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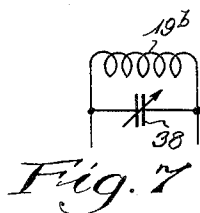
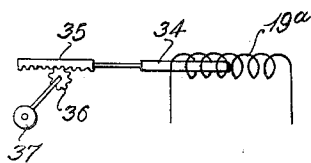
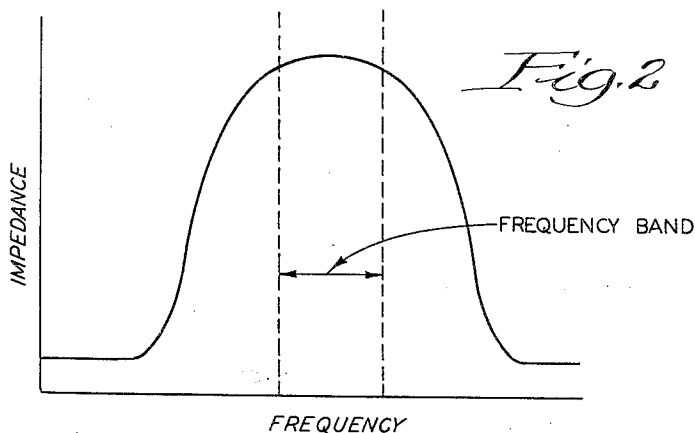
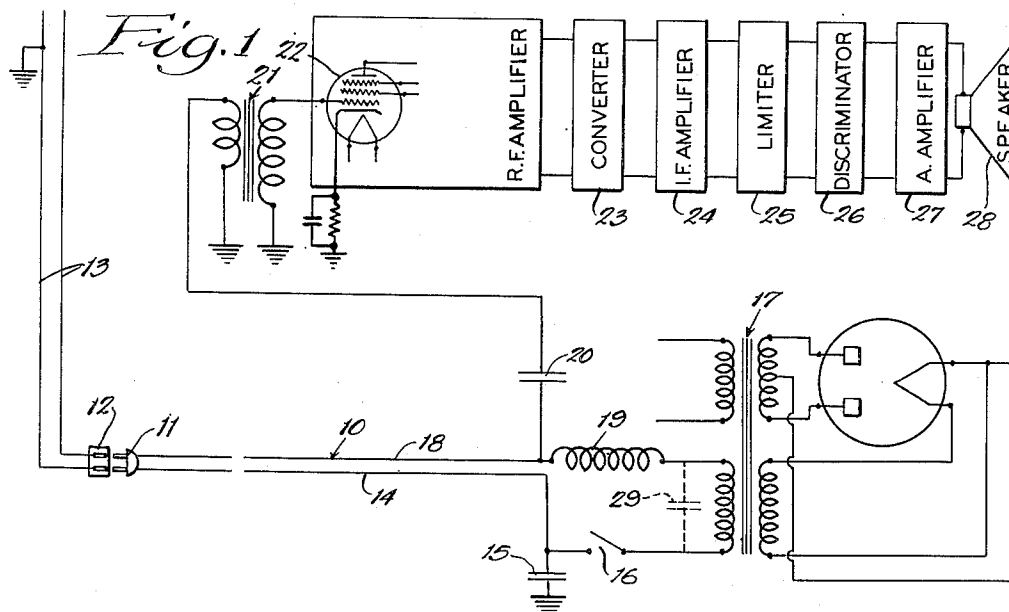
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2,310,896

