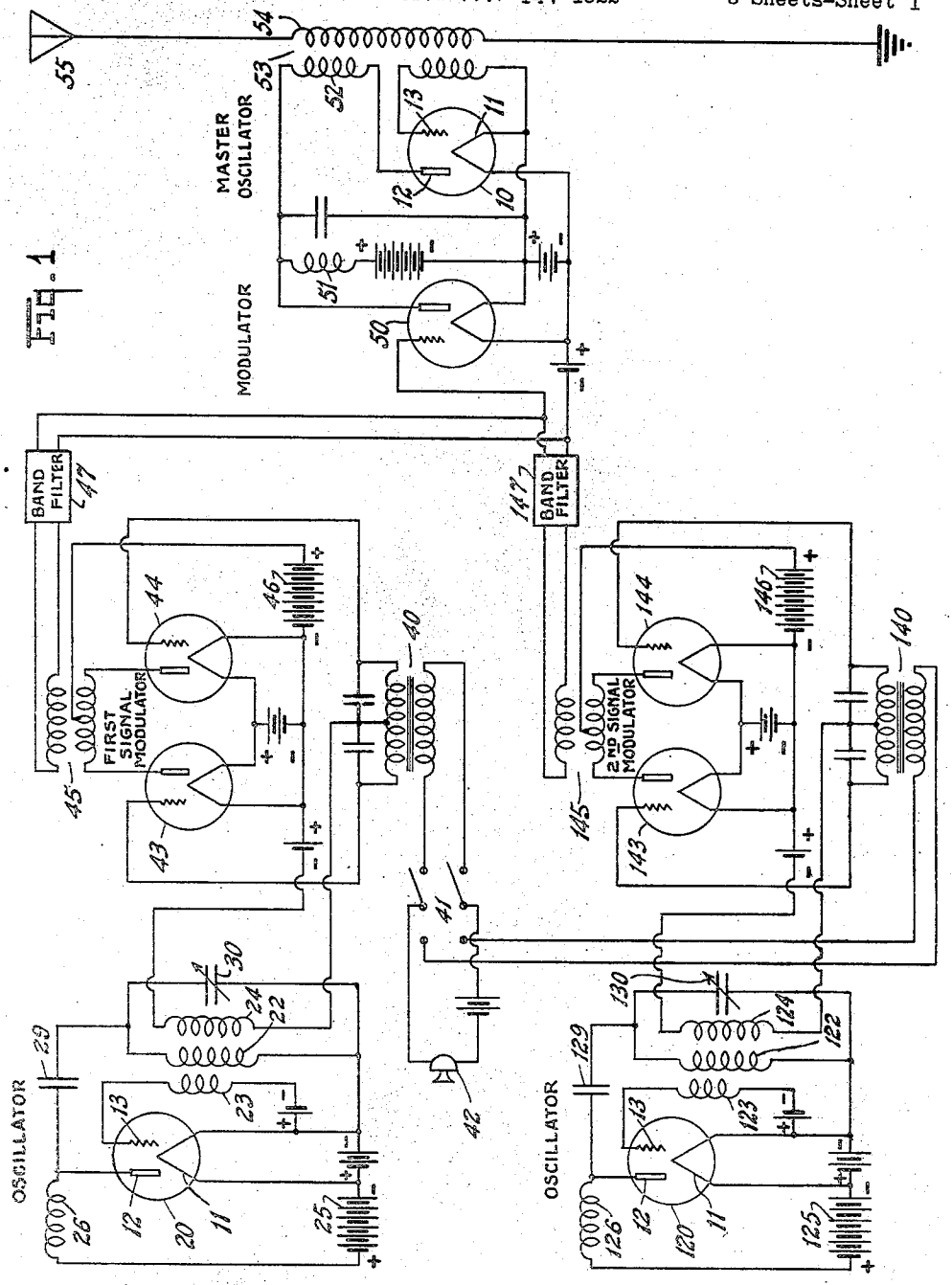
Dec. 28, 1926. 1,612,284

J. H. HAMMOND, JR

SECRET RADIANT TELEPHONE

Filed Oct. 14, 1922 3 Sheets-Sheet 1

Fig. 1



