

Dec. 28, 1926.

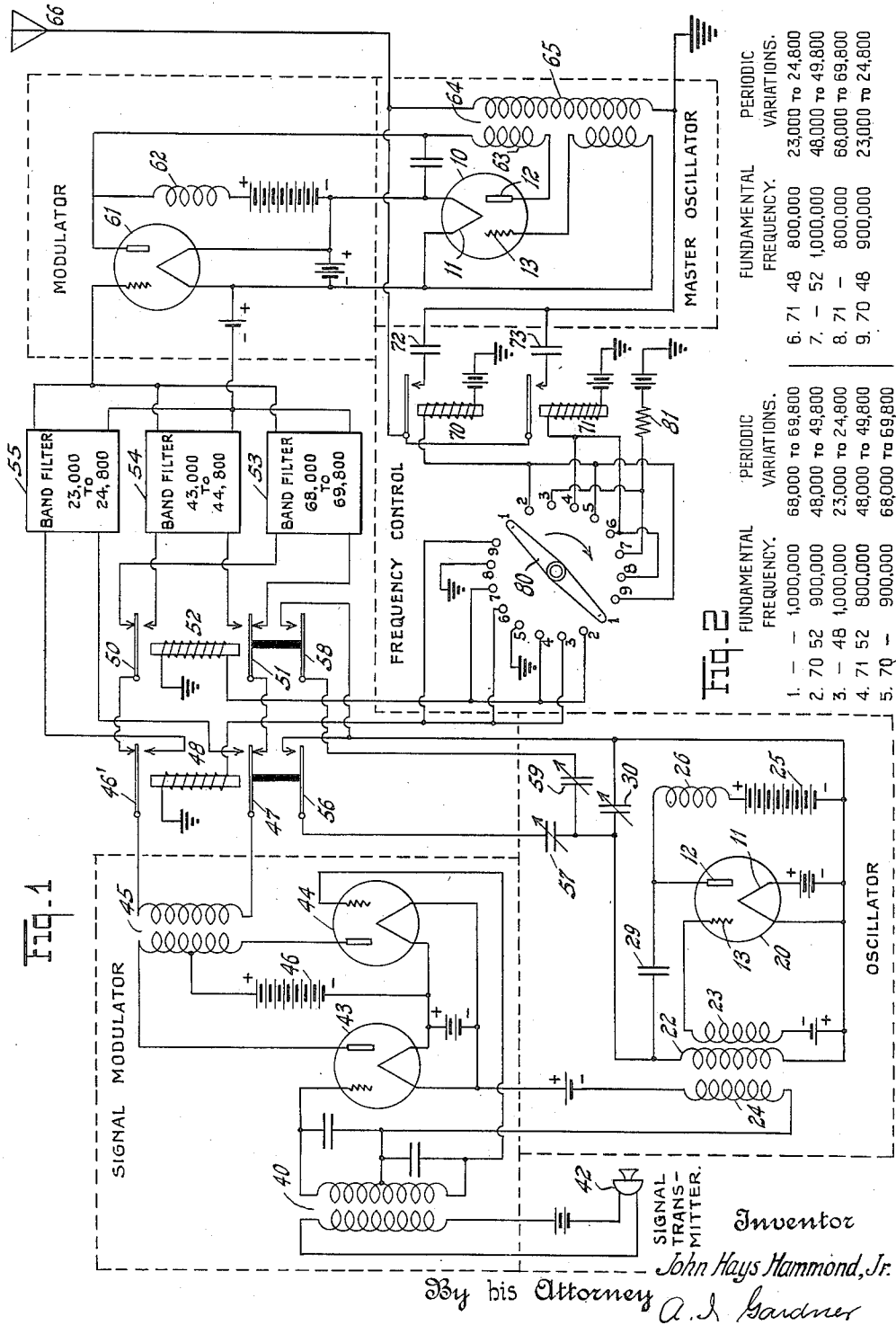
J. H. HAMMOND, JR

1,612,285

SYSTEM OF SECRET RADIANT TELEPHONY

Filed Oct. 31, 1922

2 Sheets-Sheet 1



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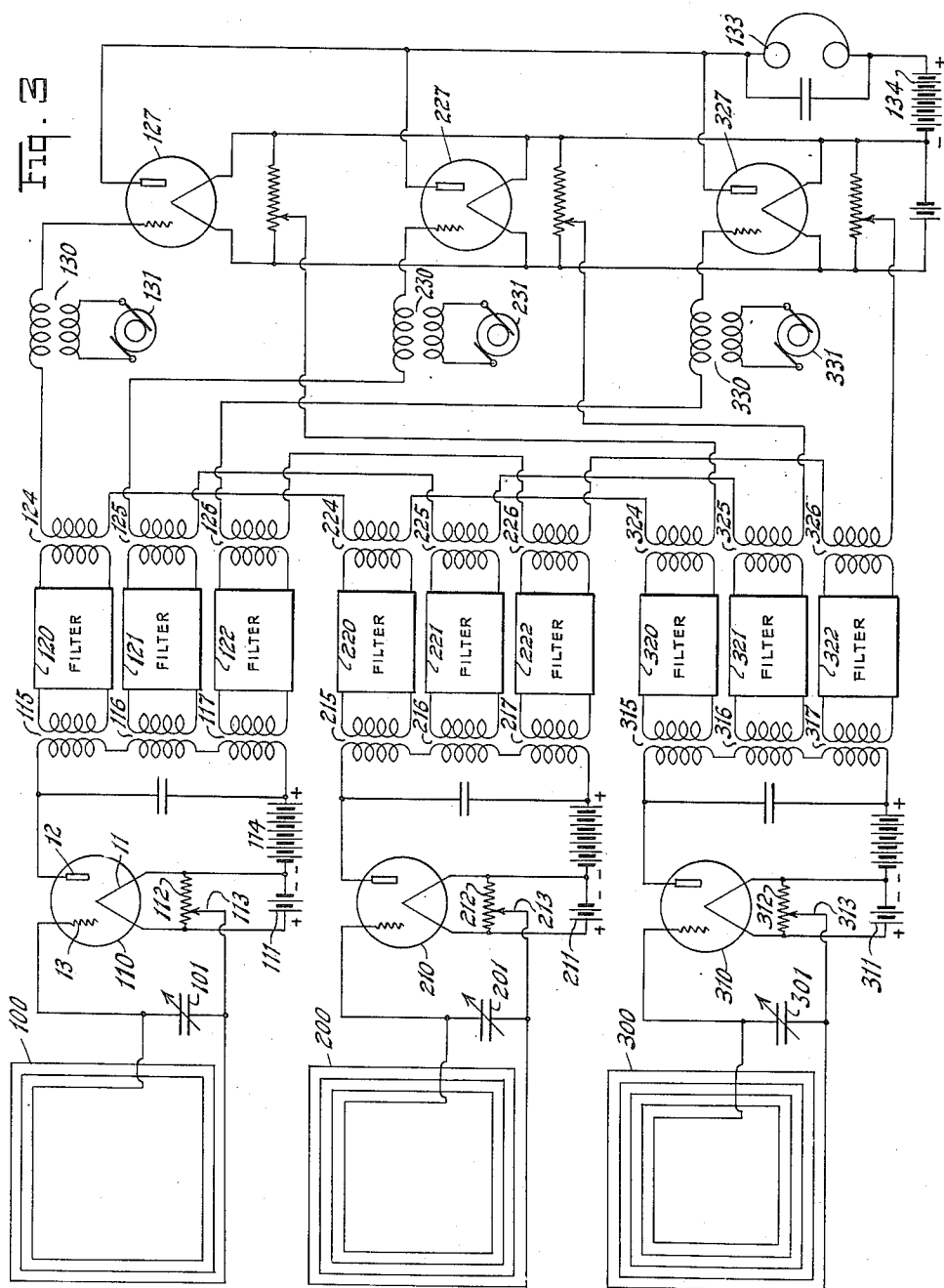
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SYSTEM OF SECRET RADIANT TELEPHONY

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2 Sheets-Sheet 2



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SYSTEM OF SECRET RADIANT TELEPHONY.

Application filed October 31, 1922. Serial No. 598,127.

This invention relates to the transmission of intelligence by radiant energy and more particularly to systems of secret radiant telephony.

6 An object of the invention is to provide a system comprising a sending station arranged to emit radiant energy of varying character and a receiving station cooperating therewith and provided with apparatus
10 responsive to the emitted energy despite the variations therein. More specifically, a further object of the invention is to provide improved means for the emission of radiant energy in the form of oscillations
15 having a fundamental frequency, modulated at successively varying supersonic frequencies each made effective and modulated by desired signals, such for example as voice waves, and to arrange for the selective reception of such energy and its transformation into sensible manifestations.

Further objects of the invention will appear from the following description taken in connection with the accompanying drawings forming a part of this application and in which—

Figure 1 is a diagram of a sending station which is an embodiment of the present invention;

30 Fig. 2 is a table showing combinations of frequency characteristics of the emitted wave; and

Fig. 3 is a diagram of one form of receiving station arranged to co-operate with the sending station of Figure 1.

35 The system of the present invention employs at its sending station a carrier wave of relatively high frequency upon which there is impressed at different times, differently characterized series of amplitude variations of supersonic frequencies relatively lower than that of the carrier wave, each of which is made effective by speech or other desired signals and is modulated thereby. Changes
