

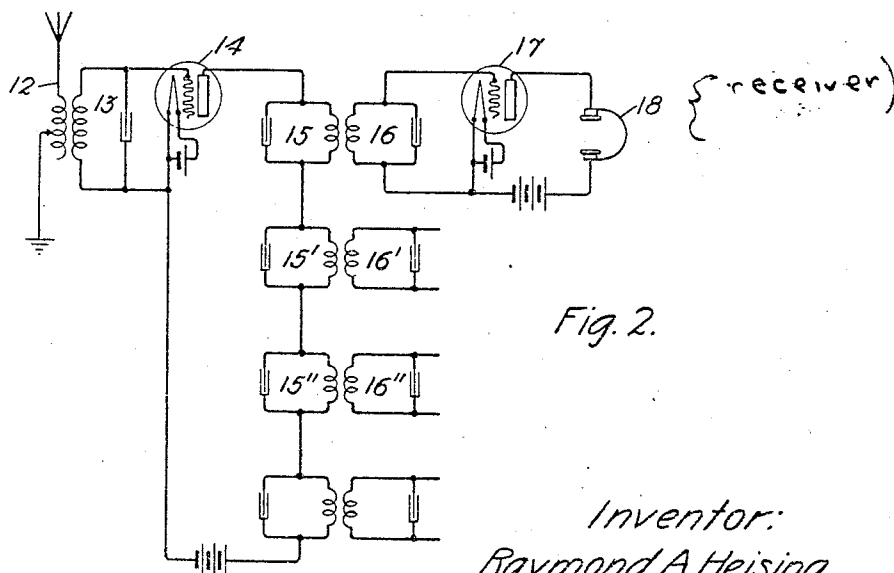
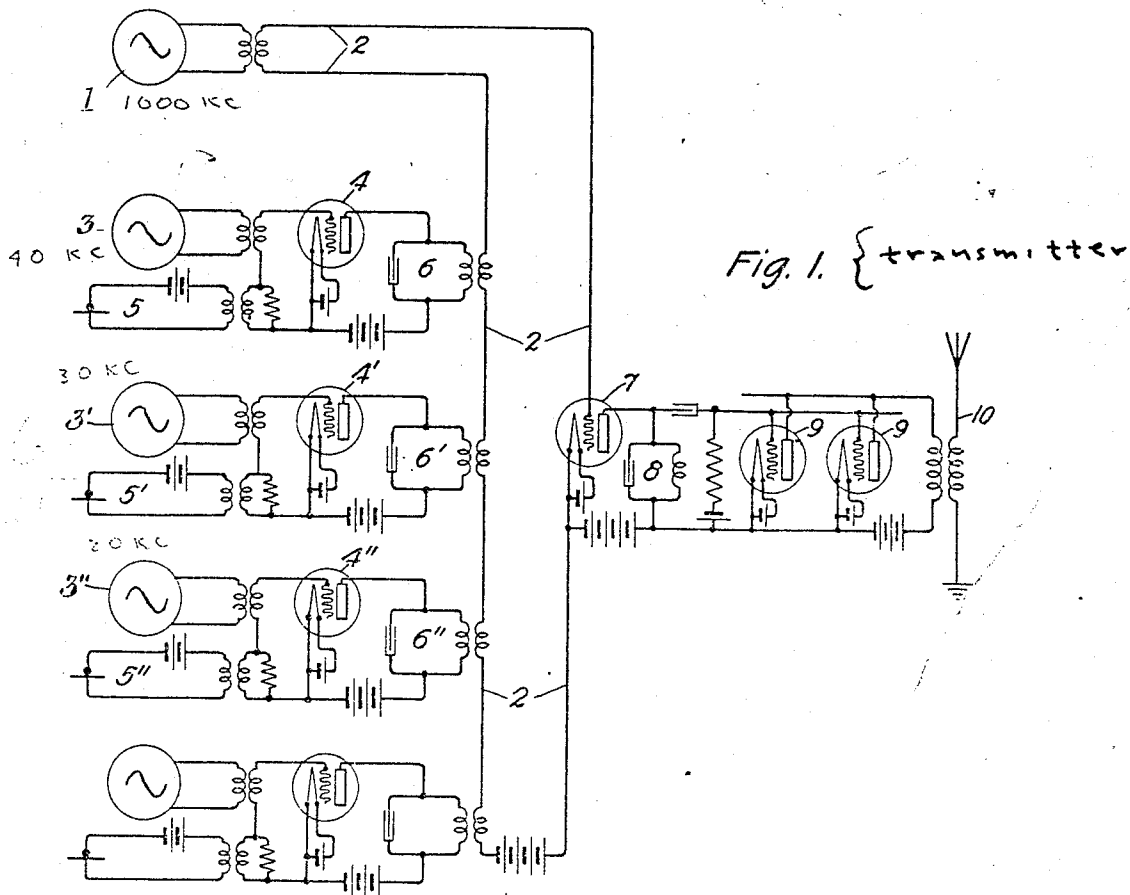
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PLURAL CHANNEL SIGNALING