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SECRET RADIANT TELEPHONE

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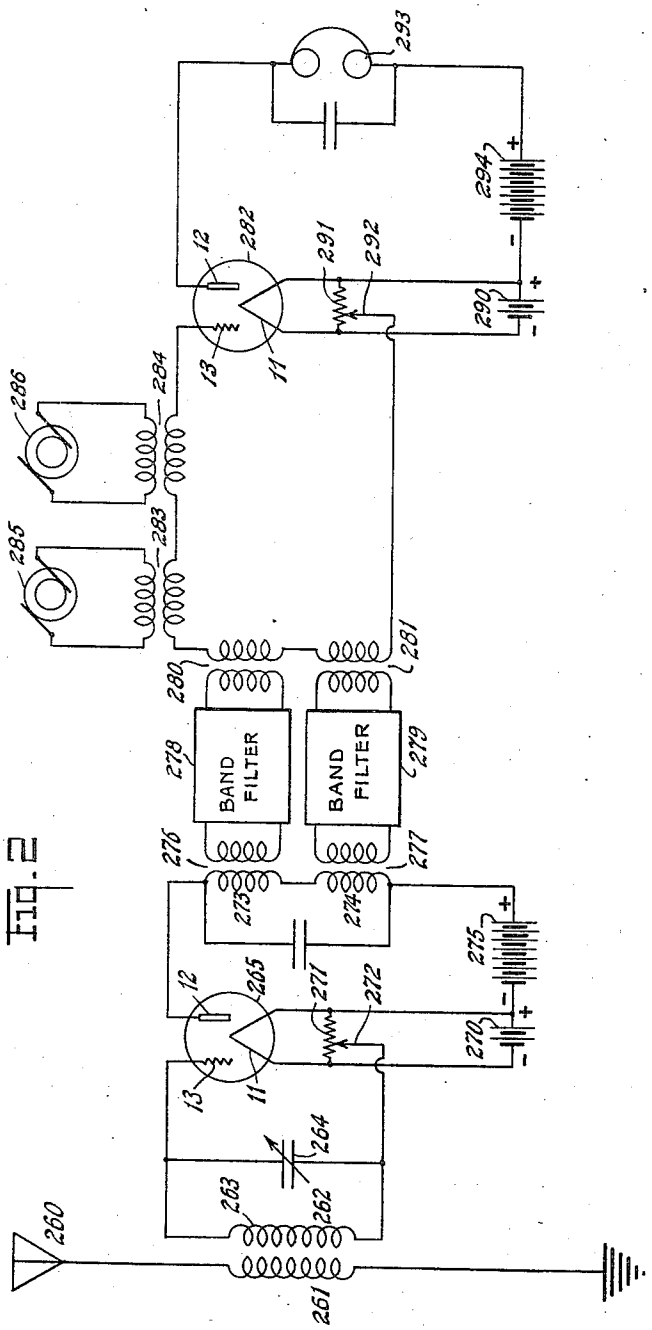