40 in the characterization of the periodic amplitude variations may be made erratically or in accordance with the will of an operator, and the carrier frequency may also be changed from one to another of a plurality
45 of different predetermined values.

In a general way the receiving set may be described as comprising a plurality of resonant channels, each including a circuit tuned to one of the carrier frequencies mentioned

above and connected to other circuits which 55 are tuned to the lower, supersonic frequencies, with detecting or rectifying means for each of the channels and a single indicating device. In combination with such receiving elements apparatus may be used which pro- 60 vides energy at the lower, supersonic frequencies of the sending station.

Referring more in detail to Fig. 1, there is shown a source of high frequency, said source being in this case a thermionic device 65 10 having a usual heated filament 11 for emitting electrons, a plate 12 upon which the electrons impinge, and a grid 13 for controlling the passage of electrons. These parts are connected with interrelated inductively coupled circuits in such a manner that the energy in the plate circuit reacts on the grid so as to cause the device to oscillate. There is thus produced an oscillatory current of relatively high frequency, the fre- 75 quency being determined by the electrical constants of the inter-related circuits.

For producing oscillations of relatively lower but supersonic frequency there is provided a thermionic device 20 having a usual 80 heated filament 11, plate 12 and grid 13. This device is connected in a regenerative circuit comprising a transformer having windings 22, 23 and 24, which are connected in the plate, grid and secondary output circuits respectively. The plate 12 of the device 20 is maintained at a positive potential with respect to the filament by means of a usual B battery 25, the positive terminal of which is connected through an inductance 26 to the plate. The regenerative circuit is 90 provided with a stoppage condenser 29 and a suitable variable condenser 30 the capacity of which may be adjusted so that oscillations of a predetermined frequency relatively lower than that of the master oscillator 95 are generated. For example, a current having a frequency of 70,000 cycles may thus be produced.