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UNITED STATES PATENT OFFICE.

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PLURAL CHANNEL SIGNALING.

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This invention relates to a method of and means for plural channel signaling with modulated high frequency waves. Its object is to provide improved methods and apparatus for carrying into effect the methods of transmission and reception of several independent messages.

In radio signaling by means of high frequency waves, it would be possible to send several messages by radiating simultaneously several high frequency waves, modulating each one and receiving by means of circuits tuned to each wave, but in practice the number of waves which can be so sent is limited by the tendency toward interference at the receiver, unless the frequency interval between any two waves is rather large.

The present invention provides means whereby any one of these non-interfering radiated waves may itself carry several independent messages and whereby the total number of messages, which may be transmitted without interference at the receiver, is increased. This object is accomplished by modulating one of the waves radiated, say one whose frequency is a million, by means of another wave whose frequency is lower, but above the limit of audibility and constant, for example 50,000 cycles per second, and by modulating this second wave in accordance with a signal to be sent. At the same time the radiated wave of frequency one million may be modulated by several other such secondary waves, for example, waves of frequencies 40,000—30,000—20,000, each of these secondary waves being modulated in accordance with one of a number of independent signals. In the particular case above, four signals may therefore be sent by means of the same carrier wave of the constant frequency one million. By using several other non-interfering carrier waves, for example three, a total of sixteen independent messages may be sent as against but four if the secondary modulating waves were not employed. This may be accomplished with the same frequency interval between radiated waves in the two cases.

The method of carrying out this invention will be described more in detail in connection with the drawings, in which Figure 1 represents a transmitting station and Fig-

ure 2 a receiving station constructed in accordance with this invention.

Referring to Figure 1, 1 represents a generator of waves of high frequency, for example one million cycles per second and 2 is a circuit energized by the generator 1 and connected to the input terminals of a thermionic amplifier 7. 3 is a generator of waves of lower frequency, perhaps 40,000 cycles per second, and 3', 3'', etc. are other generators of different high frequencies, all less than that of the generator 1. 4 is a thermionic amplifier, whose input circuit is coupled to the circuit of generator 3 and also to a circuit 5, which contains a microphone or other primary source of low frequency signal currents. Similarly 5' and 5'' represent other independent sources of signals to be transmitted simultaneously. The output circuit of the amplifier 4 is connected to a circuit 6 tuned to the frequency generated by 3, which in turn is coupled to the circuit 2. By means of this arrangement modulated currents of the frequency generated by 3 appear in the circuits 6 and are superposed upon the currents appearing in the circuit 2. There are, therefore, impressed upon the input circuit of amplifier 7—first, waves of frequency generated by 1 and second, a series of waves of frequencies determined by 3, 3', etc., which latter waves are modulated in accordance with the primary sources of signals. There will, therefore, appear in the output circuit of amplifier 7 and in the circuit 8, tuned to the highest frequency, a high frequency wave modulated in accordance with a series of modulated high frequency waves. The amplifiers 9 are arranged to increase the intensity of this modulated wave and impress it upon the radiating antenna 10.