Fig. 2

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SECRET RADIANT TELEPHONE

Filed Oct. 14, 1922 3 Sheets-Sheet 3

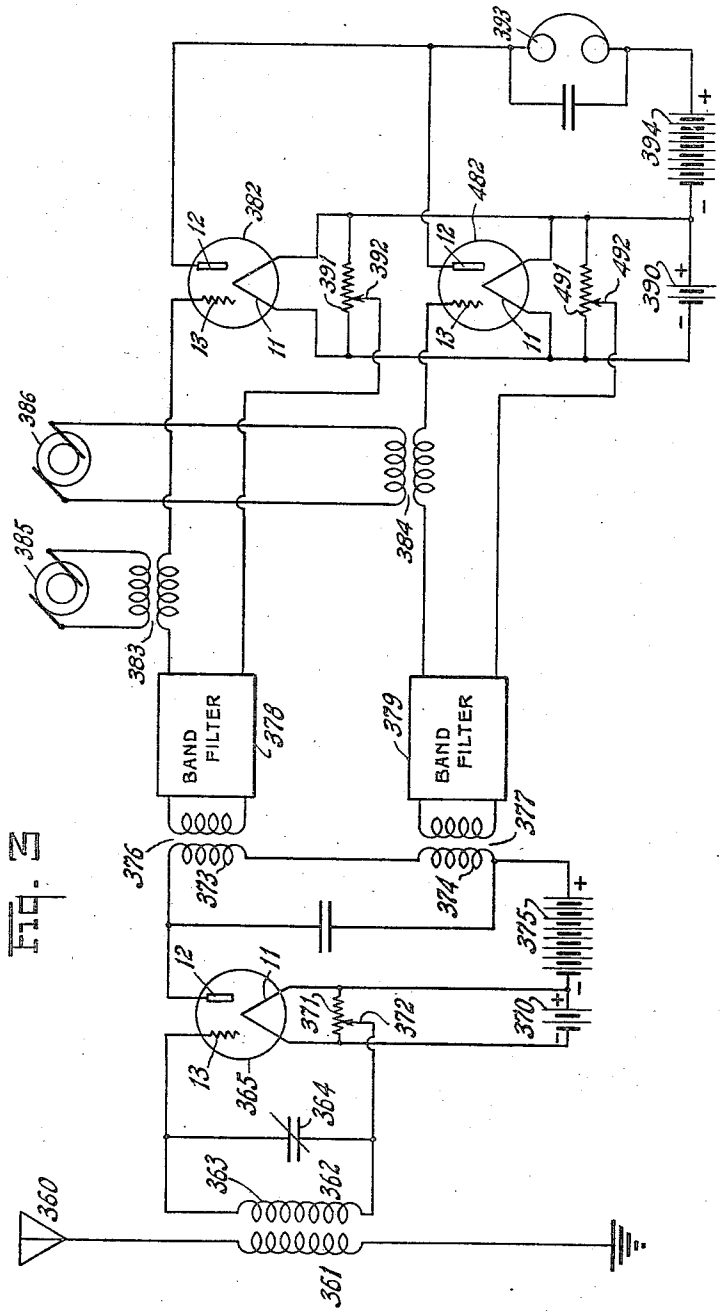


FIG. 3

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Patented Dec. 28, 1926. 1,612,284

UNITED STATES PATENT OFFICE.

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SECRET RADIANT TELEPHONE.

Application filed October 14, 1922. Serial No. 594,466.

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

An object of this invention is to provide a system comprising a sending station arranged to emit radiant energy of varying character and a receiving station co-operating therewith and provided with an indicating device responsive to all portions of the received energy in spite of its varying characteristics.

More specifically, a further object of the invention is to provide simple and efficient means for the emission of radiant energy in the form of oscillations having a fundamental frequency, modulated at successively varying supersonic frequencies each made effective and modulated by desired signals, such for example, as by voice waves, and to arrange for the selective reception of such energy and its transformation into sensible manifestations by a single indicating device.

Still 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—

Fig. 1 is a diagram of a sending station which is an embodiment of this invention;

Fig. 2 is a diagram of one form and Fig. 3 of a modified form of a receiving station constructed in accordance with the invention and arranged to co-operate with the sending station of Fig. 1.

The system of the present invention produces 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, each having a supersonic frequency lower than that of the carrier wave, being made effective by speech or other desired signals and being modulated thereby. Changes in the characterization of the periodic amplitude variations may be made erratically or in accordance with the will of an operator.

In a general way the receiving set may be described as comprising a plurality of resonant channels containing a common circuit tuned to the carrier frequency mentioned above, circuits tuned to the lower supersonic frequencies, detecting or rectifying means for each of the last-mentioned circuits and a single indicating device. In combination with such receiving elements apparatus may be used which provides 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 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 inter-related, inductively-coupled circuits in such a manner that the energy in the plate circuit reacts on the grid circuit so as to cause the device to oscillate. There is thus produced an oscillatory current of relatively high frequency, the frequency being determined by the electrical constants of the inter-related circuits.

For producing oscillations of lower but supersonic frequency, there is provided a pair of thermionic devices 20 and 120 each having a usual heated filament 11, a plate 12 and a grid 13. These devices are each connected with regenerative circuits comprising a transformer, one having windings 22, 23 and 24, and the other having windings 122, 123 and 124, which are connected in the plate circuit, grid circuit and secondary output circuit 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. Similarly, the plate 12 of the device 120 is maintained at a positive potential with respect to the filament by means of a battery 125 whose positive terminal is connected through an inductance 126 to the plate. The plate circuit of the device 20 is provided with a stoppage con-

denser 29 and a suitable variable condenser 30. The capacity of the condenser 30 may be adjusted to cause oscillations of a predetermined frequency lower than that of the oscillations produced by the master oscillator 10 to be generated. The plate circuit of the device 120 is provided with a stoppage condenser 129 and a suitable variable condenser 130 the capacity of which may be adjusted so that oscillations of a predetermined frequency differing from that of the oscillations produced by the oscillator 20 and lower than that of the oscillations produced by the master oscillator 10 are generated.

