April 12, 1932. W. VAN B. ROBERTS 1,853,178

RADIORECEIVER

Filed Sept. 15, 1928

Fig. 1

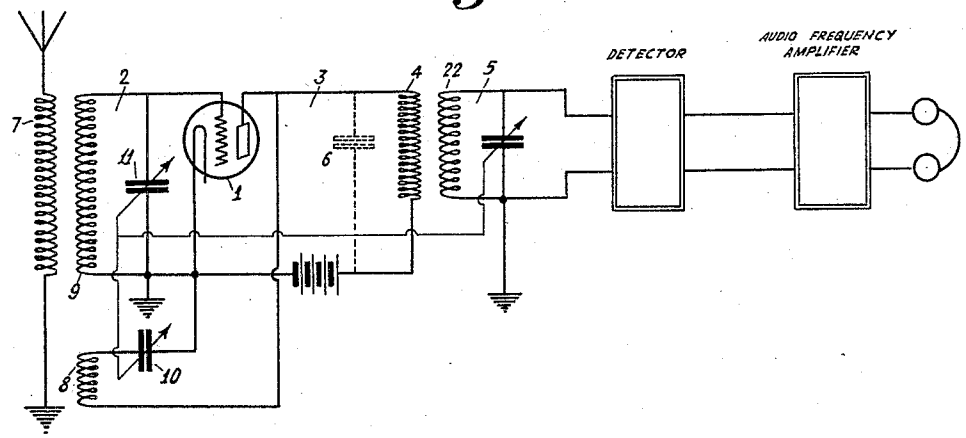


Fig. 2

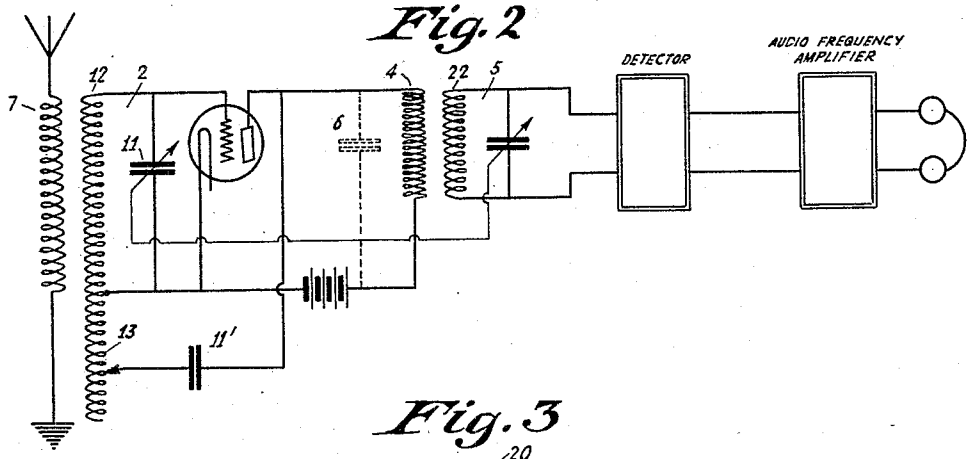
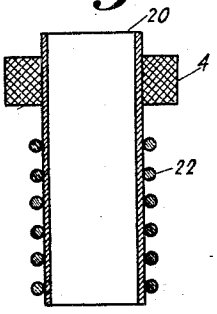


Fig. 3



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UNITED STATES PATENT OFFICE

WALTER VAN BRAAM ROBERTS, OF PRINCETON, NEW JERSEY, ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE

RADIORECEIVER

Application filed September 15, 1928. Serial No. 306,235.

It has been shown that a very large primary coil whose natural wave length is greater than the longest wave length of the range to be received, located in a certain manner with respect to a tuned secondary circuit, gives a desirable type of variation of amplification and selectivity over a wide range of frequencies, including the range utilized in ordinary radio broadcasting. However, because of the capacity reactance of this coil in the range of frequencies received, its reaction upon the input circuit through the control electrode-anode capacity of the electron discharge device utilized for amplification, dampens the input circuit to an undesirable degree.

