Jan. 27, 1925. 1,524,413

M. W. STERNS

WIRELESS TELEPHONE SYSTEM

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Fig. 1.

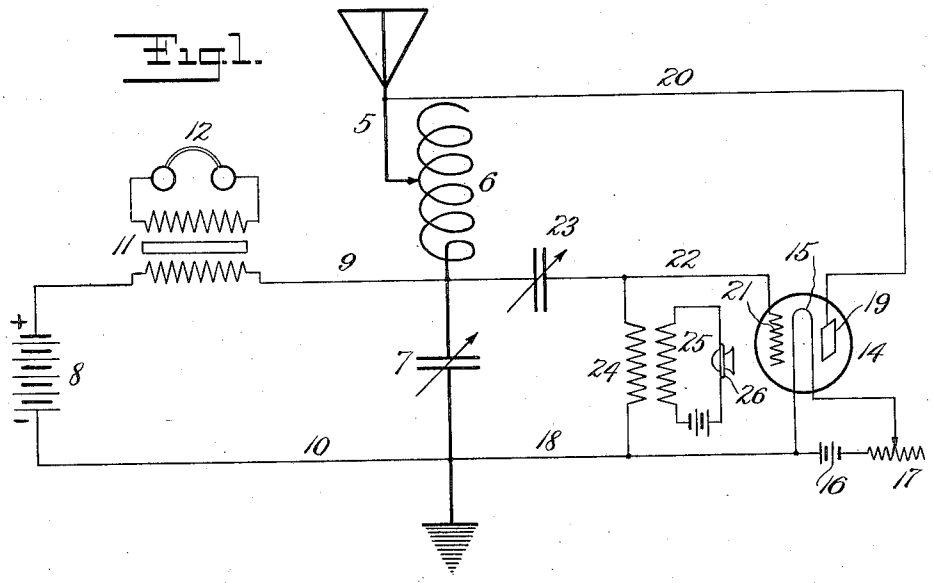
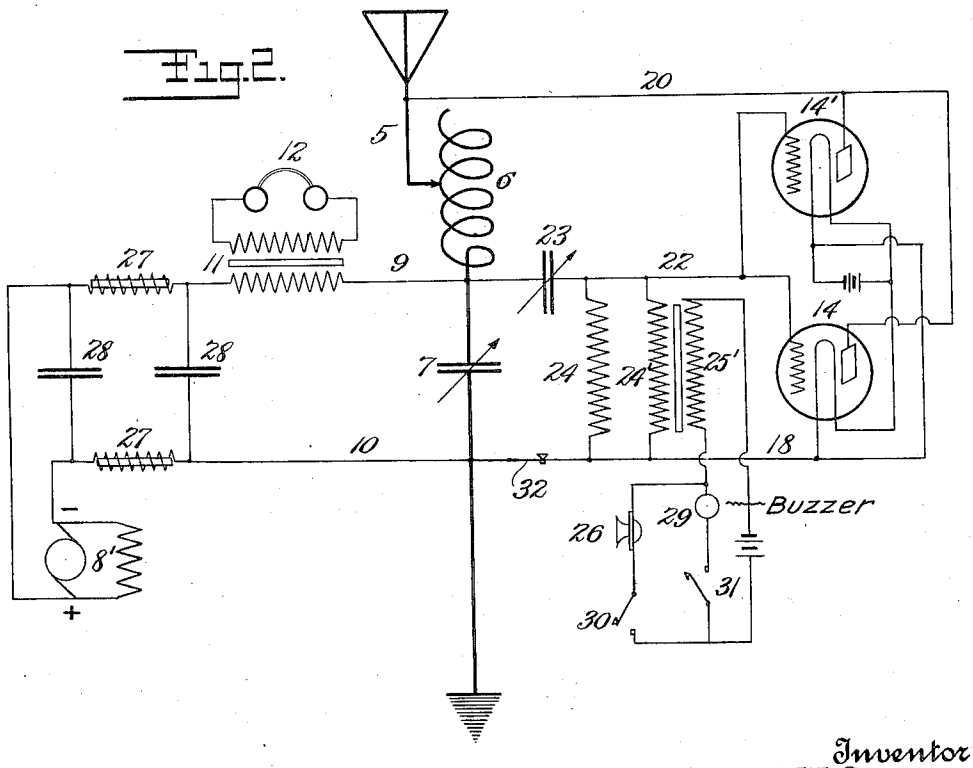


Fig. 2.