For transforming or stepping up voice or other signalling currents into currents varying in accordance with the signalling currents and having a frequency range of relatively high, supersonic frequency less than the frequency of the oscillations produced by the master oscillator 10, the output circuit of the generator 20 is connected with a signal modulator comprising a transformer 40 having ite primary winding connected through a double-throw double pole switch 41 to 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 plate potential battery 46, the secondary winding of the transformer 45 being connected to a band filter 47 adapted for either high pass or low-pass filtration. The windings of the transformers 40 and 45 and the winding 24 of the secondary output circuit of the generator 20 are so arranged that the electro-motive forces in the filter 47 are normally equal and opposite during operation of the generator 20. Accordingly currents of the lower, supersonic frequency range produce substantially no effect in the filter 47, except when the transmitter 42 is producing current variations in the primary winding of the transformer 40. Thus a so-called "push-pull" modulator is obtained by means of which only electro-motive forces corresponding to the two side bands of the voice-modulated, lower, supersonic frequency generated by the device 20 are induced in the filter 47. The filter 47 may comprise any suitable combination of inductances and capacities such as to permit the passage of one of the side bands resulting from the modulation of the lower, supersonic frequency generated by the device 20 and to suppress the other side band. For example, assuming a lower, supersonic frequency of 45,000 cycles per second, and assuming that voice currents including frequencies ranging from 200 to 2000 cycles per second are used for signals, there will be produced in the output of the signal modulator two side bands containing respectively frequencies varying from 44,800 to 43,000 cycles inclusive and 45,200 to 47,000 cycles inclusive. The filter 47 will suppress one of these bands, for example, the upper band, and there will be transmitted to the output of the filter circuit a band of frequencies ranging from 44,800 to 43,000 cycles inclusive.

Similarly, there is provided a second frequency converting means for stepping up voice or other signalling currents into currents retaining the variable characteristics of the signalling currents and having a second relatively high, supersonic frequency range differing from that of the currents produced by the first signal modulator and less than the frequency of the oscillations produced by the master oscillator. The output circuit of the generator 120 is connected with such frequency converting means in the form of a signal modulator comprising a transformer 140 having its primary winding connected to the terminals of the double-pole switch 41 opposite to those to which the primary winding of transformer 40 is connected. The secondary windings of the transformer 140 are connected in the input circuits of a pair of thermionic devices 143 and 144 respectively, each of said devices comprising a customary heated filament, plate and grid. The output circuits of thermionic devices 143 and 144 include the primary windings of a coupling transformer 145 and a plate potential battery 146, the secondary winding of the transformer 145 being connected to a band filter 147 arranged to pass either the high or low side band of frequencies produced by the respective signal modulator. The windings of the transformers 140 and 145 and the winding 124 of the secondary output circuit of the generator 120 are so connected that the electro-motive forces in the filter 147 are normally equal and opposite during operation of the generator 120. Accordingly, currents of the lower, supersonic frequency range produce substantially no effect in the filter 147 except when the transmitter 42 is producing current variations in the primary winding of the transformer 140. Thus a so-called "push-pull" modulator is obtained by means of which electromotive forces, corresponding only to the two side bands of the voice-modulated, lower, supersonic frequency generated by the device 120, are produced in the filter 147. The filter 147 comprises a suitable combination of inductances and capacities such as to permit the passage of one of the side bands resulting from the modulation of the lower, supersonic frequency generated by the device 120 and to suppress the other side band. For example, assuming a lower, supersonic frequency of 70,000 cycles per second, there will be produced in the

output of the second signal modulator two side bands containing respectively from 69,800 to 68,000 cycles inclusive and 70,200 to 72,000 cycles inclusive. The filter 147 will suppress one of these bands, for example, the upper band, and there will be transmitted to the output of the filter circuit only a band of frequencies ranging from 69,800 to 68,000 cycles per second.

The output circuits of the filters 47 and 147 are connected in parallel to the input circuit of a modulator comprising a thermionic device 50 having a usual heated filament, plate and grid. The plate circuit of the device 50 includes an inductance 51 and a source of potential, both of which are also included in the plate circuit of the master oscillator 10. The plate circuit of the oscillator 10 is connected to a winding 52 of a coupling transformer 53, the secondary winding 54 of which is included in the circuit of an antenna 55. The energy supplied to the plate 12 of the master oscillator 10 is varied by operation of the device 50.

The receiving station shown in Figure 2 includes a receiving element, such as an antenna 260, positioned so as to intercept Hertzian waves. The circuit of the antenna 260 includes an inductance 261 coupled to a closed, oscillatory circuit 262, comprising an inductance 263 and a variable condenser 264. The closed, oscillatory circuit 262 is connected with the input of a thermionic device 265 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.

The filament 11 of the thermionic device 265 may be heated by current supplied by a battery 270, the current being controlled in any desired manner as by a suitable series rheostat, not shown. In shunt with the filament 11 is a potentiometer 271 having a slider 272 connected with the closed, oscillatory circuit 262, whereby the normal potential maintained upon the grid 13 of the device 265 relative to the filament 11 thereof may be adjusted. The output circuit of the thermionic device 265 includes two inductances 273 and 274 in series and a suitable plate potential battery 275, whose positive terminal is connected to the plate 12 for maintaining the plate at a positive potential with respect to the filament 11. The inductances 273 and 274 form respectively primary windings of a pair of coupling transformers 276 and 277 whereby the output circuit of the thermionic device 265 is coupled to a pair of differently characterized band filters 278 and 279.