This invention has for its object the elimination of such damping and briefly the manner in which this object is carried out is by establishing a feed back from the output circuit of the electron discharge device or tube to the input circuit so that the damping effect of the large primary coil in the output circuit, which, at radio frequencies has a condensive or negative reactance, is counteracted.

Another important object of the present invention is to provide a method of, and means for, operating a space discharge tube amplifier circuit having an output circuit which exercises a damping effect on the tube input circuit, which consists in establishing a path between the output and input circuits other than through the tube electrodes, and feeding energy from the output to the input circuit along the said path so as to counteract the said damping effect.

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 drawings in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the accompanying drawings:

Fig. 1 shows a feed back circuit for eliminating the damping effect of the primary coil in the output circuit of a thermionic tube, the feed back circuit including a variable condenser;

Fig. 2 shows a modified feed back arrangement for the purposes discussed above, wherein use is made of a condenser or constant value; and,

Fig. 3 illustrates diagrammatically and in section a primary and secondary coil utilized in connection with my invention.

Referring to Fig. 1 of the drawings, there is provided a thermionic tube 1, having a tunable input circuit 2 and an output circuit 3 therefor. The latter has therein a large primary coil 4 coupled to a tunable secondary circuit 5. Coil 4 and the coil 22 forming part of tunable circuit 5 are usually mounted coaxially on a single cylindrical element, coil 4 consisting of a large number of turns bunched together and the other coil consisting of a relatively few turns spread out along the surface of the cylindrical element. The numeral 6 indicates the distributed natural capacity of the primary coil 4 whose natural wave length, that is the natural wave length of the circuit consisting of coil 4 and its capacity 6, is greater than the longest wave length of the range to be received. Stated differently, the coil 4 is naturally resonant to a frequency outside, and below, the frequency range to be received, including the range utilized in ordinary radio broadcasting.

It is well known that when, as in this case, the reactance of the output circuit is capacitive, the feed back from plate to grid circuits through the plate-grid capacity of the tube is of such phase as to produce a damping effect on the input circuit 2.

To eliminate this damping effect I provide, according to my invention, a feed back circuit consisting of coil 8, magnetically coupled

to coil 9 of input circuit 2, and a variable condenser 10. The use of a separate coil 8 permits the grounding of the rotor of condenser 10 and of the rotor of condenser 11 of input circuit 2.

The proper amount of feed back is obtained by varying the capacity 10 simultaneously with the tuning of input circuit 2 and this may be readily accomplished by placing the rotors of the two condensers on the same shaft, grounding the shaft, and cutting the plate or plates of condensers 10 so as to give a desired capacity at each frequency to which input circuit 2 is tuned. Feed back coil 8 is wound as to direction as though it were part of the input coil 9.

Primary coil 4 and its secondary 22 forming a part of tuned circuit 5, take the form shown in Fig. 3. Primary 4 consists of a relatively large number of turns bunched together on cylindrical member 20. The turns of secondary 22 are spread out along the surface of cylinder 20 as shown.

The remaining portions of the apparatus of Fig. 1 are self-explanatory.

In Fig. 2 I have shown another way of carrying out my invention. In this modification a fixed condenser 11′ is utilized in the feed back circuit in connection with a tapped input coil 12, the lower portion 13 of the coil 12 forming the other part of the feed back circuit. The latter is, of course, magnetically coupled to the portion of the coil 12 included in the tunable input circuit 2.

I have found that the use of a fixed value of capacity 11′ gives good results especially if the value is so chosen that there is a slight excess of regeneration at the upper or high frequency end of the range to which the receiver may be tuned.

The choice of either of the modifications shown in either Figures 1 or 2 depends upon the manufacturing advantages desired. Thus, Fig. 1 permits the grounding of the rotor of the input tuning condenser and Fig. 2 offers as its manufacturing advantage a simplified structure because the feed back coil may be simply an extension of the input coil.