Referring to Figure 2, 12 represents a receiving antenna which is coupled to the circuit 13 tuned to the frequency generated by the generator 1 of Figure 1. 14 is a detector whose input circuit is connected across the tuned circuit 13 and in whose output circuit will appear a current whose amplitude is the envelope of the radiated high frequency wave. The circuit 15 is tuned to the frequency of the generator 3 of Figure 1, 15' to the frequency of generator 3', etc.

The current induced in the tuned circuit 16 will therefore be almost exclusively of the frequency due to the modulated high frequency current originating in generator 3.

5 The detector 17 whose input circuit is connected across the tuned circuit 16 serves to detect the incoming signals from that circuit and to impress an audible signal upon the telephone receiver 18. Similar detecting
10 circuits (not illustrated) are connected to the tuned circuits 16', 16'', etc.

The detection by detector 14 thus eliminates the effect of the high frequency carrier wave and allows the lower frequency
15 signal-modulated waves to be selected by the tuned circuits, and the lower frequency signal-modulated waves, by detector 17, then produce in each telephone receiver a current which is the envelope of the intermediate
20 waves, and consequently audible.

It will be clear that by this arrangement four independent signals may be transmitted on but one high frequency radiating wave. For simplicity only one high frequency gen-
25 erator, for example of waves of a million cycles per second, has been illustrated, but it is obvious that other radiating frequencies may be employed to increase the number of signals which may be transmitted.

30 In this method it is, of course, essential that the frequencies generated by the generators 3, 3', etc. shall be above the limit of audibility and that the frequency interval between successive waves shall be sufficient
35 to prevent interference. A characteristic feature of this system and method is successive modulation at a transmitting station. Another characteristic feature is successive detection at a receiving station.

40 It will be clear that this invention need not be restricted to radio signaling, but may be applied equally well to other selective systems or to systems operated by means of carrier waves over wire conductors. It may
45 of course be used in a system in which several stations generate simultaneously the same high frequency, but in which these waves are modulated by different intermediate waves. In that case no interference will
50 be produced between separate stations, even though each is radiating the same frequency wave when modulation is not taking place.

What is claimed is:

55 1. A system comprising means for producing a uniform high frequency wave, means for producing a plurality of independent periodic energies each of periodicity above the usually employed range of audible sound wave frequencies, and means controlled by
60 the waves supplied by said first named means for producing another wave and controlled by said energies for causing it to simultaneously undergo a plurality of variations in accordance with said plurality of
65 energies.

2. The method comprising producing independently of each other an electrical variation current, a wave, and another wave, varying the characteristics of one of said waves in accordance with said electrical va-
70 riation current, and varying the characteristics of said other wave in accordance with said varied wave, all at the same station.

3. A system comprising means for producing a continuous high frequency wave, means
75 for producing a plurality of independent periodic energies at least one of which is of periodicity above the usually employed range of audible sound wave frequencies, and means controlled by the wave supplied by
80 said first named means for producing another wave and controlled by said energies for causing it to simultaneously undergo a plurality of variations in accordance with said plurality of energies.
85

4. The method which comprises modulating a given wave by a wave of lower frequency and employing a product of the first modulation to modulate a wave of higher frequency than the given wave, all at the
90 same station, transmitting the resultant energy and deriving signals therefrom by successive detection.

5. The method which comprises successively repeating waves in transit through a channel of transmission, and successively modulating waves during transmission through
95 said channel, all at the same station.

6. The method of signaling which comprises producing two different waves at a
100 transmitting station, modulating one of said waves in accordance with a signal, and modulating the other of said waves in accordance with said modulated wave.

7. The method which comprises generating a uniform carrier wave, and modifying said carrier wave to transmit elements of a plurality of telephone conversations thereon
105 simultaneously.

