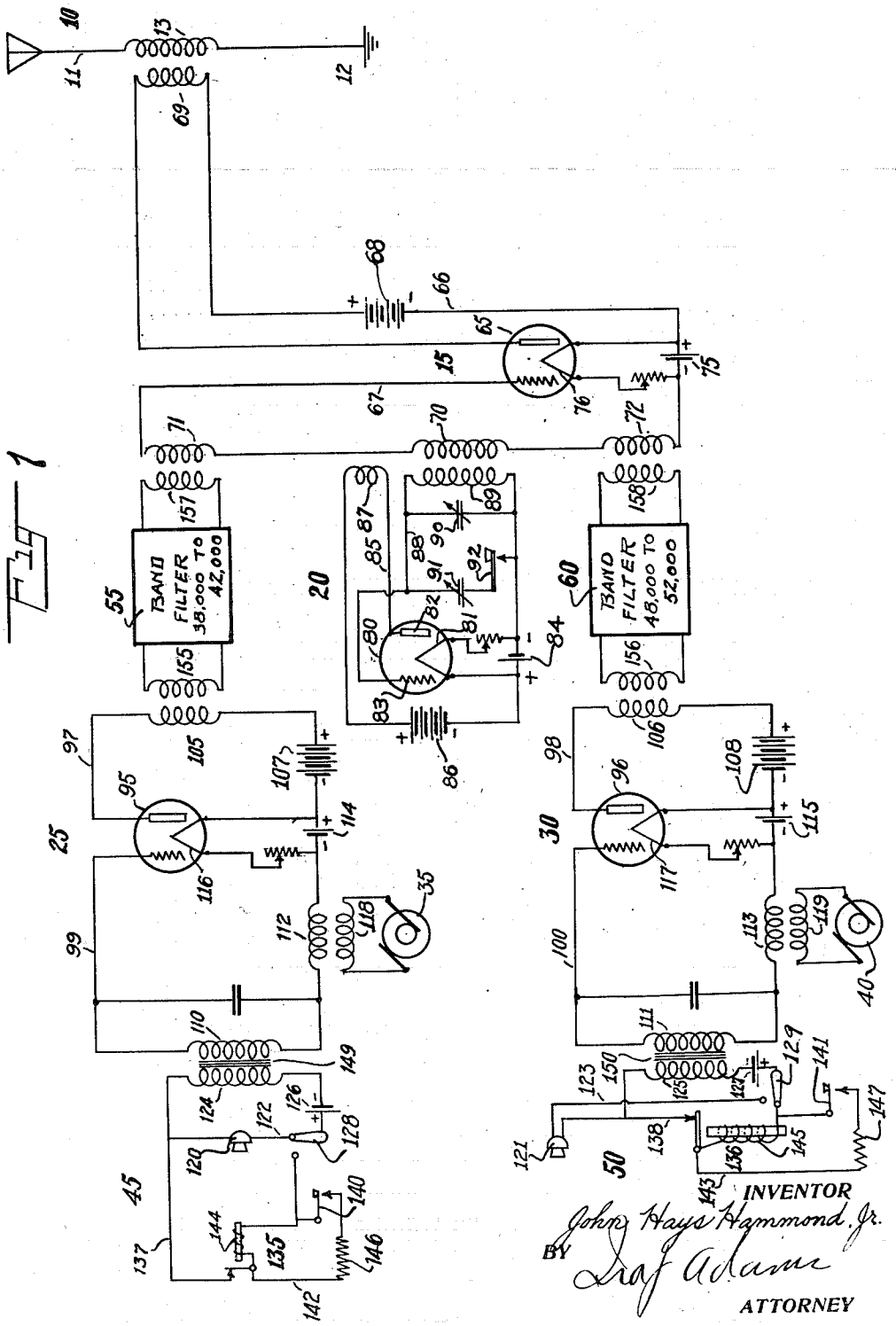
Dec. 24, 1929. J. H. HAMMOND, JR 1,740,859

