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L. W. CHUBB

RADIO SYSTEM

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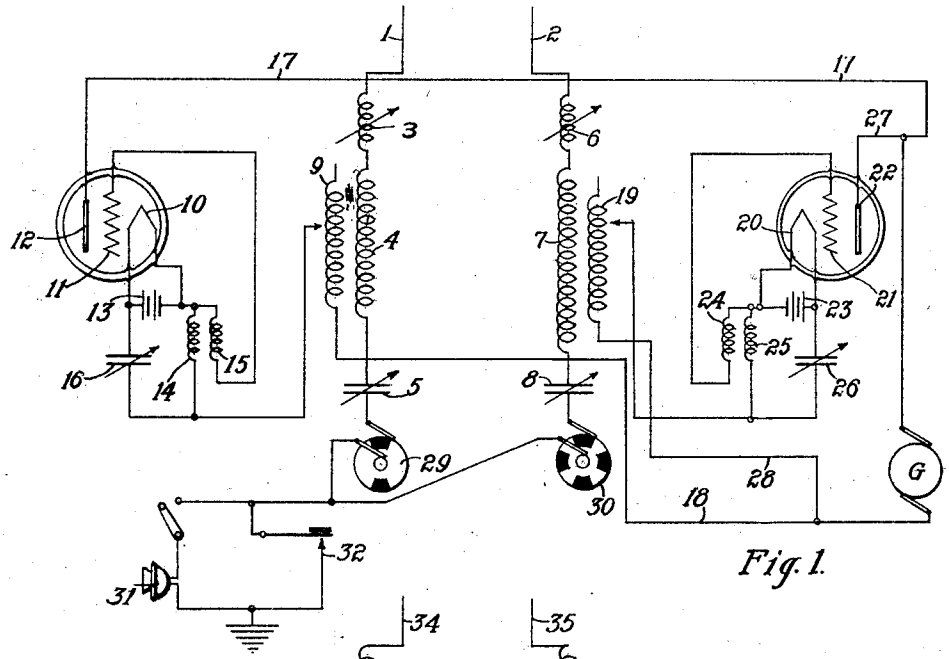


Fig. 1.

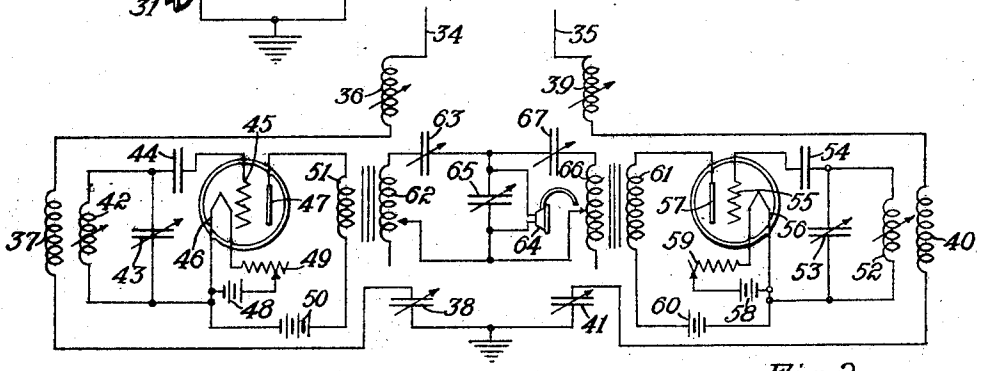


Fig. 2.

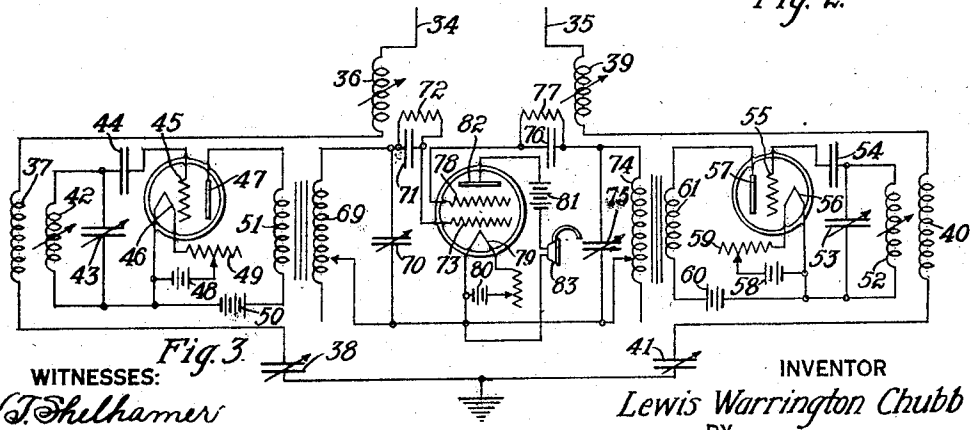


Fig. 3.

