July 28, 1931. J. H. HAMMOND, JR 1,816,579

RADIO COMMUNICATION SYSTEM

Filed Feb. 12, 1929 3 Sheets-Sheet 1

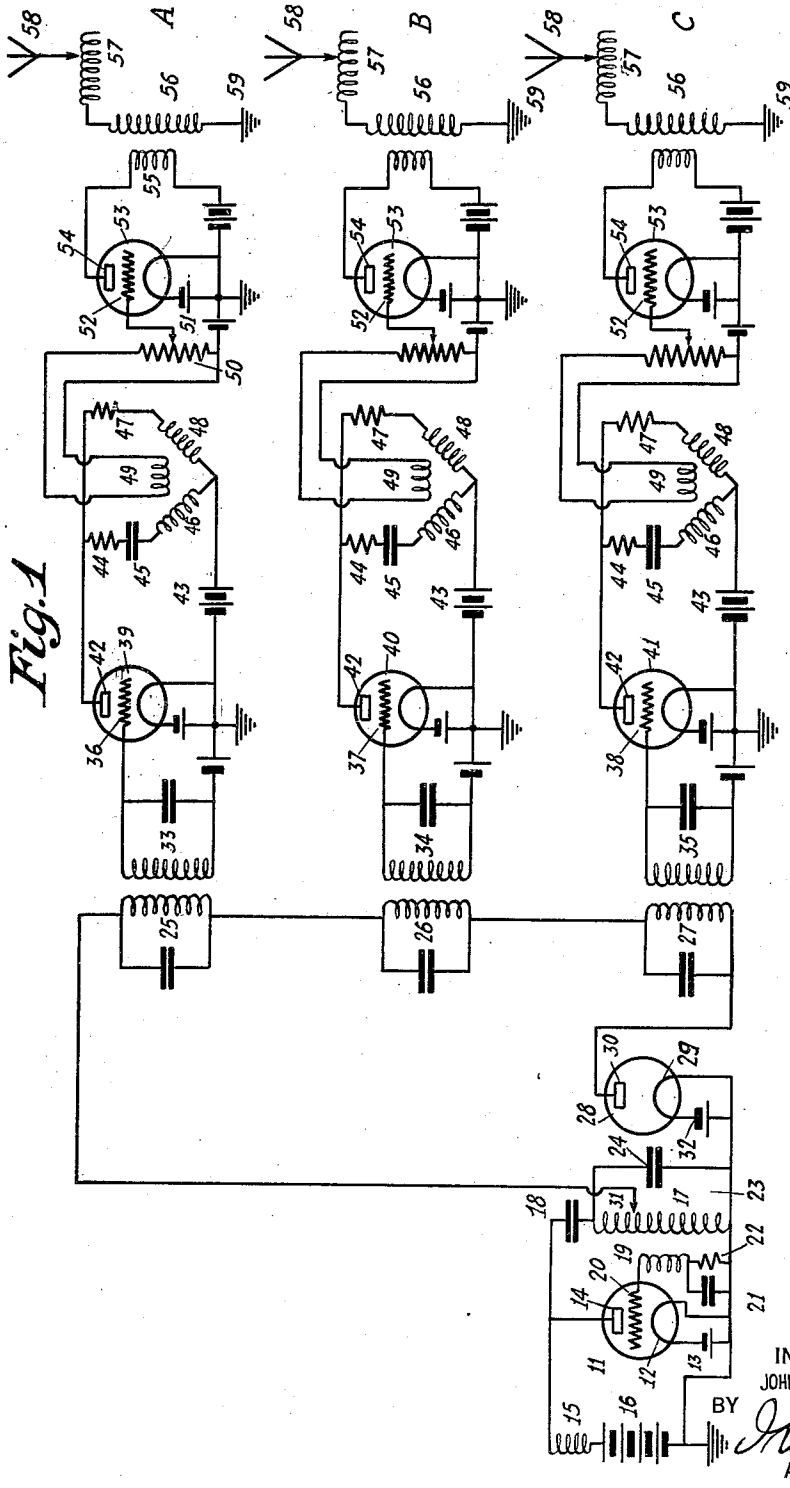


Fig. 1

INVENTOR
JOHN HAYS HAMMOND JR
BY Ira J. Adams
ATTORNEY

July 28, 1931. J. H. HAMMOND, JR 1,816,579

RADIO COMMUNICATION SYSTEM

Filed Feb. 12, 1929 3 Sheets-Sheet 2

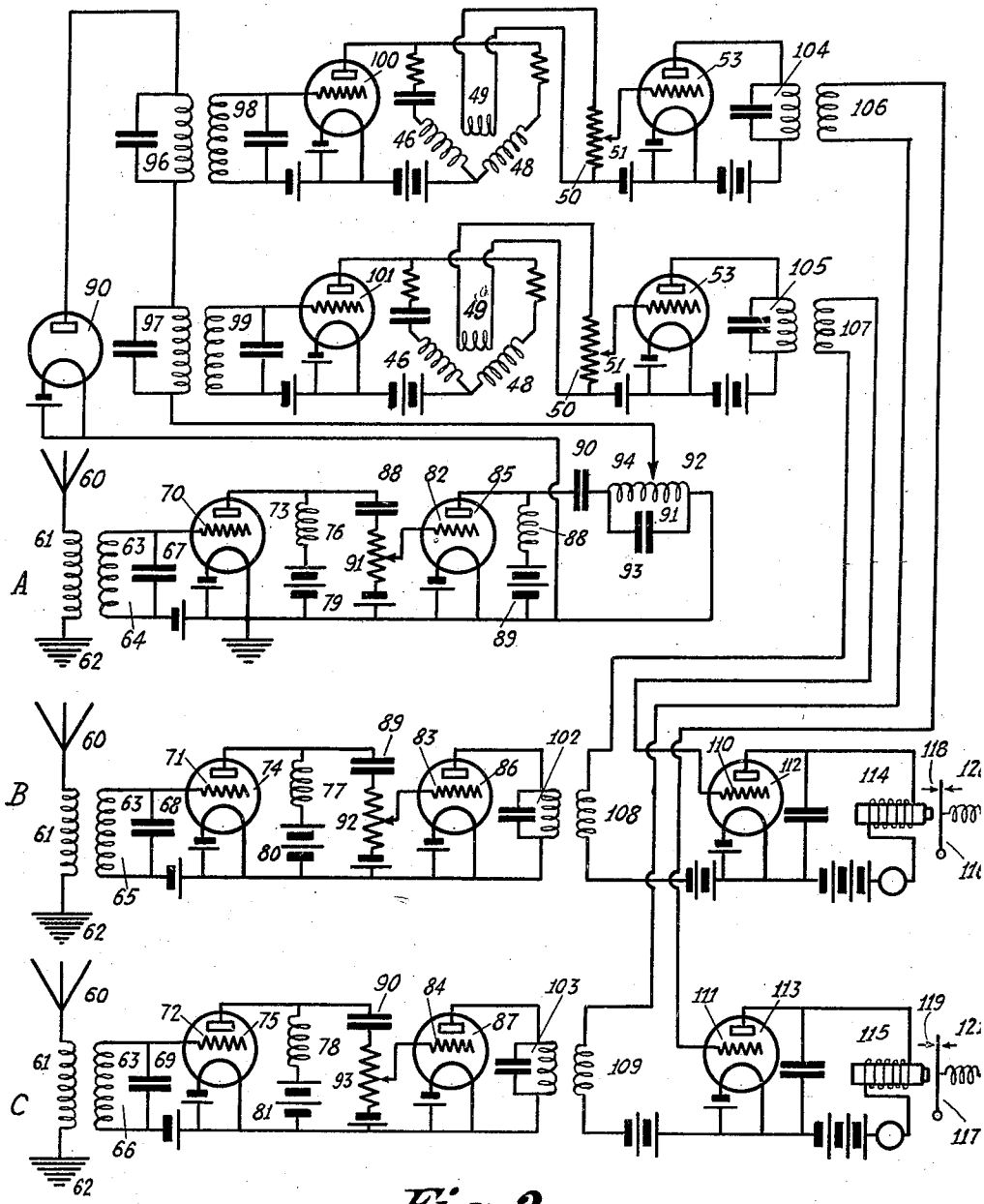


Fig. 2

INVENTOR
JOHN HAYS HAMMOND JR.
BY Ira J. Adams
ATTORNEY

July 28, 1931. J. H. HAMMOND, JR 1,816,579

RADIO COMMUNICATION SYSTEM

Filed Feb. 12, 1929 3 Sheets-Sheet 3

Fig. 3

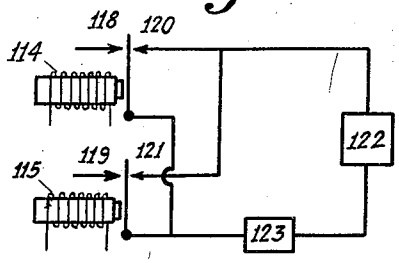


Fig. 6

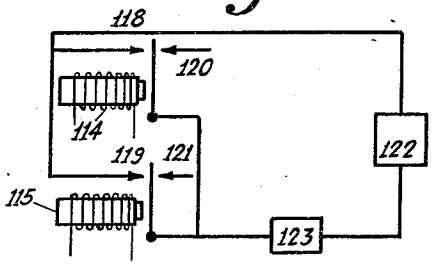


Fig. 4

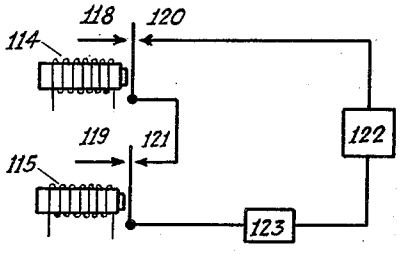


Fig. 7

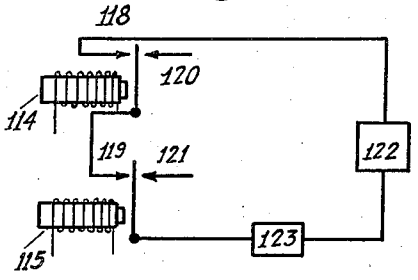


Fig. 5

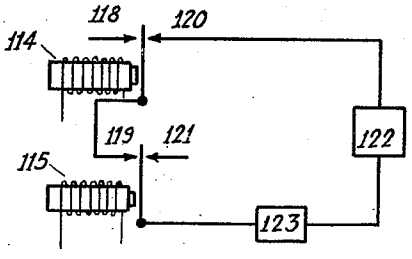
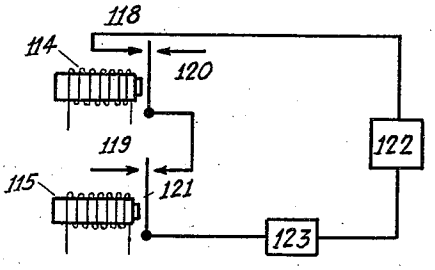


Fig. 8



INVENTOR
JOHN HAYS HAMMOND JR.
BY Jno J Adams
ATTORNEY

Patented July 28, 1931 1,816,579

UNITED STATES PATENT OFFICE

JOHN HAYS HAMMOND, JR., OF GLOUCESTER, MASSACHUSETTS

RADIO COMMUNICATION SYSTEM

Application filed February 12, 1929. Serial No. 339,329.

The object of this invention is to provide means whereby radio communication may be carried on between two parties without the knowledge of a third disinterested party. Another object of this invention is to provide a system of radio communication which shall be substantially free from interference, from static and other disturbances.

In accordance with the present invention, transmission is carried over a number of radio frequencies, the intensity and relative phase of each of which may be varied in various combinations in order to send signals. This invention relates to the provision of means for transmitting signals according to the variation of intensity or phase of any one of any number of the several components comprising the transmission.