SYSTEM OF SECRET RADIANT TELEPHONY AND TELEGRAPHY

Filed Feb. 21, 1924 2 Sheets-Sheet 1

Fig. 1



INVENTOR
John Hays Hammond, Jr.
BY Raf Adams
ATTORNEY

Dec. 24, 1929. J. H. HAMMOND, JR 1,740,859

SYSTEM OF SECRET RADIANT TELEPHONY AND TELEGRAPHY

Filed Feb. 21, 1924 2 Sheets-Sheet 2

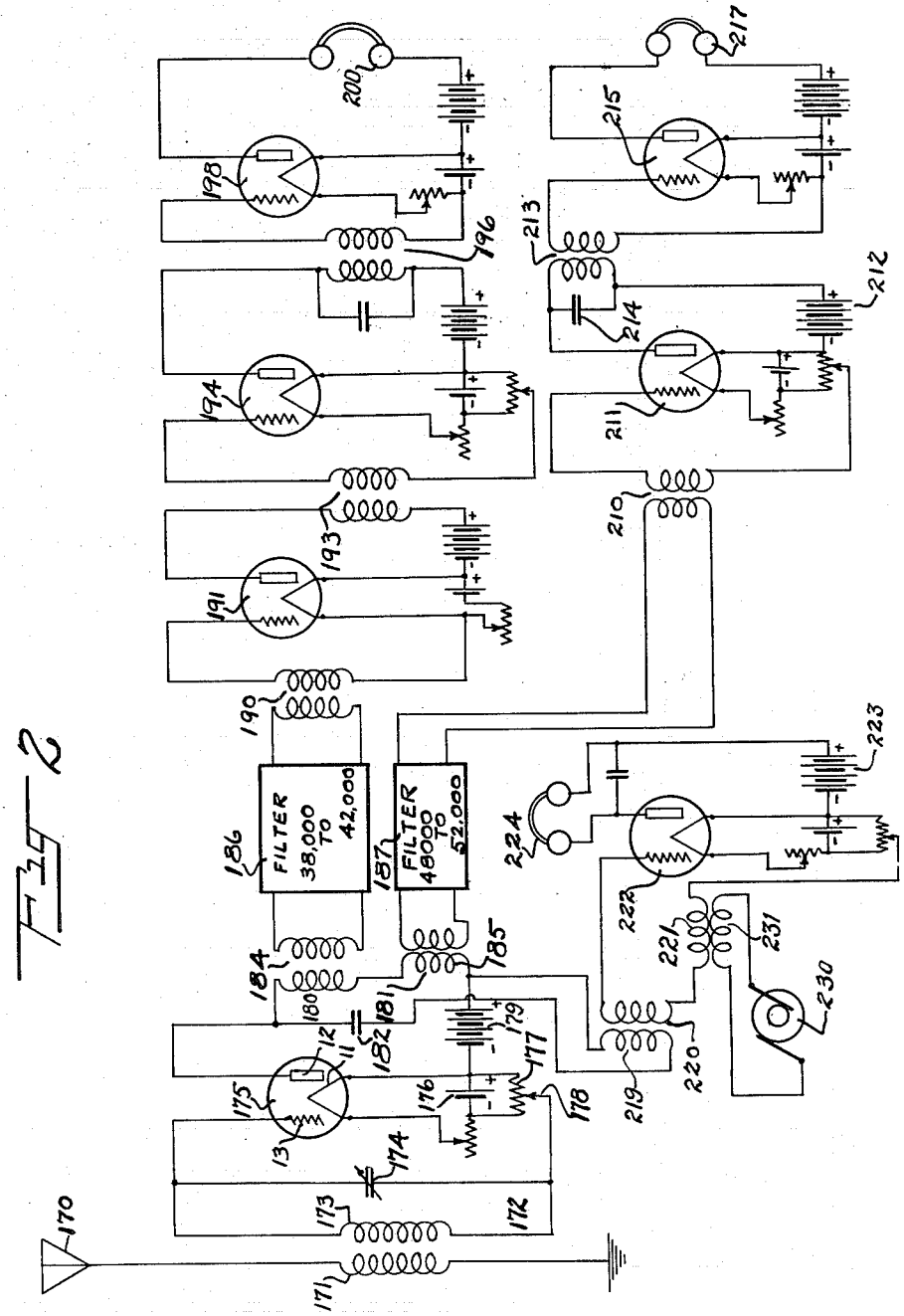


Fig 2

INVENTOR
John Hays Hammond, Jr.
BY Raf Adams
ATTORNEY

Patented Dec. 24, 1929 1,740,859

UNITED STATES PATENT OFFICE

JOHN HAYS HAMMOND, JR., OF GLOUCESTER, MASSACHUSETTS

SYSTEM OF SECRET RADIANT TELEPHONY AND TELEGRAPHY

Application filed February 21, 1924. Serial No. 694,205.

Some of the objects of this invention are to provide an improved transmission system for signalling; to provide a corresponding improved receiving system; to provide an improved radio transmission system and a corresponding radio receiving system, whereby a high degree of secrecy of operation may be insured; to provide an improved multiplex system of signalling and to provide other improvements as will appear hereinafter.

The system of this invention includes a transmission system which generates a carrier wave of relatively high frequnecy upon which are impressed a plurality of series of amplitude variations of different supersonic frequencies respectively, each lower than the carrier wave frequency. The plurality of series of amplitude variations may each be modulated by and in accordance with speech to form a telephone message or may be modulated by a current of variable audible frequency to form a telegraph message. Also the frequency of the carrier wave may be varied to form a telegraph message. The receiving system of this invention has been designed for selectively receiving the various messages transmitted from the sending station.

In the accompanying drawings Fig. 1 is a diagram of one form of transmission system constructed in accordance with this invention; and Fig. 2 is a diagram of a corresponding receiving system constructed in accordance with this invention.

