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WIRELESS TELEPHONE SYSTEM

Filed March 15, 1922

Fig. 1.

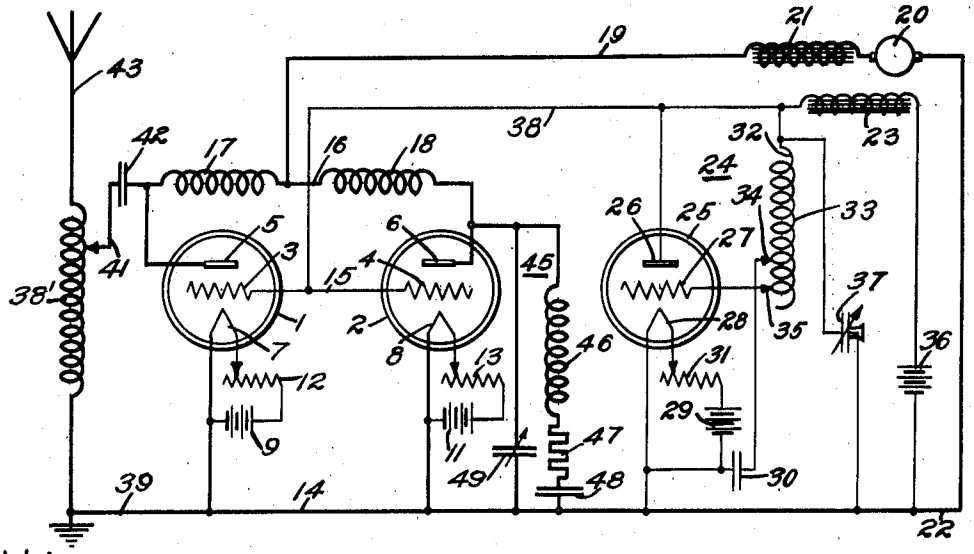


Fig. 2.

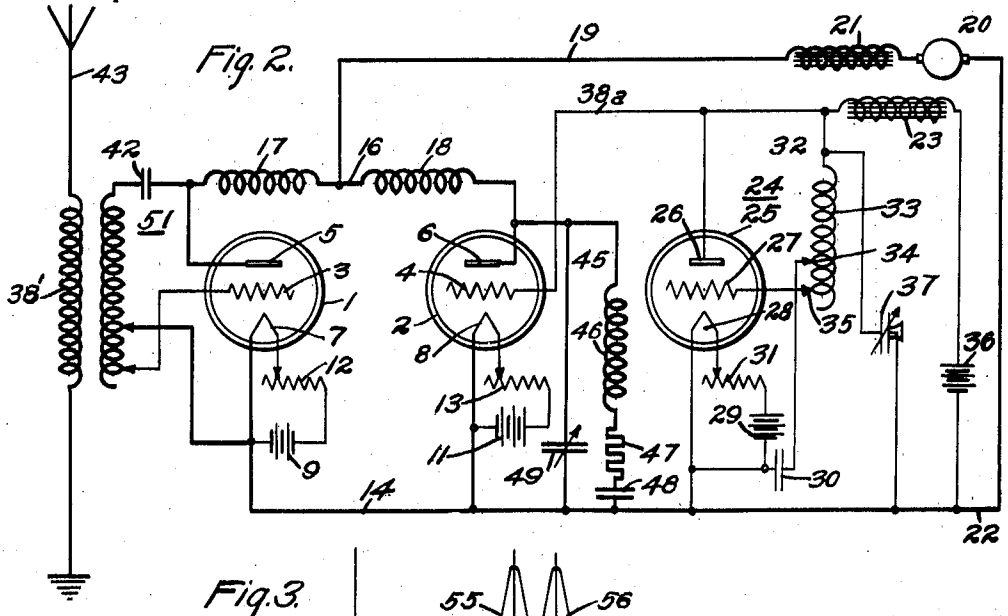
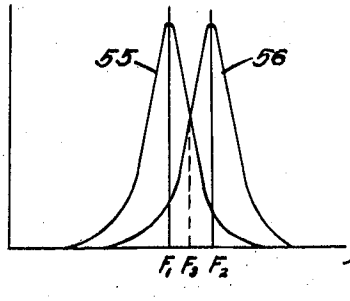


Fig. 3.



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WIRELESS TELEPHONE SYSTEM.

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To all whom it may concern:

Be it known that I, FRANK CONRAD, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Wireless Telephone Systems, of which the following is a specification.

My invention relates to wireless telephone systems and more especially to modulating systems employing vacuum tubes as modulators.

In its broad aspect, the object of my invention is to provide an improved system of modulation for use in connection with wireless telephone systems, whereby the transmission of speech by means of radiant energy may be more readily effected.

