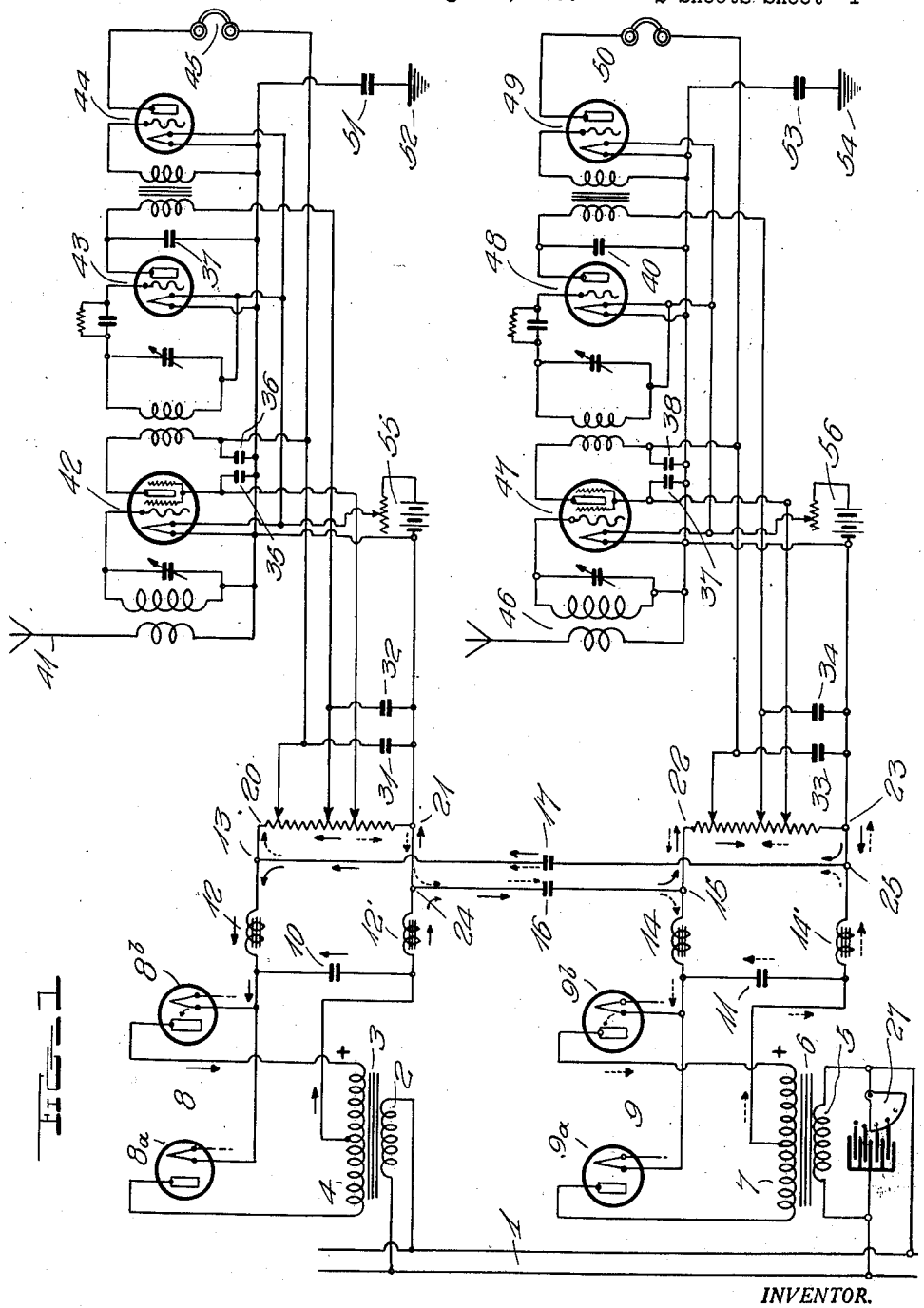
Dec. 8, 1931. E. R. HENTSCHEL 1,835,395

POWER SUPPLY APPARATUS

Filed Aug. 12, 1930 2 Sheets-Sheet 1



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POWER SUPPLY APPARATUS

Filed Aug. 12, 1930 2 Sheets-Sheet 2

FIG. 2A

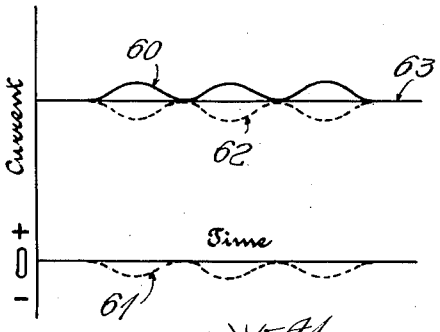
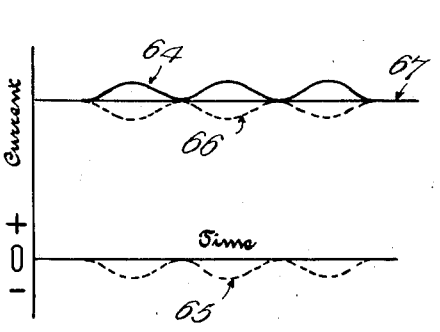


FIG. 2B



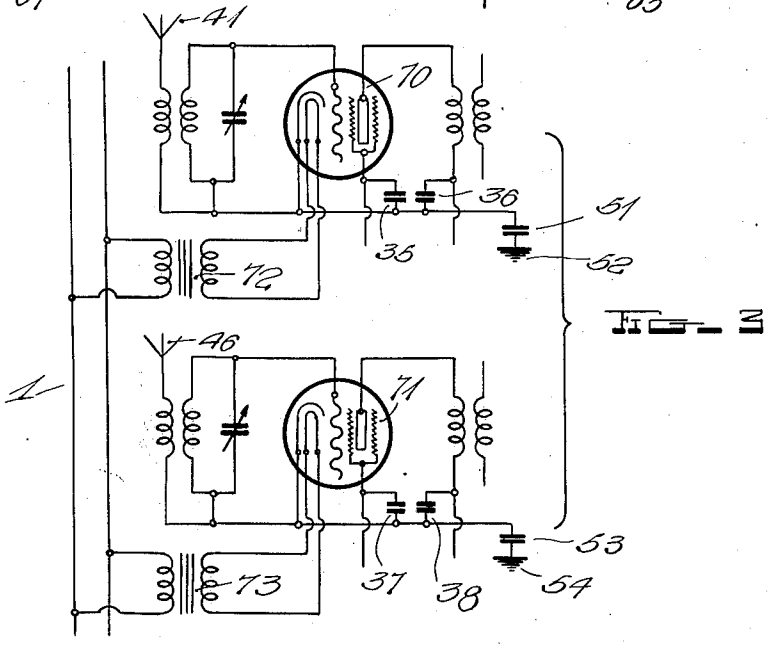


FIG. 3

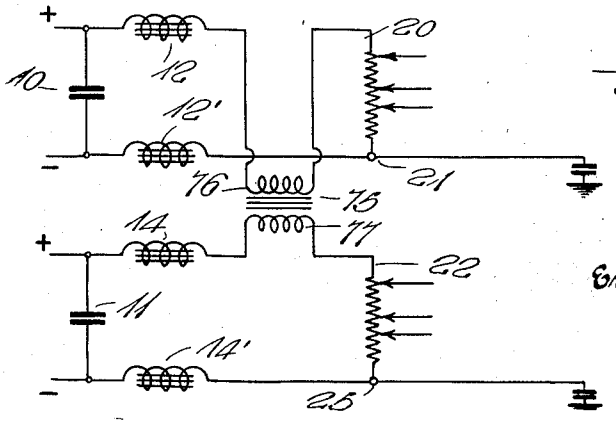


FIG. 4

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UNITED STATES PATENT OFFICE

ERNEST R. HENTSCHEL, OF WASHINGTON, DISTRICT OF COLUMBIA; JOHN OLSON, ADMINISTRATOR OF SAID ERNEST R. HENTSCHEL, DECEASED, ASSIGNOR TO WIRED RADIO, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

POWER SUPPLY APPARATUS

Application filed August 12, 1930. Serial No. 474,780.

My invention relates broadly to a radio receiving system and more particularly to a receiving system having the circuits thereof supplied with power from an alternating current supply system.

One of the objects of my invention is to provide a radio receiving system having means therein for eliminating hum from the alternating current when the power is supplied to the several circuits of the receiving system from alternating current.

Another object of my invention is to provide a receiving system having means whereby alternating current ripples occurring in one portion of the power supply circuit may be opposed by alternating current ripples occurring in a different portion of the power supply circuit leading to the radio receiving system.

Still another object of my invention is to provide a receiving system having a multiple number of channels which may operate on the same or different frequencies with a power supply system energized from a source of alternating current having means for eliminating interference from the hum of the alternating current in the receiving circuit.