In the embodiment shown, a plurality of frequencies are employed and variations in the relative intensity or variations in the relative phase of the various frequencies of the several emitted wave forms determines the operation of the indicating apparatus. While this system may be employed with as few as two carrier waves, it has been shown in the present embodiment with three carrier waves, the intensity of each of which may be adjusted in any appropriate manner and the phase of which may also be relatively adjusted as desired. Signals may be sent by any one of a plurality of changes in the transmission apparatus which will cause a recording or indicating action in the receiving apparatus.

In the specific embodiment shown, a carrier frequency is generated and from it are derived a plurality of harmonics which are properly amplified and adjusted as to phase and transmitted. The amount of transmission on each of the harmonic frequencies is adapted to be varied as well as the phase displacement relative to the carrier frequency transmitted.

In the receiving equipment the carrier frequency and each of the harmonic frequencies are received and the phase of the harmonic frequencies relative to the carrier frequencies is determined by deriving from said received carrier frequency each of the harmonic frequencies by a means similar to that employed in the transmitter and comparing the phase of the incoming harmonic frequencies with that of the locally generated harmonic frequencies.

Means are provided whereby when the received harmonic frequency and the locally produced harmonic frequency are different, an indication is manifested in an indicating apparatus which may either open or close a switch. A relay is provided for each of the harmonic frequencies employed and the varying combinations of the excited and non-excited relays will cause the off and on action of the recording instrument or the telephone as the case may be.

While I have described but a simple embodiment of my invention it is obvious that other and various embodiments may be employed utilizing the same general idea or invention and that other objects and uses of this invention will become apparent from the following specification when taken in connection with the appended claims.

The embodiment shown and illustrated for the purpose of illustration is set forth in the appended drawings in which:

Fig. 1 is a transmitter, Fig. 2 is a receiver, and Figs. 3 to 8 inclusive are various arrangements of the relay circuit for producing various combinations.

Referring now more particularly to Fig. 1 there is shown at 11 an oscillator of the ordinary and well known type, including the hot cathode 12 which is supplied by the battery 13 adjusted and regulated in the usual and well known manner. The plate circuit includes the plate 14 the choke coil 15 and the high potential source 16 and is adapted to supply the output inductance 17 through the condenser 18 with the high frequency current.

Inductively coupled to the inductance 17 is the grid inductance 19 which is adapted to impress upon the grid 20 the high frequency potential of the plate circuit in the usual and well known manner. The grid

circuit is completed through the parallel condenser 21 and resistance 22.