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UNITED STATES PATENT OFFICE.

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RADIO SYSTEM.

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My invention relates to the transmission and reception of radio or wireless signals, whereby a message may be sent and received with practical secrecy and without interference with messages simultaneously sent by other stations lying within the range of radio activity.

More particularly, my invention relates to the transmission and reception of radio or wireless signals by means of trains of radio waves, wherein radio waves of different frequencies are employed and the wave trains or impulses impressed upon these waves are likewise of differing frequencies all above the range of audibility, and to means for combining these wave trains to produce beats of audible frequency.

My invention also relates to the transmission and reception of radio or wireless signals employing the same wave length but in which the wave trains are displaced.

Heretofore, radio waves of different lengths but of the same train frequency have been employed to effect secrecy of wireless communication. As a variation to this method, wave trains of the same frequency but differing in phase were impressed on these radio waves of unequal length. This difference in phase relation of the wave trains operated to effect an angular displacement between mirrors enabling signals to be caught visually by a reflected beam of light. As a method for eliminating static effects at the receiving station, radio waves of constant frequency have been received and heterodyned by electron tubes to produce beats above the range of audibility and these wave trains above the range of audibility imposed upon a closed circuit, whereby they interacted to produce an audible beat.

An object of my invention is to provide a system for wireless communication, whereby a plurality of different wave lengths may be employed to send a message, thus necessitating tuning at the receiving station to each of the wave lengths separately. By tuning to a plurality of wave lengths, interference of the message by other messages simultaneously sent from a different station is reduced to a minimum. Again, by reason of the great selectivity in tuning and because of the practical difficulty in obtaining the exact combination, owing to the wave train frequency of each radio wave being above audible frequency, reception by unauthorized stations is unlikely.

The number of sending devices now in use is so great that any receiving system tuned to a single frequency, while it may reproduce the signals radiated on a single frequency, is likely to have such signals confused by interference from other stations. On the other hand, a station, equipped with two receiving circuits tuned respectively to the two wave lengths used by the sending station and obtaining a signal by the interaction of these two wave lengths, is far less likely to be disturbed by interference and so will obtain the message.

To this extent, the system is a secret one, since only the receiving station acquainted with the two wave lengths can obtain the message clearly, other stations being able to obtain it only with difficulty because of their inability to escape interference.

With these and other objects in view, which may be incident to the improvements, my invention consists in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising my invention may be varied in their arrangement without departing from the spirit and scope of the appended claims.

In order to make my invention more clearly understood, I have shown in the accompanying drawings, means for carrying it into practical effect without limiting the improvements, in their useful applications to the particular constructions which, for the purpose of explanation, have been made the subject of illustration.

Fig. 1 is a diagrammatic view of the sending apparatus; Fig. 2 is a diagrammatic view of one form of the receiving apparatus; Fig. 3 is a diagrammatic view of a modification of the form of receiving apparatus shown in Fig. 2.

In Figs. 1 and 2, I have indicated an arrangement for the carrying out of my invention in the application thereof to either a wireless telephone or telegraph system. Referring more particularly to Fig. 1; in circuit with a sending antenna 1 is a variable inductance 3, a fixed inductance 4 and a variable capacitance 5; correspondingly in

