



# UNITED STATES PATENT OFFICE

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## HEATER TUBE DETECTOR CIRCUIT

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My present invention relates to detector circuits, and more particularly to a detector circuit, in a radio receiving set, utilizing a heater type of tube energized by pulsating current.

In radio receivers, or audio amplifiers having a considerable amplification, it is especially important to prevent any disturbing noises from originating in the detector tube of the audio system for the reason that noises originating in this tube are amplified more than those originating in subsequent stages. If a heater type of tube is used in this detector stage, and its heater element is heated by alternating current, there is likely to result some slight disturbance in the plate circuit due in one way or another to the use of alternating current for heating purposes. This is true even though the filaments of the radio- and audio-frequency amplifier tubes will operate satisfactorily with alternating current heating.

It is not desirable to use a battery source of direct current for heating the filament of the heater type of detector tube because the rest of the set is capable of being operated entirely without batteries, and it is advantageous to be able to dispense with batteries altogether. Assuming, then, that all the tubes of the set are to be energized from a common alternating current power source, (the more common form of power delivered to homes) the detector triode may have all of its circuits energized from one alternating current transformer. The anode and grid of the triode are, of course, supplied with rectified current, filtered to eliminate pulsations. However, the filament of the detector has commonly been energized by raw alternating current directly from the transformer secondary. In practice, such a procedure has not completely eliminated the production of noises in the detector stage, that is, such noises as arise from the use of alternating current for heating the detector filament.

Now, I have devised an arrangement for completely eliminating such noises, when such a detector has its anode potential supplied from a rectifier and filter, the power

for heating the heater filament of the tube being taken from the filter, and as this power is substantially direct current power, it is a suitable substitute for battery power.

It is to be noted particularly that while this arrangement avoids all appreciable disturbance, it does so only by virtue of the combination of the indirectly heated construction of the tube with the filtered heating current. That is, the use of the indirectly heated cathode tube with alternating current is not completely satisfactory on the one hand, while on the other hand complete satisfaction is not found in the use of imperfectly filtered current for heating an ordinary filament type detector either. The combination however acts in a geometric progression to reduce hum, already made small by one element of the combination, to an absolutely negligible value.

Accordingly, it is one of the main objects of the invention to provide in a typical alternating current operated radio receiver, using a heater type of detector tube, an arrangement for heating the filament by the current flowing between the radio receiver and the pulsating current filter.

Another important object of the invention is to provide in combination with a source of pulsating continuous current, a filter for suppressing the pulsations, and a radio receiver employing an electron discharge device of the indirectly heated cathode type, the filament heater of the device being energized solely from the filtered continuous current.

Still other objects of the invention are to improve generally the simplicity and efficiency of indirectly heated cathode tubes, especially those operating as detectors, and to provide an alternating current operated radio receiver which is reliable, durable, efficient in operation, and economically arranged.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following

description taken in connection with the drawing in which I have indicated diagrammatically one circuit organization whereby my invention may be carried into effect.

5 Referring now to the drawing, there is shown a transformer T, which takes power from a 110 volt power line, and raises it to any desirable value, say 800 volts. The secondary winding is usually tapped at its mid-  
10 point to form the return path for the rectified current flowing, in turn, in each half of the secondary winding. The center tap of the secondary passes directly through lead 1 to the B (or anode) supply circuit of the  
15 radio receiving circuit, generally denoted by R.

The outside terminals of the secondary go to rectifiers 2, 3 which are of the well known hot filament type, viz, diodes. Both rectifier-output terminals, that is the diode  
20 plates, are connected together by a lead 4 to form another line 5 of the anode power supply. The condensers  $C_1$  and  $C_2$ , and choke coil L are employed between the set  
25 and rectifier output to smooth out the fluctuations of the rectified alternating current supply. It is obvious that instead of using a full wave rectifier, a half wave rectifier may be employed; and, if one choke coil and  
30 two condensers do not sufficiently attenuate the ripples, additional sections can be utilized.

The radio receiving circuit is of a usual and well known type. Thus, a grounded antenna circuit A is coupled by a transformer  
35 M to the first stage of tuned radio frequency amplification, the output of the latter being coupled by a transformer  $M'$ , to a second stage of tuned radio amplification.  
40 The output of the second radio stage is coupled by a transformer  $M^2$ , to the tuned input circuit of a detector tube 12 of the indirect-ly heated cathode type.