For transforming or stepping-up voice or other signalling currents into currents hav- 100 ing a supersonic frequency range less than the frequency of the master oscillator 10 and retaining the characteristic variations of the signalling currents, the output circuit of the generator 20 is connected with a signal modulator comprising a transformer 40 105 having its primary winding connected in

series with a signal transmitter, in this case a telephone transmitter 42, and its secondary windings respectively connected in the input circuits of a pair of thermionic devices 43 and 44, each having a customary heated filament, plate and grid. The output circuits of the thermionic devices 43 and 44 include the primary windings of a coupling transformer 45 and a common plate potential battery 46. The secondary winding of the transformer 45 is connected to armatures 46' and 47 of a relay 48. The winding 24 and the windings of the transformer 45 are so arranged that the electro-motive forces induced in the secondary winding of the transformer 45 during operation of the generator 20 are normally equal and opposite, and thus currents of the lower, supersonic frequency produce substantially no effect therein, except when the transmitter 42 is producing current variations. Thus a so-called "push-pull" modulator is obtained, by means of which electro-motive forces corresponding to the two side bands of the voice-modulated, lower, supersonic frequency generated by the device 20 are produced in the secondary winding of the transformer 45.

For selecting a desired filter, the back contacts of the armatures 46' and 47 are connected to armatures 50 and 51 of a second relay 52, the normally closed contacts of which are connected to a band filter 53, while the normally open contacts of the armatures 50 and 51 of the relay 52 are connected to a differently characterized band filter 54, and the normally open contacts of the armatures 46' and 47 of the relay 48 are connected to a still differently characterized band filter 55. By operating one of these relays, or leaving them deenergized, a desired one of the filters 53, 54 and 55 may be used. The band filter 53 comprises a suitable combination of inductances and condensers such as to permit the flow of currents of a desired frequency band, for example, 68,000 to 69,800 cycles per second; the band filter 54 is constructed to transmit currents of, for example, 43,000 to 44,800 cycles; and the band filter 55, currents of, for example, 23,000 to 24,800 cycles. The band filters are designed to suppress currents of other than the respective bands of frequencies. An auxiliary contact 56 on the relay 48 is provided for shunting an auxiliary condenser 57 around the frequency adjusting condenser 30. The capacity of the condenser 57 is adjusted so that when the relay 48 is operated to connect the filter 55 into circuit a change is simultaneously made in the frequency of the current produced by the oscillator 20 so that this current when modulated by the signal current produces a frequency band for which the respective band filter 55 is designed. Similarly, when the relay 52 is actuated there is connected

into circuit by its auxiliary contact 58, a shunting condenser 59, the capacity of which is such that the currents produced by the oscillator and modulated by voice currents produce a frequency band for which the band filter 54 is designed. In the present instance, the condenser 57 in shunt with the condenser 30 causes the oscillator 20 to produce currents of 25,000 cycles; and condensers 59 and 30 in multiple cause the oscillator 20 to produce currents of 45,000 cycles.

The outputs of the filter circuits are connected to the input circuit of a modulator comprising a thermionic device 61 having a usual filament, plate and grid. The plate circuit of the device 61 includes an inductance 62 and a battery, both of which together with a winding 63 are also connected in the plate circuit of the master oscillator 12. The winding 63 forms part of a coupling transformer 64, the secondary winding 65 of which is connected in the circuit of an antenna 66. Accordingly, the amount of energy supplied to the antenna by the master oscillator 10 is varied upon operation of the device 61.

For varying the frequency of oscillation of the device 10 there is provided a pair of relays 70 and 71, the contacts of which connect into circuit condensers 72 and 73 respectively, the capacities of which are selected so as to change the characteristics of the circuit of the oscillator 10 to change the fundamental frequency produced thereby to desired amounts. For example, if the fundamental frequency generated by the oscillator 10 with condensers 72 and 73 out of circuit is 1,000,000 cycles per second, the capacity of the condenser 72 may be such as to cause it to provide currents of, for example, 900,000 cycles and that of the condenser 73 may be such as to produce currents of 800,000 cycles.

The relays 48, 52, 70 and 71 may be operated in desired combinations by a frequency control switch comprising an arm 80 constantly rotating at a desired rate of speed which may be constantly changing in an erratic manner if desired, over an arcuate row of contacts so as to establish electrical connections therebetween. The table given in Figure 2 shows in the first vertical column numerals representing the switch points as designated in Figure 1. The normal position of the arm 80 as shown is numbered 1. In this position none of the relays is operated, and thus the energy emitted has the form of oscillations of, for example, 1,000,000 cycles per second having periodic variations impressed thereon of from 68,000 to 69,800 cycles per second, it being assumed that the frequency of the voice currents impressed upon the transmitter 42 varies between 200 and 2000 cycles and that the filter

53 suppresses the upper side band. The table shows successively the fundamental frequency and the variation frequency for the successive positions of the switch (last two columns) and in the 2nd and 3rd columns designates the actuated relays. In position 2, for example, a circuit is closed from grounded battery, winding of relay 70, contact 2, arm 80, contact 2, and winding of relay 52 to ground, operating relays 70 and 52 and connecting into circuit condensers 72 and 59 and the band filter 54.

In position 3, for example, a circuit is closed from grounded battery, resistance coil 81, contact 3, arm 80, contact 3 and winding of relay 48 to ground, operating relay 48, and connecting into circuit condenser 57 and the band filter 55.

In the form of receiving station illustrated in Figure 3, there is provided a plurality of receiving channels corresponding in number to the number of different fundamental frequencies which the sending station is enabled to emit. These comprise elements of such nature as to intercept Hertzian waves and capable of having oscillations set up therein in response to such waves. As shown, three loops, 100, 200 and 300 of well known type are used, each included in a closed, oscillatory circuit comprising a condenser 101, 201 or 301 respectively. The number of turns in the respective loops and the capacities of the associated condensers are selected so that the closed, oscillatory circuits are each tuned to one of the fundamental frequencies used, for example, the circuit 100, 101 may be tuned to 1,000,000 cycles per second, the circuit 200, 201 to 900,000 cycles and the circuit 300, 301 to 800,000 cycles. In other respects the circuit organizations associated with the several loops are identical and a description of one will suffice for all. Like parts therein are given like tens and unit numerals, the hundreds digit serving to designate the channel with which the part is associated.