circuit with a sending antenna 2 is a variable inductance 6, a fixed inductance 7 and a variable capacitance 8. By varying the amount of inductance and capacitance in these circuits, they may be tuned to any desired differing wave lengths. The fixed inductance 4 is inductively coupled to a variable inductance 9, one terminal of which is connected to a filament 10 of an electron tube containing a grid 11 and a plate or wing 12. The filament 10 is heated by a suitable battery 13. Two inductances 14 and 15 form the mutual inductance between the plate and grid circuits necessary for the sustained oscillation desired in the use of electron tubes as generators of radio-frequency current. A variable capacitance 16 is inserted in the plate-current circuit to enable careful tuning to be done. Main lead wires 17 and 18 from a suitable source of direct current are connected, respectively, to the plate and the filament. Likewise, the fixed inductance 7 is inductively coupled to a variable inductance 19, one terminal of which is connected to a filament 20 of an electron tube having a grid element 21 and a plate or wing 22. The filament 20 is heated by a suitable battery 23. Two inductances 24 and 25 form the mutual inductance between the plate and grid circuits necessary for the sustained oscillation desired in the use of electron tubes as generators of radio-frequency current. A variable capacity 26 is inserted in the plate-current circuit to enable careful tuning. Main lead wires 27 and 28 conduct a direct current from a suitable source to the plate and filament.

From the foregoing, it will be apparent that the two electron tubes are connected to the source of direct current to constitute generators of high-frequency alternating current. In the first mentioned tube, the high-frequency alternating current, passing between the plate 12 and the hot filament 10, passes through the variable inductance 9, and, because of its inductive coupling with the fixed inductance 4 of the antenna circuit of antenna 1, it sets up therein high-frequency radio oscillations. The adjustment of the variable inductance 9 and the variable capacitance 16 will allow an adjustment of the period of oscillation of the plate-current circuit. Likewise, an adjustment of the variable inductance 3 and variable capacitance 5 in the antenna circuit of the antenna 2 will permit the tuning of this circuit to the wave lengths desired. The other electron tube, because of its similarity of arrangement to that of the first mentioned tube, also oscillates according to the adjustment of the variable inductance 19 and the variable capacity 26, and, through the inductive coupling of the fixed inductance 7 and the variable inductance 19, oscillations are set up within the antenna circuit of antenna 2. The period of oscillation is regulated by the adjustment of the variable inductance 6 and the variable capacitance 8. In all cases, the antenna and plate-current circuits are tuned to insure a maximum of power output.

A suitable means for interrupting the continuous high-frequency oscillations within the antenna circuit of antenna 1 is provided by the circuit interrupter 29. To interrupt the high-frequency oscillation in the antenna 2, a circuit interrupter 30 is provided with a larger number of commutator segments than the interrupter 29. Antennæ 1 and 2 are grounded, either through microphone 31 or telegraph key 32. The purpose of the difference in the number of commutator segments in circuit interrupters 29 and 30 is to give a difference in the wave-train frequency. It is obvious that the same result could be obtained by rotating the interrupters at a different rate. The rates of the wave trains given out are above the range of audibility and it is this feature of my invention that renders it peculiarly effective for the secret transmission of messages. If desired, instead of employing separate antennæ any other type of antenna may be used. Moreover, any radio-frequency generator other than electron tubes may be used, such as the Poulsen arc and high-frequency alternating-current generators.

Referring now to Fig. 2, which illustrates an arrangement of a receiving station for carrying out my invention, there are provided receiving antennæ 34 and 35. The antenna circuit of the antenna 34 comprises variable inductance 36, a fixed inductance 37 and a variable capacitance 38. The antenna circuit of antenna 35 comprises a variable inductance 39, a fixed inductance 40 and a variable capacitance 41.

Inductively coupled to the fixed inductance 37 is a variable inductance 42. The inductance 42 forms part of a circuit including a variable capacitance 43, a fixed capacitance 44 and a grid element 45 of an electron tube having a filament 46 and a plate 47. The filament 46 is heated by means of a battery 48 in circuit with the filament through a variable resistance 49. A battery 50 places a positive potential on the plate 47. Within the plate circuit is a fixed inductance 51. In a like manner, inductively coupled to the fixed inductance 40 is a variable inductance 52. The inductance 52 forms part of a circuit including a variable capacity 53, a fixed capacitance 54 and a grid 55 of an electron tube having a filament 56 and a plate 57. The filament 56 is heated by means of a battery 58 in circuit with the filament through a variable resistance 59. A positive potential is applied to the plate element 57 by means of a battery 60. Within the plate circuit is a fixed inductance 61.