A further object of my invention is to provide an arrangement of filter system for a signal receiving circuit having means therein for opposing the effects of ripples upon a receiving circuit, whereby power may be supplied for exciting the receiving circuit without interference from alternating current hum.

A still further object of my invention is to provide a power supply circuit for signal receiving systems having a multiplicity of independent rectifier and filter systems with a circuit interconnecting the filter systems whereby the effect of ripples occurring in the individual rectifier circuits may be eliminated from the signal receiving circuits.

Another object of my invention is to provide a multiple channel receiving system having power supply means for the several circuits of the multiple channel receiving system whereby the several channels may be independently operated while energized from the same power source without interference from power noises in the power supply circuit.

Other and further objects of my invention will be understood from the specification hereinafter following by reference to the accompanying drawings, wherein:

Figure 1 diagrammatically shows a receiving system having a power supply circuit constructed in accordance with the principles of my invention; Fig. 2A and Fig. 2B show characteristic curves for the purpose of explaining the operation of my invention; Fig. 3 shows a modified form of power supply circuit for receiving systems employing the heater type of electron tube; and Fig. 4 shows a modified circuit arrangement for the filter circuit in the power supply system which connects with the signal receiving system of my invention.

In the circuit arrangement of my invention I provide means for bucking out residual hum which may exist in part of the filter circuit of the power supply system to the receiver. I may provide separate receiver circuits constituting a multiple channel receiving system or an artificial load may be connected to one of the rectifier circuits and connection taken between the artificial load and the power supply circuit to one of the receiving channels for bucking out residual hum.

Referring to Fig. 1, I have shown two power transformers 2, 3, 4, and 5, 6, 7, whose primaries are connected in parallel across alternating current line 1. Their secondaries feed full wave rectifiers 8 and 9, respectively, and the rectifiers in turn feed direct current lines 20, 21 and 22, 23, respectively. In each line are placed choke coils 12 and 12′ in upper section, and 14 and 14′ in lower, and across the plus and minus leads of each set are placed filter condensers 10 and 11, respectively. Across points 13 and 25 I connect bypass condenser 17, and across points 15 and 24 I connect condenser 16. The effect of this connection is to cause the ripple in each section to oppose that of the other, and so be bucked out in the external circuits 20, 21, and 22, 23.

The filter circuit supplies power to the circuits of two receiving systems which I have

shown diagrammatically in Fig. 1. One receiving circuit includes the antenna 41, the radio frequency amplifier 42, the electron tube detector 43 and the audio frequency amplifier 44 connected to the responsive device 45. The other receiving circuit includes the antenna 46, the radio frequency amplifier 47, the electron tube detector 48 and the audio frequency amplifier 49 connected to the responsive device 50. The first receiving circuit connects to ground 52 through condenser 51. The second receiving circuit connects to ground 54 through condenser 53. The cathode energy is supplied to the first receiving circuit from a suitable source indicated at 55. The cathode circuit of the second receiving circuit is supplied from a suitable source indicated at 56. The receivers must be connected to ground through the small condensers 51 and 53 which will not pass any appreciable amount of ripple in the "B" supply. It can be seen from the drawings, that if large condensers are used, the effect would be the same as putting in a large condenser between points 24 and 25, which would nullify the 180° out of phase feed-over of ripple from one set of rectifiers to the other. It is for the same reason that separate ungrounded batteries are shown as the source of filament current.

Alternating current tubes may be used if the filament transformers are designed and arranged so as to introduce only a small capacity effect between the two sets. The alternating current tube using a separate heater element may be used to advantage in such a circuit, as the cathode is insulated from the alternating current heater lire 1, and the capacity between the cathode and the heater element is small. Filament connections for this arrangement are shown in Fig. 3.

Consider first, the upper section of the filter alone, and assume that the lower is not working, although all connections are made, as shown. The solid arrows show the directions in which the electrons flow at the instant of maximum potential on the right hand plate. In other words, the instant shown is the time when the alternating current component of the rectified current is a maximum. As condenser 10 is to have a high capacity, and chokes 12 and 12′ a large inductance, much of the alternating current component is short circuited through condenser 10. Following the electrons as they move through the external circuit at point 24, they take two paths, one through line 21, load resistance 21—20, and back to rectifier 8; and the other through condenser 16 to the lower circuit. It is understood, of course, that electrons do not pass through the condenser, but the current flow is the same as if they did. Again, at point 15, there is a choice of two paths, namely, through choke 14 or through line 22, resistance 22—23, and line 23. Now, any current which flows through choke 14 must also flow through choke 14′ and the impedance of these chokes to alternating current is high compared to that of load resistance 22—23. Therefore, most of the alternating current transferred to the lower section from the upper will choose the load circuit path. It is understood, that for low frequencies such as are used for power lines, a single choke coil in one side of the line is just as efficient as one in each, providing the total reactance is the same. The reason for showing one in each is, that it facilitates explanation. Now, as the load resistance in the lower load circuit is to be the same as that in the upper, the alternating current from the upper rectifier will induce practically the same value of current in each load circuit.