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Fig. 3.

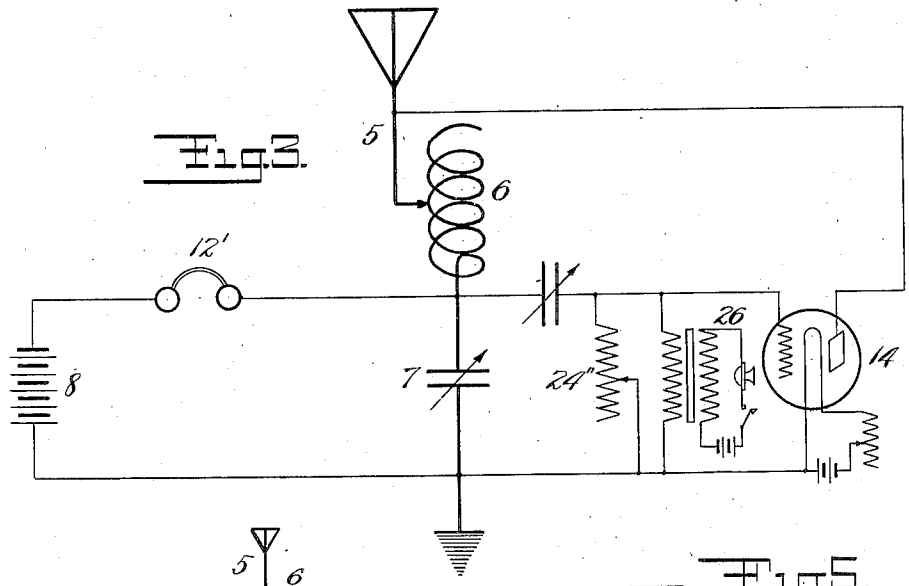


Fig. 5.

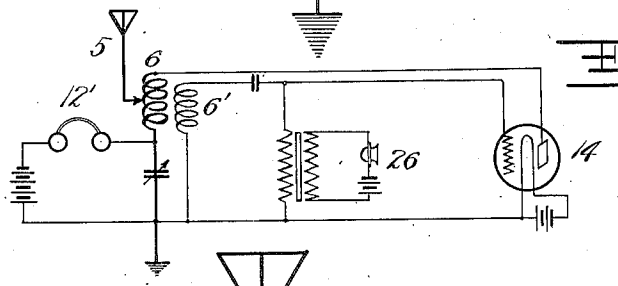
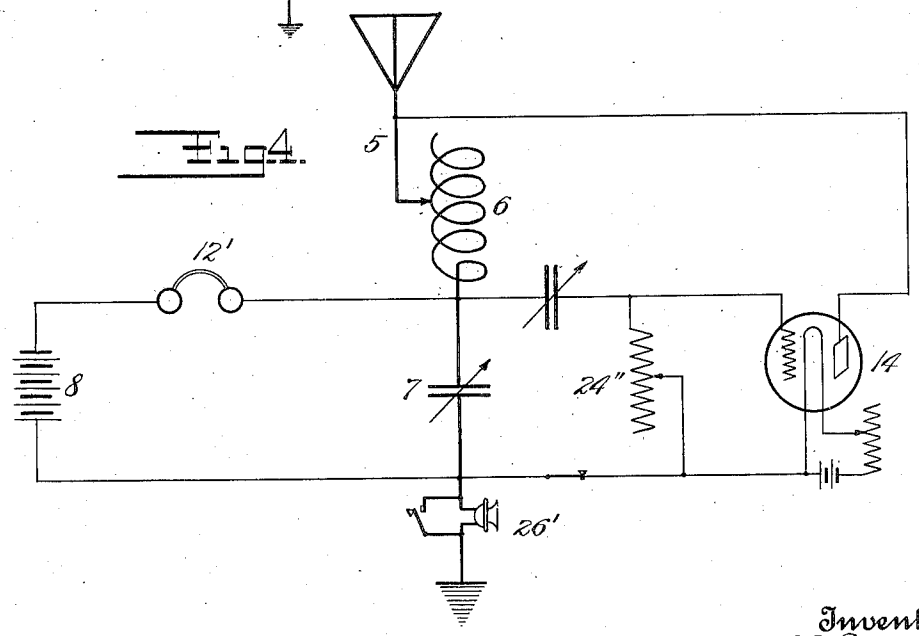