As indicated in the drawings the tuning condensers may be coupled together so as to provide a uni-control arrangement, and as shown in Fig. 1, condenser 10 may also be included in the uni-control system.

While I have indicated and described several systems 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 organizations shown and described, but that many modifications in the circuit arrangements, as well as in the apparatus employed, may be made without departing from the scope of my invention as set forth in the appended claims.

Having thus described my invention what I claim is:—

1. A tuned radio frequency amplifier having an input circuit and having an output circuit whose reactance is condensive, said output circuit delivering power to a tuned circuit, and means for feeding back power to the input circuit so as to eliminate the damping effect on said input circuit of the capacity reactance of said output circuit.

2. In combination, an output circuit of an electron discharge device whose reactance is negative, the output circuit feeding power to a tuned secondary circuit, a feed back coil and current limiting condenser connected in series between the anode and cathode of the electron discharge device, said feed back coil being magnetically coupled to the input circuit of the device.

3. In an amplifier, a thermionic tube, a tunable input circuit therefor, an output circuit therefor including a coil whose inductance is so great that the output current of the tube tends to flow mostly through the natural capacity of the coil and other capacities shunting said coil, causing a damping effect on the input circuit of said tube, and means including a path between the output and input circuits for counteracting said damping effect.

4. In an amplifier, a thermionic tube, a tunable input circuit therefor, an output circuit therefor comprising a coil whose inductance is so great that the output current of the tube tends to flow through the natural capacity of the coil causing a damping effect on the input circuit of said tube, and means for counteracting said dumping effect, said means comprising an inductance and a condenser in series, said last mentioned inductance being magnetically coupled to the input circuit of said tube.

5. The method of operating a space discharge tube amplifier having an output circuit with a negative reactance which consists in feeding back energy from the output circuit to the tube input circuit through a path other than the inter-electrode coupling of the tube, to counteract the effect of said negative reactance on the input circuit.

6. The method of operating a multi-electrode amplifier tube having an output circuit which exercises a damping effect upon the tube input circuit, the method consisting in establishing a path between the output and input circuits other than through the tube electrodes, and feeding energy from the output to the input circuit along the said path so as to counteract said damping effect.

7. The method of operating an amplifier circuit which includes a multi-electrode space discharge tube having an output circuit including a reactance naturally resonant to a frequency below the broadcast range and which exercises a damping effect on the tube

input circuit, the method consisting in regeneratively coupling the output circuit to the input circuit, and feeding back energy from the output to the input circuit to counteract said damping effect.

8. A tuned radio frequency amplifier having an input circuit and an output circuit, the latter having a negative reactance, and exercising a damping effect on the input circuit, and a path between the output and input circuit for feeding back energy to the latter to eliminate said damping effect, said path including an adjustable reactance.

9. In an amplifier, a space discharge device, an input circuit therefor, an output circuit therefor including a reactance which exercises a damping effect on the said input circuit, and a path including a pair of reactances between the output and input circuits for counteracting said damping effect, one of said reactances being variable.

10. In an amplifier, a thermionic tube, a tunable input circuit therefor including a variable condenser, an output circuit for the tube having a negative reactance which has a damping effect on the said input circuit, a subsequent tuned circuit coupled to said output circuit, said subsequent circuit including a variable condenser, and a path between the output circuit and the first tuned input circuit for feeding back energy to counteract said damping effect, said path including a variable condenser, the rotors of all of said condensers being grounded and mechanically connected for simultaneous movement.

11. In an amplifier, a spaced discharge tube including a tunable input circuit and an output circuit, a coil in said output circuit naturally resonant to a frequency outside a predetermined frequency range and causing a degenerative effect on said input circuit, and a path between the output and input circuits for counteracting said effect.

12. A tuned radio frequency amplifier tube having an input and output circuit, the output circuit including a reactance having a degenerative effect on the input circuit, a path between the output and input circuits for regeneratively counteracting the said effect, said path including a fixed reactance, and the value of said reactance being such that excess of regeneration results at the upper end of the frequency range to which the amplifier may be tuned.