More specifically, one object of my invention is to provide a modulating system which shall be particularly adapted to high-power wireless telephone systems.

Another object of my invention is to provide a modulating system which employs a thermionic tube as a modulator and which is so associated with energy-absorbing circuits that only relatively small amounts of energy are dissipated in the modulator tube itself, the larger portion thereof being dissipated in the absorbing circuit.

A further object of my invention is to provide a wireless telephone system employing distinct radiating and absorbing circuits, one of which is tuned to a natural frequency slightly above the frequency of the high-frequency supply-currents, the other circuit being tuned to a natural frequency slightly below the supply frequency, together with means for modulating the frequency of the supply-currents, whereby a constant load is maintained.

Other objects of my invention will be apparent from the following description and claims, when considered in connection with the accompanying drawing, wherein:

Figure 1 is a diagrammatic view of a wireless telephone system embodying my invention;

Fig. 2 is a similar view showing an alternative arrangement of the circuits, and

Fig. 3 is a curve diagram showing the variation of the current in the antenna and absorbing circuits in accordance with the frequency of the supply-current.

In Fig. 1 is shown a pair of thermionic valves 1 and 2 comprising, respectively, input electrodes 3, 4 and output plate-filament electrodes 5, 6, 7 and 8. The filament electrodes 7 and 8 of the tubes 1 and 2, respectively, may be energized from energy sources 9 and 11 through resistors 12 and 13 and are connected in parallel relation by means of a conductor 14. The input electrodes or grids 3, 4 are connected in parallel by means of a conductor 15. The remaining output electrodes or plates 5, 6 are connected in parallel by means of a conductor 16 which includes a pair of radio-frequency choke coils 17 and 18.

One terminal of source 20 of direct-current energy is connected, by means of a conductor 19, through a choke coil 21, to a point on the conductor 16, intermediate the choke coils 17 and 18. The remaining terminal of the source 20 of direct-current energy is connected, by means of a conductor 22, to the conductor 14. The choke coil 21 is so designed as to maintain a substantially constant power-supply to the thermionic tubes 1 and 2 under all conditions of operation.

For purposes of illustration, an oscillation generator system 24 is shown as an oscillator-tube system of known form, comprising a thermionic tube 25 having an anode 26, a control electrode 27 and a hot cathode 28 disposed therein. The hot cathode 28 may be energized by means of an energy source 29 through a resistor 31.

A plate-filament circuit comprises a portion 32—34 of a tuning coil 33 and a stopping condenser 30. A grid-filament circuit comprises a portion 35—34 of the tuning coil 33. A condenser transmitter 37 is connected in a conductor which is shunted across the anode 26 and the cathode 28, thereby serving to supply capacitive reactance to both the plate-filament and grid-filament circuits. The condenser transmitter 37 is designed to effect changes in the frequency of the currents generated by the oscillation generator system 24 in accordance with variations in intensity of sound waves. An anode-cathode current is supplied by a direct-current source 36 in series with a choke coil 23.

A conductor 38 extends from the anode 26 of the oscillator tube 25 to the conductor 15 which connects the grids of the vacuum tubes 1 and 2 in parallel. The cathode 28

of the oscillator tube 25 is connected to the cathodes 7 and 8 of the tubes 1 and 2. By reason of the fact that the plate-filament circuit of the oscillation generator system 24 is directly connected across the grids 3, 4 and the filaments 7, 8 of the vacuum tubes 1 and 2, respectively, the potentials of the grids are varied at frequencies corresponding to those of the oscillation generator system 24.

The anode 5 of the thermionic tube 1 is connected, by a conductor 41, to a tuning coil 38′ through a stopping condenser 42. The cathode 7 of the thermionic tube is connected to the coil 38′ by a conductor 39. An antenna circuit 43 is operatively associated with the tuning coil 38′.

The modulator tube 2 is provided with a plate-filament circuit including a parallel-resonant circuit 45 which may include a tuning coil 46, an energy-absorbing element 47 and a stopping condenser 48, shunted by a variable tuning condenser 49. The condenser 48 is so designed as to have relatively low-impedance to currents of radio-frequency. The period of the parallel-resonant circuit may be adjusted to any desired value by the variable condenser 49.

The modification of my invention shown in Fig. 2 differs from that of Fig. 1 in that the lead 38*a* is connected only to the grid 4 of the tube 2, and the tube 1 is connected to function as an oscillator tube in an oscillation generator system 51 similar to that employed with the tube 25. An additional modification consists in the employment of an inductive coupling between the oscillation-generator system 51 and the antenna circuit 43. To secure best results, the coupling just mentioned should be tight.