The radio stages include tubes 10, 11, both  
45 of the screen grid type, the screen grids of each tube being biased from a potentiometer P connected between ground and line 1. The cathodes of the two tubes 10, 11 may be of the directly heated cathode type, the anodes  
50 thereof being energized from the anode line 1, the return for both cathodes and anodes being through ground to the heater of the detector, and then through line 5 to the transformer T. The rotors of the tuning  
55 condensers of the two radio stages and the detector stage are mounted on a common shaft (in dotted lines) for uni-control.

The detector tube includes the heater filament 20 connected in series with the filter  
60 output and ground, the cathode 21 of the tube being made of material which emits electrons freely at low temperature, and which is heated by the filament sufficiently to produce the required electron emission.  
65 The cathode 21 is grounded, for alternating

currents by condenser 30 and thus provides a substantially fixed potential surface.

The output of the detector tube is coupled by an audio-transformer  $M^3$  to the input of a tube 13, the output of the latter being coupled by a second audio-transformer  $M^4$  to a pair of tubes 14, 15 connected in push-pull. Any well known type of utilization means, as a loud speaker or head phones, may be coupled by an audio transformer  $M^5$  to the  
70 output of the push-pull audio stage. I will not describe the circuit in any further detail, as it is well known to those skilled in the art, and may be replaced in any portion thereof by other well known circuits, it being pointed out, nevertheless, that the anodes of the audio stages are fed from line 1, the return being through the detector heater and  
75 line 5.

In case the current supplied by the filter is greater than the current requirements of the heater 20 of the detector tube, a variable resistance  $P'$  shunted across the heater terminals will reduce the current through the heater to the proper amount. In case, however, the filter supplies only a small current, either of two methods may be used to obtain sufficient power for the detector heater. In the first place, additional current drain on the filter can be induced by shunting a  
85 conducting path P between the positive terminal of the filter and the point marked with the symbol for ground in the diagram. This extra path may also be desirable as it forms a potentiometer allowing lower voltages to be obtained, as, for example, in the diagram it (P) allows the screens of the first two tubes to be connected to a point of less potential than the positive terminal of  
90 the filter.

In the second place, if the above is not desirable, or does not result in sufficient current through the detector heater without undue reduction in voltages at the filter terminals, the detector tube may be re-designed so that its heater obtains sufficient power from a smaller current. This result is, of course, arrived at by increasing the resistance of the heater wire. While I have shown the heater connected in series with the filter output, it is also possible to connect it in parallel with the filter output provided that the resistance of the heater is made suitably high to operate efficiently on high  
95 voltages such as delivered by the filter.

While I have indicated and described one arrangement for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the  
100 appended claims.

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What I claim is:

1. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter. 70
2. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element designed to consume a relatively small current at a relatively high voltage and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter. 75
3. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of high frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and at least one audio frequency amplification stage, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter. 80
4. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of high frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and at least one audio frequency amplification stage, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter, each of said high frequency stages including a screen grid tube, and a potentiometer connected to said filter and the screen electrode of each of said screen grid tubes. 85
5. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter. 90
6. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter and an impedance across the filter output for increasing the power for said heater. 95
7. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter. 100
8. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter and a variable impedance connected between the filter and heater to reduce the current through the heater to a predetermined value. 105
9. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter and a conducting path across the filter output for increasing the power for the heater. 110
10. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element designed to consume a relatively small current at a relatively high voltage and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter. 115
11. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element designed to consume a relatively small current at a relatively high voltage and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter and a variable impedance connected across the heater to reduce the current through the latter to the current requirement of the heater when the current supplied by the filter exceeds the said requirement. 120
12. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element designed to consume a relatively small current at a relatively high voltage and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter and a variable impedance connected across the heater to reduce the current through the latter to the current requirement of the heater when the current supplied by the filter exceeds the said requirement. 125
13. In combination with a source of rectified alternating current and a filter, a radio receiver including a plurality of radio frequency amplification stages, a detector stage comprising a tube having a heater element designed to consume a relatively small current at a relatively high voltage and a cathode, and a plurality of audio frequency amplification stages, means for energizing said amplification stages from said filter, and additional means for energizing said heater directly from the filter and a variable impedance connected across the heater to reduce the current through the latter to the current requirement of the heater when the current supplied by the filter exceeds the said requirement. 130

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