8. The method which comprises generating a uniform and continuously maintained carrier wave, modifying said continuous wave to transmit a plurality of messages
110 simultaneously, said messages including a telephone message, and causing certain portions of said wave to carry portions of a plurality of the messages.
115

9. The method which comprises generating an unmodified carrier wave, segregating the energy of said unmodified wave in a circuit, and employing said wave for transmitting a
120 plurality of telephone messages.

10. The method of signaling which comprises producing a uniform and unmodulated carrier wave, simultaneously producing a
125 plurality of trains of other waves each of which has a distinguishing characteristic other than a difference in frequency, each corresponding to an individual message, and modulating said carrier wave in accordance
130

with a plurality of the wave trains simultaneously.

11. A system comprising an electrical channel of transmission having modulators in tandem at the same station, each modulator comprising a discharge device having a circuit for controlling the discharge and means for impressing the waves to be modulated upon said circuit.

12. A method of obtaining modulated waves of large energy for signaling purposes which consists in producing a low-frequency wave, a high frequency wave and a higher frequency wave each independently of the other, causing the modulation of the wave of high frequency by the low-frequency wave, producing modulation of the wave of frequency higher than that of either of the first two-mentioned waves by the modulated wave, and amplifying the high-frequency modulated wave all at the same station.

13. The method of signaling which comprises simultaneously modulating a high frequency wave by other waves of low frequency, said other waves each being modulated in accordance with signals.

14. The method of signaling which comprises modulating high frequency waves by means of signal waves, employing said modulated waves to simultaneously modulate other waves of high frequency, and successively detecting said modulated other waves at a receiving station.

15. A system comprising a source of high frequency waves, a plurality of sources of other waves, a modulating device energized by said first named source, and individual channels of unsymmetrical wave transfer characteristic, one for each of said plurality of sources, for conveying waves to said device from said plurality of sources whereby said plurality of sources are substantially prevented from reacting on each other, means for transmitting waves from said modulating device, means for receiving transmitted waves, and means for causing the selective operation of a plurality of instruments each in accordance with waves from a particular one of said sources.

16. The method comprising modulating a carrier wave in accordance with a plurality of different frequency currents, transmitting and receiving the energy of said modulated carrier wave, detecting said received energy to produce a complex current including as components waves having the frequencies of said currents, and causing each of said waves to selectively operate a device individual thereto at a receiving station.

17. The method of radio transmission comprising modulating a wave in accordance with signals at one station, modulating at the same station a second wave in accordance with said modulated wave, radiating said modulated second wave, receiving said ra-

diated wave and successively detecting said wave to reproduce said signals.

18. The method of signaling wherein different frequency currents from a plurality of sources conveyed by a plurality of paths are to be impressed upon an electron discharge device which comprises simultaneously impressing upon the electron discharge device different frequency currents, and preventing the currents from one path from traversing another path in a direction toward the source associated with said other path, whereby interference of one of said sources with the operation of the others is prevented.

19. A signaling system comprising means for producing a carrier wave, a single modulating instrumentality for simultaneously modulating said carrier wave in accordance with a plurality of other waves, means for producing and segregating into separate circuits waves corresponding to each of said plurality of other waves, and means for detecting each of said other waves.

20. A system comprising at one station a plurality of modulators each having input and output circuits, the output circuit of one of said modulators being adapted to supply waves to the input circuit of another of said modulators, and means for utilizing waves supplied by one of the modulators which are of a frequency different from those supplied to the input circuit thereof.

21. A selective system comprising at one station a plurality of vacuum tube modulators of electrical waves, the output circuit of one of said modulators being connected to the input circuit of another of said modulators.

22. A system comprising means for successively modulating several electrical waves each, except that of the lowest frequency, in accordance with waves of lower frequency, in combination with a plurality of wave distorting devices connected in tandem for deriving from the successively modulated waves other waves having the frequencies of modulation.

23. A receiving system comprising an audion detector having an input circuit, means for tuning said input circuit to a carrier frequency, a second audion detector adapted to be supplied with energy from said first-mentioned detector, a circuit for connecting said detectors, said connecting circuit comprising means for tuning the same to a carrier frequency different from said first mentioned carrier frequency, and a signaling device associated with said detectors.