For detecting the received energy to produce the lower, supersonic currents, there is provided a detector 110, which may be a three electrode thermionic vacuum tube having a usual filament, plate and grid. A filament-heating battery 111 supplies current to incandesce the filament, and there is connected in shunt with this battery a potentiometer 112 having a slider 113 connected to the associated, closed, oscillatory circuit whereby the normal potential of the grid of the thermionic device 110 may be adjusted. A plate potential battery 114 of suitable voltage maintains a positive potential on the plate of the thermionic device with respect to its filament, there being included in this circuit three inductances in series. These inductances form the primary windings of coupling transformers 115, 116 and 117 re-

spectively, through which are induced currents corresponding to the envelopes of the input current of the detector.

For conducting these currents and suppressing others, there is connected to the secondary windings of the transformers 115, 116 and 117 a corresponding plurality of filters 120, 121 and 122. These filters are designed to pass currents of different bands of frequencies respectively. For example, the filters 120, 220 and 320 are designed to pass currents of, for example, 68,000 to 69,800 cycles inclusive; the filters 121, 221 and 321 pass currents of 43,000 to 44,800 cycles inclusive; and the filters 122, 222 and 322 currents of 23,000 to 24,800 cycles inclusive. The output circuits of the filters of each channel are connected to the input circuits of different detectors through coupling transformers 124, 125 and 126, for example, and the secondary windings of the transformers 124, 224 and 324 are connected in series in the input circuit of a detector 127; those of transformers 125, 225 and 325 are connected in series in the input circuit of a detector 227; and those of transformers 126, 226 and 326 are similarly connected in the input circuit of a detector 327. The detectors 127, 227 and 327 may comprise usual three-electrode, thermionic vacuum tubes each having a customary heated filament, plate and grid and each having a potentiometer associated therewith for maintaining its grid at a desired normal potential with respect to its filament.

For producing energy corresponding in frequencies to those of the oscillatory currents suppressed at the sending station, there are included in the input circuits of the detectors 127, 227 and 327 the secondary windings of transformers 130, 230 and 330 respectively, the primary windings of which are in circuit with suitable sources 131, 231 and 331, respectively of alternating current of predetermined frequencies. The frequencies of the sources are relatively different. For example, the source 131 is in the present instance of 70,000 cycles; 231 of 45,000 cycles and 331 of 25,000 cycles. The output circuits of the detectors 127, 227 and 327 are joined in common to a single indicating device 133, there being included in the output circuits a suitable battery 134 for maintaining a positive potential upon the plates of the detectors 127, 227 and 327, with respect to their filaments.

In operation the sending station of Figure 1 emits radiant energy having the form of high frequency oscillations such as given in the fourth column of the table of Figure 2, upon which there are impressed periodic amplitude variations produced by modulating a supersonic frequency by speech currents. Such variations may be as given in the fifth column of the table of Figure 2.

The system of frequency changes is irregular and thus there is imparted to the wave form of the emitted energy a disordered succession of changes of frequency, so that an unauthorized station cannot tune in sufficiently quickly to overhear the message.

At the receiving station the energy is received in the particular loop the oscillatory circuit of which is tuned to the fundamental frequency being employed. The first detector 110, 210 or 310, produces in the circuit of the respective transformers current corresponding to the supersonic periodic variations being impressed upon the transmitted wave. This current is conducted through a filter corresponding to the supersonic frequency which is being employed, and is combined with the electro-motive force generated by the heterodyne 131, 231 or 331. The combined forces are detected by the detector 127, 227 or 327 and there is consequently produced in the indicating device 133, unidirectional currents whose envelope corresponds to the original voice waves used at the sending station.

The invention upon which this application is based is broader than the specific embodiments shown and described for the purpose of illustrating some of the ways in which it may be employed. The scope of the invention is therefore understood not to be limited by the present specific description. I intend no limitations other than those imposed by the appended claims.

What is claimed is:

1. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for producing periodic variations of said high frequency oscillations arranged to be non-actuate when not affected by signal disturbances, means for periodically changing the frequency of said variations, and a signal transmitter arranged when operated to cause said periodic modifying means to affect the high frequency oscillations.

2. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for periodically changing the frequency of the last-named oscillations, a push-pull modulator interposed between said generators, and a signal transmitter cooperatively associated with said modulator.

3. Apparatus for emitting radiant energy comprising a generator of oscillations of super-audible frequency, means for periodically changing the frequency of said oscillations to produce a plurality of series of oscillations of different frequencies respectively, means for producing side bands of said frequencies, a plurality of means for suppressing some of said side bands, and means operatively connected with the fre-

quency-changing means for selecting a desired one of the side band suppressing means according to the frequency of the oscillations being used.

4. A radio system comprising at its sending station means for producing oscillations of different, super-audible frequencies, means for producing side bands of said different frequencies, a plurality of band filters, and means operatively connected with the oscillation producing means for rendering the band filters alternatively operative in accordance with the changes in frequency of the oscillations.

5. Apparatus for emitting radiant energy comprising a generator of oscillations of super-audible frequency, means including said generator for transforming signal currents into currents having a supersonic frequency range and retaining the characteristic variations of the signal currents, means for changing the supersonic frequency range employed from one to another of a plurality of different predetermined values to produce a plurality of different frequency ranges, a plurality of band filters constructed to operate on currents within the different frequency ranges respectively, each of said filters being arranged to pass one side band of its respective frequency range and to suppress the other side band, switch mechanism included in said frequency-changing means operable in one position simultaneously to cause said frequency range to have a predetermined value and to render operative an appropriate one of said band filters and operable in a different position simultaneously to cause said frequency range to have a different, predetermined value and to render operative a different one of said band filters.

