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POWER SUPPLY SYSTEM FOR VACUUM TUBE AMPLIFYING DEVICES

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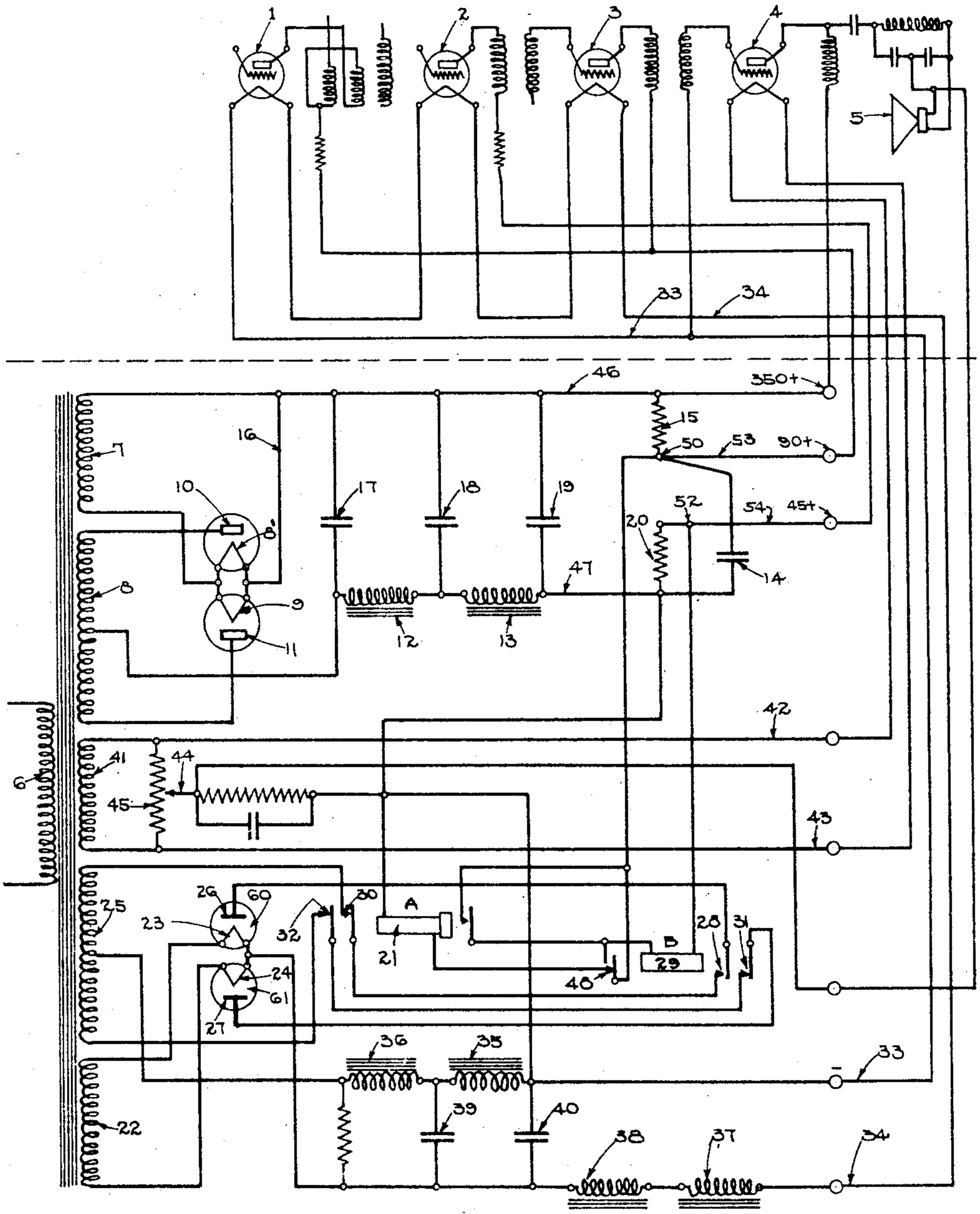

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POWER SUPPLY SYSTEM FOR VACUUM TUBE AMPLIFYING DEVICES

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This invention relates to rectifying systems and more particularly to rectifying systems utilized in connection with vacuum tube amplifiers. It has been discovered in rectifying systems where a large voltage output is required that the rectifying tubes are frequently of very short life due to the fact that a very high voltage is applied to the anodes of the rectifiers before the filaments have been heated to full brilliancy with the result that it causes a certain "stripping" action whereby the material of the filaments is rapidly eroded so that they quickly deteriorate. As a remedy for this defect it has been discovered that if the anode voltage is not applied to the anodes of the rectifiers until the filaments have been lighted to full brilliancy this stripping action is avoided and the expected life of the tubes is obtained.

The main feature of the invention resides in the provision of means in a rectifying system utilized in connection with a vacuum tube amplifier for preventing the anode voltage from being applied to the anodes until the filaments have been heated to approximately 90% of their normal operating temperature.

