

Sept. 16, 1941.

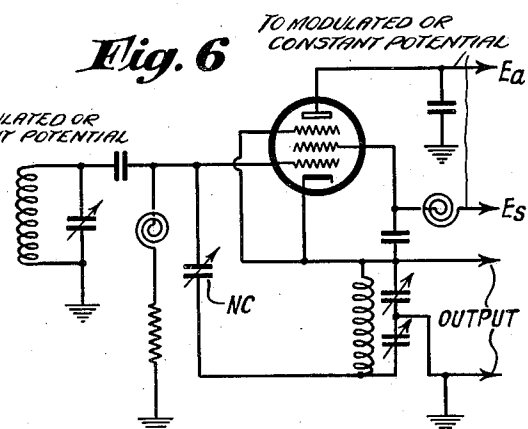
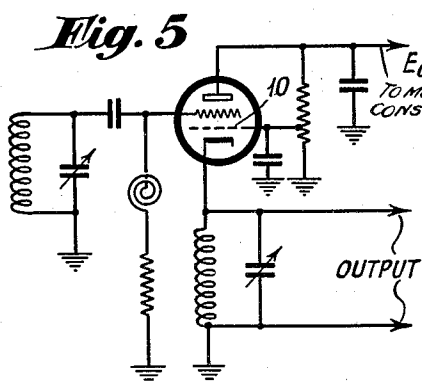
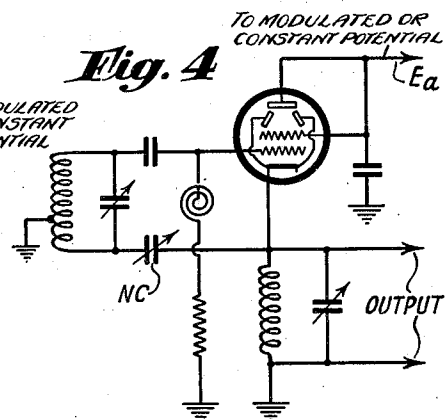
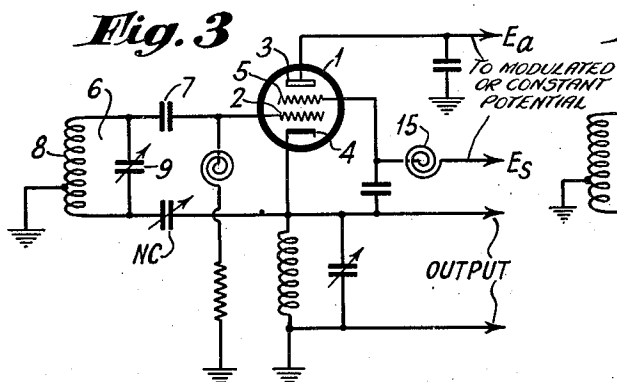
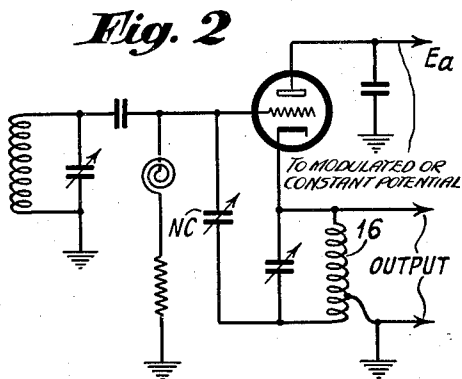
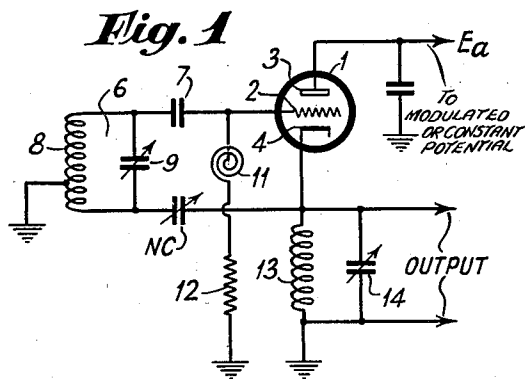
J. L. HATHAWAY ET AL

