \\ 2300 \\ a=300 \\ b=2000 \end{matrix}$$

The upper side band and the 2300 are then eliminated by the band filter 14 and the

lower side band of $a=300$ and $b=2000$ is transmitted to line L. This lower side band is the original speech band, reinverted and restored to its original shape.

In Fig. 2 are shown receiving arrangements whereby the messages may be intercepted and detected in a simple manner, which consist of a receiving antenna 16 to which is coupled a detector of the well known heterodyne type comprising a vacuum bulb detector 17 and a circuit 18 connected to a source 19 of oscillations. The source 19 may be arranged so that the frequency may be varied as desired. Associated with the output of detector 17 is the band filter 20 which is similar to filters 6 and 14 heretofore mentioned and designed to cut off and eliminate frequencies above a limit, such as 2000 cycles. Associated with filter 20 is a receiving circuit 21 and a telephone receiver 22.

The operation of the receiving arrangements of Fig. 2 is as follows:

If, as has already been pointed out, we assume arbitrary values for the speech band limits such as $a=300$ and $b=2000$ then the frequency components sent out from the transmitting station would be

$$\begin{aligned} a &= 702,000 \\ b &= 700,300 \\ &700,000 \\ b &= 699,700 \\ a &= 698,000 \end{aligned}$$

If these components were detected by an ordinary detector we would simply get $b=300$ and $a=2000$ which would be the inverted and unintelligible speech band. However in accordance with this invention there is impressed simultaneously upon the detector 17 a strong local frequency from the source 19. The frequency value of this local frequency should be adjusted to be equal to the difference between the carrier frequency, such as 700,000, and the local oscillation frequency from the source 5 at the sending station, such as 2300. In other words in this instance the frequency value from source 19 should be 697,700 cycles. This will act with the incoming signals in giving the following:

$$\begin{array}{l|l} \begin{array}{l} a=702,000 \\ b=700,300 \\ 700,000 \\ b=699,700 \\ a=698,000 \end{array} & \begin{array}{l} a=4300 \\ b=2600 \\ 2300 \\ b=2000 \\ a=300 \end{array} \end{array}$$

The band filter 20 will then eliminate the upper side band and the beat note of 2300 and will leave the band whose frequency limits are $a=300$ and $b=2000$. This, it will be seen is the original speech band reinverted and restored to its intelligible formation.

The principle of operation of the receiving arrangements of Fig. 2 may be further

understood from reference to the frequency scale shown in Fig. 3. The frequency scale shows at A the carrier and the two inverted side bands, which are radiated from the transmitting antenna. This combination, if received in the ordinary way with a simple detector, results in the production of B, an inverted and unintelligible speech band. If, however, there is impressed simultaneously upon the detector a strong local frequency C, the action of this with the incoming signals will predominate and result in D, which consists of an intelligible speech band, a strong beat note at 2300 cycles and an inverted speech band—this place upward into the range of 2600 to 4300 cycles. The intelligibility of the speech produced by this process is greatly hindered by the presence of the strong beat note and the higher frequency inverted speech band. The introduction into the detector output of an efficient low-pass filter, which cuts off frequencies above 2000 cycles, will largely eliminate the difficulty and leave only E, an intelligible speech band.

In Fig. 4 are shown the sending arrangements of this invention whereby the method of intercepting or receiving the message, as shown in Figs. 2 and 3, may be prevented and secrecy in the transmission of said messages may be further insured. These sending arrangements comprise a transmitting circuit 51 which may be associated with an amplifier 52. The output of the amplifier is shown associated with a vacuum bulb modulator 54 which includes a local source 55 of oscillations, such as of the order of 2300 cycles. The output of modulator 54 is coupled to a band filter 56 which cuts off frequencies above 2000 cycles. The output of filter 56 is connected by circuit 57 to the modulator 58, which is herein illustrated schematically as it is well known in the art. Associated with the modulator is an oscillator 61 for supplying the modulator with a high frequency carrier current. The oscillator includes a variable condenser for regulating the frequency of the carrier. In the circuit with this condenser is a low capacity condenser 62 which is shown as variable and of the rotary type. Associated with condenser 62 is a motor or any other driving mechanism 63 for rotating the plates of the condenser to vary its capacity. The capacity of the condenser may be made to vary in a random and erratic manner if desired. The variation of the capacity of condenser 62 will cause the carrier frequency generated by oscillator 61 to vary also. Associated with the output of modulator 58 may be an amplifier 59 which will be coupled to an antenna 60. The receiving arrangements of Fig. 5 are substantially similar to those of Fig. 1 and include an antenna 64, a detector 65, a modulator 67 to which is connected a

source of oscillations 68 of a frequency of 2300 cycles, a band filter 67 which cuts off frequencies above 2000, and a receiver circuit 70.