Fig. 4.



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Fig. 6.

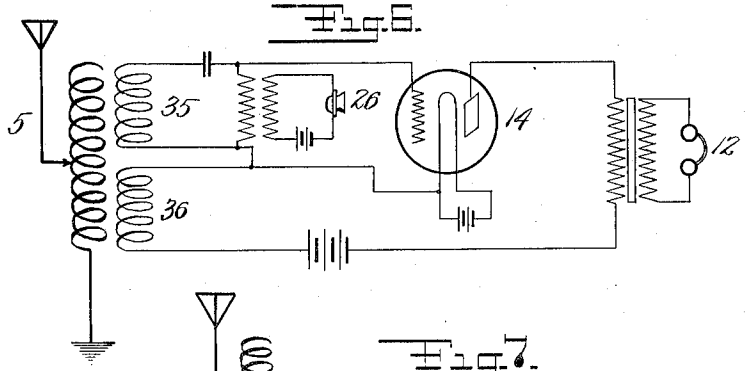


Fig. 7.

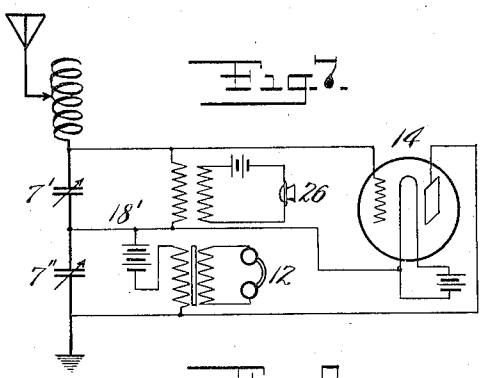


Fig. 8.

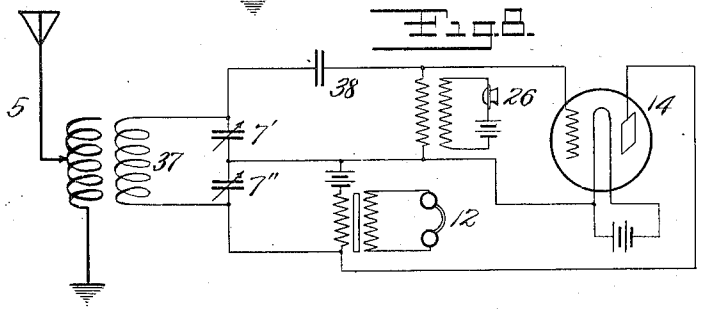
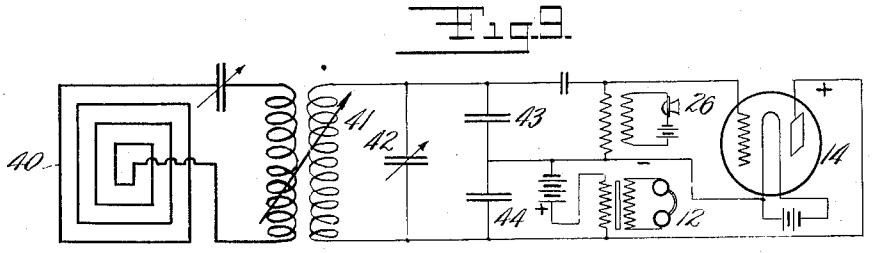


Fig. 9.