FREQUENCY MODULATION RECEIVER

Filed Nov. 27, 1941

2 Sheets-Sheet 1



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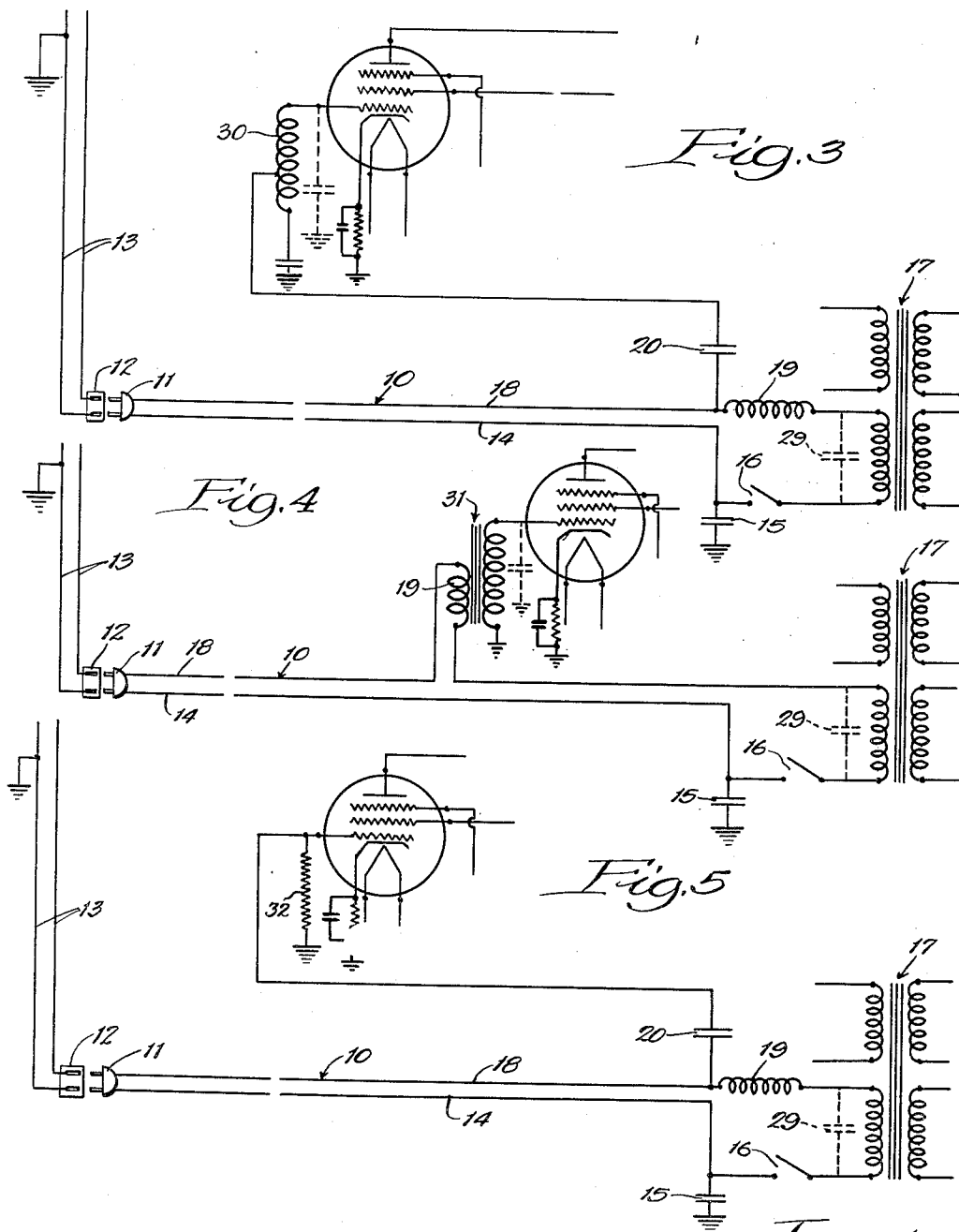
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FREQUENCY MODULATION RECEIVER

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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FREQUENCY MODULATION RECEIVER

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19 Claims. (Cl. 250—20)

This invention relates to frequency modulation receivers and particularly to the antenna systems thereof.

Before this invention it was considered quite impossible to use the power lines with the aid of conventional household outlets as the antenna in the case of frequency modulation receivers. The frequency modulation wave bands lie in the ultra high frequency range and in the case of such ultra high frequency receivers the erection of a suitable antenna at a high position and its adjustment for best reception has always been regarded as a critical part of the installation.

In the ultra high frequency range—normally considered as the range having frequencies above about 28 and 30 megacycles—the frequency is so great that the reactance of two long conductors in as close relation as a normal pair of power wires, is so slight that they would be expected to be effectively short-circuited for ultra high frequency signal. Furthermore, in all modern buildings and installations the power lines are shielded, being located in grounded conduit. Indeed, this is true of practically all wiring except in rare instances. Grounded shield of such wire would normally be expected to prevent any useful signal of ultra high frequency from appearing in the conventional outlet.