24. A signaling system comprising at one station means including a space discharge device having an anode, a cathode and space impedance controlling means for producing a signal modulated wave, and means includ-

ing a space discharge device having an anode, a cathode and space impedance controlling means for modulating another wave in accordance with elements of said signal modulated wave.

25. The combination at one station of two modulators of electrical waves in tandem in an electric wave transmission channel, each of said modulators comprising an electron discharge device having a cathode, an anode and a control element.

26. A plurality of modulators, signaling means and a source of carrier waves associated with each of said modulators, and an additional source of carrier waves and a modulator in common to said plurality of modulators.

27. A signaling system including means for producing high frequency currents in a circuit, means for modulating said currents in accordance with other currents, means for modulating said other currents in accordance with signals, and a receiving station comprising tuned circuits for separating said frequency components and detecting devices responsive thereto.

28. In a transmitting system, electrical energy supply means for setting up at one station a plurality of unidirectional currents, means for varying one of said currents in accordance with a signal wave, means for varying a second of said currents in accordance with a mode of variation in the first which is different from the mode of variation of said signal wave, and means for varying a third of said currents in accordance with a mode of variation in the second.

29. In a system for energy transmission, a station comprising a wave source, means for varying the characteristics of the wave produced by said source in accordance with an electrical variation current, means for producing another wave, and additional means for varying the characteristics of said other wave in accordance with said varied wave.

30. In combination, a single detector controlled by high frequency waves to produce a complex current, means to derive from said complex current individual waves corresponding to different messages, circuits into which said individual waves are respectively segregated, and means at least partly including said aforementioned means to prevent said circuits from reacting upon each other.

31. In a system for transmitting energy, a station comprising means for successively modulating a plurality of waves in accordance with variations representing the same signal elements, and sources of energizing current other than said waves for supplying each of said means for modulating.

32. A transmitting station comprising

sources of a plurality of waves of different frequencies, means in addition to said sources for successively modulating said plurality of waves in accordance with the periodic variations representing the same signal elements.

33. A transmitting station comprising means for producing two different waves, means for modulating one of said waves in accordance with a signal, and additional means for modulating the other of said waves in accordance with said modulated wave.

34. A signaling system comprising at one station means including a space discharge device having an anode, a cathode, and space impedance controlling means for varying a wave in accordance with a signal, and means including a space discharge device having an anode, a cathode, and space impedance controlling means for varying another wave by at least one component of said varied wave, and a selective circuit connected in tandem between said devices.

35. A signaling system comprising a unitary means functioning in common to a plurality of message transmitting channels for generating a carrier wave; means for simultaneously transmitting a plurality of messages, including a telephone message, on the carrier wave produced by said unitary means.

36. In combination, a single detector operating on high frequency waves to produce a complex current, selecting means to derive from said complex current individual currents corresponding to different messages, and individual detectors controlled by the individual currents.

37. In a signaling system, means for generating a high frequency carrier wave at a station, means for generating an intermediate frequency current at the same station, means for producing a signal current, means for modulating the intermediate frequency current by the signal current, means for modulating the high frequency wave by the modulated intermediate frequency current, and means tending to prevent the modulation of the high frequency wave by the signal current.

38. The method which comprises generating a high frequency current, generating an intermediate frequency current, producing a signal current, modulating the intermediate frequency current by the signal current at a station, modulating the high frequency current by the modulated intermediate frequency current at the same station, and preventing the modulation of the high frequency current by the signal current.

39. The method of transmitting energy which comprises producing more than two electrical energies of different frequencies, varying the intensity of each energy except the lowest in accordance with variations in

the intensity of that energy having the next lower frequency, and preventing its variation in accordance with variations in intensity of an energy of still lower frequency.

5 40. A signaling system comprising means for modulating high frequency waves in accordance with signal waves, means for causing said modulated waves to modulate other waves of high frequency, means for transmitting energy of said other waves, and a receiving station including means for successively detecting said transmitted waves.