6. Apparatus for emitting radiant energy comprising a generator of oscillations of super-audible frequency, means including said generator for stepping-up signal currents into currents of different supersonic frequency ranges retaining the characteristic variations of the signal currents, means for changing periodically and continuously the supersonic frequency range employed to produce a plurality of different frequency ranges, a plurality of band filters constructed respectively to operate on currents within said different frequency ranges, each of said filters being arranged to pass one side band of its respective frequency range and to suppress the other side band, means for normally connecting one of said band filters in the output circuit of said first-mentioned means, a plurality of switches included in said frequency changing means and arranged to be separately closed to cause currents of said different frequency ranges to be produced at different times, a relay for closing one of said switches and simul-

taneously rendering said first-mentioned band filter inoperative and another of said band filters operative, and a second relay for closing another of said switches and simultaneously rendering a third one of said band filters operative and the other band filters inoperative.

7. Apparatus for impressing on the ether radiant energy of peculiar wave form, comprising a source of high frequency oscillations, a second source of oscillations of a frequency above good audibility, means for modulating said high frequency oscillations by oscillations from said second source to produce periodic variations in the high frequency oscillations, said means being arranged to be ineffective when not affected by signal disturbances, a frequency changer for periodically changing the frequency of the oscillations supplied by said second source, and a signal transmitter arranged when operated to cause the high frequency modulating source to affect the high frequency oscillations.

8. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower frequency, a frequency changer for periodically changing the frequency of the second-named oscillations to produce a plurality of series of oscillations of different frequencies respectively, a push-pull modulator interposed between said generators, and a signal transmitter cooperatively associated with said modulator whereby side bands are produced, a plurality of means for suppressing some of said side bands, and means for selecting a desired one of the side band suppressing means according to the frequency of the second-named series of oscillations being used.

9. A radio system comprising at its sending station a generator of high frequency oscillations, means for producing periodic variations of said high frequency oscillations, said means being arranged to be non-actuated when not affected by signal disturbances and comprising a plurality of band filters, means for periodically changing the frequency of said variations, and means controlled by said frequency changing means for rendering the band filters alternatively operative.

10. A radio system comprising at its sending station a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for periodically changing the frequency of the last-named oscillations, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with the modulator whereby side bands are produced, a plurality of alternatively operable means for suppressing some of said side bands, and means con-

trolled by said frequency-changing means for causing an appropriate one of said suppressing means to be rendered operative for each frequency of said second-named oscillations.

11. A method of generating intelligible radiant energy which consists in modifying high frequency waves by waves rendered effective by signals and of a different basic frequency varied between different, predetermined values in a predetermined order.

12. A method of generating intelligible radiant energy which consists in modifying high frequency waves by waves rendered effective by signals and of a lower basic frequency varied between different, predetermined values in a predetermined order.

13. A method of transmitting radio signals which consists of modifying high frequency waves by waves rendered effective by signals and of a different basic frequency varied between different, predetermined values in a predetermined order, changing the frequency of said first-mentioned waves from one to another of different, predetermined values, receiving the energy thus produced in separate receiving channels corresponding in number to the number of different, predetermined values of said last-mentioned frequency, and operating a single indicating device by current set up in the different receiving channels.

14. A method of transmitting radio signals which consists in modifying high frequency waves by waves rendered effective by signals and of a lower, basic frequency varied continually between different predetermined values in a predetermined order, changing the frequency of said first-mentioned waves from one to another of different, predetermined values, receiving the energy thus produced in separate receiving channels corresponding in number to the number of different, predetermined values of said wave frequency, producing in each of said channels at different times currents corresponding in frequency with each value of said lower frequency waves, and operating a single indicating device by such currents.

15. A method of transmitting radio signals which consists in producing side bands above and below each of a plurality of predetermined frequencies by a single series of signal disturbances, suppressing the higher of each of said pairs of side bands, modifying high frequency waves by impressing thereon the waves of a selected unsuppressed side band, receiving the waves thus produced in differently responsive instrumentalities, supplying energy of said predetermined frequencies and transforming the energy set up in said instrumentalities into sensible manifestations.

16. Apparatus for emitting radiant energy comprising a generator of high frequency

oscillations, means for transforming signal currents into a supersonic frequency range retaining the characteristics of the signal currents, means for changing the supersonic frequency range employed in a predetermined order from one to another of different, predetermined values and means for modulating the currents generated by the high frequency generator according to the transformed supersonic signal currents.

17. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for transforming signal currents into currents having a supersonic frequency range lower in frequency than the frequency of said oscillations and retaining the characteristic variations of the signal currents, means for changing the supersonic frequency range employed from one to another of different, predetermined values to produce a plurality of different frequency ranges, means for modulating the currents generated by the high frequency generator according to the transformed supersonic signal currents, a plurality of band filters interposed between said transforming means and said modulating means and constructed to operate on currents within said frequency ranges respectively, each of said filters being constructed to pass one side band of its respective frequency range and to suppress the other side band, and means controlled by the frequency-changing means for alternatively rendering the appropriate band filter operative upon change from one of said frequency ranges to another.

18. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for transforming voice currents into currents having a supersonic frequency range and retaining the characteristic variations of the voice currents, means for changing the supersonic frequency range employed from one to another of a plurality of different predetermined values to produce a plurality of different frequency ranges, means for modulating the currents generated by the high frequency generator according to the transformed supersonic voice currents, a plurality of band filters interposed between said transforming means and said modulating means and constructed to operate on currents within different frequency ranges respectively, each of said filters being arranged to pass one side band of its respective frequency range and to suppress the other side band, a plurality of switches included in said frequency-changing means and arranged to be separately closed to cause said frequency range to have different predetermined values, means for closing one of said switches and simultaneously rendering operative an appropriate one of said band filters, and

means for closing another of said switches and simultaneously rendering operative a different one of said band filters.

19. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for stepping-up signal currents into currents having a supersonic frequency range and retaining the characteristic variations of the signal currents, means for changing periodically and continuously the supersonic frequency range employed to produce a plurality of different frequency ranges, means for modulating the currents generated by the high frequency generator according to the stepped-up supersonic signal currents, a plurality of band filters interposed between said first-mentioned means and said modulating means and constructed to operate on currents within said frequency ranges respectively, each of said filters being constructed to pass one side band of its respective frequency range and to suppress the other side band, and means controlled by the frequency changing means for alternatively rendering the appropriate band filter operative upon change from one of said frequency ranges to another.

20. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for stepping-up signal currents into currents having a supersonic frequency range lower in frequency than the frequency of said oscillations and retaining the characteristic variations of the signal currents, means for changing periodically and continuously the supersonic frequency range employed to produce a plurality of different frequency ranges, means for modulating the currents generated by the high frequency generator according to the stepped-up supersonic signal currents, a plurality of band filters interposed between said first-mentioned means and said modulating means and constructed respectively to operate on currents within said different frequency ranges, each of said filters being arranged to pass one side band of its respective frequency range and to suppress the other side band, means for normally connecting one of said band filters in the output circuit of said first-mentioned means, a plurality of switches included in said frequency changing means and arranged to be separately closed to cause currents of said different frequency ranges to be produced at different times, a relay for closing one of said switches and simultaneously rendering said first-mentioned band filter inoperative and another of said band filters operative, and a second relay for closing another of said switches and simultaneously rendering a third one of said band filters operative.

21. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for stepping-up voice cur-

rents into currents having a high frequency range and retaining the characteristic variations of the voice currents, means for changing the supersonic frequency range employed from one to another of a plurality of different, predetermined values to produce a plurality of different frequency ranges, means for modulating the currents generated by the high frequency generator according to the stepped-up supersonic voice currents, a plurality of band filters interposed between said first-mentioned means and said modulating means and constructed respectively to operate on currents within said different frequency ranges, each of said filters being arranged to pass one side band of its respective frequency range and to suppress the other side band, means for normally connecting one of said band filters in the output circuit of said first-mentioned means, a plurality of circuits included in said frequency-changing means and arranged to be separately controlled to cause currents of said different frequency ranges to be produced at different times, means for changing the condition of one of said circuits and simultaneously rendering said first-mentioned band filter inoperative and another of said band filters operative, and means for changing the condition of another of said circuits and simultaneously rendering a third one of said band filters operative.

22. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for producing periodic variations of said high frequency oscillations arranged to be non-actuate when not affected by signal disturbances, means for periodically changing the frequency of said high frequency oscillations in relatively large steps, and a signal transmitter arranged when operated to cause said periodic modifying means to affect the high frequency oscillations.

23. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for periodically changing the frequency of the first-named oscillations in relatively large steps, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with said modulator and a receiver comprising a plurality of receiving channels including circuits tuned to different frequencies of said first-named oscillations and an indicating device arranged to be operated by current from any of such circuits.

24. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower frequency, a frequency changer for periodically changing the frequency of the first-named oscillations in relatively large

steps, a push-pull modulator interposed between said generators, and a signal transmitter cooperatively associated with said modulator, and a receiver comprising a plurality of receiving channels including circuits tuned to different frequencies of the first-named oscillations, detectors in said channels for producing currents corresponding in frequency to currents produced at the transmitter by said modulator, an indicating device, and means for causing the indicating device to be operated by currents of the character above indicated set up in any of such receiving channels.

25. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for periodically changing the frequency of the first-named oscillations in relatively large steps, a push-pull modulator interposed between said generators whereby side bands are produced, means for suppressing one of said side bands, and a receiver comprising a plurality of receiving channels including circuits tuned to different frequencies of the first-named oscillations, detectors in said channels for producing current corresponding in frequency to the unsuppressed side band produced at the transmitter, an indicating device and means for causing the indicating device to be operated by currents of the character above indicated set up in any of such receiving channels.

26. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower frequency, a frequency changer for periodically changing the frequency of the first-named oscillations in a predetermined order from one to another of different, predetermined values, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with said modulator whereby side bands are produced, means for suppressing one of said side bands, a receiver comprising a plurality of receiving channels including circuits tuned to the different, predetermined frequencies of said first-named oscillations and an indicating device arranged to be operated by current from any of such circuits.

27. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for periodically changing the frequency of the first-named oscillations in a predetermined order from one to another of different, predetermined values, a push-pull modulator interposed between said generators, whereby side bands are produced, means for suppressing the higher of said bands, and a receiver comprising a plurality of receiving channels including circuits tuned to

the different frequencies of the first-named oscillations, detectors in said channels for producing currents corresponding in frequency to the unsuppressed side band produced at the transmitter, an indicating device, and heterodyne means for causing the indicating device to be operated by currents of the character above indicated set up in any of such receiving channels.

- 10 28. Apparatus for impressing on the ether radiant energy of peculiar wave form, comprising a source of high frequency oscillations, a second source of oscillations arranged to modulate said oscillations to produce periodic variations therein at a frequency above good audibility and arranged to be ineffective when not affected by signal disturbances, a frequency changer for periodically changing the frequency of the first
15 named oscillations in relatively large steps from one to another of different predetermined values, and a signal transmitter arranged when operated to cause the high frequency modulating source to affect the high
20 frequency oscillations.

- 25 29. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower frequency, means for periodically changing the frequency of said high frequency and said lower frequency oscillations, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with said modulator
30 whereby side bands are produced, a plurality of means for suppressing some of said side bands, and means for selecting a desired one of the side band suppressing means according to the frequency of the second-named
35 series of oscillations being used.