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Patented Jan. 27, 1925. 1,524,413

UNITED STATES PATENT OFFICE.

MORTON W. STERNS, OF NEW YORK, N. Y.

WIRELESS-TELEPHONE SYSTEM.

Application filed January 28, 1920. Serial No. 354,611.

To all whom it may concern:

Be it known that I, MORTON W. STERNS, a citizen of the United States of America, residing at New York, N. Y., have invented a new and useful Wireless Telephone System, of which the following is a specification.

The main object of my invention is to provide a simple apparatus and system for wireless telephony which can be used both for sending and receiving at the same time.

Another object is to provide apparatus which is simple and compact and inexpensive and which can be used for transmitting or receiving, or both.

Another object is to obtain a maximum power effect with the least possible apparatus and at a minimum of cost.

Another object is to utilize the same tube or tubes both for transmission and reception.

In its preferred form, the invention contemplates the use of a three electrode valve or tube with a telephone transmitter arranged between the grid and filament circuits and a telephone receiver arranged between the plate and filament circuit. The circuits are so related to a grounded aerial or to a loop that messages may be simultaneously sent and received. Signalling devices may be employed for undamped or damped signals. Where more power is required a number of tubes may be used with their elements in parallel.

Fig. 1 is a diagram of one form of apparatus embodying the improvements of my invention and showing a battery as the power source and a single tube.

Fig. 2 is a diagrammatic view of a complete system embodying a D. C. generator with a commutator filter, a plurality of valves or tubes, and a combined telephone and buzzer transmitter.

Fig. 3 is a diagrammatic view of another modification showing the telephone receiver connected directly in the power circuit which is of the battery type and a variable grid leak independent of the telephone transmitter transformer.

Fig. 4 is a diagram of another modification showing the transmitter inserted directly in the aerial circuit.

Fig. 5 is a diagram of another modification showing inductive coupling between the plate and grid circuits.

Fig. 6 shows another form of inductive coupling.

Fig. 7 shows a capacitative feed back and conductive coupling to the antenna.

Figs. 8 and 9 show other forms of inductive coupling to antenna and loop respectively.

In the arrangement shown in Fig. 1, the grounded aerial 5 contains a tuning inductance 6 and capacity 7.

The power circuit contains the source of current such as battery 8 which is connected by leads 9 and 10 to the aerial on opposite sides of the condenser 7. A telephone transformer is coupled to the lead 9 either directly or through an amplifier. In this case the telephone transformer 11 has its primary in the battery circuit and its secondary in the circuit of the telephone receiver 12.

The tube or valve 14 of any suitable type has a heating filament 15 with the local battery 16 and preferably an adjustable resistance 17. This filament circuit is connected by lead 18 to the aerial below the condenser 7.

The anode or plate element 19 is connected by lead 20 to the aerial above the tuning inductance.

The grid or control element 21 is connected by lead 22 to the aerial above the condenser 7 but with a condenser 23 interposed and a grid leak resistance 24 connected to the filament circuit to maintain a proper negative grid potential.

The grid leak resistance 24 may be one winding of a transformer having its primary 25 in circuit with a telephone transmitter 26.

Instead of using the grid leak 24 as a part of the transformer, a separate coil 24′ may be used in conjunction with the coil 25′ as shown in Fig. 2. A separate grid leak resistance is necessary however where the resistance of the secondary of the transformer is too high to keep the grid negative.

When considerable powers are used, several tubes or valves 14 and 14′ may be employed as shown in Fig. 2 with their respective elements placed in parallel, that is, the filaments are connected together and to the aerial below the tuning condenser, the anode plates are connected together and to the aerial above the tuning inductance, and the grids are connected together and to the aerial between the inductance and capacity elements of the aerial.

