

March 14, 1933.

A. S. RIGGS

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RADIO RECEIVING SYSTEM

Original Filed March 2, 1927

2 Sheets-Sheet 1

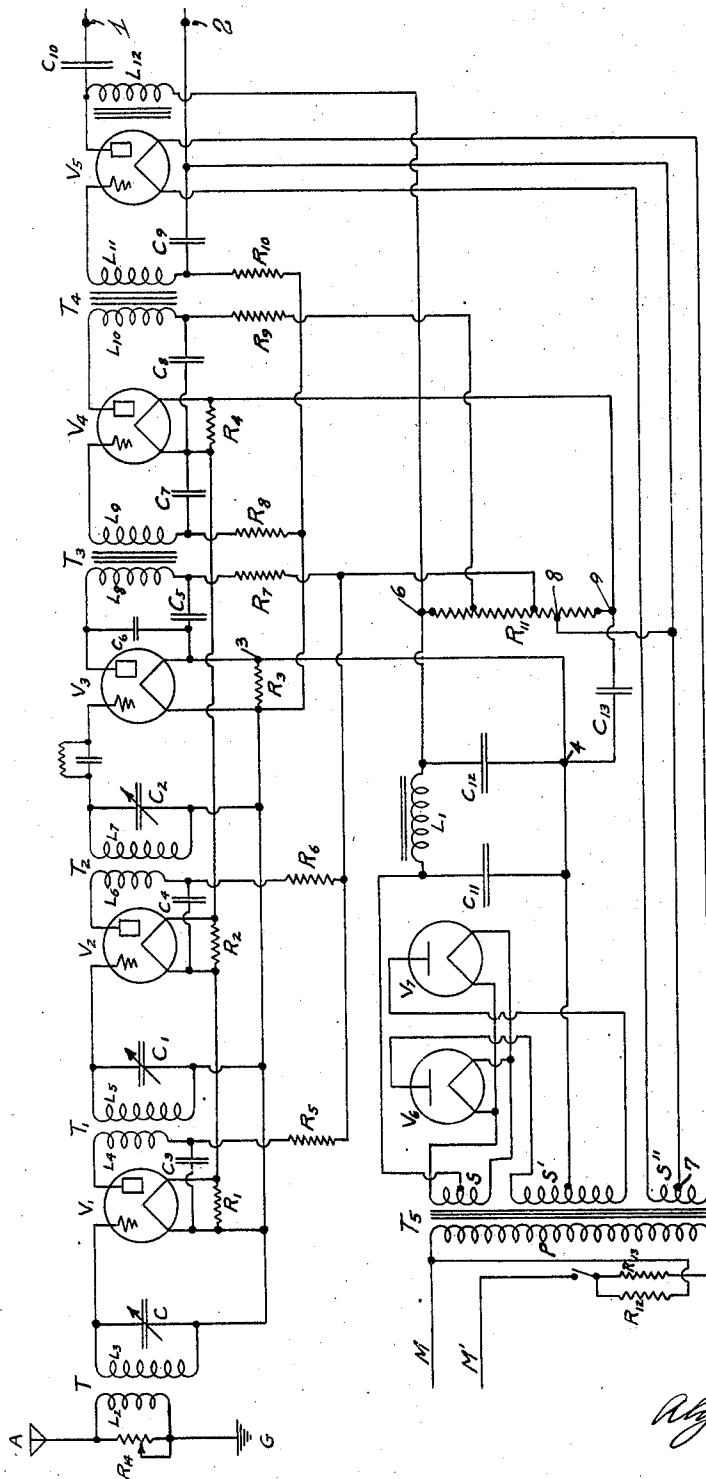


FIG. 1.