15 41. A system comprising a carrier wave source, a circuit connected to said source in which unmodulated waves produced by said source are segregated, means for producing a carrier wave controlled by energy in said circuit and modulated in accordance with a plurality of lower frequency waves, means for transmitting energy controlled by said modulated carrier wave, a distant station for receiving said transmitted energy, and a plurality of devices at said receiving station each adapted to be actuated in accordance with the variation of a particular one of said lower frequency waves.

20 42. A radio transmission system comprising means for modulating a wave in accordance with signals, means for modulating a second wave in accordance with said modulated wave, means for radiating energy of said modulated second wave, and means for receiving said energy and successively detecting it to reproduce said signals.

25 43. A system of distant control, comprising an aerial receiving circuit, a closed oscillatory circuit tuned to a given frequency and arranged to be controlled by said aerial circuit, a detector arranged to be controlled by said closed circuit, a circuit including a source of electric energy arranged to be controlled by said detector, a plurality of secondary closed circuits arranged to be controlled by said second mentioned closed circuit and tuned to respond to different secondary frequencies respectively, a plurality of detectors controlled by said secondary circuits respectively, and a plurality of devices arranged to be separately controlled by said last mentioned detectors respectively.

30 44. The method of transmission which comprises sending from the transmitting station a high frequency wave modulated in accordance with a plurality of modulated high frequency waves.

35 45. The method of impressing upon a transmitting medium electrical energy representing speech, which consists in generating at one station electric currents of different inaudible frequencies interacting to produce beats of inaudible frequency, modulating at the same station the energy in accordance with speech, amplifying the beat energy, and impressing the amplified energy upon the transmitting medium.

46. Transmitting apparatus comprising means for producing electric currents of different inaudible frequencies interacting to produce beats, means for controlling the energy at the same station where it is produced to represent a signal or message, means for amplifying the beat energy, a transmitting medium, and means for impressing the amplified beat energy upon said transmitting medium.

70 47. Transmitting apparatus comprising means at one radio terminal station for producing electric currents of different inaudible frequencies interacting to produce beats of inaudible frequency, means at said station for controlling the energy to represent a signal or message, a transmitting medium, means for amplifying the beat energy before transmission, and means for impressing the amplified beat energy upon said transmitting medium.

75 48. In a wave receiving system, the combination, at one station, of a receiving conductor, a discharge device having a cathode-control-element circuit coupled to said conductor for the reception of energy therefrom, an anode-cathode circuit for said device, a selective circuit coupled to the anode-cathode circuit for selecting waves of a frequency other than the waves transferred from said receiving conductor, and a device operated by energy of the selected wave frequency to produce waves of other frequency.

80 49. In a wave receiving system, a conductive interceptor of wave energy included in a tuned circuit, a circuit including the grid and cathode of an electron discharge device coupled to said tuned circuit, a plate or anode-to-cathode circuit for said device including a high frequency coil and a source of electric current, for example, a battery, a selective circuit including a coil connected to said first mentioned coil, said selective circuit being selective of a frequency other than that to which the circuit including the interceptor is tuned, said circuit being electrically connected in energy transfer relation to the cathode and control element of a second electron discharge device, and a plate or anode circuit for said second electron discharge device for transferring electrical energy to an indicating instrument.

85 50. The method of radio telephony which consists in impressing telephonic vibrations representing different conversations upon a plurality of electric wave group frequency variations, each conversation being individual to one group frequency variation, impressing said wave group frequency variations thus modified by speech upon another electric wave, controlling the production in an antenna of a wave having essentially the wave form of the other electric wave thus modified, and receiving signals by impressing the radiant energy upon circuits tuned

to wave length and group variation frequencies.

51. A receiving system for waves comprising successively responsive circuits connected together in cascade relation and tuned, respectively, to different frequencies above good audibility, a wave amplifying relay interposed between said circuits, and a device arranged to be actuated in response to the conjoint action of said circuits.

