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PLATE CIRCUIT EXCITATION

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Fig. 1.

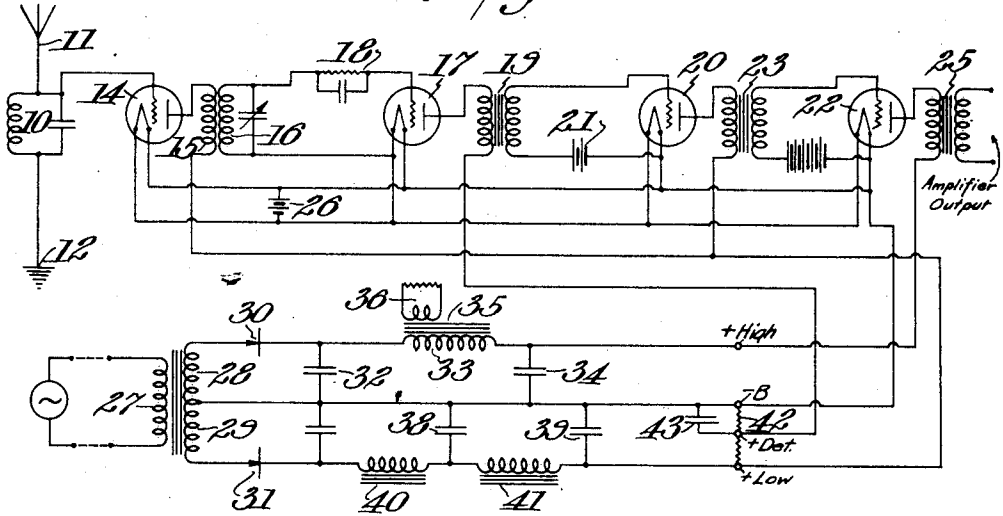


Fig. 2.

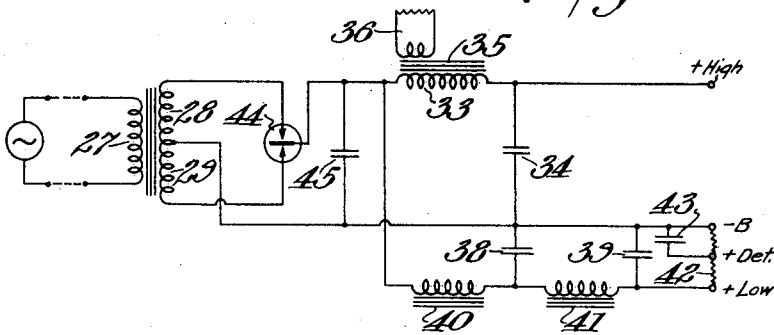
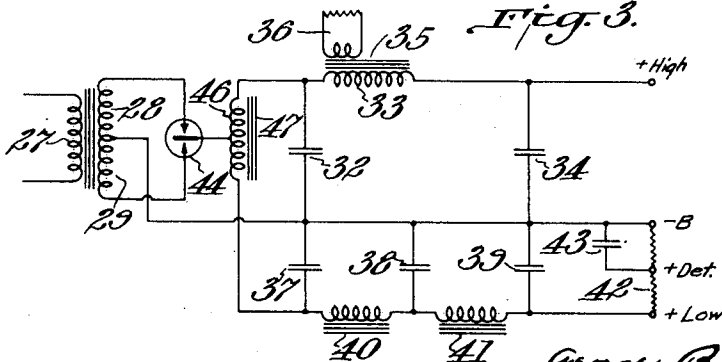


Fig. 3.



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PLATE CIRCUIT EXCITATION

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This invention relates to the excitation of the plate circuits of audions and more particularly to systems for exciting a plurality of plate circuits from a commercial power line without establishing detrimental couplings between the several plate circuits.

The increasing use of rectified and filtered alternating current for the plate circuit energization of multistage amplifier has imposed serious limitations upon the design of radio receivers. The filters which have been employed for the suppression of alternating components introduce high inductive impedances in the portion of the space current path which is common to the several tubes. The interstage coupling which results must be taken into consideration in the design of radio receivers. Receivers designed for satisfactory operation with batteries as a common source of plate circuit excitation may be unstable and prone to continuous oscillation when one of the so-called B-battery eliminators is substituted for the battery. It is possible, of course, to reduce the plate voltages to values below those recommended for the audions, and it is also possible to redesign the receiver to secure increased stability but this expedient usually introduces distortion in the audio amplifiers.

An object of this invention is to provide a method of exciting a plurality of plate circuits from a source of alternating current, and apparatus therefor, which will give results substantially identical with those obtainable when batteries serve as the common source of space current. Further objects are to provide a method of and apparatus for rectifying and for filtering alternating components from a source of alternating current without introducing interstage coupling between a plurality of plate circuits which are supplied in parallel from the rectified current source. Further objects are to provide a plurality of substantially independent sources of space current from a common source of alternating current. More particularly, an object is to provide apparatus for delivering rectified and filtered direct currents of different voltages at different output terminals, and in which a change of current output at one positive terminal will not appreciably affect the voltages at the other positive terminals.