Referring to Fig. 1, one form of transmission system constructed in accordance with this invention comprises an open aerial circuit 10, including an antenna 11, grounded as at 12 through a coil 13; a main modulating system 15; a main source of oscillations 20; a plurality of secondary modulating systems 25 and 30; a corresponding plurality of secondary sources of oscillations 35 and 40; a corresponding plurality of signalling systems 45 and 50; and a corresponding plurality of band filters 55 and 60.

The main modulating system 15 comprises a three-electrode thermionic modulator 65 of well-known construction, having a plate or output circuit 66 and a grid or input circuit 67. The plate circuit includes a battery 68, and a coil 69 inductively coupled to the coil 13 of the aerial circuit. The grid circuit 67 includes three coils 70, 71 and 72. A battery 75 is arranged to heat the filament electrode 76.

The main source of the oscillations 20 is designed to produce a carrier wave having a variable high frequency, for instance a normal frequency of 1,010,000 per second variable at will for instance to a frequency of 1,000,000 per second. The source shown includes a three electrode thermionic oscillator 80 of well-known construction including a filament 81, a plate 82, and a grid 83. A battery 84 is arranged to heat the filament 81. The oscillator 80 is provided with plate or output circuit 85 including a battery 86 and a coil 87. The oscillator 80 is also provided with a grid circuit 88 including a coil 89, which is inductively coupled to the coil 70 of the grid circuit of the main modulator 65. Also, for the purpose of regeneration, the coil 89 of the grid circuit is inductively coupled to the coil 87 of the plate circuit of the oscillator. Two variable condensers 90 and 91 are in shunt with the coil 89, and, for the purpose of sending telegraph messages by varying the frequency of the oscillator one, 91, of these condensers is controlled by a key 92. These elements are so selected, arranged and adjusted that normally, when the key 92 is open, oscillations of a frequency of for instance 1,010,000 per second will be produced, and so that when the key 92 is closed oscillations of for instance 1,000,000 per second will be produced.