I have discovered that the usual power lines, even when enclosed in a shielding conduit and even in large modern steel buildings, are a remarkable and unexpected source of ultra high frequency, frequency modulated signal, and that the same may be derived therefrom with the aid of simple apparatus as hereinafter described. The antenna system of the present invention is extremely efficient and is much more satisfactory than loop antennas and rod antennas heretofore proposed. My antenna system is, in fact, comparable in results to specially built antennas having high elevation and it is, nevertheless, rendered available merely by plugging the receiver into a power outlet.

One of the objects of the invention is to provide an improved antenna for ultra high frequency, frequency modulated signals.

Another object of the invention is to provide an improved antenna system including the power supply for ultra high frequency, frequency modulated signals.

A further object of the invention is to provide a combined power and antenna system for ultra high frequency, frequency modulation receivers.

A further object of the invention is to provide an improved antenna system for ultra high frequency, frequency modulation receivers, which is built into the receiver and which is adapted for use with small and large receivers with equally good results.

A further object of the invention is to provide

an improved ultra high frequency, frequency modulation antenna system, which is highly efficient for the reception of signals which are transmitted polarized horizontally or vertically.

Other objects, advantages and capabilities of the invention will appear from the following description of preferred embodiments thereof taken in conjunction with the accompanying drawings, in which:

Figure 1 is a wiring diagram showing a frequency modulation receiver having an antenna system embodying the invention;

Fig. 2 is an impedance frequency curve showing the manner in which the self-resonant coil 19 resonates with respect to the ultra high frequency band for which the frequency modulation receiver is intended;

Fig. 3 is a wiring diagram similar to Fig. 1 but showing a modified form of antenna system;

Fig. 4 is a wiring diagram similar to Fig. 1 showing still a modified form of antenna system;

Fig. 5 is a wiring diagram similar to Fig. 1, showing yet another form of antenna system;

Fig. 6 is a fragmentary diagram showing a modified self-resonant coil in which the resonant frequency can be varied; and

Fig. 7 is a diagram similar to that of Fig. 6, showing another manner of varying the resonant frequency.

Referring to Fig. 1, the reference numeral 10 designates the cable of the ultra high frequency receiver, the cable terminating in a plug 11. The plug 11 is inserted in an outlet 12 which connects the conductors of the cable 10 to the power lines 13. One of the conductors 14 of the cable 10 is connected to chassis ground through a condenser 15, suitably a .005 microfarad condenser, which serves as an ultra high frequency ground. The conductor 18 should be connected to an ungrounded power line or to one which is grounded at some distance from the outlet. In some cases the results can be improved by reversing the plug 11 in the outlet 12. The conductor 14 is connected through the switch 16 to the primary of the power supply transformer 17.

The other conductor 18 of the cable 10 is connected through a coil 19 to the other side of the primary of the transformer 17 and is also connected through condenser 20, suitably a .0001 microfarad condenser, to the primary of the input transformer 21.

The secondary of the transformer 21 is connected to the grid of the tube 22, this being the first R. F. amplifying tube. The radio frequency amplifier is connected to a converter 23 which in turn is connected to the I. F. amplifier 24. The I. F. amplifier is connected to the limiter section 25 which in turn is connected to the discriminator detector section 26. The output of the discriminator detector section passes to the

A. F. amplifier 27 from whence the audio signal passes to the speaker 28.

The receiver as shown represents the most approved type of frequency modulation receiver. But it is noted that a frequency modulation receiver can be made to function, if of the super-heterodyne type, if it omits one or more of the following stages: R. F. amplifier, limiter, audio amplifier. If of the radio frequency type it might consist only of R. F. amplifier and discriminator stages to which might or might not be added audio amplification. In such receivers other than of the newest approved type suitable interconnections will suggest themselves after the undesired stages have been omitted.

The coil 19 is wound so as to be self-resonant for the band of ultra high frequencies for which the receiver is intended while offering a negligible resistance or impedance to current of lower frequency. Thus, for the 42-50 mc. band, I have found a coil of 38 turns of insulated No. 24 wire wound on a $\frac{5}{8}$ " form with the turns in contact to be eminently satisfactory. Another coil which I have used is 22 turns of insulated No. 18 wire wound on a 1" form.

Such coils have an impedance-frequency relation of the general nature shown in Fig. 2, the coil having a relatively low Q and being wound so that the relatively flat resonance peak extends through the ultra high frequency band for which the receiver is intended. Consequently, the coil 19 presents substantially no impedance or resistance to any frequency except the ultra high frequency band in which the receiver is intended to operate.