When a D. C. generator 8′, as shown in

Fig. 2, is used in place of the battery 8, of Fig. 1, it is desirable to employ a commutator filter consisting of choke coils 27—27 in the power circuit, and condensers 28—28 so as to minimize the commutator hum.

In the transmitting circuit of Fig. 2, I have shown a telephone transmitter 26 and a buzzer 29 in parallel, and I have provided switches 30 and 31 so that either the human voice or buzzer modulated signals may be transmitted. By providing a switch 32 in the filament lead 18, undamped or continuous wave signals may be transmitted. By using normally closed spring contacts at 32 and normally opened contacts at 31, an ordinary telephone jack and signalling key may be employed for use interchangeably at 32 or 31. The tone of the signal transmitted from 31 will of course depend upon the frequency of the buzzer 29. When the switch 30 is closed and with the switch 31 open, speech directed at the transmitter 26 will be transmitted in the form of voice modulated electromagnetic waves.

When smaller powers are used, the receiver such as 12′ may be connected directly in the circuit with the battery 8, as shown in Figs. 3 and 4.

The grid leak resistance 24″ may be adjustable, if desired, as indicated in Figs. 3 and 4.

A very simple form of arrangement is shown in Fig. 4 where the transmitter 26′ is shown connected directly in the aerial circuit. While this is satisfactory for small currents of say one ampere or less, the transmitter is likely to become inoperative very quickly with higher power.

In designing the apparatus for proper modulation, the impedance of the secondary of the modulation transformer or induction coil should equal the input impedance of the tube or tubes or the impedance between the grid and the filament. Furthermore, the impedance of the primary of the transformer should equal the impedance of the transmitter, buzzer or other alternating current source. The ratio of the primary to the secondary should be large so as to impress a high potential on the grid. On the other hand, in the power circuit the impedance of the primary should equal the impedance of the circuit into which it is inserted, and the impedance of the secondary should equal the impedance of the circuit into which it feeds such as a receiver or amplifying device. A strong D. C. which supplies power to the plate circuit will not affect the receiving device, but any weak A. C. effect such as received signals or your own voice in the transmitter will affect the receiving device.

By the foregoing invention it is possible to simultaneously transmit and receive on the same aerial and with the same wave length and the same tube without the use of switches.

In case station A wishes to speak telephonically with station B, station A will say, "Hello B, Hello B, A calling, A calling, answer please." Station B on hearing A will tune to A's wave length automatically as that is the point of loudest and clearest speech. If B now speaks to A, A will hear him, as he is tuned to the same wave length as B, due to the previous operations. It is evident therefore that A can break in on B, or vice versa, at any instant and ask for a repeat in case of misunderstanding or for any other purpose and without throwing any switches. This circuit will therefore give all the advantages of an ordinary land line telephone with the added advantage of the peculiarly clear speech which is a well known advantage of the radio phone.

The connections of the filament and plate to the aerial may be transposed but in any case the positive of the battery 8 or generator 8′ should be connected to the plate. The plate and grid connections to the aerial may also be transposed. The receiving device may be inserted in or coupled with the negative lead of battery 8 or generator 8′. The connection to the aerial above the condenser may be direct to the inductance. The grid may be inductively coupled to the aerial instead of directly.

In the arrangement shown in Fig. 5, the grid and plate are inductively coupled through the coils 6 and 6′, but the transmitter and receiver are connected with the grid and power circuits as above described.

In Fig. 6 both the grid and filament circuits are inductively coupled with the aerial inductance by the coils 35 and 36 respectively, and the receiver is connected between the plate and power source.

In Fig. 7 two condensers 7′ and 7″ are arranged in the aerial circuit. The filament is connected between these two condensers by the lead 18′ and the grid and plate are connected on opposite sides of the condensers. The transmitter is connected as before between the grid and filament circuits and the receiver is connected in the power circuit between the filament and plate circuits.