The two secondary modulating systems 25 and 30 comprise respectively two three-electrode thermionic modulators 95 and 96 of well-known construction and having respectively plate circuits 97 and 98, and grid circuits 99 and 100. The plate circuits include respectively two coils 105 and 106 and two batteries 107 and 108. The grid circuits 99 and 100 include respectively two coils 110 and 111, and two coils 112 and 113. Batteries 114 and 115 are arranged to heat respectively the two filaments 116 and 117.

The two secondary sources of oscillations 35 and 40 are arranged to produce respectively two series of electrical oscillations of two supersonic frequencies differing by a frequency equal to the difference in frequency in the carrier wave produced by opening or closing the key 92, these two supersonic frequencies being for instance 40,000 and 50,000 respectively when the key 92 causes a difference of 10,000 in the carrier wave frequency. As shown these two secondary sources of oscillations comprise respectively two alternators 35 and 40 having output circuits including respectively two coils 118 and 119, which are inductively coupled respectively to the coils 112 and 113 of the two secondary modulators 95 and 96.

In practice it may be found desirable first to select the frequencies of the two secondary generators 35 and 40 and then adjust the condenser 91 so as to make the change in radio or carrier wave frequency due to the opening and closing of the key 92 equal to the difference between the frequencies of the secondary generators. The adjustment of the condenser 90 determines the normal or higher frequency of the carrier wave.

The two signalling systems 45 and 50 comprise means for sending either simultaneously or selectively two telephone messages including respectively two telephone transmitters 120 and 121, arranged respectively in circuits 122 and 123, including respectively two coils 124 and 125, two batteries 126 and 127, and two switches 128 and 129. The two signalling systems 45 and 50 also comprise means operative in alternation with the telephone transmitters for sending either simultaneously or selectively two telegraph messages, including respectively two buzzers or tone producers 135 and 136, which are respectively in circuits 137 and 138 shunted around the two telephone transmitters 120 and 121 and controlled respectively by the switches 128 and 129. The arrangement is such that the two switches 128 and 129 may be used either to render the telephone transmitters 120 and 121 operative, and the buzzers 135 and 136 inoperative, or to render the buzzers operative and the telephone transmitters inoperative. Two telegraph keys 140 and 141 are arranged respectively in circuits 142 and 143 shunted around the coils 144 and 145 of the electromagnets of the buzzers, and contain respectively resistances 146 and 147, which are so proportioned that when either key 140 or 141 is closed the tone produced by the corresponding buzzer will be appreciably lowered from that produced when the key is open and will have a higher degree of audibility. For instance each buzzer may have a normal frequency of 2000 vibrations per second when the corresponding key is open and a frequency of 1000 when the key is closed. The coils 124 and 125 of the two signalling systems are inductively coupled respectively to the coils 110 and 111 of the modulators 95 and 96, iron cores 149 and 150 being preferably placed between the two pairs of coils respectively for increased efficiency. When the switches 128 and 129 are in proper positions the keys 140 and 141 may be operated in accordance with the dots and dashes of the telegraph code to send telegraph messages.

For receiving the output of the two secondary modulators 95 and 96 and for filtering and transmitting the filtered product to the input circuit of the main modulator 65, the two band filters 55 and 60 are provided, and these are provided respectively with input circuits having coils 155 and 156, inductively coupled respectively to the coils 105 and 106 of the secondary modulators 95 and 96, and with output circuits including respectively two coils 157 and 158 inductively coupled respectively to the coils 71 and 72 of the main modulator 65. The secondary filters 55 and 60 may be of any well-known or suitable construction, and for the secondary oscillator frequencies and buzzer frequencies mentioned may be constructed to let pass respectively through one filter, 55, only currents of frequencies between 38,000 and 42,000 both inclusive, and through the other filter, 60, only currents of frequencies between 48,000 and 52,000 both inclusive. But one or both of these filters may be omitted, and, instead, the two coils 105 and 106 may be inductively coupled directly to the coils 71 and 72 respectively.