For a clearer understanding of the invention reference is made to the drawing in which a portion thereof above the broken line represents a portion of a radio receiver having a radio frequency amplifying stage, a detector and two stages of audio amplification while a loud speaker is associated with the output stage of the last audio amplifier. The portion of the drawing below the broken line represents a rectifying system for supplying plate voltage to the vacuum tubes of the radio receiver and an additional set of rectifiers for furnishing the heating current to the filaments of the vacuum tubes or electron discharge devices.

In the drawing the numeral 1 designates a vacuum tube in a radio frequency stage of a radio receiver while the numeral 2 designates a detector, and the numerals 3 and 4 indicate vacuum tubes in the audio amplifying stage of a radio receiver. The circuits of the radio receiver are not completely shown but only those portions relating to the circuits for heating the filaments of these vacuum tubes and for applying a plate voltage to the anodes thereof. The output circuit of the last audio stage includes a loud speaker 5 together with the usual audio filter associated therewith. The circuits and operation of the radio receiver may be similar to that of any of the well-known types of radio receivers now on the market which utilize rectified or partially rectified alternating current for heating the filaments of the vacuum tubes in the several stages thereof.

The rectifying system of this invention includes the primary winding 6 of a transformer connected by suitable switching means in series with a source of alternating current (not shown). This transformer is provided with a plurality of secondary windings, one of which designated 7 furnishes heating current for heating the filaments 8′ and 9 of the rectifier tubes which furnish the plate or anode voltage to several of the vacuum tubes of the radio receiver. The secondary winding 8 of this transformer has its ends connected to the anodes 10 and 11 of these rectifiers and its intermediate point connected through the choke coils 12 and 13 and thence through resistance 20, the resistance of either the winding of relay 21 or of relay 29, the resistance 15 over conductors 46 and 16 to a point on the fllament heating system. It will be understood that the choke coils 12 and 13 serve with condensers 17, 18 and 19 as a multi-stage filter for filtering out the ripple or alternating current component in the rectified current. The resistances 15, 20 and the resistance of the winding of the slow releasing relay 21 or of the substitute relay winding 29 operate by the drop in potential method to apply the necessary different voltages to the anodes of several of the vacuum tubes. The secondary winding 22 of the mentioned transformer is connected in series with the filaments 23 and 24 of the rectifying tubes 60 and 61 which furnish the rectified current for heating the filaments of the several vacuum tubes of the radio receiver.

The secondary winding 25 of this transformer has its ends respectively connected

to the anodes 26 and 27 of the two rectifying devices 60 and 61. The circuit including the anode 26 may be traced through the normally open contacts 28 of the relay 29 and through the normally closed contacts 30 of the slow releasing relay 21 and thence to the upper terminal of the secondary winding 25. The circuit including the anode 27 may be similarly traced through the normally open contacts 31 of the relay 29 and the normally closed contacts 32 of the slow releasing relay 21 and thence to the lower end of the winding 25. The purpose of the normally opened contacts 28, 31 and of the normally closed contacts 30, 32 will be set forth hereinafter.

It will be noted that the filaments of the vacuum tubes or electron discharge devices 1, 2 and 3 are connected in series to the conductors 33 and 34, the conductor 33 being connected through the inductances 35 and 36 to an intermediate point on a secondary winding 25 and the conductor 34 being connected through the choke coils 37 and 38 to a point on the filament system of filaments 23 and 24. The choke coils 35, 36, 37 and 38 together with the condensers 39 and 40 form a two-stage filter for filtering out a ripple or alternating current component. The secondary winding 41 of the transformer has its ends connected in series with the conductors 42 and 43 which in turn serially include the filament of the vacuum tube 4 in the last audio stage. A potentiometer 45 is connected across the secondary winding 41 in such a manner that its adjustable member 44 which is connected to the negative lead 33, may be adjusted to balance out any hum which otherwise would be introduced into the filament system of the vacuum tube 4.

The rectifier tubes 60 and 61 which supply the heating current to the filaments of the vacuum tubes 1, 2 and 3 are of the type in which the electrodes operate in a gas. It has been discovered that if a voltage is applied to the anodes 26 and 27 before the filaments such as 23 and 24 are heated to approximately 90% of their normal operating temperature there is a tendency for an arc to form in the rectifier tubes which erodes the filaments and in a relatively short time causes them to deteriorate so that their life is very much less than their normal rating. In order to overcome this defect slow releasing relay 21 and relay 29 are introduced into the network of the power supply device to hold the circuits of the anodes 26 and 27 open for a sufficient period to permit the filaments 23 and 24 to approach 90% of their normal heating temperature.