These and other objects of the invention will be apparent from the following specifications when taken with the accompanying drawings, in which,

Fig. 1 is an electrical diagram showing one embodiment of the invention associated with a conventional radio receiver, and

Figs. 2 and 3 are electrical diagrams showing other embodiments of the invention.

The radio receiver which is shown in Fig. 1 includes a tuned input circuit 10 having a primary winding for connections between the antenna 11 and ground 12, which form the pick-up system of the receiver. The circuit 10 forms the input circuit of the radio frequency amplifier 14, the plate circuit of the audion including the primary 15 of an air core transformer whose tuned secondary 16 is connected to the audion detector 17 through the usual grid leak and condenser 18. The iron core transformer 19 provides the coupling between the detector audion 17 and the audion 20 of the first audio stage, a grid bias battery 21 being provided in the grid return of the amplifier. The output of the first audio stage is repeated into the audion 22 by means of the transformer 23. The audio amplifier 22 is of the "power tube" type and a biasing battery 24 of relatively high voltage is provided in the grid return of the tube. The plate circuit of the power tube 22 includes the primary winding of a transformer 25 by which the signals are repeated to any suitable reproducer. The several filaments may be energized from a battery 26 or other suitable source of current.

The construction of this typical radio receiver forms no part of the present invention and has been described in detail only for the purpose of facilitating the description of the invention.

The embodiment of the invention which is shown in Fig. 1 is designed to furnish a plurality of substantially independent sources of substantially pure direct current from a power line or other source of alternating current. The converter comprises an iron core transformer having a primary winding 27 for connection to the source of alternating current and a pair of secondary windings 28, 29 which deliver alternating current to the independent half-wave rectifiers 30, 31, respectively. The winding 28 and rectifier 30 supply current only to the plate circuit of the power tube 22 while the winding 29 and rectifier 31 supply current to the plate circuits of the other tubes of the receiver. The parallel current paths have a common return which is connected to the junction of the secondary windings.

The half-wave rectified current passed by the rectifier 30 is smoothed out and alternating components are suppressed by the filter mesh formed by shunt capacity 32, series inductance 33 and shunt capacity 34. Inductance 33 preferably has an iron core 35, and is loosely coupled to a winding 36 which is closed upon itself.

The positive terminal of this filter mesh, indicated by the legend "+High", is connected through the primary of transformer 25 to the plate of the power tube 22 in the last stage of the audio frequency amplifier. The low terminal of the filter mesh, indicated by the legend "-B" is connected to the appropriate terminal of the filament battery 26, and the terminals of the filter mesh provide a source of direct current at a voltage of the comparatively high order appropriate for the plate circuits of tubes of the type requiring a high negative grid bias.

The plate circuits of the other tubes require voltages of a much lower order of magnitude and are all connected across the plate current supply provided by the output terminals of a second filter mesh which is fed by winding 29 and rectifier 31. The filter illustrated is of a conventional type employing shunt capacities 37, 38, 39 and series inductances 40, 41. A resistance 42 is connected between the positive terminal "+Low" of this filter mesh and the terminal "-B", and at a suitable point along the resistance a terminal "+Detector" is provided for receiving a connection from the plate of the detector 17. A condenser 43 is connected between the detector terminal and the common return "-B". The plate circuits of the radio amplifier 14 and first audio amplifier 20 are connected to the terminal "+Low" of the mesh.

The secondary windings 28 and 29 are so

arranged that the two rectifiers are not simultaneously conductive, i. e. when power is being supplied from the alternating current source to the high voltage plate current supply system through rectifier 30, the rectifier 31 in the low voltage plate current supply system is open. It will be apparent that this arrangement results in a complete dissociation of the two parallel plate supply circuits and that signal or space currents flowing in the plate circuit of the audion 22 can in no way affect or feed back to the other stages of the receiver. Since the secondaries 28 and 30 alternate in supplying energy to the parallel filter systems, a change of load in one system will not affect the voltage supplied to the other.

These two advantages remove the limitations upon radio set designing which were introduced by the use of power tubes in the final audio stage. The use of power tubes is essential for good quality at high volume, but the space currents flowing in the plate circuits of power tubes may be of such values that feed back or coupling to the other plate circuits results when the known battery eliminator systems were used. The arrangement shown in Fig. 1 prevents all undesired coupling between the plate circuits of the tubes and avoids the difficulties which have been experienced when the amplifier stages were supplied with rectified and filtered current from a source of alternating current.

It is also a surprising fact that economy of material is secured although the number of parts is increased when two independent filter systems are formed. The shunt condensers 32, 34 must withstand part of the high voltages (in ordinary commercial design say 250 volts peak value) but may be of comparatively small capacity since the high voltage filter passes current only to the last stage of the amplifier. This stage does not require the degree of filtering which would be necessary in the earlier stages of the amplifier. The short-circuited winding 36 protects the condensers against steep wave front voltages due to sudden opening of the output circuit. The shunt condensers of the low voltage mesh, while double the capacity of those of the high voltage mesh, are required to withstand only moderate voltages. The several series inductances may all be physically very much smaller than would be required if the total current were supplied from a single filter having the usual potentiometer for providing the intermediate voltages. In the low voltage system the resistance 42 may be of comparatively high value and low current consumption since only the small plate current of the detector audion is supplied through the resistance. All of these factors combine to reduce the overall cost of manufacture materially below that of a single filter supplying the entire plate power of a set.