Referring to Fig. 2, one form of receiving system constructed in accordance with this invention comprises an open aerial receiving circuit 170 including a coil 171 which is inductively coupled to a closed oscillatory circuit 172, including a coil 173 and a variable condenser 174. The closed circuit 172 is tuned to respond to the wave frequency or frequencies of the energy received by the open circuit 170 from the transmission system of Fig. 1, for instance to respond selectively to frequencies of 948,000 to 1,062,000 cycles per second. The open circuit 170, 171 is arranged to respond to the same frequencies and may be either tuned or untuned.

The closed circuit 172 is arranged to control a three electrode thermionic detector or demodulator 175 of well-known construction including a filament 11, a plate 12 and a grid 13. The filament 11 is heated by a battery 176. In shunt with the filament circuit is a potentiometer 177 having a slider 178 connected to the closed circuit 172 whereby the normal potential of the grid 13 may be adjusted. The plate circuit is provided with the usual plate or "B" battery 179.

For selecting and segregating any messages which may be received from the two signalling systems 45 and 50 of Fig. 1, and

for separating the same one from the other and both from any message which may be received due to the action of the signalling device or key 92 of Fig. 1 whereby the frequency of the carrier wave may be varied, the output circuit of the detector 175 includes two inductances 180 and 181 in series, and having in shunt therewith a by-pass containing a high frequency condenser 182. The inductances 180 and 181 form respectively primary windings of coupling transformers 184 and 185 whereby the output circuit of the detector 175 is coupled to a pair of differently characterized band filters 186 and 187, constructed to let pass respectively only the two series of impulses due to the two secondary oscillators 35 and 40 and corresponding signalling systems 45 and 50.

One filter, 186, is arranged to act through a coupling 190 to control a three electrode thermionic amplifier 191 which acts through a coupling 193 to control a three electrode therminoic detector 194 which acts through a coupling 196 to control a three electrode thermionic amplifier 198 having in its output circuit a telephone receiver 200 or other suitable indicating device.

The second filter, 187, is arranged to act through coupling 210 to control a three electrode thermionic detector 211 which controls a three electrode thermionic amplifier 215 which controls a telephone receiver 217 or other indicating device.

For detecting any message that may be received due to the action of the key or signalling device 92 of Fig. 1 whereby the frequency of the carrier wave may be varied, a coil 219 is arranged in the bypass containing the condenser 182 and is inductively coupled to a coil 220 in a circuit including a coil 221 and controlling a three electrode thermionic detector 222 having an output circuit containing the usual "B" battery 223, and a telephone receiver 224 or other indicating instrument. A local source of oscillations 230 is arranged to act through a coil 231 inductively coupled to the coil 221 to produce in the input circuit of the detector 222 oscillations differing in frequency by an audible frequency from the frequency of the impulses received in the input circuit due to the closing of the telegraph key 92 of the transmitting system of Fig. 1 so that when these local oscillations are combined with the incoming oscillations due to the closing of the key 92 audible beats will be produced in the telephone receiver 224 and the telegraph message of the key 92 thereby indicated. For instance the local source of oscillations 230 may be arranged to produce oscillations either of 999,000 or of 1,001,000 frequency per second which will unite with the received oscillations to produce a tone of about 11,000 vibrations per second in the telephone receiver 224 when the key 92 is open and to produce a tone of 1,000 vibrations per second in the teleprone receiver 224 when the key 92 is closed.

In the operation of the transmitting system shown in Fig. 1, either a telephone message or a telegraph message may be sent at any time by utilizing either of the two signalling systems 45 or 50, or at any time two messages, both telephonic, or both telegraphic, or one telephonic and the other telegraphic, may be sent simultaneously by utilizing both signalling systems 45 and 50, and also at any time a telegraph message may be sent by utilizing the key 92 or other signalling device, whereby the frequency of the carrier wave is varied to form a message.