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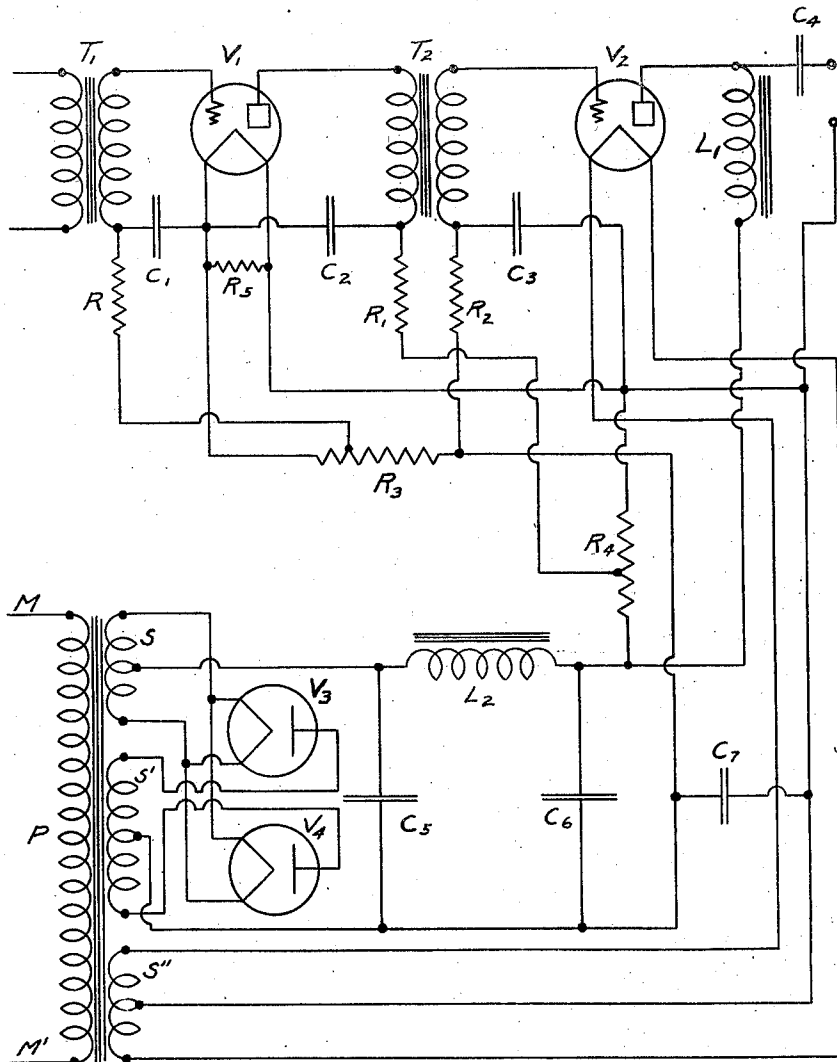


FIG. 2.

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RADIO RECEIVING SYSTEM

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My invention relates broadly to radio receiving systems, and more especially to such apparatus when associated with circuits permitting the radio receiving system to be supplied with power for the operation of the amplifiers from commercial alternating current circuits.

An object of my present device is to provide a system whereby a radio receiving device is supplied with power from commercial alternating current circuits. A further object of my present invention is to provide such a system, incorporating extremely stable operating condition of the amplifier circuits comprising portions of the radio receiving set. A still further object of my invention is to provide restricted paths for the flow of the alternating currents generated in the amplifiers, and to restrict and confine these currents to their correct respective portions of the circuit thus effectively eliminating conductive and other coupling between the circuits. A still further object of my invention is to provide a system of operation, including means of rectifying and filtering commercial alternating-current so that the radio receiving set is operated without the presence of excessive "hum" in the loud speaker, or other translating device, due to the frequency of the commercial supply line.

Referring to the drawings, of which Fig. 1 is a diagrammatic view of a radio receiving set comprising two stages of radio frequency amplification, detector and two stages of audio frequency amplification together with such attendant apparatus and devices as are essential for the operation of the system constituting my present invention, and, Fig. 2 is a diagrammatic view of an audio frequency amplifier comprising two stages of transformer coupled audio amplification and the essential apparatus and devices to permit the operation of the amplifier from a commercial alternating current circuit.

It is understood that portions of my invention are shown in the drawings merely for the purpose of illustration, and the drawings shall not be construed as a final and complete application of my present invention, inas-

much as the substitution of other apparatus and devices will not materially affect the operation of my system as a whole.

With reference to the drawings, and more especially to Fig. 1, it will be seen that the conventional tuned radio frequency type of radio receiver together with two stages of audio frequency amplification is connected in a circuit whereby the complete radio receiving set is operable from commercial alternating current circuits.

The radio receiving set consists of two stages of radio frequency amplification including the tuned transformers, T and T_1 and the vacuum tubes V_1 and V_2 together with attendant apparatus hereinafter described in greater detail.