In the operation of the system shown in Fig. 1, the natural frequencies of the antenna circuit 43 and of the absorption circuit 45 are adjusted to the resonant frequencies F1 anl F2, as indicated in the curve diagram 55 and 56, respectively, shown in Fig. 3, where ordinates represent intensities of currents and abscissæ represent the corresponding frequencies.

The frequency of the oscillation generator system 24 is then adjusted to a value F_3 intermediate the frequencies F_1 and F_2. When sound waves enter the condenser transmitter 37, the frequency of the currents generated by the oscillation generator system 24 is correspondingly varied. The modulated energy of the oscillation generator system 24 is then impressed upon the grids of the amplifier tube 1 and of the modulator tube 2 to cause the passage of high-frequency currents having similar characteristics in the antenna circuit and in the absorption circuit.

As can readily be seen by referring to the resonance curves shown in Fig. 3, the effect of an increase in the frequency of the currents impressed upon the grids 3 and 4 is to decrease the power taken by the radiating circuit 43 and to increase that taken by the absorbing circuit 45, and vice versa. Thus, the energy in the antenna circuit is modulated in amplitude in accordance with the variations in frequency effected by the condenser transmitter 37, while the total current flowing in the direct-current source 20 is substantially constant, owing to the fact that the curves 55 and 56, at the frequency F_3 have slopes that are equal numerically but opposite in sign. The controlling power supplied by the oscillator tube 25 is also constant, since its frequency only is varied.

The constants of the resonant circuit 45 are so adjusted that a condition is secured wherein the energy dissipated in the tube 2 is extremely small, as compared with the energy dissipated in the resonant circuit 45 in the plate-filament circuit of the tube, thereby admitting of the use of tubes of relatively high efficiency in the modulating circuit and also decreasing the number of tubes that must be employed for such purposes.

The operation of the system shown in Fig. 2 is somewhat different from that of Fig. 1 in that the amplifier tube 1 is caused to serve as an oscillator tube. Modulation of the high-frequency energy is effected through the control of the power-supply to the oscillator tube, in a manner hereinafter described.

In this arrangement, the effect of speaking into the telephone transmitter 37 is to cause the frequency of the currents in the plate-filament circuit 45 to approach and recede from the resonant-frequency of that circuit, thereby varying the power absorbed.

The power delivered to the tubes 1 and 2 remains constant in value by reason of the choke-coil 21, under all working conditions. The effect of varying the power absorbed by the absorption circuit is, therefore, to correspondingly vary the power delivered to the tube 1. Since variations in the power supplied to tube 1 effect similar changes in the energy supplied to the antenna circuit, the resulting modulation of the radiant energy is similar to that obtained in the previous system.

While I have shown but two embodiments of my invention, I do not wish to be limited thereby, and I desire that only such limitations shall be imposed upon my invention as are indicated in the appended claims.

I claim as my invention:

1. In an electrical system, a pair of parallel-associated evacuated electric devices having space-current paths therein, input and output electrodes individual to each space-current path, means associated with

said input electrodes for impressing electrical energy thereon modulated in frequency, and an energy-absorbing circuit associated with the output electrodes of each device, said circuits being so tuned that said modulations in frequency cause opposite variations in the relative amounts of power absorbed by the respective circuits.

2. In an electrical system, a pair of parallel-associated evacuated electric devices having space-current paths therein, input and output electrodes individual to each space-current path, means associated with said input electrodes for impressing high-frequency electrical energy thereon, means for modulating the frequency of said energy according to the signals to be transmitted, and an energy-absorbing circuit associated with the output electrodes of each device, said circuits being so tuned that said modulations in frequency cause opposite variations in the relative amounts of power absorbed by the respective circuits.

3. In a wireless system, a pair of parallel-associated evacuated electric devices having space-current paths therein, input and output electrodes individual to each space-current path, means for energizing said devices, a circuit carrying frequency-modulated, high-frequency signal-currents associated with said input electrodes, and two circuits, one for translating energy and the other for absorbing energy, associated with the output electrodes of the respective devices, said circuits being tuned to different frequencies, one above and the other below the frequencies of said signal-currents.

4. In a wireless system, a pair of parallel-associated relays, each of said relays having a supply circuit, a control circuit and a load circuit, common means associated with both of said control circuits for impressing high-frequency electrical energy thereon modulated in frequency in accordance with signals to be reproduced, an energy-absorbing device associated with the load circuit of each device, and tuning means associated with said devices and said load circuits, said tuning means being so tuned that increases in the frequency of the impressed energy upon said control circuits increases the power absorbed in one device and decreases that absorbed in the other device.

5. In an electrical system, a supply circuit, a pair of parallel paths connected therein, an evacuated electric device having a space-current path therein connected in each of said parallel paths, input and output electrodes for each space-current path, similar electrodes being operatively connected, energy-absorbing circuits associated with each of said evacuated electric devices and means associated with said input electrodes for impressing thereon substantially constant-power currents of modulated frequency, said absorbing circuits being so tuned that the modulations in frequency cause opposite variations in the power absorbed by the respective circuits.