The outputs of the filters 278 and 279 are inductively coupled by means of couplings 280 and 281 respectively to the input of a second thermionic device 282, which is provided with a usual plate, filament and grid. The grid or input circuit of the device 282 has the secondary windings of a pair of transformers 283 and 284 connected in series therewith, whereby there is impressed on this circuit alternating electro-motive forces having frequencies determined by the frequencies of a corresponding pair of alternators 285 and 286, or other suitable sources of alternating current. The sources 285 and 286 in combination with the transformers 283 and 284 form heterodynes for producing electro-motive forces of frequencies corresponding respectively to the suppressed, lower, supersonic frequencies produced by the generators 20 and 120 at the sending station.

For heating the filament of the thermionic device 282 there is provided a suitable battery 290, the current from which may be controlled by a suitable rheostat, not shown. In shunt with the filament circuit there is provided a potentiometer 291 having a slider 292 connected with the input circuit of the thermionic device 282 whereby the normal potential maintained upon the grid 13 of the device 282, relative to the filament 11, may be adjusted. The output circuit of the thermionic device 282 includes an indicating device, such as a telephone receiver 293, and a plate potential battery 294, which maintains a positive potential upon the plate 12 of the thermionic device 282 relative to the filament 11.

In the form of receiving station shown in Figure 3, a receiving element in the form of an antenna 360 is positioned so as to intercept Hertzian waves. The circuit of the antenna 360 includes an inductance 361, coupled to a closed, oscillatory circuit 362, comprising an inductance 363 and a variable condenser 364. The closed, oscillatory circuit 362 is connected with the input of a thermionic device 365 having a usual filament 11 for emitting electrons, a plate 12 upon which the electrons impinge, and a grid 13 for controlling the passage of electrons.

The filament 11 of the thermionic device 365 may be heated by current supplied by a battery 370, the current being controlled in any desired manner as by a suitable series rheostat, not shown. In shunt with the filament 11 is a potentiometer 371 having a slider 372 connected with the closed, oscillatory circuit 362, whereby the normal potential maintained upon the grid 13 of the device 365 relative to the filament 11 thereof may be adjusted. The output circuit of the thermionic device 365 includes two inductances 373 and 374 in series and a suitable plate potential battery 375, whose positive terminal is connected to the plate 12 for maintaining the plate at a positive potential

with respect to the filament 11. The inductances 373 and 374 form respectively primary windings of a pair of coupling transformers 376 and 377 whereby the output circuit of the thermionic device 365 is coupled to a pair of differently characterized band filters 378 and 379.

The outputs of the filters 378 and 379 are connected respectively to the inputs of a pair of thermionic devices 382 and 482, each of which is provided with a usual plate, filament and grid. The grid or input circuits of the devices 382 and 482 include secondary windings of transformers 383 and 384 respectively in series therewith, whereby there is impressed on these circuits respectively alternating electro-motive forces having frequencies determined by the frequencies of a corresponding pair of alternators 385 and 386, or other suitable sources of alternating current. The sources 385 and 386 in combination with transformers 383 and 384 form heterodynes for producing electro-motive forces of frequencies corresponding respectively to the suppressed, lower, supersonic frequencies produced by the generators 20 and 120 at the sending station.

For heating the filament of the thermionic device 382 there is provided a suitable battery 390, the current from which may be controlled by a suitable rheostat, not shown. In shunt with the filament circuit there is provided a potentiometer 391 having a slider 392 connected with the input circuit of the thermionic device 382 whereby the normal potential maintained upon the grid 13 of the device 382 relative to the filament 11 may be adjusted. Similarly, the filament of the thermionic device 482 may be heated by the same battery 390, and a second potentiometer 491 having a slider 492, is provided for variably predetermining the normal grid potential of the device 482. The output circuits of the thermionic devices 382 and 482 include an indicating device such as a telephone receiver 393, and a plate potential battery 394, which maintains a positive potential upon the plates 12 of the thermionic devices 382 and 482 relative to the filaments 11.