5 The voice frequency currents will be transmitted from circuit 51 through the amplifying device 52 to the modulator 54 where they will modulate the 2300 cycle current from source 55. The modulated wave will
10 then be transmitted to the filter circuit 56 and the upper side band and the 2300 cycle current will be eliminated and the lower side band will be transmitted on to circuit 57. The lower side band, it is pointed out, is the
15 speech band with the frequency inverted and hence is unintelligible. This lower side band will then be transmitted to the modulator 58 and will modulate a carrier frequency supplied thereto from the oscillator 61. As has been previously pointed
20 out this carrier frequency will be continually varying due to the varying of the capacity of condenser 62. The modulated carrier wave will then be transmitted through
25 the amplifier 59 and radiated from the antenna circuit 60.

Due to the fact that the carrier wave is continually varying it will be impossible to detect and receive intelligibly the message
30 by the apparatus illustrated in Figs. 2 and 3. This will appear more clearly from the following. If, as has been previously pointed out, we assume arbitrary limits for the speech frequency band of a and b and
35 let $a=300$ and $b=2000$, then upon modulating the carrier of 700,000 by the inverted speech band we get

$$\begin{array}{l} a=702,000 \\ 40 \quad b=700,300 \\ \quad 700,000 \\ \quad b=699,700 \\ \quad a=698,000 \end{array}$$

45 This when detected would give

$$\begin{array}{l} b=300 \\ a=2000 \end{array}$$

which is the speech band in inverted shape. If we should now cause the carrier to vary
50 1000 cycles, as from 700,000 to 701,000 and should then modulate 701,000 by the inverted speech band we would get

$$\begin{array}{l} a=703,000 \\ 55 \quad b=701,300 \\ \quad 701,000 \\ \quad b=700,700 \\ \quad a=699,000 \end{array}$$

60 This when detected would give

$$\begin{array}{l} b=300 \\ a=2000 \end{array}$$

which is the speech band in inverted shape. Accordingly it will be seen that a continual
65 variation in the carrier frequency will not

effect the detecting and receiving operation of the receiving arrangements, such as of Fig. 1 or Fig. 5. However, if we should take the modulated carrier of 701,000 and beat it with a frequency of 697,700 as illustrated with respect to the arrangements of Figs. 2 and 3 the result should be as follows:

$$\begin{array}{l} a=703,000 \\ b=701,300 \\ \quad 701,000 \\ b=700,700 \\ a=699,000 \end{array} \left. \vphantom{\begin{array}{l} a=703,000 \\ b=701,300 \\ \quad 701,000 \\ b=700,700 \\ a=699,000 \end{array}} \right\} 697,700 \left\{ \begin{array}{l} a=5500 \\ b=3600 \\ \quad 3300 \\ b=3000 \\ a=2300 \end{array} \right. \quad 75$$

It will accordingly be seen that the frequency components thus attained will not be those of the original voice band but will be something unintelligible. Accordingly with the arrangements of this invention it will not be possible to intercept or detect the messages with a simple heterodyne detector as before and the messages may readily be transmitted in a secret manner.

While the arrangements of the invention have been disclosed, it is pointed out that the frequency values utilized herein are for purposes of illustration only and that the invention is not limited thereto. Furthermore, while the arrangements of the invention have been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that they are capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. The method of signaling which comprises inverting the speech band, modulating a carrier wave in accordance with said inverted speech band to produce a carrier component and side band, causing said carrier component and side band to vary together in the frequency scale in an arbitrary manner, transmitting said varying carrier component and side band to a distant station, beating together said arbitrarily varying carrier component and side band to produce a band of frequencies invariable in the frequency scale and corresponding to said inverted speech band, and reinverting said invariable band of difference frequencies to produce said original speech band.

2. The method of signaling which comprises modulating an oscillation current at a sending station in accordance with speech current, selecting the components of the resultant modulated oscillation current lying within the frequency range of the difference in frequencies of said oscillation current and said speech current, modulating a carrier wave in accordance with said selected components, causing said carrier wave to vary in the frequency scale in an arbitrary manner, transmitting said varying modulated

carrier wave to a receiving station, detecting
at said receiving station said arbitrarily
varying carrier wave to produce a band of
frequencies invariable in the frequency
5 scale and corresponding to said band of
difference frequencies selected at said send-
ing station, modulating by said produced
band of frequencies an oscillation current
similar to said oscillation current at said
10 sending station, and selecting the compo-

nents of the resultant modulated oscilla-
tion current lying within the frequency
range of the difference in frequencies of
said oscillation current and said produced
band of frequencies.

In testimony whereof, I have signed my
name to this specification this 7th day of
November 1921.

RALPH BOWN.