52. The method of radio signaling, which consists in translating a plurality of low frequency signaling currents into higher frequency currents which are lower than radio frequencies and which are different in frequency from each other, and conjointly increasing each of said frequencies by translating them to still higher frequencies, so as to step them up into a range suitable for radio transmission.

53. In a radio system, a plurality of low frequency signaling circuits, modulators associated with said circuits for modulating separate carrier frequencies in accordance with low frequency signals transmitted over said circuits, a common modulator, means whereby the resultant modulated frequencies may be impressed upon said common modulator, thereby modulating another frequency and producing thereby a band of radio frequencies.

54. A signaling system comprising a modulator having an input circuit and an output circuit, means for supplying carrier waves to said modulator, a plurality of message channels associated with said input circuit, each of said channels comprising means for discriminating against currents from the other channels, and a transmission circuit associated with said output circuit.

55. In a signaling system, the combination of an electron discharge device, a plurality of input circuits adapted to impress a plurality of currents simultaneously upon said device, and means connected in each input circuit to protect the respective input circuits from interference by currents of the frequencies impressed upon the other input circuits.

56. In a high frequency signaling system, the combination of a modulating device, a circuit supplied by source of current of one frequency, a circuit supplied by source of current of different frequency, each of said circuits having selecting electrical networks adapted to transmit currents of the frequency produced by each particular source, and each of said circuits being so connected with its supplying source as to prevent current in one of said sources inducing current in the other of said sources.

57. A system for transmitting and receiving radiant energy, comprising means for emitting a series of radiant impulses having a frequency substantially above audibility,

and means for impressing upon said impulses a series of periodic variations having a frequency different from the said first mentioned frequency and substantially above audibility, in combination with means for receiving said impulses and variations including two elements tuned to respond selectively to said impulses and variations respectively, a vacuum tube rectifier interposed between said elements, and a receiving device arranged to be controlled by the conjoint action of said elements.

58. A system for transmitting and receiving radiant energy, comprising means for emitting a series of radiant impulses having a frequency substantially above audibility, and means for impressing upon said impulses a series of periodic variations having a frequency different from the said first mentioned frequency and substantially above audibility, in combination with means for receiving said impulses and variations including two elements tuned to respond selectively to said impulses and variations respectively, a vacuum tube rectifier interposed between said elements, and a receiving device arranged to be controlled by the conjoint and successive action of said elements.

59. A system of wave transmission comprising at one station a source of waves, a wave modifying device controlled by a signaling device for effecting signaling variations in said waves, a selective circuit for transmitting selected waves from said wave modifying device to a second wave modifying device, additional means for supplying other waves to said second wave modifying device, and an outgoing transmission conductor supplied with waves from said second wave modifying device.

60. In a system in accordance with claim 59, a second selective circuit connected between said second wave modifying device and said transmission conductor and selective of waves of a different frequency range than said first named selective circuit.

61. A system for the reception of speech modulated or modified carrier waves comprising at a receiving station a first detector, for example, a rectifier, upon which the received waves are impressed, and a circuit for supplying from said detector to a second detector, for example, a rectifier, waves produced by said first detector, and a circuit designed to freely convey speech waves and containing a speech reproducing instrument supplied by said second detector.

62. The method of receiving speech modified high frequency waves and deriving speech currents therefrom which comprises detecting the high frequency waves to produce currents, selecting from the resultant currents other high frequency currents, and detecting the selected currents to reproduce the speech currents.

63. A system for carrier wave transmission and reception comprising a transmitter including elements for impressing speech wave variations on high frequency waves, and a receiver comprising at one station two detectors, one of which is supplied by waves incoming from said transmitter, the second of which is supplied by waves from said first detector, and a circuit supplying a speech reproducing instrument with waves supplied from said second detector whereby variations corresponding to the speech wave variations impressed upon the high frequency waves are reproduced as speech. 10

In witness whereof, I hereunto subscribe my name this 1st day of March A. D., 1916. 15

RAYMOND A. HEISING.