In the arrangement of Fig. 8, the transmitting and receiving circuits are inductively coupled with the aerial by means of the coil 37 which is connected on opposite sides of the condensers 7′ and 7″, and a condenser 38 is provided in the grid circuit.

In the arrangement of Fig. 9, I have shown a loop 40 in place of the aerial, with a tuning coil and capacity inductively coupled through the coil 41 with the transmitting and receiving circuits. In this case there is variable capacity 42 connected between the grid and plate circuits. This arrangement also requires condensers 43 and

44 connected substantially as in the arrangement of Figs. 7 and 8. Of course the telephone instruments may be inserted directly in the circuits for low powers without the interposition of transformers.

It should be understood that any of the circuit arrangements may use a loop antenna such as shown in Fig. 9 in place of the grounded aerial.

I claim:

1. In a wireless telephone system, the combination of a grounded aerial containing a tuning inductance and condenser, a power circuit connected to said aerial and including a receiving device, a three electrode valve having a filament, a plate and a grid connected to said aerial, said plate being connected directly to said aerial, a condenser in the grid circuit, a grid leak resistance connecting the grid circuit and the filament circuit, and a telephone transmitter inductively connected with the grid and filament circuits.

2. In a wireless telephone system, an aerial including an inductance and a capacity, a power circuit including a receiving device and connected on opposite sides of said capacity, a three element tube having its filament circuit connected on one side of said capacity, its grid connected between said inductance and said capacity and its plate connected on the opposite side of said inductance, and a modulating device inductively connected between the grid and filament circuits.

3. In a wireless telephone system, the combination of a grounded aerial, a power circuit connected to said aerial and including the primary of a receiving device, a three electrode valve having a filament, a plate and a grid connected to said aerial, a condenser in the grid circuit, a grid leak resistance connected to the grid circuit between the grid and said condenser and connected to the filament circuit, and a telephone transmitter inductively connected with the grid and filament circuits.

4. In a wireless telephone system, an inductance and a capacity, a power circuit including the primary of a receiving device and connected on opposite sides of said capacity, a three element tube having its filament circuit connected on one side of said capacity, its grid connected between said inductance and said capacity and its plate connected on the opposite side of said inductance, and a modulating device inductively connected between the grid and filament circuits.

5. In a wireless telephone system, the combination of a tuning inductance and condenser, a power circuit connected thereto and including a receiving device, a three electrode valve having a filament, a plate and a grid connected to said circuit, a condenser in the grid circuit, a grid leak resistance connected to the grid circuit between the grid and said condenser and connected to the filament circuit, and a telephone transmitter connected with the grid and filament circuits.

6. In a wireless telephone system, an aerial including an inductance and a capacity, a power circuit connected on opposite sides of said capacity, a telephone receiver coupled to said power circuit, a three element tube having its filament circuit connected on one side of said capacity, its grid connected between said inductance and said capacity and its plate connected on the opposite side of said inductance, and a modulating device including a transmitter inductively connected between the grid and filament circuits.

7. In a signaling system, an aerial including a variable inductance and a variable capacity, a three-element tube having a plate directly connected to the aerial and a filament directly connected to the aerial and a grid having a capacity connection to the aerial, a transmitting device inductively connected between the grid and filament, a grid leak between the grid and filament, and a source of direct current connected between the plate and filament.

8. In a signaling system, an aerial including a variable inductance and a variable capacity, a plate directly connected to the aerial, a filament directly connected to the aerial, a grid connected between the inductance and capacity, a source of direct current between the filament and plate and a receiving device inductively coupled thereto, the impedance of the primary of the inductive coupling being equal to the impedance of the plate circuit, and the impedance of the secondary being equal to the impedance of the receiving device.

9. In a wireless telephone system, the combination of a grounded aerial containing a tuning inductance and condenser, a three electrode power tube having a filament, a plate and a grid all connected to said aerial, a condenser in the grid circuit, a grid leak resistance connecting the grid circuit and the filament circuit, said filament being connected to the low potential end of said aerial, a telephone transmitter and a transformer connecting the transmitter with the grid and filament circuits, the impedance of the secondary of the transformer being equal to the input impedance of the tube.