It may here be noted that the primary of the power transformer 17 has so much distributed capacity that at the ultra high frequency it serves effectively as an ultra high frequency ground, this capacity being shown in phantom at 29. The ultra high frequency voltage built up on the coil 19 is communicated through the condenser 20 to the primary of the input transformer 21. The secondary of this transformer is preferably self-resonant for the same band as the coil 19.

In the embodiment of the invention shown in Fig. 3, the ultra high frequency voltage developed across the coil 19 is transmitted through the condenser 20 to a coil 30, one side of which is grounded to the chassis, the other being connected to the grid of the first radio frequency amplifying tube which may suitably be a 6SD7GT tube. The coil 30 is tuned by its distributed capacity and the capacity of the grid so as to be broadly resonant in the same band as the coil 19.

In the embodiment of the invention shown in Fig. 4, the coil 19 is arranged to serve as the primary of the input transformer 31, the secondary of which is tuned by its distributed capacity together with the capacity of the grid to be self-resonant at the same frequency as the coil 19.

In Fig. 5 the high voltage side of the coil 19 is connected through the condenser 20 directly to the grid of the first radio frequency amplifying tube. The grid is grounded to the chassis by a very high resistance 32, for example a resistance of one megohm.

In all the modifications of the invention thus far described, the coils 19 may be, for the particular band of ultra high frequencies mentioned, the same as those heretofore described in detail. The coil may, however, be modified to a considerable degree without departing from the ambit of this invention. Thus, the coil may be modified

so as to make the inductance as high as possible without introducing the distributed capacity to an extent which would render the coil self-resonant out of the band. I may space the turns and increase their number, for example. This increases the inductance while reducing the distributed capacity. It will, of course, be understood that the size of the coil is such that it is self-resonant in the desired ultra high frequency band.

Fig. 6 illustrates a modification including a coil 19a which may be generally similar to and which may be employed instead of the coil 19 of any of Figures 1 and 3 to 5, inclusive. The coil 19a of Fig. 6 may be provided with a movable iron core 34, preferably of the compressed powdered iron type, which may be inserted in or withdrawn from the coil by any suitable means such as the rack 35 and pinion 36 rotated by a manual control knob 37. The coil 19a may, when the core 34 is withdrawn, have somewhat less inductance or distributed capacity or less of both than the coil 19 thus providing an LC somewhat less than that of coil 19 so that the resonant frequency of the coil 19a can be varied by inserting the core 34 to insure that the resonant curve of Fig. 2 corresponds to the desired frequency band. Furthermore, the resonant frequency of the coil 19a may be adjusted for each station being received so that the peak of its resonant curve corresponds to the frequency of the unmodulated signal from the station being received, in which case it is possible to interconnect the control knob 37 with the tuning controls of the receiver for conjoint operation therewith, or the coil 19a can be separately tuned. If the resonant frequency coil 19a is thus capable of being varied, the Q of the coil can be somewhat increased to provide a sharper resonant peak and higher impedance at the frequency of the desired station.

A similar coil 19b is shown in Fig. 7 in which the LC is also less than that of the coil 19 and which is provided with a variable condenser 38 across the coil for adjusting the resonant frequency to the frequency band or station being received in a manner similar to that of the coil 19a of Fig. 6.

It will thus be seen that I have provided a new and improved antenna system for ultra high frequency, frequency modulated signals, derived in unexpected fashion from the usual power lines. In operation, the signal appears across the coil 19 as an ultra high frequency voltage, this coil being effectively grounded to chassis as far as the ultra high frequency is concerned. In all the modifications, the ultra high frequency built up across the coil 19 is communicated to the first radio frequency amplifying tube which consequently amplifies this frequency and the desired signal is further amplified in well-known manner and finally supplied to the loud speaker 28.

Although the invention has been described in connection with specific details of preferred embodiments thereof, it must be understood that such details are not intended to be limitative of the invention except in so far as set forth in the accompanying claims.

Having thus described my invention, I declare that what I claim is:

1. In a frequency modulation receiver for reception of ultra high frequency signals and having amplifying and frequency demodulating means, in combination, a pair of conductors

adapted to be connected to power lines, a self-resonant coil and a power supply transformer primary effectively connected across said conductors for series flow of current at said ultra high frequency through said coil from one conductor to the other, means for effectually grounding one of said conductors, and means for supplying ultra high frequency, frequency modulated signal from said coil to said amplifying and frequency demodulating means.