The embodiment of Fig. 2 is similar to that of Fig. 1 and has identical parts identically numbered. This circuit differs from Fig. 1 in that one double wave rectifier 44 is used in place of the two independent rectifiers 30 and 31 and the capacities 32 and 37 of Fig. 1 are combined into one capacity 45 in Fig. 2. This arrangement does not provide complete electrical separation of the sources of plate current supply, but provides a high degree of separation inasmuch as any alternating current signal voltage applied between the terminals "-B" and "+High" is attenuated through a three-section filter before it can reach the terminals "-B" and "+Low". In other words, it must pass through the three series impedances 33, 40 and 41 and the four shunt impedances 34, 45, 38 and 39. In many applications this will be found sufficient electrical separation, and at the same time the advantages of economy in manufacturing costs are retained.

The modification shown in Fig. 3 provides a degree of electrical separation intermediate to that obtained with the forms illustrated in Figs. 1 and 2. Parts identical with Fig. 1 are identically numbered. One double wave rectifier 44 is used as in Fig. 2. The positive terminal of this rectifier is led to an intermediate point on a coil 46 having an iron core 47. This winding is so arranged that the unidirectional impulses from the rectifier cancel each other in the winding and set up substantially no flux in the core 47. Any alternating current signal voltage applied at the direct current terminals "-B" and "+High" must, in passing to the direct current terminals "-B" and "+Low", traverse the coil 46, in addition to all of the filter elements enumerated in Fig. 2. This results in the addition of another filter section effective to dissociate the source of power tube plate current from the source which energizes the other tubes of the set.

Although I have described the invention in connection with converters for exciting the plate circuits from a power line, it will be apparent the invention may be used with a direct current generator or other source delivering current containing alternating components to such a degree as to prevent its use as the source of plate circuit supply. The invention is not limited to the use of two parallel filter systems but may include as many parallel filters as may be required to effect the isolation of those plate circuits which tend to react upon each other. It will be understood that various changes may be made in the several parts, their relative size and relationship, without departing from the spirit of the invention as set forth in the following claims.

I claim:

1. In apparatus for energizing the plate circuits of a plurality of audions from a

source of alternating current, means for rectifying the alternating current, a filter mesh comprising series inductance and shunt capacity for passing rectified current to the plate of a tube requiring the maximum voltage, a parallel filter mesh for passing rectified current to the plate circuits of tubes having materially lower voltage requirements, and a closed winding loosely coupled to said series inductance to protect the said shunt capacities upon opening of the circuit energized through said first filter mesh.

2. An apparatus for energizing the plate circuits of a plurality of audions from a source of alternating current, means for rectifying both halves of the alternating current wave, a filter mesh comprising series inductance and shunt capacity for passing rectified current of one half-wave to the plate of a tube requiring the maximum voltage, and a parallel filter mesh for passing rectified current of the other half-wave to the plate circuits of tubes having materially lower voltage requirements.

3. The invention as set forth in claim 2, in which a winding closed upon itself is loosely coupled to said series inductance to protect the shunt capacities upon opening of the circuit energized through said first filter mesh.

4. Apparatus for energizing plate circuits from a source of alternating current, and of the type including a transformer with a pair of secondary windings, a half-wave rectifier for each secondary winding, and impedance elements eliminating alternating components from the current passed to a plurality of plate circuits, characterized by the fact that said impedance elements form two independent filter meshes individually associated with the respective half-wave rectifiers and having output terminals serving as sources of plate current supply for the different audions, the maximum voltages across the two sets of output terminals being of different orders of magnitude.

5. In apparatus for supplying rectified and filtered current to a plurality of plate circuits, a transformer having a pair of secondary windings and a half-wave rectifier and a filter mesh for passing current from each of said windings to a plate circuit, said rectifiers being so connected with their respective windings and filters that when one rectifier passes current to one filter mesh, the other rectifier is non-conductive.

6. The invention as set forth in claim 5 wherein the filter mesh for passing current of maximum potential includes series inductance, and a winding closed upon itself and coupled to said inductance to suppress surges arising from the opening of the plate circuit supplied by the said filter mesh.

7. In apparatus for energizing the plate circuits of an audion amplifier, a converter

having output terminals for delivering full-wave rectified current, an inductance having a core of magnetic material, a connection from a mid-point of said inductance to the positive output terminal of said converter, a pair of filter meshes having a common return connected to the negative output terminal, and connections between the respective ends of the said inductance and the positive sides of the said filter meshes.

In testimony whereof, I affix my signature.
GEORGE B. CROUSE.