The tuned transformer T_2 is connected in conventional manner, thru grid condenser and leak to the vacuum tube V_3 , which functions as a rectifier, or more correctly, as a detector or de-modulator which resolves the modulated high frequency picked up from the antenna "A" into two major components:—a low or audio frequency, and a high or radio frequency. The output circuit of the tube V_3 is so connected that the high frequency component of its output is short-circuited through the condenser C_6 , but the low, or audio frequency, is amplified thru the transformer T_3 , tube V_4 , transformer T_4 , tube V_5 , and then is supplied to a loud speaker or translating device connected to the terminals 1—2 of the audio amplifier of the apparatus.

It is evident by further inspection of the drawings that the filaments of the vacuum tubes, V_1 , V_2 , V_3 , and V_4 are all connected in series, the negative end of such series being designated as point 3 which is connected to the negative side (4) of a filter system comprised by the inductance or choke coil L_1 and the condensers C_{11} and C_{12} . The positive end of this series of filaments, point 5, is connected through resistance R_{11} to the point 6, which is the positive side of the filter last referred to.

The filament of tube V_5 is supplied with current from the secondary S'' of the transformer T_5 , a center tap of said secondary,

point 7, being connected to the point 8 on resistance R_{11} . The connection to the anode, or plate of the tube V_5 is connected through inductance L_{12} to the positive side 6 of the filter system comprised by the inductance or choke L_1 and the condensers C_{11} and C_{12} .

It is evident from the foregoing that all current flowing from the filter circuit at point 4 must pass successively through the filaments of V_3 , V_1 , V_2 , and V_4 in the order named, thence to point 9 of the resistance R_{11} . All of the current also flows through the portion of resistance R_{11} which is between points 9 and 8. Part of the current then flows through the resistance R_{11} above point 8 to the positive side of the filter at point 6, and part of the current flows through the tube V_5 through the paths represented by the filament to plate resistance of V_5 , thence through L_{12} to point 6.

Now, inasmuch as the plate current to the tube V_5 flows through a choke, or inductance, L_{12} , it is evident that this circuit is one of high reactance and is therefore a direct current branch circuit. Hence the normal current taken for the plate of tube V_5 (which is usually a power tube requiring large direct-current and voltage) is also used for partly maintaining the filament heating current of the tubes V_1 , V_2 , V_3 and V_4 .

The maximum current taken from the filter system is therefore equal only to the filament current of a tube similar to V_1 , V_2 , V_3 or V_4 , plus the space currents taken by these tubes under normal conditions.

By further inspection of the drawings it will be seen that the resistances R_1 , R_2 , R_3 , and R_4 are connected across the filaments of tubes V_1 , V_2 , V_3 and V_4 , respectively, these resistances being of such values as to effectively by-pass that portion of the total current taken from the filter system which is not required to heat the filaments of V_1 , V_2 , V_3 and V_4 .

From the foregoing, it will be seen that the circuit including the filaments of tubes V_1 , V_2 , V_3 and V_4 comprise a portion of a direct current series circuit which includes the resistance R_{11} and the direct-current plate resistance of tube V_5 .

Now, in a vacuum tube circuit there are two currents present: one being a direct-current, and the other being an alternating-current component super-imposed thereon. My system contemplates the proper separation and restriction of both these components to proper paths. This separation effectively restricts the alternating-currents to a well-defined path which is as follows:—From plate (or anode) and filament of the tube, between which the alternating-current component is generated, to and through the transformer, or other electro-responsive device and the plate circuit of the tube, thereby insuring the presence of direct-current only in the circuit

supplying plate voltage to the amplifier tube.

This not only limits both components to their proper path, but moreover, prevents the occurrence of conductive coupling between the circuits.

For instance, the alternating-current component of tube V_1 is effectively by-passed through condenser C_3 ; this path offering less opposition to the flow of said components than does the path through the resistance R_5 .

In each of the amplifier circuits I have provided filter systems consisting of suitable by-pass condensers and resistances which function as above described.

It is seen that the grids of all tubes are maintained at proper predetermined potentials, the filaments of tubes V_1 , V_2 , V_3 , and V_4 being so located in the circuit as to allow all grid return leads to be brought to a common point.

Resistance capacity filters are provided in the grid returns of all audio stages for the purpose of eliminating coupling and also to obviate the possibility of an alternating-current component originating in the main filter (L_1 , C_{11} and C_{12}) from being passed on to the grids of the amplifier tubes.