6. In a wireless system, a pair of parallel-associated evacuated electric devices having space-current paths therein, input and output electrodes for each space-current path, means for energizing said devices, means associated with said input electrodes for impressing electrical energy thereon modulated in frequency, an energy-absorbing circuit associated with the output electrodes of one of said devices and a useful energy-translating circuit operatively associated with the output electrodes of the remaining device, each of said circuits including capacitance and inductance, whereby the relative periods of said circuits may be so adjusted that said modulations in frequency cause opposite variations in the power absorbed by the respective circuits.

7. In a wireless system, a pair of parallel-connected relays, input and output terminals therefor, means for energizing said relays, a tuned circuit including an energy-absorbing element associated with the output terminals of one relay, a tuned radiating circuit operatively associated with the output terminals of the remaining relay and means for impressing high-frequency electrical energy of varying frequency upon said input terminals, said circuits being so tuned that said variations in frequency cause opposite variations in the power absorbed by each circuit.

8. In a wireless transmission system, a pair of relays, each of said relays having a supply circuit, a control circuit and a load circuit, a substantially constant-power source common to both of said supply circuits, a tuned reactance means including an energy-absorbing element associated with the load circuit of one of said relays, a tuned reactance means including a useful energy-translating device operatively associated with the load circuit of the remaining relay, and means for impressing high-frequency electrical energy of varying frequency upon at least one of said control circuits, said reactance means being so tuned that said modulations in frequency cause opposite variations in the power absorbed by the energy-absorbing and translating devices.

9. The method of varying the amplitude of currents in an antenna circuit which consists in generating radio-frequency currents, modifying the frequency of said currents in accordance with a signal to be transmitted, impressing said currents upon the input circuits of a pair of parallel-connected valves, each of which is associated with a radiating circuit and with an absorbing circuit and energized by a source of

energy, and so adjusting the tuning of said circuits that said modifications in the frequency of the impressed radio-frequency currents cause opposite variations in the power absorbed by the respective circuits.

10. The method of signaling which consists in modulating the frequency of the oscillations generated by a driver tube in accordance with sound waves, impressing said oscillatory currents upon the grids of two parallel-connected tubes which are associated with a tuned radiating circuit and a tuned absorbing circuit, respectively, and so adjusting the tuning of said circuits that said modulation in frequency causes opposite variations in the power absorbed by the respective circuits.

11. The method of modulation which consists in causing the power supplied to an oscillation generator to vary in accordance with the power supplied to an absorbing circuit and causing said absorbing circuit to approach and recede from a resonant condition, or vice versa, in accordance with a signal to be transmitted.

12. In a wireless transmission system, the combination with coupled radiating and absorbing circuits tuned to different frequencies, of a high-frequency supply circuit having intermediate frequencies, and modulating means for varying the frequency of said supply circuit over a range intermediate the frequencies of said radiating and absorbing circuits.

13. In an intelligence-transmission system, the combination with two coupled energy-translating circuits tuned to different frequencies, of a circuit coupled thereto carrying relatively high-frequency carrier currents of intermediate frequency, said carrier-current frequency being varied within the limits of said translating-circuit frequency, in accordance with a signal.

14. The combination with a source of alternating current, of a translating device supplied thereby, and modulating means associated therewith for varying the energy delivered to said translating device, said modulating means comprising a parallel-resonant circuit including an energy-consuming element and tuned to a frequency slightly different from that of the currents circulating therein, and means for causing said frequency-difference to vary in accordance with a signal.

15. The combination with a source of electrical energy of substantially constant power, of useful energy-translating apparatus and an energy-absorbing apparatus both energized from said source, said energy-absorbing apparatus including means for generating alternating currents, a parallel-resonant circuit adapted to be energized by said alternating currents and deriving energy from said constant-power source, an energy-consuming element associated with said parallel-resonant circuit, said parallel-resonant circuit being tuned to a frequency slightly different than that of said alternating currents, and means for causing said frequency-difference to vary in accordance with a signal.

16. In an electrical system, a modulating device including a space-current path, means disposed in operative relation to said space-current path for controlling the current therein, an alternating-current circuit associated with said controlling means, whereby alternating-component currents of corresponding frequency are caused to circulate in said space-current path, an external circuit for said alternating-component currents comprising a parallel-resonant path tuned to a slightly different frequency, energy-absorbing means associated with said parallel-resonant path, and means for causing said differences in frequency to vary.

In testimony whereof, I have hereunto subscribed my name this 4th day of March, 1922.

FRANK CONRAD.