10. In a wireless telephone system, an inductance and a capacity in series, a power circuit including a choke coil and connected on opposite sides of said capacity, a three element tube having its filament circuit connected on the low potential side of said capacity, its grid connected between said inductance and said capacity and its plate connected on the opposite side of said in-

ductance, a modulation device and a transformer connected between the grid and filament of said tube, the impedance of the primary of the transformer being equal to the impedance of the modulation circuit, and the impedance of the secondary being equal to the input impedance of the tube.

11. In a wireless telephone system, the combination of a radiating circuit, a three electrode tube having a filament, a plate and a grid connected to said circuit, a condenser in the grid circuit, a grid leak resistance connecting the grid circuit and the filament circuit, a telephone transmitter inductively connected with the grid and filament circuits of said tube, said filament being connected to the low potential side of said radiating circuit the impedance of the secondary of the inductive coupling being equal to the input impedance of the tube.

12. In a wireless telephone system, an inductance and a capacity, a power circuit including a power source and a choke coil and connected on opposite sides of said capacity, a three element tube having its filament circuit connected to the low potential side of said capacity, its grid connected between said inductance and said capacity and its plate connected on the oppoosite side of said inductance, and a modulating device inductively coupled between the grid and filament of said tube, the impedance of the secondary of the inductive coupling being equal to the input impedance of the tube, and the impedance of the primary being equal to the impedance of the modulating device.

13. In a wireless system for simultaneous reception and transmission, an aerial including inductance and capacity, a three-element emission device having a filament, an anode, and a grid connected to said aerial, a source of direct current connected to the aerial, a transmitting device inductively coupled between the grid and filament, a receiving device inductively coupled to the plate circuit, the impedance of the transmitter being substantially equal to the impedance of the primary of its inductive coupling, and the impedance of the secondary inductive coupling being equal to the impedance between the grid and filament, the impedance of the receiving device being substantially equal to the impedance of the secondary of its inductive coupling, and the impedance of the secondary inductive coupling being substantially equal to the impedance of the plate circuit.

14. In a wireless telephone system, a reception and transmission circuit, an oscillation device connected thereto and having an electron emitting element, a receiving element and a control element, a modulation transformer having its secondary connected between the emitting element and the control element and with an impedance equal to the input impedance of the oscillation device, said secondary having a direct current resistance at least sufficient to serve as a leak between the emitting element and the control element.

15. In a wireless telephone system, an oscillation device having an electron emitting element, a receiving element and a control element, a modulation transformer having its secondary connected between the emitting element and the control element and with an impedance equal to the input impedance of the oscillation device, and a resistance in parallel with said secondary.

16. In a wireless telephone system, an electron emitting element, a receiving element, a controlling element, a modulation transformer having its secondary connected across the emitting and control elements, the impedance of the secondary of the transformer being equal to the impedance between the control and emitting elements, and a resistance in parallel with said secondary.

17. In a wireless set, an aerial, a three element tube having a plate directly connected to the aerial, a filament circuit directly connected to the aerial, and a control element connected to the aerial, a transmitter connected in the grid circuit, and a receiving device connected in the plate circuit.

18. In a wireless telephone set for simultaneous transmission and reception, a radiating aerial, a power circuit connected to said aerial and including the primary of a telephone receiver, an oscillation device connected with said power circuit and having an electron emitting element, a receiving element and a control element, a modulation telephone transformer having its secondary connected between said emitting and control elements and with an impedance equal to the input impedance of the oscillation device.

19. In a wireless set for simultaneous transmission and reception, a radiating aerial, an oscillation device having an emitting element, a receiving element and a control element, said receiving element being directly connected with said aerial, said emitting element being directly connected with said aerial, said control element being connected with said aerial, a telephone transmitter connected to modify the radiations for said aerial and a telephone receiving device connected in the circuit with said receiving element.

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