The power supply consists of a power transformer, T_5 , having a primary winding, P , which is energized from an alternating-current circuit through the ballast resistance R_{13} , which in combination with the resistance R_{12} acts to maintain a constant voltage across the terminals of the primary P of the power transformer T_5 . The secondary S serves to furnish power for heating the filaments or cathode of the rectifier tubes, V_6 and V_7 . The secondary windings S' serves to furnish high potential for the rectifier; and the winding S'' serves to supply current to the filament or cathode of the power tube V_5 .

The rectified current passes into the radio set through the filter consisting of inductance L_1 and the condensers C_{11} and C_{12} . This filter effectively resolves the pulsating current from the rectifier system to a substantially pure direct-current. The condenser C_{13} is placed in the circuit for the purpose of by-passing alternating-current components which would otherwise travel through the series circuit containing the filaments of tubes V_1 , V_2 , V_3 , and V_4 .

From the foregoing it is evident that the system comprising my present invention represents a stable circuit having a constant current direct-current branch, and several well-restricted alternating-current paths for the flow of currents of corresponding qualities.

In Fig. 2 of the drawings I have shown more particularly the circuit connections for the power supply stages of the radio receiver where a power amplifier is constituted by electron tubes V_1 and V_2 associated with audio frequency transformer systems T_1 and

T2 which provide the coupling means for the circuits of the electron tubes. The power transformer and rectification system are shown arranged in the same manner as in Fig. 1. The rectifier tubes are indicated at V3 and V4 for full wave rectification of the alternating current power supply. The filter circuit is constituted by condensers C5 and C6 and inductive reactance L2 and the input circuit thereof connected to the cathode circuit of electron tube V1 and to the output circuits of each of the electron tubes. I have illustrated the circuit connections for the output circuit of electron tube V1 as extending from a tap on resistance R4 through filter resistance R1. The output circuit of electron tube V2 is completed through the choke or inductance L1 connected to the positive side of the filter circuit. The biasing potential for each of the power amplifier stages is supplied from the negative side of the filter circuit through resistance R2 and from a tap on resistance R3 through the resistance R to the grid circuit of electron tube V1. I provide blocking condensers C1, C2, C3 and C7 disposed in the input and output circuits of the power amplifier stages for preventing the interference of hum from the supply system in the circuits of the electron tubes.

I also provide a condenser C4 in the sound reproduced circuit for the further reduction of interference from noises inherent in the supply circuit. The condensers C1, C2, C3, C7 and C4 serve to restrict and separate the paths of the alternating and direct current components. It will be observed that the cathode of electron tube V2 is energized from the secondary winding S'' of the power transformer system while the cathode of electron tube V1 is excited from a direct current derived from the rectification system. The cathode circuit for electron tube V1 is completed through the midtap of secondary winding S'' and the anode circuit of electron tube V2. It is therefore evident that the space current of the electron tube V2 passes through the cathode of electron tube V1 thereby supplying a portion of the power necessary to maintain the last mentioned cathode at proper temperature. It is therefore evident that this results in a considerable saving of power drawn from the rectification part of the system.

It is understood that modifications and changes may be made in my system without departing from the spirit of the original invention or the scope of the appended claims.

I claim:

1. A radio receiving system including a plurality of electron tubes connected in cascade, an alternating current power source, a rectification circuit for supplying rectified current to the circuits of said electron tubes, a distribution circuit connected with said

rectification circuit and independent reactance devices interposed in series between points in each of the output circuits of said electron tubes and the input circuits of selected electron tubes and points in said power distribution circuit for energizing the output circuits of each of the electron tubes while preventing interference in said electron tube circuits from said alternating current source.

2. A radio receiving system including a plurality of electron tubes, a power source of alternating current, a rectification system, means for supplying constant current from said rectification system to the circuits of said electron tubes, a power distribution circuit connected in shunt with said rectification system and a reactance constituted in part by a resistance interposed in series in each of the leads between the output circuits of the several tubes and the input circuits of selected tubes and said power distribution circuit for energizing the output circuits of said electron tubes while preventing interference from the alternating current source.

3. A radio receiving system including a plurality of electron tubes connected in cascade, a power source of alternating current, a rectification system for supplying rectified current to the circuits of said electron tubes, a power distribution circuit connected with said rectification system, a capacity reactance interposed in series between a point in each of the output circuits of said electron tubes and the cathodes thereof, individual reactance members connected between the said points in said output circuits and one side of the power distribution circuit connected with said rectification system and separate reactance members connected between the input circuit of selected tubes and said system for energizing the circuits of said electron tubes while preventing interference from said alternating current source.