A telephone message may be sent at any time by utilizing either telephone transmitter 120 or 121, the corresponding switch 128 or 129 having been properly adjusted. The telephone transmitter 120 or 121, acting in response to voice waves produces through the coil 124 or 125 electrical oscillations or variations having an audible frequency usually varied between the extremes of 200 and 2,000 variations per second, and these produce in the input circuit of the corresponding secondary modulator 95, or 96, oscillations of the same frequency and character. At the same time inaudible oscillations of 40,000 or 50,000, per second are produced in the same circuit by the corresponding secondary oscillator 35 or 40. These oscillations, audible and inaudible, act through the secondary modulator 95 or 96 to produce in the output circuit thereof a plurality of series of supersonic oscillations or variations having supersonic frequencies in a band between 38,000 and 42,000, or between 48,000 and 52,000 per second, as the case may be, and possibly some other frequencies, for instance harmonics of the band frequencies. These oscillations within the band mentioned act through the corresponding band filter 55 or 60 to produce corresponding oscillations or variations in the circuit of the main modulator 65, and these act in co-operation with the carrier wave or oscillations of a frequency, for instance, of 1,010,000 or 1,000,000 per second produced inductively in the input circuit of the main modulator 65 by the master oscillator 20, to produce in the carrier wave corresponding amplitude variations and consequently to produce in the output circuit of the main modulator 65 a plurality of series of oscillations of resultant frequencies, which cause the aerial 11 to emit corresponding radiant oscillations which act to reproduce in the corresponding telephone receiver 200 or 217 of the receiving system of Fig. 2, or other suitable system, the telephone message transmitted, as will appear hereinafter.

By a process similar to that just described for telephony, a telegraph message may be sent by using either of the telegraph keys 140

or 141 of Fig. 1, the corresponding switch 128 or 129 having been suitably adjusted. In Fig. 1 the switch 129 is adjusted for utilizing the telegraph key 141. When the telegraph key 140 or 141 is open the corresponding buzzer 135 or 136 produces interruptions, for instance of 2,000 per second in the current through the corresponding coil 124 or 125, and these co-operate with the oscillations of 40,000 or 50,000 per second produced by the corresponding secondary oscillator 35 or 40, to produce in the output circuit of the corresponding secondary modulator 95 or 96 resultant oscillations or impulses of a corresponding band of frequencies and these act through the corresponding filter to produce corresponding amplitude variations in the carrier wave being generated inductively in the input circuit of the main modulator 65 by the main source of oscillations 20. The carrier wave thus varied will act through the main modulator 65 to cause the aerial to emit corresponding radiant oscillations which will act to produce at the corresponding telephone receiver 200 or 217 of Fig. 2, as will appear hereinafter, an audible tone of substantially the same frequency, for instance 2,000 per second, as the interruptions of the corresponding buzzer. This tone will be lowered in frequency, for instance to about 1,000 frequency, and thus rendered more clearly audible, by closing the corresponding key 140 or 141, and thus "dots" and "dashes" may be sent by manipulating the key 140 or 141, and may be clearly distinguished at the corresponding receiver 200 or 217, as will appear hereinafter.

Also, at the same time that a message is being sent by the use of one of the signalling systems 45 or 50, and also perhaps another message by the use of the other signalling system 50 or 45, a third message, a telegraph message, may be sent by using the key 92, the closing of which in the process of forming "dots" and "dashes" acts to change the frequency of the carrier wave, for instance from 1,010,000 to 1,000,000 oscillations per second, thereby producing in the receiving system, by a process of beat reception audible indications in the corresponding telephone receiver 224, as will appear hereinafter.

In the operation of the receiving system shown in Fig. 2 in co-operation with the transmission system shown in Fig. 1, energy transmitted from the transmission system is intercepted and selectively received by the open aerial circuit 170, 171, acting in combination with the closed oscillatory circuit 172, which is tuned for this purpose to respond to impulses within the band of impulses emitted by the transmission system. The oscillations thus produced in the closed circuit 172 act through the detector 175 to produce in that portion of the output circuit containing coils 180 and 181, rectified or otherwise detected impulses of frequencies and nature corresponding to the frequencies of the periodic variations impressed on the carrier wave at the transmission system.