13. A tuned radio frequency amplifier tube having an input and output circuit, the output circuit including a reactance having a degenerative effect on the input circuit, a path between the output and input circuits for regeneratively counteracting the said effect, said path including a fixed capacity, and the value of said capacity being such that excess of regeneration results at the upper end of the frequency range to which the amplifier may be tuned.

14. A tuned radio frequency amplifier tube having an input and output circuit, the output circuit including a coil having a degenerative effect on the input circuit, a path between the output and input circuits for regeneratively counteracting the said effect, said path including a fixed capacity, and the value of said capacity being such that excess of regeneration results at the upper end of the frequency range to which the amplifier may be tuned.

WALTER VAN BRAAM ROBERTS.

DISCLAIMER

1,853,178.—*Walter van Braam Roberts*, Princeton, N. J. RADIORECEIVER. Patent dated April 12, 1932. Disclaimer filed December 21, 1932, by the assignee, *Radio Corporation of America.*

Hereby enters this disclaimer to the said claims of said Letters Patent which are in the following words, to wit:

"1. A tuned radio frequency amplifier having an input circuit and having an output circuit whose reactance is condensive, said output circuit delivering power to a tuned circuit, and means for feeding back power to the input circuit so as to eliminate the damping effect on said input circuit of the capacity reactance of said output circuit.

"2. In combination, an output circuit of an electron discharge device whose reactance is negative, the output circuit feeding power to a tuned secondary circuit, a feed back coil and current limiting condenser connected in series between the anode and cathode of the electron discharge device, said feed back coil being magnetically coupled to the input circuit of the device.

"3. In an amplifier, a thermionic tube, a tunable input circuit therefor, an output circuit therefor including a coil whose inductance is so great that the output current of the tube tends to flow mostly through the natural capacity of the coil and other capacities shunting said coil, causing a damping effect on the input circuit of said tube, and means including a path between the output and input circuits for counteracting said damping effect.

"4. In an amplifier, a thermionic tube, a tunable input circuit therefor, an output circuit therefor comprising a coil whose inductance is so great that the output current of the tube tends to flow through the natural capacity of the coil causing a damping effect on the input circuit of said tube, and means for counteracting said damping effect, said means comprising an inductance and a condenser in series, said last mentioned inductance being magnetically coupled to the input circuit of said tube.

"5. The method of operating a space discharge tube amplifier having an output circuit with a negative reactance which consists in feeding back energy from the output circuit to the tube input circuit through a path other than the inter-electrode coupling of the tube, to counteract the effect of said negative reactance on the input circuit.

"6. The method of operating a multi-electrode amplifier tube having an output circuit which exercises a damping effect upon the tube input circuit, the method consisting in establishing a path between the output and input circuits other than through the tube electrodes, and feeding energy from the output to the input circuit along the said path so as to counteract said damping effect.

"7. The method of operating an amplifier circuit which includes a multi-electrode space discharge tube having an output circuit including a reactance naturally resonant to a frequency below the broadcast range and which exercises a damping effect on the tube input circuit, the method consisting in regeneratively coupling the output circuit to the input circuit, and feeding back energy from the output to the input circuit to counteract said damping effect.

"8. A tuned radio frequency amplifier having an input circuit and an output circuit, the latter having a negative reactance, and exercising a damping effect on the input circuit, and a path between the output and input circuit for feeding back energy to the latter to eliminate said damping effect, said path including an adjustable reactance.

"9. In an amplifier, a space discharge device, an input circuit therefor, an output circuit therefor including a reactance which exercises a damping effect on the said input circuit, and a path including a pair of reactances between the output and input circuits for counteracting said damping effect, one of said reactances being variable."

"11. In an amplifier, a space discharge tube including a tunable input circuit and an output circuit, a coil in said output circuit naturally resonant to a frequency outside a predetermined frequency range, and causing a degenerative effect on said input circuit, and a path between the output and input circuits for counteracting said effect."

[*Official Gazette January 17, 1933.*]