The output inductance 17 is included in a tank circuit 23 which also includes the condenser 24, the latter of which is adapted to tune the circuit to the desired carrier or fundamental frequency. The tank circuit 23 is adapted to supply the resonant circuits 25, 26 and 27 through the distortion rectifier tube 28 which comprises the hot cathode 29 and the plate or anode member 30. For this purpose the adjustable tap 31 on the inductance 17 is provided. The cathode 29 of the rectifier 28 is supplied by the low potential source 32 in the usual and well known manner.

For transferring energy from the resonant circuits 25, 26 and 27, the inductances of said circuits are inductively coupled to the inductances included in the circuits 33, 34, 35, respectively. The circuits 33, 34, 35 are each composed of an inductance and a capacity, the latter of which is adapted to tune the circuits respectively to the desired frequency. The frequency which said oscillatory circuits 33, 34 and 35 are adapted to radiate is either the frequency generated by the generator 11 or a harmonic of said frequency as desired. The circuits 33, 34 and 35 supply the grids 36, 37 and 38 of the amplifiers 39, 40 and 41 respectively, which latter are adapted to amplify the oscillations impressed thereon in the usual and well known manner.

The output of the amplifier 39 includes a plate member 42, the high potential source 43 and the two parallel connections, one composed of the resistance 44, the condenser 45, and the inductance 46, and the other parallel circuit composed of the resistance 47 and the inductance 48. The capacity 45 is for the purpose of producing a lead in the phase of the current in the coil 46 over that in coil 48 by approximately 90° so that by means of the pick-up coil 49 which may be rotated relative to the inductances 46 and 48 an oscillatory current having the desired phase relationship with respect to the phase in the output of the amplifier may be obtained.

The circuit of the pick-up coil 49 is completed through the potentiometer 50, the center or variable tap 51 of which is connected to, and adapted to supply a variable grid potential to the grid 52 of the amplifier 53.

Thus it can be seen that upon the grid of the amplifier 53 there is adapted to be impressed a high frequency potential both the relative phase and intensity of which may be varied as desired.

The plate of the amplifier 53 includes in its circuit the inductance 55 and the high potential source not numbered. The inductance 55 is adapted to supply the antenna inductance 56 with the high frequency which it is desired to transmit.

The antenna circuit includes the aforementioned inductance 56, the variable tuning inductance 57, the antenna 58 and the ground 59, and is thus adapted to be tuned to the frequency transmitted. The output circuit for the carrier frequency I have designated as A.

The phase adjustment, intensity regulating, amplifying and output circuits, corresponding to the amplifiers 40 and 41, are similarly constructed and are for the purpose of radiating properly adjusted harmonics of the carrier which is radiated at A. The antennæ systems are designated as B and C respectively.

Referring now more particularly to Fig. 2, there are shown antennæ circuits A, B and C, corresponding to the circuits A, B and C of the transmitter of Fig. 1. These antennæ circuits comprise the antennæ 60, the input inductance 61 and the ground 62. The inductance 61 is adapted to supply the secondary inductance 63 with the received high frequency. The inductances 63, 63, 63 are included in the input oscillatory circuits 64, 65 and 66 the frequency of which is adapted to be regulated by the condensers 67, 68 and 69 respectively. The oscillatory circuits 64, 65 and 66 are adapted to supply the high frequency oscillating current to the grids 70, 71 and 72 of the amplifiers 73, 74 and 75 respectively. The amplifiers 73, 74 and 75 include in their output circuits the inductances 76, 77 and 78 and the high potential sources 79, 80 and 81 respectively and are adapted to supply the grids 82, 83 and 84 respectively of the amplifiers 85, 86 and 87 through the condensers 88, 89 and 90 and the potentiometers 91, 92 and 93 respectively. The amount of the grid bias voltage is regulated by the adjustment of the center tap of the said potentiometer.

The output of the thermionic amplifier 85 includes besides the radio frequency choke 88 and the high potential source 89 the condenser 90 and the tank circuit 91 composed of the inductance 92 and condenser 93. The tank circuit 91 is adapted to be resonant to the carrier frequency and is adapted to supply the circuits 96 and 97 through the variable tap 94 and through the thermionic rectifier device 90. The circuits 96 and 97 are resonant to the same harmonic frequencies as those originally transmitted. The circuits 96 and 97 supply the tuned input circuits 98 and 99 of the amplifier devices 100 and 101 with the harmonic frequencies which are to be compared with the received harmonic frequencies.

The output circuits of the amplifier devices 100 and 101 are similar to the output circuits of each of the devices 39, 40 and 41 of Fig. 1 and include the two parallel cir-

cuits including the inductances 46 and 48, the phase of current in each of which is adapted to be displaced by approximately 90°. The pick-up coils 49, 49, are adapted to supply the amplifier devices 53, 53 through the potentiometer 50 and 51 by means of the variable tap 51 which latter is adapted to vary the strength of the bias voltage impressed upon the grid of said amplifier device.