Of these detected impulses only those resulting from the action of the secondary oscillator 35, as modified perhaps by the signalling system 45 are passed by the filter 186, while only those impulses due to the action of the other secondary oscillator 40, perhaps modified by the corresponding signalling system 50, are passed by the filter 187. The output of the filter 186 is amplified by the amplifier 191 to produce in the output of the amplifier 191 amplified oscillations which act through the detector 194 to produce in the output of the detector rectified or otherwise detected impulses having the characteristics of the original voice currents acting upon the telephone transmitter 120, or having the characteristics of the original buzzer currents of the buzzer 135, as the case may be. These rectified impulses act through the amplifier 198 to produce in the telephone receiver 200 amplified audible sounds corresponding to the telephone message transmitted, or amplified audible tones corresponding to the telegraph message transmitted, by the signalling system 45.

The amplifier 191 between the filter 186 and the detector 194 might be omitted, under some conditions, together with its function, as is shown for instance in connection with the filter 187 where an amplifier does not follow immediately after the filter but the output of the filter is first detected by the detector 211 the output of which is amplified by the amplifier 215 to produce in the corresponding telephone receiver 217 amplified sounds corresponding to the telephone message transmitted by the telephone receiver 121 or the telegraph message transmitted by the key 141, as the case may be.

While two messages are being received by the telephone receivers 200 and 217 respectively, a third message, a telegraph message, transmitted by the key 92 may be received by the telephone receiver 224. The detector or thermionic device 175 acts in a well-known manner not only as a detector but also as an amplifier and the energy received from the transmission system and acting through the device 175 produces not only rectified impulses in the coils 180 and 181 but also produces high frequency oscillations in the by-pass containing the condenser 182 and the coil or inductance 219. These oscillations have the frequencies of the received carrier wave, a frequency for instance of 1,010,000 oscillations per second when the key 92 is open and 1,000,000 oscillations per second when the key 92 is closed, as in forming "dots" and "dashes". These oscillations in the coil 219 produce oscillations of the same frequency in the circuit 220, 221 of the detector

222. Also in this circuit are produced oscillations of a frequency of for instance 999,000 oscillations as a result of the operation from the local source of oscillations 230. All of these oscillations will co-operate through the detector 222 to produce in the output circuit of the detector rectified impulses in the form of electrical beats, which may be heard in the telephone receiver 224. When the key 92 of the transmitter is closed these beats will have a frequency for instance of 1,000 per second, and when the key 92 is open the beats produced will have a frequency for instance of 11,000 per second. The telegraph message transmitted on the key 92 may, therefore, be clearly distinguished in the telephone receiver 224, while at the same time since the open aerial circuit 170 and 171 and the closed oscillatory circuit 172 are responsive to all frequencies of the received waves, messages transmitted from the other signalling systems 45 and 50 may be clearly heard, without interruption, in the corresponding telephone receivers 200 and 217.

If a person, having only receiving apparatus of the ordinary type including a controlling circuit tuned to respond selectively to received waves of a single frequency, should attempt to "listen in" on any message transmitted by the signalling system 45 or the signalling system 50, at the same time that the frequency of the carrier wave is being frequently varied by the operation of the key 92 either in sending a telegraph message or merely for the purpose of secrecy, such person owing to the frequent variation in the frequency of the carrier wave, due to the operation of the key 92, would be able to hear not more than fragmentary sounds which would not form an intelligible message.

From the foregoing it is evident that this invention provides a multiplex system of signalling whereby one or more telegraph or telephone messages may be simultaneously sent over a carrier wave by impressing thereon suitable amplitude variations, and at the same time an additional message may be sent by varying the frequency of the carrier wave, such variation acting not only to send a message but also to give a high degree of secrecy to any other message or messages being sent by this system.