4. A radio receiving apparatus including a plurality of electron tubes connected in cascade, a power source of alternating current, a rectification system, circuits for delivering constant current from said rectification system to the circuits of said electron tubes, resistance members interposed in series between one side of said first mentioned circuits and points in each of the output circuits of said electron tubes for impressing high potentials upon the output circuits of said electron tubes while preventing interference in said electron tube circuits from said alternating current source and separate resistance members connected between said system and the input circuits of selected electron tubes.

5. In a radio receiving system the combination with a plurality of electron tubes connected in cascade, a source of alternating current power, a rectification system, a filter associated therewith, connections whereby said electron tubes are energized from said

- rectification system, means for preventing inter-stage coupling between said electron tubes including resistances interposed in series between said filter circuit and the output circuits of each of said electron tubes, and capacitive reactances interposed in series between the cathodes of said electron tubes, the output circuits of said electron tubes and the last mentioned resistances for restricting and confining alternating and direct current components to independent paths in said circuits and separate resistance members connected between said system and the input circuits of selected electron tubes.
6. In a radio receiving system including a plurality of electron tubes, input and output circuits coupling said tubes, a power source of alternating current, a rectification system, a filter circuit for delivering constant current to the circuits of said electron tubes, connections between the output circuits of said electron tubes and said filter circuit, and connections between selected ones of the input circuits of said electron tubes and said filter circuits and condensers connected in shunt between said connections and the cathode circuits of the several electron tubes, said connections including in series position resistance members independent one from another for controlling the potential impressed upon said circuits while preventing interference from the power source of alternating current.
7. In a radio receiving system including a plurality of electron tubes each having input and output circuits coupled one to the other, a rectification system interposed between a power source of alternating current and the circuits of said electron tubes, the output circuits of selected electron tubes having resistance members interposed in series between said rectification system and the input circuits of selected ones of said tubes having independent reactances interposed in series with said rectification system, and auxiliary reactances connected between said first mentioned resistance members and the cathode circuits of said tubes for confining the alternating and direct current components to separate paths and preventing interference from the alternating current source in said electron tube circuits.
8. A radio receiving system including a plurality of electron tubes arranged in cascade, input and output circuits for each of said tubes, a power source of alternating current, a rectification system, means interposed between said source and said rectification system for effecting the delivery of constant current to the circuits of said electron tubes, a cathode circuit including the cathodes of selected ones of said electron tubes in series, connections between said cathode circuit and said rectification system, and resistance members interposed between each cathode in said independent cathode circuit and points in said output circuit and condensers connected between the cathode adjacent the point of connection of said resistance members thereto and the output circuit of the associated tube for preventing interference from the alternating current source.
9. In a radio receiving system including a plurality of electron tubes each having input and output circuits and having their cathodes arranged in series relation, an alternating current power supply for said tubes, the order of arrangement of said cathodes being such that all grid returns of said electron tubes may be grouped and brought to a common point thereby maintaining selected predetermined potentials on each of the grids of the several electron tubes composing a part of said system and resistors in series with each of the output circuits of said tubes and said source.
10. In a radio receiving system including a plurality of electron tubes having input and output circuits and having their cathodes arranged in series relation including a source of rectified and filtered alternating current for energizing said cathodes and for supplying potentials to the input and output circuits of said electron tubes, a circuit connecting all grid returns in said system to a common point with respect to said source, separate alternating current and direct current branches connected with said cathodes and isolated by capacitive reactance and resistance on one side of each of said cathodes and capacitive reactance on the other side of each of said cathodes and resistors in series with each of the output circuits of said tubes and said source.
11. A radio receiving system including a plurality of electron tubes constituting amplification of detector stages each having input and output circuits, means coupling the output circuit of one electron tube with the input circuit of a succeeding electron tube, a power source of alternating current, a rectification and filter power distribution system interposed between said power source and said electron tube circuits, connections including resistances connecting in series between said power distribution system and points in the input and output circuits of said detector stage and selected amplification stages, and condensers disposed between the ends of said resistances and the cathode elements of said tubes for separating the alternating and direct current components in said circuits and preventing interference from said source.
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