The output circuits 102 and 103 of the thermionic devices 86 and 87 are resonant to the harmonic frequencies received through the antennæ B and C respectively and are adapted to supply the oscillations received to the link circuits which are related also to the two oscillatory output circuits 105 and 104 respectively of the devices 53. Thus there is presented to the grids 110 and 111 of the amplifier devices 112 and 113 respectively the sum or differences of the voltages impressed in said link circuits through the inductances 106 and 109 and 107 and 108 respectively, so as to compare both the phase and strength of the harmonic frequencies locally generated with the incoming harmonic signals.

The output circuits of the devices 112 and 113 each comprise a high potential source for supplying the electromagnets 114 and 115 respectively. The relay 114 comprises the movable armature 116 which is adapted to be in contact with either the contacts 118 or 120. The relay 115 is similarly provided with contacts 119 and 121 for contact with its armature 117.

The circuits connecting the contacts of the relays 114 and 115 are shown in detail in Figs. 3 to 8 inclusive.

Referring now more particularly to Fig. 3 there is shown the connection for the two relays so that an indicating device 122 is adapted to be connected in series with the local source 123 whenever either of the two relays 114 or 115 is unenergized.

Fig. 4 shows the connection arrangement for the two relays and the indicating device wherein the said indicating device 122 is adapted to be connected in series with the local source 123 only whenever both of the relays 114 and 115 are unenergized.

Fig. 5 shows the circuit connection whereby the indicating device 122 is adapted to be connected in series with the local source 123 only when the relay 114 is unenergized and the relay 115 is energized.

Fig. 6 shows the connections whereby the indicating device is adapted to be connected in series with the local source 123 whenever either of the two relays 114 and 115 are energized.

Fig. 7 shows the connections whereby the indicating device 122 is adapted to be connected in series with the local source 123 whenever both of the relays 114 and 115 are energized.

Fig. 8 shows the connections whereby the indicating device 122 is adapted to be connected in series with the local source 123 whenever the relay 114 is energized and the relay 115 is unenergized.

Having thus described this specific embodiment of my invention at length, I will now briefly describe its operation.

The tube generator 11 of Fig. 1 generates a current of fundamental frequency N. From the tank circuit 17 in the output of this generator the voltage is tapped off to deliver pulses of current to the rectifying tube 28 through the tuned circuits 25, 26 and 27 which in connection with their tuned secondaries deliver voltage of the fundamental frequency N, and various harmonic frequencies, to the grid of the amplifier tubes 39, 40 and 41 respectively. The output circuits of these tubes each include a phase splitter whereby the current in the coil 46 is at phase quadrature with that in coil 48 and by means of which the rotatable coil 49 may have impressed therein a current of any phase whatsoever and deliver through the potentiometer 50 an oscillating voltage to the grid of the amplifier 53. The amount of voltage impressed upon the grid of said amplifier is adapted to be varied by the tap 51 to transmit varying amounts of radio energy in the desired phase.

It can thus be seen that in the transmitter shown for puposes of illustration the antenna system A may transmit a fundamental or carrier frequency, the antenna system B may transmit the second harmonic or double frequency and the antenna C may transmit the third harmonic or triple frequency. It is understood that the phase and strength of the signals sent from each of the antenna systems may be varied in any desired combination and in a predetermined manner to send code messages. The fundamental and harmonic frequencies transmitted by the antennæ A, B and C of Fig. 1 are adapted to be received on the corresponding antennæ A, B and C of Fig. 2 and to be transferred to the inputs of the thermionic amplifier devices 73, 74 and 75 respectively. The output of the amplifier device 73 is impressed through the rectifier tube 90 upon the harmonic tank circuits 96 and 97 which will select out the second and third harmonic of the rectified energy. These harmonics are then amplified by means of the amplifiers 100 and 101 and the phase of the output is adjusted in a manner similar to that in which the output of the amplifiers of the Fig. 1 is adjusted in any desired manner. The strength of the harmonic frequency produced by the rectifier 90 is adapted to be varied by the potentiometer tap 51 which

constitutes the input of the amplifier device 53.

The antenna systems B and C pick up the originally transmitted harmonic frequencies and through the proper amplifying devices present them to the link circuit by means of which the transmitted and the locally generated harmonic frequencies are compared and either added or subtracted with respect to each other.

When the received harmonic energy and that produced by the received carrier frequency are in opposition a zero result can be made to obtain in the output of the amplifier device 112. The same may be had with respect to the amplified device 113. Variation of either the amplitude or phase of the radiations of the antenna of Fig. 1 will cause the prearranged balance to be thrown out and cause energy to be supplied through the two amplifier tubes 112 and 113. The relays 114 and 115 are thus actuated independently or together depending upon the combination of alterations at the transmitter.