In the operation of the system shown, band filters 47 and 278 or 378 are selected for passing conductively currents of the band of frequencies produced by the modulation of the currents generated by the thermionic device 20 (see Fig. 1), in accordance with speech currents produced by operating the transmitter 42 when the switch 41 is in the right-hand position. Similarly, the band filters 147 and 279 or 379 are designed to pass conductively currents having frequencies produced by the modulation of the currents generated by the thermionic device 120 in accordance with the currents produced by the operation of the transmitter 42, when the switch 41 is in the left-hand position. The master oscillator 10 is caused to generate oscillations of a radio frequency such, for example, as 1,000,000 cycles per second. The oscillator 20 is caused to generate a current having a frequency relatively less than this but above the limit of audibility for the ordinary operator, for example, 45,000 cycles per second. The oscillator 120 is caused to generate a current having a frequency relatively less than the radio frequency selected and above the limit of audibility for the ordinary operator but differing from that generated by the oscillator 20; for example, 70,000 cycles per second.

When the switch 41 is in the right-hand position, there is emitted from the antenna 55 radiant energy having the form of high frequency oscillations of, for example, one million cycles per second with periodic amplitude variations impressed thereon, the frequency of which varies between 44,800 and 43,000 cycles inclusive in accordance with voice currents. This method of operation is substantially secret because, in order to receive the message, a foreign station must be provided with suitable apparatus responsive to such complex wave form and adjusted to both the fundamental and the lower, supersonic frequency. This is almost impossible ordinarily. In order to make it still more difficult for another station to listen in, the speaker may be instructed to change the switch 41 from the right-hand position to the left-hand position at different times, or this switch may be moved by any mechanical means in an erratic fashion into and out of its operative positions. When the switch 41 is in its left-hand position, the energy emitted from the antenna 55 has the form of high frequency oscillations of, for example, one million cycles per second, having impressed thereon periodic amplitude variations, the frequency of which varies between 69,800 and 68,000 cycles inclusive in accordance with voice currents.

At the legitimate receiving stations shown diagrammatically in Figures 2 and 3, the closed oscillatory circuits 262 and 362 are tuned to the fundamental frequency of one million cycles per second. The devices 265 and 365, acting as detectors, are responsive to the current oscillations set up in these closed, oscillatory circuits by the received energy, and act to produce in their output circuits rectified or otherwise detected oscillations which are induced through the couplings 276 and 277 of Figure 2, or 376 and 377 of Figure 3. When the switch 41 of the sending station is in its right-hand position, these rectified or detected currents are of such a nature as to be transmitted through the band filter 278 or 378 but are effectually suppressed by the band filter 279 or 379. Assuming for the present that the switch 41 is in its right-hand position, there appears

in the output circuit of the band filter 278 or 378 oscillating electro-motive forces having a frequency range between 44,800 and 43,000 cycles. These relatively high frequency currents are heterodyned by current from the generator 285 or 385 of the lower, supersonic frequency suppressed at the sending station and rectified or otherwise detected by the thermionic device 282 or 382 to produce currents having the frequencies of the signalling currents originally produced in the transmitter 42. These currents flow through the indicating device 293 or 393, causing it to produce sound waves of the same character as those which operated the signal transmitter 42.

Similarly, when the switch 41 is in its left-hand position, the output currents of the thermionic device 265 or 365 are transmitted only through the band filter 279 or 379 and are combined with the electro-motive forces generated by the heterodyne 286 or 386 to produce after rectification currents having the frequencies of the signal currents. These currents flow through the indicating device 293 or 393, causing it to produce, as before, sound waves of the same character as those which operated the signal transmitter 42.

When the signal transmitter 42 is not being actuated, currents of the lower, supersonic frequency generated by the signal modulator to which it happens to be connected by switch 41 oppose and neutralize each other so that they have no effect upon the energy radiated from the sending station. Similarly, the signal modulator connected to the open contacts of the switch 41 has no effect upon the radiated energy. Since the heterodynes 285, 286 and 385, 386 produce oscillations at a frequency above the range of audibility for the ordinary operator, they do not produce audible sounds in the indicating device 293 or 393.

The invention upon which this application is based is broader than the specific embodiment 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. In a system for the transmission of intelligence by radiant energy, a transmitter comprising means for producing oscillations of radio frequency, a plurality of means for modulating said oscillations at frequencies relatively lower, differing from each other, and above the range of audibility, a signal transmitter for modulating the oscillations produced by said last named means, and means for selectively connecting the signal transmitter with the first-named modulating means one at a time, and a receiving arrangement responsive to the emitted energy comprising a detector actuated by oscillations of said high frequency, a plurality of band filters arranged to transmit currents corresponding in frequencies with those produced by said modulating means respectively, and an indicating device simultaneously connected to said band filters and responsive without adjustment to currents conducted by any one of said band filters.