Next, consider the lower rectifier. At the same instant that the electron flow in the upper section is at a maximum, the electron flow in the lower section will also be at a maximum and the direction of this electron flow will be from cathode to anode in tube 9b, through the right hand section of transformer secondary 7 to the filter. At this point, the alternating component of the current divides, part of which takes the path through condenser 11 back to the rectifier cathode. The other path, taken by both the direct and the alternating current component, is through choke 14′. From this point the current again divides. A portion of the alternating current component takes a path through condenser 17 to the upper section, while the other path carrying both direct and alternating current, is through the load resistance 23—22. There is no transfer of direct current from the upper section to the lower nor is there a transfer of direct current from lower to upper, but only a transfer of alternating current. As can be seen from the connection of condensers 16—17, the alternating currents supplied from one circuit to the other, are exactly out of phase with one another.

A further explanation of this is illustrated in Fig. 2, in which Fig 2A represents conditions existing in the upper circuit while Fig. 2B represents conditions existing in the lower. Line 60 in Fig. 2A represents the combination of direct and alternating current in load resistance 20—21 as supplied from the upper rectifier power supply alone, while dotted line 61 represents the alternating current component supplied to this same load resistance from the lower rectifier through condensers 16 and 17.

As can be seen in the illustration, the phase relations of the alternating current components are exactly in opposition and when added in the load resistance, the result is smooth steady current as represented by line 63. Fig. 2B represents conditions in the lower recti-

fier. Line 64 shows the combination of direct and alternating current in load resistance 22—23 as supplied by the lower rectifier system alone. The dotted line 65 represents the alternating component supplied to this same load resistance 22—23 from the upper rectifier system through condensers 16 and 17 as in above case. The two alternating current components are exactly out of phase and therefore add as in the above case to give the resultant smooth direct current as indicated by line 67.

While I have illustrated in Fig. 1 a system of connections using batteries for filament supply, it will also be possible to use alternating current filament tubes by using the connections shown in Fig. 3, illustrating the use of a separately heated cathode tube at 70 and 71. Inasmuch as the capacity between the heating conductor and the cathode is small and as there is no conductive connection between the heating current conductor and the other portion of the receiver, there will be a negligible amount of ripple passed through this capacity and therefore all the tubes in both receivers may be supplied from a common alternating current line. Transformers 72 and 73 supply the cathode heating current to the tubes in the receivers represented at 70 and 71 from power line 1, or one transformer may be used to supply current to all filaments.

In Fig. 1, I have shown a condenser means for transferring the alternating current ripple from one circuit to the other. It is also possible to use a transformer 75 for this transfer, as shown in Fig. 4. The connections to windings 76 and 77 are such that the ripple in one circuit is directly opposed by the ripple in the other. The action will be the same as previously explained giving a smooth direct current in each of the output load resistances.

Any increase in the reactance of the choke coils will cause more of the alternating current which is transferred from one circuit to the other, to flow in the load circuit of the receiving circuit, and less to flow through the choke. Therefore, the increase in the value of the choke is doubly beneficial, and so the attenuation of the ripple is greatly increased.

If the power drawn from each circuit is different, there will still be the same bucking action, but the exact symmetry will be disturbed and the phase relations of the currents will also be disturbed, so the bucking action will not be perfect as before. Inserting phase changer 27 in one circuit will correct the phase relations, and if saturation and distortion do not occur in any of the tubes and transformers, a balance is again produced. It would be possible then to operate one circuit with a very small load, and to use it to buck the ripple in the other. If smooth, direct current is wanted from only one circuit, then the constants of the two circuits can be so adjusted that the bucking currents will have exactly the same amplitudes.

The multiple arrangement of the receiving channels enables the receiving system to function for separate communication channels or one channel may be used for sound reception and another channel used for visual reception in television. I may also use one channel for the purpose of transmitting synchronizing signals in a television system while the television signals are transmitted over the other channel.