- 40 30. A radio system comprising at its sending station a generator of high frequency oscillations, means for producing periodic variations of said high frequency oscillations arranged to be non-actuating when not
45 affected by signal disturbances, means for periodically changing the frequency of said high frequency oscillations in relatively large steps, a signal transmitter arranged when operated to cause said periodic modifying means to affect the high frequency oscillations, whereby waves modified by signal controlled periodic variations are produced
50 and a receiver comprising elements arranged to intercept said waves, differently tuned, closed, oscillatory circuits responsive to the different frequency values of the high frequency oscillations, other closed, oscillatory circuits responsive to the signal controlled
55 periodic variations, and means for transforming the energy set up in said circuits into sensible manifestations.

- 60 31. A radio system comprising at its sending station a generator of high frequency oscillations, another generator of oscillations

of different frequency, means for changing the frequency of said last-named oscillations, a frequency changer for periodically changing the frequency of the first-named oscillations in relatively large steps, a push-pull
70 modulator interposed between said generators, a signal transmitter cooperatively associated with the modulator, whereby waves modified by signal controlled periodic variations are produced and a receiver comprising
75 a plurality of receiving channels including circuits tuned to different frequencies of said high frequency oscillations, detectors for producing in said channels currents of frequencies corresponding to those of currents produced by said modulator, detectors
80 each connected with all of said channels and corresponding in number with the number of different frequencies of said second-named oscillations, an indicating device connected in the output circuits of said detectors, and heterodyne devices in the input circuits of said detectors operable respectively to produce currents corresponding in frequency with the different frequencies of said
85 second-named oscillations.

32. A method of generating intelligible radiant energy which consists in modifying high frequency waves by waves of a different frequency rendered effective by signals and
90 periodically changing the frequency of said high frequency waves in relatively large steps.

33. A method of generating intelligible radiant energy which consists in modifying high frequency waves by waves of a lower frequency rendered effective by signals, periodically changing the frequency of said high frequency waves in relatively large steps, and receiving signals transmitted on high frequency waves of different frequencies in a single indicating device.
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34. A method of transmitting radio signals which consists in modifying high frequency waves by waves of a lower frequency rendered effective by signals, changing the frequency of said high frequency waves in relatively large steps in a predetermined order from one to another of different predetermined values, receiving the waves thus produced in separate receiving channels and transforming the energy set up in said channels into sensible manifestations by a single indicating device.
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35. A method of transmitting radio signals which consists in modifying high frequency waves by waves of a lower, supersonic frequency rendered effective by signals, changing the frequency of said high frequency waves in relatively large steps in a predetermined order from one to another of different, predetermined values, receiving the waves thus produced in separate resonant receiving channels corresponding in number to the number of different values of
110
115
120
125
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said high frequency, detecting the currents set up in each of said receiving channels to produce currents corresponding in frequency with said lower, supersonic frequency, heterodyning said last-mentioned currents, and indicating them.

36. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for producing periodic variations of said high frequency oscillations arranged to be non-actuate when not affected by signal disturbances, means for periodically changing the frequency of said variations, means for periodically changing the frequency of said high frequency oscillations in relatively large steps, and a signal transmitter arranged when operated to cause said periodic modifying means to affect the high frequency oscillations.

37. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for periodically changing the frequency of the last named oscillations, a frequency changer for periodically changing the frequency of the first named oscillations in relatively large steps, a push-pull modulator interposed between said generators, and a signal transmitter cooperatively associated with said modulator.

38. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower frequency, a frequency changer for changing the frequency of the last-named oscillations from one to another of different predetermined values, a frequency changer for changing the frequency of the first-named oscillations from one to another of different, predetermined values, a push-pull modulator interposed between said generators, and a signal transmitter cooperatively associated with said modulator.

39. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for changing the frequency of the last-named oscillations from one to another of different, predetermined values, a frequency changer for changing the frequency of the first-named oscillations in relatively large steps from one to another of different, predetermined values, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with said modulator whereby side bands are produced, and means for suppressing one of said side bands.

40. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower frequency, means for changing the

frequency of the second-named oscillations, means for changing the frequency of the first-named oscillations, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with said modulator whereby side bands are produced, a plurality of band filters interposed between the modulator and said high frequency generator and constructed to operate on currents of different frequency ranges respectively resulting from the different frequencies of said second-named oscillations, each of said filters being constructed to pass one side band of its respective frequency range and to suppress the other side band, and means for controlling said frequency changing means and for alternatively rendering the appropriate band filter operative upon change from one of the frequencies of said second-named oscillations to another.

41. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower, supersonic frequency, means for changing the frequency of the second-named oscillations from one to another of different, predetermined values, means for changing the frequency of the first-named oscillations in relatively large steps in a predetermined order from one to another of different, predetermined values, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with said modulator whereby side bands are produced, a plurality of band filters interposed between the modulator and said high frequency generator and constructed to operate on currents of different frequency ranges respectively resulting from the different frequencies of said second-named oscillations, each of said filters being constructed to pass one side band of its respective frequency range and to suppress the other side band, relays included in said frequency-changing means, and means operatively connected with said relays for alternatively rendering the appropriate band filter operative upon change from one of the frequencies of said second-named oscillations to another.

42. Apparatus for impressing on the ether radiant energy of peculiar wave form, comprising a source of high frequency oscillations, a second source of oscillations arranged to modulate said oscillations to produce periodic variations therein at a frequency above good audibility arranged to be ineffective when not affected by signal disturbances, means for changing the frequency of the second-named oscillations from one to another of different, predetermined values, means for changing the frequency of the first-named oscillations in relatively large steps from one to another of different predetermined values, a signal transmitter

arranged when operated to cause the high frequency modulating source to affect the high frequency oscillations, a plurality of band filters interposed between said modulator and said high frequency generator and constructed to operate on currents of different frequency ranges respectively resulting from the different frequencies of said second-named oscillations, each of said filters being constructed to pass one side band of its respective frequency range and to suppress the other side band, and means for controlling said frequency-changing means and for alternatively rendering the appropriate band filter operative upon change from one of the frequencies of said second-named oscillations to another, said last-mentioned means including an automatically operated control element.

43. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, another generator of oscillations of lower frequency, a frequency changer for periodically changing the frequency of the second-named oscillations, a frequency changer for periodically changing the frequency of the first named oscillations in relatively large steps, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with said modulator whereby side bands are produced, a plurality of means for suppressing some of said side bands, and means for selecting a desired one of the side bands suppressing means according to the frequency of the second-named series of oscillations being used.

44. A radio system comprising at its sending station a generator of high frequency oscillations, means for producing periodic variations of said high frequency oscillations arranged to be non-actuating when not affected by signal disturbances, means for changing the frequency of said variations, means for changing the frequency of said high frequency oscillations in relatively large steps, a signal transmitter arranged when operated to cause said periodic modifying means to affect the high frequency oscillations, whereby waves modified by signal controlled periodic variations are produced, and a receiver comprising a plurality of receiving channels including circuits tuned to the different frequencies of said high frequency oscillations and each including circuits tuned to different frequencies of said variations and a single indicating device operatively connected to all of said circuits.

45. A radio system comprising at its sending station a generator of high frequency oscillations, another generator of oscillations of different frequency, a frequency changer for periodically changing the frequency of

the second-named oscillations, a frequency changer for periodically changing the frequency of the first-named oscillations in relatively large steps, a push-pull modulator interposed between said generators, a signal transmitter cooperatively associated with the modulator, whereby waves modified by signal-controlled periodic variations are produced, and a receiver comprising a plurality of receiving channels including circuits tuned to the different frequencies of said first-named oscillations, and each including filter circuits tuned respectively to frequencies determined by the different frequencies of said second-named oscillations, a plurality of detectors each having its input circuit connected with similarly tuned filter circuits of the receiving channels, and an indicating device in the output circuit of said detectors.

46. A method of generating intelligible radiant energy which consists in modifying high frequency waves by waves of a different and constantly varying frequency rendered effective by signals and periodically changing the frequency of said high frequency waves in relatively large steps.

47. A method of generating intelligible radiant energy which consists in modifying high frequency waves by waves rendered effective by signals and of a lower frequency varied in a predetermined order from one to another of different, predetermined values and changing the frequency of said high frequency waves in relatively large steps from one to another of different, predetermined values.

48. A method of transmitting radio signals which consists in modifying high frequency waves by waves of a different and continually changing frequency rendered effective by signals, periodically changing the frequency of said high frequency waves in relatively large steps, receiving the waves thus produced in separate receiving channels and transforming the energy set up in said channels into sensible manifestations by a single indicating device.

49. A method of transmitting radio signals which consists in modifying high frequency waves by waves rendered effective by signals and of a lower frequency varying from one to another of different, predetermined values, changing the frequency of said high frequency wave in a predetermined order from one to another of different, predetermined values, receiving the waves thus produced in separate, resonant, receiving channels corresponding in number with the number of different values of said high frequency, detecting the currents set up in each of said receiving channels to produce at different times currents corresponding in frequency with different values of said lower frequency heterodyning said last-mentioned

currents with oscillations determined by the frequency of said currents and indicating the resultant current.

50. A radio system comprising at its sending station a generator of high frequency oscillations, means for changing the frequency of said high frequency oscillations, means for transforming signal currents into currents having a supersonic frequency range and retaining the characteristic variations of the signal currents, means for changing the supersonic frequency range employed, means for modulating the currents generated by the high frequency generator according to the transformed supersonic signal currents, whereby waves modified by signal-controlled periodic variations are produced, and a receiver comprising a plurality of receiving channels including circuits tuned to different frequencies of said high frequency oscillations, and each including a plurality of filter circuits corresponding in number to the number of different frequencies of said variations and tuned to said different frequencies, a plurality of detectors corresponding in number with the number of different frequencies of said variations, connections between the input circuits of said detectors and the filter circuits of each of said channels respectively, said connections being arranged to couple each of said detectors with the similarly tuned filters of the various receiving channels, heterodyne devices associated with said last-mentioned detectors and indicating means also associated with said detectors.

51. A radio system comprising at its sending station a generator of high frequency oscillations, means for changing the frequency of said high frequency oscillations in relatively large steps from one to another of different, predetermined values, means for transforming signal currents into currents having a supersonic frequency range and retaining the characteristic variations of the signal currents, means for changing the

supersonic frequency range employed from one to another of different, predetermined values, means for modulating the currents generated by the high frequency generator according to the transformed, supersonic, signal currents, whereby waves modified by signal-controlled periodic variations are produced, and a receiver comprising closed, oscillatory circuits responsive respectively to each series of high frequency oscillations employed, other closed, oscillatory circuits responsive to the signal-controlled periodic variations employed, means for transforming the energy set up in said circuits into currents of audible frequency having the characteristics of the signal currents and means for impressing said currents of audible frequency obtained from energy set up in a plurality of said circuits on a single indicating device.

52. A radio system comprising at its sending station a generator of high frequency oscillations, means for periodically changing the frequency of said high frequency oscillations in relatively large steps, means for transforming voice currents into currents having a supersonic frequency range and retaining the characteristic variations of the voice currents, means for changing periodically and continuously the supersonic frequency range employed, means for modulating the currents generated by the high frequency generator according to the transformed supersonic voice currents, whereby waves modified by voice-controlled periodic variations are produced, and a receiver including circuits responsive respectively to each series of high frequency oscillations employed, closed, oscillatory circuits responsive to the voice-controlled periodic variations employed and means for transforming the energy set up in said circuits into sensible manifestations.

In testimony whereof I hereunto affix my signature.

JOHN HAYS HAMMOND, Jr.