It will be apparent to one skilled in the

art, from an inspection of the above described connections, that the two electron tubes are here connected to constitute amplifiers of the high-frequency alternating current received by the antennæ 34 and 35. Inductively connected to the inductance 51 is a variable inductance 62 in circuit with a variable capacitance 63 and the telephone receivers 64 between the terminals of which is connected a variable capacitance 65. The inductance 61 is likewise inductively coupled to a variable inductance 66 which is in series with a variable capacitance 67 and the terminals of the telephone receiver 64. The circuit 62, 63 and 64 is tuned to the frequency of the antenna circuit 34, 36, 37 and 38. In like manner, circuit 66, 67 and 64 is tuned to the frequency of the antenna circuit 35, 39, 40 and 41. As in case of the transmitting apparatus, instead of employing separate antennæ, any other form of antenna may be employed, if desired.

From the foregoing, it will be clear that radiowaves of different radiofrequency are set up in the transmitting antenna circuits by means of electron tubes acting as high-frequency generators, the antenna 1 deriving its wave oscillations through the inductance 4, inductively coupled to the variable inductance 9 through which pass oscillations of radiofrequency from one of the electron tubes. Likewise, the antenna 2 derives its wave oscillations through the inductance 7 coupled to the variable inductance 19 through which pass oscillations of a different radiofrequency from the other electron tube. The antenna circuit consisting of the antenna 1, the variable inductance 3, the fixed inductance 4 and the variable capacitance 5 is interrupted by the rotary circuit breaker 29 which revolves at a speed that gives to the wave trains a frequency above the range of audibility. Similarly, the antenna circuit consisting of the antenna 2, the variable inductance 6, the fixed inductance 7, the variable capacitance 8, has its radio waves broken up into wave trains of a frequency above the range of audibility by the circuit breaker 30. The frequency of the wave trains in the two antenna circuits are different. Either by the microphone 31 or the telegraph key 32, signals are impressed upon these two differing wave trains. The receiver is tuned to a plurality of radiofrequencies corresponding to those of the transmitter. The oscillations set up in antenna circuit including the antenna 34, the variable inductance 36, the fixed inductance 37, and the variable capacitance 38 are transmitted through the vacuum-tube amplifier to the circuit, variable inductance 62, variable capacitance 63 and telephone receiver 64. This last mentioned circuit is in tune with the antenna circuit. Antenna circuit comprising the antenna 35, the variable inductance 39, the fixed inductance 40, the variable capacitance 41, is tuned to another of the transmitted radiofrequencies, and the oscillations set up in this circuit are transmitted, through the electron-tube amplifier, to the circuit containing the variable inductance 66, the variable capacitance 67, and the telephone 64, which is in tune with this last mentioned antenna circuit.

When radio waves of differing frequencies, broken up into wave trains of differing frequencies the train frequencies lying above the limit of audibility are sent out from the transmitting station they set up, within the tuned circuits of the receiver mechanism, oscillations. Within the tuned circuit comprising the variable inductance 62, the variable capacitance 63, and the telephone 64, these oscillations are set up. Likewise, within the tuned circuit including the variable inductance 66, the variable capacitance 67, and the telephone 46, oscillations corresponding to the other wave length are set up. These oscillations in the two last mentioned circuits are in the form of trains of oscillations, the train frequency being, in each case, above the range of audibility, but, at the common connection which is through the telephone 64, these wave trains will interfere to form a beat within the range of audibility, and, therefore, signals may be received through the telephone receiver.

Referring to the modification of the receiving mechanism shown in Fig. 3 of the drawings, the connections of the receiving antenna and of the amplifiers are like that shown in Fig. 2. However, in this modification, the circuit tuned to the frequency of waves received in antenna circuit including the antenna 34, the variable inductance 36, the fixed inductance 37, the variable capacitance 38, is the circuit comprising a variable inductance 69, a variable capacitance 70, a fixed capacitance 71, shunted by a resistance 72 and a grid element 73 of an electron tube. Likewise, the circuit tuned to the antenna circuit including the antenna 35, the variable inductance 39, the fixed inductance 40, the variable capacitance 41 is the circuit comprising a variable inductance 74, a variable capacitance 75, a fixed capacitance 76, shunted by a resistance 77 and another grid element 78 of the same electron tube. Within the electron tube is a filament 79 heated by a battery 80 through a variable resistance. The plate circuit of this tube consists of a battery 81, the positive terminal of which is connected to a plate or wing 82. Within the circuit including the filament 79 and the plate 82 are mounted telephone receivers 83. Upon receiving radio waves of the correct frequency, the circuit including the grid 73 is set in periodic vibration according to the number of wave trains sent out from the sending