When it is desired to operate the radio receiver a switch (not shown) is closed to connect the primary winding 6 of the transformer in circuit with the alternating current source. As soon as this takes place the filaments 8′ and 9 heat up and the rectifier tubes of which they are a part begin to rectify the alternating current and the two-stage filters across the conductors 46 and 47 function to filter out the alternating current component. Rectified current flowing in conductors 46 and 47 operates the slow releasing relay 21 in a circuit partially described as including resistance 15, continuity spring and back contact 48 of relay 29, winding of relay 21 and thence to conductor 47. The relay 21 attracts its armatures and at the contacts 30 and 32 opens the circuits which supply the potential to anodes 26 and 27. As soon as the right hand armature and contact of the relay 21 is closed an operating circuit for the relay 29 is completed from the conductor 46, resistance 15, right-hand contact and armature of relay 21, winding of relay 29, resistance 20 and thence to conductor 47. As soon as the relay 29 is operated it closes a locking circuit for itself through its left-hand armature and continuity spring which renders the operation of the relay 29 independent of the operation of the slow releasing relay 21. Also with the relay 29 operated contacts 28 and 31 in the plate circuits of the anodes 26 and 27 are closed but these circuits are ineffective until the slow releasing relay 21 has retracted its armatures which it starts to do as soon as the relay 29 is operated. It will thus be seen that the relays 21 and 29 measure a predetermined interval of time after the power device is connected in circuit with the alternating current source so that the filaments 23 and 24 have an opportunity to become heated before the anode circuits including the anodes 26 and 27 are closed. This time interval may be explained as follows: The relay 21 requires a short period of time before it fully attracts its armatures. Thereafter the relay 29 requires another interval of time before it fully attracts its armatures and when it has done so, it opens the operating circuit of the relay 21 which requires a relatively long interval for it to release its armatures. These three intervals of time are long enough to permit the filaments to become heated and during these time intervals the anode circuits are opened either at the back contacts 30 and 32 of the relay 21 or at the normally open contacts 28 and 31 of the relay 29. In order to provide the proper drop in potential across conductors 53 and 54 it has been customary to connect the points 50 and 52 with a resistance of the proper value. In the present arrangements the resistance of the winding of relay 29 replaces the resistance formerly used and yet provides the proper voltage across the conductors 53 and 54.

What we claim, is:

1. In combination, a circuit network, a source of alternating current, a rectifier unit for furnishing voltages of different values to said circuit network from said source, a

second rectifier unit including a cathode and an anode, a cathode circuit including said cathode, an anode circuit including said anode for furnishing current to said circuit network, and means controlled by said first rectifier unit for disabling said anode circuit until said rectifier cathode is heated.

2. In a rectifying system, a source of current to be rectified, an alternating current rectifier unit including a rectifier tube having a filamentary cathode and an anode operating in an atmosphere of gas, circuits including said cathode and said anode, a second rectifier unit, and means operated by said second rectifier unit for completing said anode circuit whereby said cathode is protected.

3. In a rectifying system, a source of current to be rectified, a rectifier unit connected to said source of current, an output circuit for said rectifier unit, resistance units connected across said output circuit, a second alternating current rectifier unit including a tube having a cathode and an anode, a circuit including said cathode electrically connected to said source of current, a work circuit including said anode, and a relay connected in series with one of said resistance units for controlling said anode circuit whereby said cathode is protected.

4. In a rectifier system, a source of current to be rectified, a rectifier unit connected to said source of current, an output circuit for said rectifier unit, resistance units connected to said output circuit, a slow relay connected in series with one of said resistance units across said output circuit, a second rectifier unit including a tube having a cathode and an anode, a circuit including said anode electrically connected to said source of current, a work circuit including said anode, and means including said slow relay for controlling said anode circuit.

5. In a rectifying system, a source of current to be rectified, a rectifier unit connected to said source of current, an output circuit for said unit, resistance units connected to said output circuit, a slow releasing relay normally connected in series with one of said resistance units across said output circuit, a second rectifier unit including a tube having a cathode and an anode, a circuit including said cathode electrically connected to said source of current, an anode circuit including said anode, a second relay cooperating with and arranged to be substituted for said slow relay for controlling said anode circuit.

6. In a rectifying system, a source of current to be rectified, a rectifier unit connected to said source of current, an output circuit for said unit, resistance units connected to said output circuit, a slow releasing relay normally connected in series with at least one of said resistance units across said output circuit, a second rectifier unit including a tube having a cathode and an anode, a circuit including said cathode electrically connected to said source of current, an anode circuit including said anode, and a second relay cooperating with and arranged to be substituted for said slow relay for controlling said anode circuit, said slow releasing relay having a normally closed set of contacts and said second relay having a normally open set of contacts, said anode circuit being completed through said normally closed and through said normally open set of contacts.

7. In a rectifying system, a source of alternating current, a rectifier unit connected to said source of current, an output circuit for said rectifier unit, a second rectifier unit including a tube having a cathode and an anode, a circuit including said cathode electrically connected to said source of current, a work circuit including said anode, resistance units connected to said output circuit, a slow releasing relay normally connected across said output circuit, a second relay connected in circuit to be operated on the operation of said slow releasing relay, said second relay when operated being substituted in circuit for said slow releasing relay, said anode circuit being completed through contacts of said relays.

In witness whereof, we hereunto subscribe our names this 24th day of February, 1928.

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