If after the transmitter and receiver are balanced so that when it is desired to send no signal neither of the relays 114 or 115 are energized, an alteration of either the phase or the amplitude of the transmission of antenna A will result in throwing off both of the harmonics produced by means of the received carrier frequency at the receiver of Fig. 2 and thus cause both of the relays to be operated. Similarly alterations of both of the outputs of antennæ B and C of Fig. 1 relative to the output of antenna system A of Fig. 1 will cause the input harmonic frequency of B and C in the receiver of Fig. 2 to be varied with respect to the locally generated harmonic frequencies as produced by the input of the carrier frequency through the distortion tube 90 and thereby actuate both of the relays. Variation of the phase or amplitude of the output of the antenna system B or C with the output of antenna system and the carrier frequency of A and either C or B remaining constant will result in the operation of the relay 114 or 115 respectively in a similar manner. Alteration of either the frequency and/or amplitude of the outputs of antenna A and either of B and C of the transmitter will result in the operation of the relays 115 or 114 of the receiver respectively.

For transmitting messages selective means are provided which may work any of the above noted alterations and thereby cause an abnormality in the output of the three antennæ A, B and C of Fig. 1 means may be provided by a switch subject to manual or mechanical control at stated intervals of time which will connect the key of the operator for instance first with the coil 49 in the carrier frequency transmitter then after that with the tap 51 of the third harmonic transmitter B or any other desirable combination which may cause an abnormality or indeed the keying may be so arranged that except when the signal is being sent the transmission on all of the systems is abnormal and then when the key is pressed they all become normal and either of the relays 114 or 115 at the receiver are operated.

At the receiving end connections are provided with the contact of the relays 114 and 115 as shown in Figs. 3 to 8 inclusive. Means may be provided for altering the connections to the relay contact from that shown in Fig. 3 to any of the other arrangements shown in Figs. 3 to 8 either at will of the operator in accordance with the predetermined schedule or mechanically in accordance with a predetermined cycle.

Using, for instance, the combination of contact circuits shown in Fig. 3, an indication will be obtained when the transmission on channels A and B is normal and the transmission on channel C is abnormal or when the transmission on channels A and C is normal and that on channel B is abnormal or when the transmission on all channels A, B and C is normal.

An indication of the arrangement shown in Fig. 4 is obtained only when the transmission of channels A, B and C are all normal.

On the arrangement shown in Fig. 5 it is evident that the indicating device 122 will be excited only when the transmission from A and B is normal while the transmission from C is abnormal.

The indicator shown in the arrangement shown in Fig. 6 will be actuated whenever any change is made or any abnormality exists in the transmitter whatsoever, the indicator remaining off only when all of the transmissions are normal.

The indicator of the arrangement shown in Fig. 7 will be operated when the transmission on A, B and C is abnormal, when the transmission on channels A and C is abnormal and the transmission on channel B is normal, when the transmission on channels A and B is abnormal and that on channel C is normal, when the transmission on channel A is abnormal and that on B and C is normal, or when the transmission on channel A is normal and that on B and C is abnormal.

The indicator 122 of the arrangement shown in Fig. 8 will be operated when the transmission transmitted on channels A and C is normal while that of channel B is abnormal.

Thus with the arrangement as shown in Fig. 6 the particular variation undertaken at the receiver is not important and it would be unnecessary to change the receiving relay combination under any circum-

stances. In operation the transmitter will have a normal setting of phase and amplitude controls which, however, may be changed from day to day or at other intervals if desired. The receiver will be set in operation and through controls provided may be so adjusted that harmonic voltages to the grids of tubes 112 and 113 will be zero as indicated by minimum plate current of these respective tubes giving "off" connections to the relays.

From the above explanation it is evident that unauthorized transmitters not possessed of the schedule and not knowing the phase and amplitude combinations could not produce an "on" signal on a receiver constructed as disclosed in accordance with my invention. It is also evident that unauthorized receivers even of the same type would not know what combination of relay connections would be necessary to produce an "on" signal. Therefore, this system readily lends itself secrecy as well as freedom from malicious interference. In this latter respect it is particularly useful in the control of dirigible bodies by radio.

It is to be understood, of course, that the use of this invention is not limited as to the number of harmonics used nor need the plurality of radiated waves necessarily bear a harmonic relationship. Also it is to be understood that the indicating circuit need not be limited to the type shown as it will be understood that beat reception methods may be employed.

It is to be understood that a great number of variations in the transmitting and receiving equipment and various combinations thereof may be made still remaining within the scope of the invention disclosed above. Therefore, I do not desire to be limited by the specific embodiment shown but rather to the scope of said invention as indicated in the appended claims.

It is to be understood further that the system of transmission and reception herein disclosed is equally applicable to transmission and reception by the methods of wire radio communication.