While I have described my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A signal receiving system comprising a pair of independent receiving circuits, an alternating current line wire circuit, independent rectifier circuits connected with said line wire circuit, filter circuits disposed between each of said filter circuits and the power circuits of said independent receiving circuits, and means interconnecting said filter circuits for opposing the effects of energy fluctuations therein.

2. In a signal receiving system, a pair of independent signal receiving channels, electron tube amplifiers connected in each of said signal receiving channels, an alternating current power supply circuit, rectifier circuits connected with each of said power supply circuits, separate filter circuits interconnecting each of said rectifier circuits and the power circuits of said electron tube amplifier, and means interconnecting said filter circuits for opposing the effects of energy fluctuations therein.

3. In a signal receiving system, a pair of independent signal receiving channels, electron tube amplifiers connected in each of said signal receiving channels, an alternating current power supply circuit, rectifier circuits connected with each of said power supply circuits, separate filter circuits interconnecting each of said rectifier circuits and the power circuits of said electron tube amplifier, and connections through impedance elements extending between points in said filter circuits for opposing the effects of energy fluctuations in said filter circuits.

4. In a signal receiving system, a pair of independent signal receiving channels, electron tube amplifiers connected in each of said signal receiving channels, an alternating current power supply circuit, rectifier circuits connected with each of said power supply circuits, separate filter circiuts interconnecting

each of said rectifier circuits and the power circuits of said electron tube amplifier, and connections including capacity elements extending between said filter circuits for opposing the effects of fluctuations in said filter circuits.

5. In a signal receiving system, a pair of independent signal receiving channels, electron tube amplifiers connected in each of said signal receiving channels, an alternating current power supply circuit, rectifier circuits connected with each of said power supply circuits, separate filter circuits interconnecting each of said rectifier circuits and the power circuits of said electron tube amplifier, and circuits extending between said filter circuits for establishing an interaction by the fluctuations in energy in said filter circuits for substantially eliminating the effects of energy fluctuations in said electron tube amplifiers.

6. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and means interconnecting said filter circuits for opposing the effects of energy fluctuations in one filter circuit with the effects of energy fluctuations in the other filter circuit for eliminating the effects of power noises in the circuits of said electron tube amplifier.

7. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and coupling condensers connected between said filter circuits for opposing the effects of energy fluctuations in one filter circuit with the effects of energy fluctuations in the other filter circuit for substantially eliminating the effects of power noises in the circuits of said amplifier.

8. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and coupling impedances connected between said filter circuits for opposing the effects of energy fluctuations in one filter circuit with the effects of energy fluctuations in the other filter circuit for substantially eliminating the effects of power noises in the circuits of said amplifier.

9. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and circuits interconnecting said filter circuits for transferring energy fluctuations from one filter circuit to the other filter circuit displaced in phase substantially 180° for eliminating the effects of power noises in the circuits of said electron tube amplifier.

10. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, a condenser connected between the positive side of one filter circuit and the negative side of the other filter circuit, and a separate condenser connected between the positive side of said last mentioned filter circuit and the negative side of said first mentioned filter circuit, whereby energy fluctuations are transferred between said filter circuits displaced in phase substantially 180° for eliminating the effects of power noises in the circuits of said electron tube amplifier.

11. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and means interconnecting the output of one filter circuit with the output of the other filter circuit for substantially annulling the effects of energy fluctuations in said filter circuits and eliminating power noises in the circuits of said electron tube amplifier.

12. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits

with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and means interconnecting the output circuits of said filter circuits and adapted to transfer alternating current components of energy between said filter circuits while preventing the passage of direct current for opposing the effects of alternating current fluctuations in one filter circuit with respect to alternating current fluctuations in the other filter circuit for substantially annulling the effects of power noises in the circuits of said electron tube amplifier.

13. In a power supply system, an alternating current power supply line, independent rectifier circuits connected with said power supply line, filter circuits connected with each of said rectifier circuits, separate load circuits, and means interconnecting the output circuits of said filter circuits and adapted to transfer alternating current components of energy between said filter circuits while preventing the passage of direct current therebetween for opposing the effects of alternating current fluctuations in one filter circuit with respect to alternating current fluctuations in the other filter circuit, for substantially annulling the effects of power fluctuations in the load circuits.