2. In a system of communication, a sender arranged to emit waves having the form of oscillations of a high frequency having a series of periodic amplitude variations of lower but supersonic frequency impressed thereon, said series of variations being made effective by and modulated by signal currents, and including means for changing the characterization of said series of variations intermittently and a receiver containing elements selectively responsive to the emitted energy, one of said elements being constructed to be responsive to current produced at the receiver when said series of variations is characterized in one manner and another of said elements being constructed to be selectively responsive to current produced at the receiver when said series of variations is differently characterized, and an indicating device simultaneously connected to said elements.

3. In a system of communication, a sender including a telephone transmitter and arranged to emit waves having the form of oscillations of a high frequency having a series of periodic amplitude variations of lower but supersonic frequency impressed thereon, said series of variations being modulated by the speech currents produced upon the operation of said transmitter, and said sender including manually operable means positioned in proximity to the telephone transmitter for changing the characterization of said series of variations at the will of an operator, and a receiver containing a single indicating device and connections to said device which without change in themselves cause the device to respond to the emitted energy regardless of changes in the characterization of said series of variations.

4. In a system of communication, a sender comprising a master oscillator for generating oscillations of a relatively high frequency, a plurality of subsidiary oscillators for generating currents of supersonic frequencies lower than said high frequency and differing from each other, means for impressing a selected series of said last named oscillations upon the high frequency oscillations to produce periodic amplitude variations therein, and modulating means actuated by signal currents arranged to render the selected series of periodic amplitude variations effective and to modulate said variations and a receiv-

ing device comprising a plurality of resonant circuits, one tuned to the high frequency and others tuned to the variation frequencies respectively, detecting means for each of the circuits, and a single indicating device simultaneously and operatively connected to all of said circuits.

5. The method of generating intelligible radiant energy which consists of modifying high frequency waves by waves of a different frequency rendered effective by signals, changing erratically the frequency of the last-named waves, during transmission of a series of signals constituting a single message, and reproducing the signals by an indicating device responsive to the different frequencies of the last-named waves.

6. The method of transmitting radio signals which consists in modifying high frequency waves by waves of a lower, supersonic frequency modulated by signals, changing erratically the frequency range of the last-named waves during transmission of a single message, producing at a receiver currents of frequencies corresponding respectively with the different frequencies of the last-named waves and modulated in accordance with the signals and operating a single indicating device in response to all of said currents to reproduce the signals.

7. The method of transmitting radio signals which consists in modifying high frequency waves by waves of a different frequency rendered effective by signals, changing the last named frequency erratically during transmission of a single message, receiving the waves thus produced with differently responsive instrumentalities and transforming the received energy into sensible manifestations.

8. The method of transmitting radio signals which consists of modifying high frequency waves by waves of a lower frequency rendered effective by signals, changing the last named frequency erratically during transmission of a single message receiving, the waves thus produced with differently responsive instrumentalities and transforming all portions of the received energy into sensible manifestations by a single indicating device.

9. In a system of electrical communication, a generator of high frequency oscillations, means for transforming voice currents into currents having a predetermined supersonic frequency range and retaining the characteristics of the voice currents, means for changing at will the selected frequency range from one to another of a plurality of different, predetermined values, means for modulating the currents generated by the high frequency generator according to the transformed supersonic voice currents, and a receiver comprising an indicating device, means for producing currents having different frequency ranges corresponding respectively to those of the transformed supersonic voice currents, and means for simultaneously and operatively connecting the indicating device with said producing means to cause currents of any of such frequency ranges to operate the indicating device.

10. In a system of electrical communication, a generator of high frequency oscillations, means for stepping-up signal currents into currents having a selected supersonic frequency range and retaining the characteristics of the signal current, means for changing at desired times the selected frequency range from one to another of a plurality of different, predetermined values, means for modulating the currents generated by the high frequency generator according to the stepped-up supersonic signal currents, and a receiver comprising an indicating device, means for producing currents having different frequency ranges corresponding respectively to those of the transformed supersonic signal currents, means for simultaneously and operatively connecting the indicating device with said producing means, and means including heterodyne devices for causing currents of any of such frequency ranges to operate the indicating device.