I claim:

1. The method of secret radio communication which comprises generating a plurality of related frequencies, radiating each of said frequencies, sending a message by altering the relationship of certain of said frequencies as to phase and amplitude, receiving said transmitted frequencies, reproducing several of the transmitted frequencies at said receiver from one of said received frequencies, comparing the other of said received frequencies with the frequencies generated from said first received frequency, and controlling an indicating means thereby in accordance with the alterations at said transmitter.

2. The method of secret radio communication which comprises generating a plurality of related frequencies controllable as to phase and amplitude, radiating each of said frequencies, sending a message by altering the relationship of certain of said phases and amplitudes, receiving each of said transmitted frequencies, reproducing certain of said transmitted frequencies by the reception of one of said frequencies, comparing the other received frequencies with the frequency generated from said first mentioned received frequency, and controlling an indicating device thereby in accordance with the alterations as to phase and amplitude at the transmitter.

3. The method of secret radio communication which comprises generating a carrier frequency, distorting said carrier frequency to produce a plurality of harmonic frequencies, transmitting said carrier frequencies, transmitting the harmonic frequencies, sending a message by the alteration of the phases and amplitudes of the said harmonic frequencies relative to said carrier frequency, receiving each of the frequencies thus transmitted, from said received carrier frequency reproducing each of said harmonic frequencies, comparing the received harmonic frequencies with the locally produced harmonic frequencies and operating an indicating device by the differential of said frequencies.

4. The method of secret radio communication which comprises generating a carrier frequency, generating a plurality of harmonic frequencies therefrom, transmitting each of said frequencies, sending a message by alteration of the phase or amplitude of various of said frequencies, receiving each of the frequencies thus transmitted, reproducing each of said harmonic frequencies from the received carrier frequency, comparing the received harmonic frequencies with the locally produced harmonic frequencies, and operating an indicating device by the differential action of said locally produced and transmitted and received harmonic frequencies.

5. The method of secret radio communication which comprises generating a carrier frequency, distorting said carrier frequencies to produce a plurality of harmonic frequencies, transmitting said carrier frequencies, adjusting the relative phase and amplitudes of the harmonic frequencies generated, transmitting the adjusted harmonic frequencies, sending a message by alteration of the phase and amplitudes of said harmonic frequencies relative to said carrier frequency, receiving each of the frequencies thus transmitted, reproducing said harmonic frequencies from said received carrier frequency, adjusting the phases and amplitudes of the harmonic fre-

quencies thus produced, comparing the received harmonic frequencies with the respective locally produced harmonic frequencies, and operating an indicating device by the differential of said locally produced and said transmitted harmonic frequencies.

6. A receiver adapted to receive waves of a plurality of frequencies comprising, means for receiving each of said plurality of radio frequencies, means for producing from one of said radio frequencies the remaining radio frequencies, means for matching said locally produced radio frequencies with said received radio frequencies, and means for indicating differences existing between the said received radio frequencies and said locally generated frequencies to receive a message.

7. The apparatus for secret radio communication which comprises a transmitter and a receiver, said transmitter being composed of means for generating a carrier frequency, means for distorting said carrier frequency to produce therefrom a plurality of harmonic frequencies, means for amplifying said carrier frequencies and the harmonics thus generated, means for adjusting the relative phases of said carrier frequencies and said harmonic frequencies, means for amplifying said relatively adjusted frequencies, means for regulating the amount of amplification at each of said frequencies, and means for transmitting each of said frequencies, and said receiver comprising means for receiving each of the transmitted frequencies, means for amplifying each of the received frequencies, means for adjusting the amplitudes of each of said received frequencies, means for producing from said received and amplified carrier frequencies a distortion wave from which harmonics may be reproduced, means for reproducing harmonic frequencies from said distortion wave, means for amplifying said harmonic frequencies, means for adjusting the phase relationship of said harmonic frequencies, with respect to said carrier frequencies, means for adjusting the amplitude of said harmonic frequencies, means for comparing the locally produced harmonic frequencies and the received harmonic frequencies as to phase and amplitude, means for indicating the relationships of said phases and amplitudes, and means for operating a final indicating device in accordance with various positions of said last mentioned means.