14. In a power supply system, an alternating current power supply line, independent rectifier circuits connected with said power supply line, filter circuits connected with each of said rectifier circuits, separate load circuits and a transformer coupling one of said filter circuits with the other for transferring alternating current components of energy in opposed phase relation between said filter circuits for annulling the effects of power fluctuations in said load circuits.

15. In a power supply system, an alternating current power supply line, independent rectifier circuits connected with said power supply line, filter circuits connected with each of said rectifier circuits, separate load circuits, and an impedance comprising a pair of inductances coupled one to the other, one of said inductances being disposed in series in one of said filter circuits and the other of said inductances being connected in series in the other of said filter circuits said inductances being adapted to transfer alternating current components of energy in opposed relation between said filter circuits for annulling the effects of power fluctuations in said load circuits.

16. In a power supply system, an alternating current power supply line, independent rectifier circuits connected with said power supply line, filter circuits connected with each of said rectifier circuits, separate load circuits, and an impedance comprising a pair of inductances coupled one to the other, one of said inductances being disposed in series in one side of one of said filter circuits and the other of said inductances being connected in series with the opposite side of the other of said filter circuits for transferring alternating current components of energy in opposed phase relation between said filter circuits for annulling the effects of power fluctuations in said load circuits.

In testimony whereof I affix my signature.

ERNEST R. HENTSCHEL.

DISCLAIMER

1,835,395.—*Ernest R. Hentschel*, Washington, D. C. Power Supply Apparatus. Patent dated December 8, 1931. Disclaimer filed August 2, 1933, by the assignee, *Wired Radio, Inc.*

Hereby enters a disclaimer to claims 6, 8, 9, 11, 12, 13, 14, and 15 of said patent, which are in the following words, to wit:

"6. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and means interconnecting said filter circuits for opposing the effects of energy fluctuations in one filter circuit with the effects of energy fluctuations in the other filter circuit for eliminating the effects of power noises in the circuits of said electron tube amplifier."

"8. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and coupling impedances connected between said filter circuits for opposing the effects of energy fluctuations in one filter circuit with the effects of energy fluctuations in the other filter circuit for substantially eliminating the effects of power noises in the circuits of said amplifier.

"9. In a signal receiving system, an electron tube amplier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and circuits interconnecting said filter circuits for transferring energy fluctuations from one filter circuit to the other filter circuit displaced in phase substantially 180° for eliminating the effects of power noises in the circuits of said electron tube amplifier."

"11. In a single receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and means interconnecting the output of one filter circuit with the output of the other filter circuit for substantially annulling the effects of energy fluctuations in said filter circuits and eliminating power noises in the circuits of said electron tube amplifier.

"12. In a signal receiving system, an electron tube amplifier, an alternating current power supply line, independent rectifier circuits connected with said power supply line, separate filter circuits connected with said independent rectifier circuits, a load circuit, connections between one of said filter circuits with said load circuit, independent connections between the other of said filter circuits and the power circuits of said electron tube amplifier, and means interconnecting the output circuits of said filter circuits and adapted to transfer alternating current components of energy between said filter circuits while preventing the passage of direct current for opposing the effects of alternating current fluctuations in one filter circuit with respect to alternating current fluctuations in the other filter circuit for substantially annulling the effects of power noises in the circuits of said electron tube amplifier.

"13. In a power supply system, an alternating current power supply line, independent rectifier circuits connected with said power supply line, filter circuits connected with each of said rectifier circuits, separate load circuits, and means interconnecting the output circuits of said filter circuits and adapted to transfer alternating current components of energy between said filter circuits while preventing the passage of direct current therebetween for opposing the effects of alternating current fluctuations in one filter circuit with respect to alternating current fluctuations in the other filter circuit, for substantially annulling the effects of power fluctuations in the load circuits.

"14. In a power supply system, an alternating current power supply line, independent rectifier circuits connected with said power supply line, filter circuits connected with each of said rectifier circuits, separate load circuits and a transformer

coupling one of said filter circuits with the other for transferring alternating current components of energy in opposed phase relation between said filter circuits for annulling the effects of power fluctuations in said load circuits.

"15. In a power supply system, an alternating current power supply line, independent rectifier circuits connected with said power supply line, filter circuits connected with each of said rectifier circuits, separate load circuits, and an impedance comprising a pair of inductances coupled one to the other, one of said inductances being disposed in series in one of said filter circuits and the other of said inductances being connected in series in the other of said filter circuits said inductances being adapted to transfer alternating current components of energy in opposed relation between said filter circuits for annulling the effects of power fluctuations in said load circuits."

[*Official Gazette August 29, 1933.*]