11. In a system of electrical communication, a generator of high frequency oscillations, means, including two sources of oscillations of different, supersonic frequencies less than the frequency of said high frequency oscillations, for stepping-up signal currents into currents having a selected supersonic frequency range lower in frequency than the frequency of said oscillations and retaining the characteristics of the signal currents, means for changing at desired times the selected frequency range from one to another of a plurality of different, predetermined values, means for modulating the currents generated by the high frequency generator according to the stepped-up supersonic signal currents, and a receiver comprising an indicating device, means for producing currents having different frequency ranges corresponding to those of the transformed supersonic signal currents, and means for causing currents of any of such frequency ranges to operate the indicating device, said last-named means including a plurality of heterodynes for combining with said currents of different frequency ranges oscillations of frequencies corresponding to the frequencies of the oscillations employed in stepping-up the signal currents and means for simultaneously and operatively connecting the indicating device with said heterodynes.

12. Apparatus for emitting radiant energy comprising a generator of high frequency oscillations, means for stepping-up voice currents into currents having a selected supersonic frequency range and retaining

the characteristics of the signal currents, means for changing at desired times the selected frequency range from one to another of a plurality of different predetermined values, means for modulating the currents generated by the high frequency generator according to the stepped-up supersonic signal currents, and a receiver comprising a detector for producing currents having frequency ranges corresponding respectively with those of the transformed supersonic signal currents, a plurality of circuits tuned respectively to the currents produced by said detecting means, an indicating device, and heterodyne devices simultaneously interposed between said circuits and the indicating device for producing currents corresponding in frequency with the signal currents from currents of any of said frequency ranges, so as to cause the receiver without adjustment to be operated by any of said last-mentioned currents.

13. The method of generating intelligible radiant energy which consists of transforming signal currents into a relatively high frequency range, erratically changing the range during transmission of a single message and modulating by the high frequency currents thus produced currents of still higher frequency.

14. The method of generating intelligible radiant energy which consists of transforming voice currents into a relatively high frequency range, erratically changing the range during the transmission of a single message and modulating by the high frequency currents thus produced currents of still higher frequency.

15. In a system of electrical communication, means for impressing voice currents on waves modulated at different times with different supersonic variations and a receiver comprising an indicating device, and means for causing the indicating device to be operated by waves modulated at any of said supersonic frequencies.

16. In a system of electrical communication, means for impressing voice currents on waves modulated at different times with variations of different, supersonic frequencies respectively and a receiver comprising an indicating device, means for producing currents at the receiver of frequencies corresponding respectively to said different frequencies of modulation and means for causing the currents of said different frequencies to operate the indicating device.

17. In a system of electrical communication, means for transmitting signals on waves modulated at different times with variations of different, supersonic frequencies respectively and a receiver comprising an indicating device, a receiving circuit tuned to the frequency of said waves, a detector controlled thereby for producing currents corresponding in frequencies with said different frequencies of modulation respectively, and means for causing said currents of different frequencies to operate the indicating device.

18. In a system of electrical communication, means for impressing voice currents on waves modulated at different times with variations of different, supersonic frequencies respectively and a receiver comprising an indicating device, means for producing currents corresponding in frequencies respectively with said different frequencies of modulation, circuits tuned to said frequencies respectively and heterodyne devices for stepping-down said different currents to cause them to operate the indicating device in accordance with the voice currents.

19. In a system of electrical communication, a receiving arrangement comprising detecting means, a single indicating device connected with the output side of the detecting means, a plurality of heterodyne devices connected with the input side of the detecting means and means for causing currents modulated only at audible signal frequencies to be combined with current from the heterodyne devices, said current supplying means and heterodyne devices being constructed to cause signals to be reproduced at the indicating device when signal current is combined with current from any one of the heterodyne devices.

20. In a system of electrical communication, means for receiving waves having different frequency characteristics, means for producing currents differing from each other in accordance with such different frequency characteristics, an indicating device and independently acting heterodyne devices for causing said currents to operate the indicating device.

21. In a system of electrical communication, means for receiving waves modulated at different, supersonic frequencies, means for producing currents corresponding in frequencies with said different, supersonic frequencies respectively, an indicating device and heterodyne devices interposed between said means and the indicating device for causing said currents to operate the indicating device.

22. In a system of electrical communication, means for successively receiving waves modulated in different frequency ranges above audibility in accordance with signals, a detector for producing current having frequency ranges corresponding respectively to those of said frequencies of modulation, an indicating device and heterodyne devices interposed between said detector and the indicating device for causing said currents to operate the indicating device in accordance with the signals.

23. In a system of electrical communication, means for successively receiving waves

modulated at different times in different frequency ranges above audibility in accordance with voice currents, a detector for producing currents having frequency ranges corresponding respectively to those of said frequencies of modulation, an indicating device and heterodyne devices interposed between said detector and the indicating device for causing said currents to operate the indicating device in accordance with the voice currents.

In testimony whereof I hereunto affix my signature.

JOHN HAYS HAMMOND, JR.