Although one theory as to the operation of this invention has been described herein it is desired to have it understood that such theory, owing to the abstruseness of the subject, may not be correct in every particular and applicant reserves the right to make such changes or corrections in such description as may be found desirable or proper at any time.

This invention is not limited to the specific forms disclosed but might be embodied in various forms without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. The method of signalling which consists in generating a series of high frequency oscillations of a predetermined frequency, impressing therein two series of periodic variations of substantially constant, superaudible frequency and differing in frequency one from the other by a given difference frequency and varying the frequency of said oscillations from time to time by a frequency equal to said difference frequency.

2. The method of signalling which consists in generating a series of high frequency oscillations of a given frequency, varying said oscillations in accordance with two series of variations of substantially constant, superaudible frequency and differing in frequency one from the other by a given difference frequency for simultaneously sending two messages, and at the same time varying said first-mentioned frequency from time to time by an amount equal to said difference frequency, for producing a third message.

3. A receiving system including a circuit responsive to oscillations of a given frequency, varied in accordance with variations of superaudible frequency and also in accordance with variations of audible frequency, detecting means controlled by said circuit and operative to produce impulses of said superaudible frequency, a detector controlled by said impulses to produce impulses of said audible frequency, and means controlled by said first-mentioned detecting means for detecting said oscillations and for producing therefrom audible beats.

4. In a transmitting system the combination with a vacuum tube modulator of means coupled with the input side of the modulator for generating a series of carrier waves and for producing variations in the frequency of said carrier waves in accordance with a message, and means also coupled with the input side of the modulator for impressing in said carrier waves a plurality of series of amplitude variations of a corresponding plurality of frequencies corresponding to a plurality of messages, the frequency variation in said carrier frequency being equal in amount to the difference between the frequency of two of said plurality of series of amplitude variations.

5. In a signalling system the combination with means for generating a series of carrier waves, having impressed therein a plurality of series of variations of superaudible frequency which are in turn modulated to correspond to a plurality of messages, of means for producing variations in the frequency of said carrier waves in accordance with a message, by an amount equal to the difference between two of the superaudible frequencies, and means controlled as a result of the action of said first-mentioned variations and said

second-mentioned variations respectively for selectively receiving said messages.

6. In a transmission system the combination with means for generating a series of high frequency oscillations having impressed therein several series of variations of substantially constant inaudible frequency and a series of variations of audible frequency corresponding to a message, of means for varying the frequency of said first-mentioned oscillations by an amount equal to the difference between two of said inaudible frequencies in accordance with a message.

7. In a signalling system the combination with means for generating a series of high frequency oscillations having impressed therein several series of variations of inaudible frequency and a series of variations of audible frequency corresponding to a message, of means for varying the frequency of said first-mentioned oscillations in accordance with a message by an amount equal to the difference between two of said inaudible frequencies and means for receiving said messages including a device controlled as a result of the conjoint action of said high frequency oscillations, said series of variations of inaudible frequency, and said series of variations of audible frequency for reproducing said first-mentioned message, and a device controlled as a result of the action of said oscillations for reproducing said second-mentioned message.

8. In a transmission system the combination with means for generating a series of waves, and for impressing therein a plurality of series of periodic variations of different, substantially constant, superaudible frequencies respectively, means for impressing upon said plurality of series of superaudible variations, respectively, a corresponding plurality of series of audible variations corresponding to different messages, and means for varying the frequency of said waves in accordance with a signal, by an amount equal to the difference between two of said superaudible frequencies.

9. In a signalling system the combination with means for generating a series of waves, and for impressing therein a plurality of series of periodic variations of different, substantially constant, superaudible frequencies respectively, means for impressing upon said plurality of series of superaudible variations, respectively, a corresponding plurality of series of audible variations corresponding to different messages, means for varying the frequency of said waves in accordance with the signal, by an amount equal to the difference between two of said superaudible frequencies and means arranged to receive selectively and reproduce all of said messages.

This application signed this 6th day of Feb., 1924.

JOHN HAYS HAMMOND, Jr.