station. Again, the circuit including the grid element 78 has periodic oscillations set up therein corresponding to the frequency of the wave trains sent out over the circuit of similar tuning at the transmitting station. These oscillations in the two grid circuits separately, would produce oscillations in the telephone 83 above the range of audibility but, because of their interaction, there are produced beats within the range of audibility and thus signals are received in the telephone.

I wish it expressly understood that, whereas I have, for the purpose of simplicity, illustrated my invention as applied to the sending and receiving of but two radiowave frequencies and but two train frequencies, a greater number could be employed. The arrangement of apparatus for a plurality of different wave lengths and train frequencies exceeding two will be apparent to those skilled in the art.

While I have described certain embodiments of my invention, it is apparent that many modifications may be made thereunder by those skilled in the art without departing from the spirit thereof, and I desire, therefore, that my invention be limited only as set forth in the appended claims or by the showing of the prior art.

I claim as my invention:—

1. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, with means for receiving the wave trains, means for causing the wave trains to interact to produce a beat of audible frequency, and means for receiving the beat.

2. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different train frequency, the train frequency being above the range of audibility, with means for receiving the wave trains, means for causing the wave trains to interact to produce a beat of audible frequency, and means for receiving the beat.

3. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequency being above the range of audibility, with receiving antennæ tuned to a plurality of frequencies, means for causing the received wave trains to interact to produce a beat of audible frequency, and means for receiving the beat.

4. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequency being above the range of audibility, with receiving antennæ tuned to a plurality of frequencies, amplifiers coacting with the antenna circuits, means coacting with the amplifiers to cause the wave trains to interact to produce a beat of audible frequency, and means for receiving the beat.

5. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequencies being above the range of audibility, with means for receiving said wave trains, two circuits tuned to the frequency of the received radio waves, and means at their point of interaction for combining the train-frequencies to produce a beat of audible frequency.

6. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequencies being above the range of audibility, with means for receiving said wave trains, two interacting circuits tuned to the frequency of the received radiowaves, an electron tube, two grids within the electron tube in operative relation with the two interacting circuits, and means for receiving the beat produced by the interaction of the wave trains.

7. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequency being above the range of audibility, with receiving antennæ tuned to a plurality of frequencies, two interacting circuits tuned to the frequencies of the received radio waves, and means at their point of interaction for producing from the differing train frequencies a beat of audible frequency.

8. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequency being above the range of audibility, with antennae tuned to a plurality of frequencies, amplifiers coacting with the antenna circuits, two interacting circuits coacting with the amplifiers and tuned to the frequencies of the received radiowaves, and means at their point of interaction for producing therefrom a beat of audible frequency, equal to the beat-frequency of the said train-frequencies.

9. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequencies being above the range of audibility, with receiving antennæ tuned to a plurality of frequencies, interacting circuits tuned to the frequencies of the received radiowaves, an electron tube, grids within the electron tube coacting with the interacting tuned circuits, whereby a beat of audible

frequency is produced in the plate circuit of the electron tube from the interaction of the differing train frequencies.

10. In a system for wireless communication, the combination of means for propagating a plurality of wave trains of different radiofrequency and different train frequency, the train frequencies being above the range of audibility, with receiving antennæ tuned to a plurality of frequencies, amplifiers co-operating with the antenna circuits, interacting circuits tuned to the frequencies of the received radiowaves and co-operating with the amplifiers, an electron tube, a plurality of grids within the electron tube coacting with the interacting tuned circuits, whereby a beat of audible frequency is produced in the plate circuit of the electron tube from the interaction of the differing train frequencies and means for indicating the presence of said beat.

11. In a system for wireless communication, the combination of a plurality of antennæ tuned to a plurality of frequencies, with means for propagating wave trains therein at different rates, one rate for each antennæ, means for receiving said wave trains, and means for causing the wave trains to interact to produce an audible beat.

In testimony whereof, I have hereunto subscribed my name this 27th day of May 1920.

LEWIS WARRINGTON CHUBB.