2. In a frequency modulation receiver adapted to receive ultra high frequency signal and including an amplifying tube, in combination, a pair of conductors adapted to be plugged into the power lines, a coil resonant to the ultra high frequency band of the receiver, a power supply transformer having a primary, said primary and said coil being effectively connected across said conductors for series flow of current at said ultra high frequency through said coil from one conductor to the other, means for effectually grounding one side of said coil, and inductive means for supplying ultra high frequency, frequency modulated signal from said coil to said amplifying tube.

3. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signal, and including an amplifying tube, in combination, a pair of conductors adapted to be plugged into the power lines, a coil resonant to the ultra high frequency band of the receiver, a power supply transformer having a primary, said primary and said coil being effectively connected across said conductors for series flow of current at said ultra high frequency through said coil from one conductor to the other, means for effectually grounding one of said conductors, and inductive means for supplying ultra high frequency signal from said coil to said amplifying tube, said inductive means comprising a transformer having a secondary self-resonant to said ultra high frequency band.

4. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signal, and including an amplifying tube, in combination, a pair of conductors adapted to be plugged into the power lines, a coil resonant to the ultra high frequency band of the receiver, a power supply transformer having a primary, said primary and said coil being effectively connected across said conductors for series flow of current at said ultra high frequency through said coil from one conductor to the other, means for effectually grounding one of said conductors, and means including another coil self-resonant to the ultra-high frequency band for supplying ultra high frequency signal from said coil to an amplifying tube.

5. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signal, and including an amplifying tube, in combination, a pair of conductors adapted to be plugged into the power lines, a coil resonant to the ultra high frequency band of the receiver, a power supply transformer having a primary, said primary and said coil being effectively connected across said conductors for series flow of current at said ultra high frequency through said coil from one conductor to the other, means for effectually grounding one of said conductors, a second coil tuned to said ultra high frequency band, said amplifying tube including a control grid connected to said second coil, and a conductor including a blocking condenser for cou-

pling said first coil to said second coil to supply ultra high frequency signal thereto.

6. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signal and including an amplifying tube, in combination, a pair of conductors adapted to be plugged into the power lines, a coil resonant to the ultra high frequency band of the receiver, a power supply transformer having a primary, said primary and said coil being connected in series with said conductors, one of said conductors being directly connected to said primary, means for effectually grounding said one conductor, said amplifying tube having a control grid, and means coupled to said last coil and connected to said control grid, for supplying signal energy at said ultra high frequency to said grid.

7. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signal and including an amplifying tube, in combination, a pair of conductors adapted to be plugged into the power lines, a coil resonant to the ultra high frequency band of the receiver, a power supply transformer having a primary, said primary and said coil being effectively connected across said conductors for series flow of current at said ultra high frequency through said coil from one conductor to the other, means for effectually grounding one of said conductors, said amplifying tube having a control grid, and capacitive means for connecting the opposite side of said coil to said control grid whereby ultra high frequency signal voltage developed across said coil is supplied directly to said grid.

8. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signal and including an amplifying tube, in combination, a pair of conductors adapted to be plugged into the power lines, a coil resonant to the ultra high frequency band of the receiver, a power supply transformer having a primary, said primary and said coil being connected in series with said conductors, one of said conductors being directly connected to said primary, means for effectually grounding said one conductor, said amplifying tube having a control grid, capacitive means for connecting the opposite side of said coil to said control grid whereby ultra high frequency signal voltage developed across said coil is supplied directly to said grid, and a high resistance through which said grid is grounded.

9. In an ultra high frequency receiver including an amplifying tube and adapted to operate on an ultra high frequency band of frequencies greater than twenty-eight megacycles per second, in combination, a pair of conductors adapted to be plugged into conventional power lines, a tuned circuit effectively connected across said conductors for flow of current at said ultra high frequency through said circuit from one conductor to the other and broadly tuned to resonate through said ultra high frequency band, means for effectually grounding one of said conductors, and means for transferring ultra high frequency signal from said tuned circuit to said amplifying tube.