8. Apparatus for secret radio communication which comprises a transmitter and receiver, said transmitter being composed of a thermionic oscillation generator for generating a carrier frequency, thermionic rectifier means for distorting said carrier frequency to produce therefrom a plurality of harmonic frequencies, amplifier devices for amplifying said carrier frequencies and the harmonic frequencies thus generated, phase shifting devices for adjusting the relative phases of said carrier frequencies and harmonic frequencies, thermionic means for amplifying the relatively adjusted frequencies, grid biasing means for adjusting the amplitude of each of said frequencies upon amplification, and an antenna circuit for transmitting each of said frequencies, and said receiver comprising antenna circuits for receiving each of the transmitted frequencies, thermionic amplifying devices for each of the received frequencies, grid biasing means for adjusting the amplitudes of the frequencies resulting from said amplification, thermionic rectifier means for producing from said received and amplified carrier frequency a distortion wave from which harmonics may be produced, a plurality of circuits resonant to each of said harmonic frequencies for producing said harmonic frequencies from said distortion wave, thermionic amplifying devices for amplifying said harmonic frequencies, phase shifters for adjusting the phase relationship of said harmonic frequencies with respect to said carrier frequencies, grid biasing means for adjusting the amplitudes of said harmonic frequencies when they are being amplified, a linked circuit for feeding said received and locally produced harmonic frequencies in differential relation to a thermionic amplifying device, a relay for indicating the relationship of the phases and amplitudes of said received and locally generated harmonics, and connections to said relays for operating an indicating device in accordance with various positions of said relays.

9. Apparatus for secret radio communication which comprises in combination, a transmitter, and a receiver, said transmitter being composed of means for generating a carrier frequency, means for distorting said carrier frequency to produce therefrom a plurality of harmonic frequencies, means for amplifying said carrier frequency and the harmonic frequencies thus generated, means for adjusting the relative phases of said carrier frequency and said harmonic frequencies, means for amplifying said relatively adjusted frequencies, means for regulating the amount of amplification at each of said frequencies to send a signal, and means for transmitting each of said frequencies, and said receiver comprising means for cooperating with said transmitter to receive the energy thus transmitted and detect the amount of amplification to receive the signal.

10. Apparatus for secret radio communication which comprises in combination, a transmitter and a receiver, said transmitter comprising means for radiating a plurality of related high frequencies variously varied as regards phase and amplitude to transmit

a signal, and said receiver comprising means for receiving each of the plurality of transmitted frequencies, means for amplifying each of the received frequencies, means for adjusting the amplitude of each of the received frequencies, means for producing from said received and amplified carrier frequency a distortion wave from which harmonic frequencies may be produced, means for producing harmonic frequencies from said distortion waves, means for amplifying said harmonic frequencies with respect to said carrier frequency, means for adjusting the amplitudes of said harmonic frequencies, means for comparing the locally produced harmonic frequencies and the received harmonic frequencies as to phase and amplitude, means for indicating the relationship of said phases and amplitudes, and means for operating a final indicating device in accordance with various positions of said last mentioned means, to receive said signals.

11. Apparatus for secret radio communication which comprises in combination, a transmitter and a receiver, said transmitter being composed of a high frequency generator for generating a carrier frequency, means for producing a plurality of harmonic frequencies, amplification means for amplifying said carrier frequency and the harmonic thus generated, phase changing means for adjusting the relative phases of said carrier frequencies and harmonic frequencies, thermionic devices for amplifying the relatively adjusted frequencies, grid biasing means for regulating the amount of amplification of each of said frequencies to send a signal, and an antenna system for transmitting each of the said adjusted frequencies, and said receiver comprising means for cooperating with said transmitter to receive the energy thus transmitted and detect the signal.

12. Apparatus for secret radio communication which comprises in combination, a transmitter and a receiver, said transmitter comprising means for radiating a plurality of related high frequencies varied variously as respects relative phase and amplitude to send a signal and said receiver comprising antenna circuits for receiving each of the transmitted frequencies, means for amplifying each of the received frequencies, means for adjusting the amplitudes of each of the received frequencies, rectification means for producing from said received carrier frequencies a plurality of harmonic frequencies, thermionic devices for amplifying said harmonic frequencies, phase shifting means for adjusting the phase relationship of said harmonic frequencies with respect to carrier frequency, means for adjusting the amplitudes of each of said harmonic frequencies, a link circuit for impressing differentially the locally produced harmonic frequencies and the received harmonic frequencies upon the grid of a thermionic device, relay devices in the plate circuit of said thermionic device for indicating the relationship of the phase and amplitude of the received and locally generated harmonic frequencies, circuit connections for each of said relays for operating a final indicating device in accordance with the various positions of said relays, to indicate said signal.

13. A receiver adapted to receive waves of a plurality of harmonic frequencies including the fundamental frequency comprising antennæ circuits for receiving each of said frequencies, rectifier means for producing harmonic frequencies from the received fundamental frequencies, a link circuit adapted to impress upon the grid of the thermionic amplifying device the locally produced frequencies and the received frequencies, relays in the output of each of said thermionic devices for indicating the differences existing between said received frequencies said locally generated frequencies to receive a message.

14. Apparatus for secret radio communication which comprises a transmitter and a receiver, said transmitter being composed of means for generating and radiating a plurality of normally related radio frequencies and means for altering the relationship of certain of said frequencies to send a message, and said receiver comprising means for receiving each of said frequencies and producing from one of said frequencies each of the remaining frequencies and means for comparing the locally generated frequencies with said received frequencies to receive said message.

JOHN HAYS HAMMOND, Jr.