10. In an ultra high frequency receiver including an amplifying tube and adapted to operate on an ultra high frequency band of frequencies greater than twenty-eight megacycles per second, in combination, a pair of conductors adapted to be plugged into conventional power lines, a self-resonant coil effectively connected across said conductors for series flow of current at said ultra

high frequency through said coil from one conductor to the other broadly tuned to resonate through said ultra high frequency band, means for effectually grounding one of said conductors, and means for transferring ultra high frequency signal from said coil to said amplifying tube.

11. A radio receiver for receiving radio frequencies in an ultra high frequency band, comprising, an input radio frequency amplifying tube, a pair of conductors adapted to be connected to a power line, a parallel tuned circuit broadly tuned to provide relatively high impedance for frequencies within said band and relatively low impedance for frequencies substantially removed from said band, said circuit being effectively connected across said conductors for flow of current at said ultra high frequency through said circuit from one conductor to the other, and means for applying the ultra high frequency voltages developed across said circuit to the input terminals of said tube.

12. A radio receiver as defined in claim 11 in which said tuned circuit comprises a self-tuned coil in which the inductance and distributed capacity provide substantial resonance through said ultra high frequency band.

13. A radio receiver as defined in claim 11 in which said receiver includes a power transformer and said conductors constitute the connection of said transformer to said power line, and in which said tuned circuit comprises a self-tuned coil connected in one of said conductors in series with said power transformer, the other conductor being connected directly to said power transformer, the distributed capacity of said power transformer effectively completing the connection of said coil across said conductors within said ultra high frequency band.

14. A radio receiver for receiving radio frequencies in an ultra high frequency band, comprising, an input tube for radio frequencies in said band, a pair of conductors adapted to be connected to a power line, a parallel tuned circuit effectively connected across said conductors for flow of current at said ultra high frequency through said circuit from one of said conductors to the other and resonating at frequencies within said band, means for varying the resonant frequency of said circuit to provide maximum impedance for a selected frequency within said band, and means for applying the ultra high frequency voltages developed across said circuit to the input terminals of said tube.

15. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signals over a band of frequencies, and including an amplifier tube having input terminals, the combination of a pair of conductors adapted to be connected to power lines, means connected between said conductors for producing broad parallel resonance therebetween to maintain maximum potential difference between said conductors over said band of frequencies, and means for transferring energy of frequencies within said band of frequencies from said resonance producing means to the input terminals of said amplifier tube.

16. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signals over a band of frequencies, and including an amplifier tube having input terminals,

the combination of a pair of conductors adapted to be connected to power lines, a power supply transformer for said receiver, means connected serially with said transformer between said conductors for producing broad parallel resonance between said conductors to maintain maximum potential difference therebetween over said band of frequencies, said resonance producing means being effective to excite said power supply transformer from the power lines to which said conductors are connected whereby said resonance producing means minimizes dissipation of energy of frequencies within said band of frequencies in said power supply transformer, and means for transferring such energy of frequencies within said band of frequencies to the input terminals of said amplifier tube.

17. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signals over a band of frequencies, and including an amplifier tube having input terminals, the combination of a pair of conductors adapted to be connected to power lines, means connected between said conductors for producing broad parallel resonance therebetween to maintain the maximum potential difference between said conductors over said band of frequencies, and means comprising a transformer resonant within said band of frequencies for transferring energy of frequencies within said band of frequencies from said resonance producing means to the input terminals of said amplifier tube.

18. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signals over a band of frequencies, and including an amplifier tube having input terminals, the combination of a pair of conductors adapted to be connected to power lines, means connected between said conductors for producing broad parallel resonance therebetween to maintain maximum potential difference between said conductors over said band of frequencies, and means comprising an inductance connected between said input terminals and having a portion thereof connected across said resonance producing means for transferring energy of frequencies within said band of frequencies from said resonance producing means to said amplifier tube.

19. In a frequency modulation receiver adapted to receive ultra high frequency, frequency modulated signals over a band of frequencies, and including an amplifier tube having input terminals, the combination of a pair of conductors adapted to be connected to power lines, a power supply transformer for said receiver, a second transformer resonant within said band of frequencies, means comprising said two transformers connected serially between said conductors for producing broad parallel resonance between said conductors to maintain maximum potential difference therebetween over said band of frequencies, said resonance producing means being effective to minimize dissipation of energy of frequencies within said band of frequencies in said power supply transformer, and means comprising said resonant transformer and connections between the secondary thereof and said input terminals for transferring energy of frequencies within such band of frequencies from such resonance producing means to said amplifier tube.

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