2,255,882

RADIO FREQUENCY AMPLIFIER

Filed March 30, 1938

2 Sheets-Sheet 1



BY

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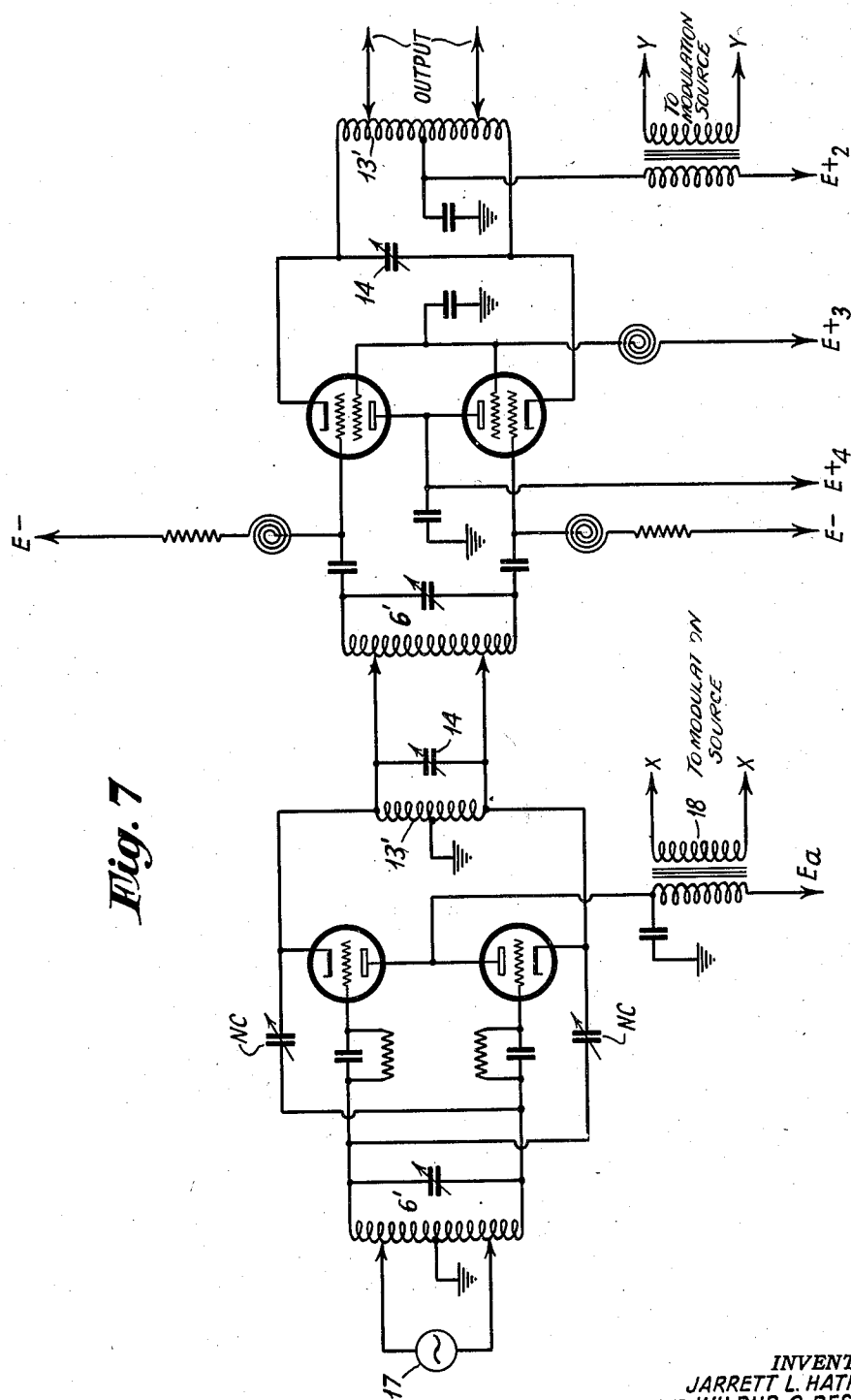
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UNITED STATES PATENT OFFICE

2,255,882

RADIO FREQUENCY AMPLIFIER

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Application March 30, 1932, Serial No. 198,838

7 Claims. (Cl. 179—171)

This invention relates to radio frequency amplifiers and, more particularly, to improved coupling circuits for said amplifiers.

An object of the present invention is to efficiently couple together a plurality of stages of radio frequency amplification. Another object is to provide a source of well-regulated radio frequency without resorting to resistance loading of the source.

Still another object is to provide a radio frequency amplifier having a high effective grid to cathode impedance in its operating condition.

Briefly, our invention involves a radio frequency amplifier in which the output energy is derived from a tuned cathode circuit instead of from a tuned plate circuit, as heretofore known and used. The neutralization which is necessary, just as with plate coupled amplifiers, is provided for by means of either a split grid circuit or a split cathode circuit. The amplifier constructed according to our invention may be conveniently modulated by supplying one or more of the electrodes with a modulated direct current instead of pure direct current. Any of the circuits of our invention may be conveniently used for frequency multiplication. For such operation the cathode circuit is tuned to the multiple frequency desired.

Referring, now, for a more complete disclosure of our invention, to the subsequent detailed description which is accompanied by drawings in which Figure 1 illustrates an embodiment of our invention, while Figures 2, 3, 4, 5 and 6 illustrate modifications thereof and Figure 7 illustrates the application of our invention to push-pull operation.

In Figure 1 reference numeral 1 indicates a radio frequency amplifying tube having a grid 2, a plate 3 and a cathode 4. The input circuit 6 which is coupled to grid 2 by means of condenser 7 comprises coil 8 and tuning condenser 9. The grid circuit of the tube is completed by means of radio frequency choke 11 and resistance 12 to ground. The output circuit which is coupled to cathode 4 comprises coil 13, which is tuned by condenser 14 to the desired frequency. Plate potential E_a applied to plate 4 may be either pure direct current or it may be modulated in any known manner. As an example, there is shown in Figure 7 one way in which the direct current supply may be modulated. The manner of modulating the current is described more fully with reference to Figure 7. In order to neutralize the amplifier the grid coil 8 is tapped and the tap grounded. The lower end

of the coil is connected to the cathode circuit through neutralizing condenser NC.

Figure 2 is similar to Figure 1 except that instead of using the split grid neutralization a tap on the cathode coil 16 is grounded and the end of the coil remote from the cathode is connected to the grid 2 through neutralizing condenser NC. Otherwise, the circuit is similar to Figure 1.

In Figure 3 our invention has been applied to a radio frequency amplifier using a tetrode tube instead of a triode. As shown in the figure screen grid 5 is energized from a source of potential E_s through radio frequency choke 15. The amplifier shown in this figure acts as a modulator for either the plate voltage supply E_a or the screen grid voltage supply E_s , or both may be a modulated source of direct current. This has been indicated in the drawings by labeling the potential sources E_a and E_s as modulated or constant potential. Neutralization is provided in the same way as in Figure 1, though cathode neutralization may be employed.

Figure 4 is similar to Figure 1, except that a beam power tube is shown with the screen connected to the plate and thus operated as a triode. The tetrode connection shown in Figure 3 may also be employed with this tube.

The modification shown in Figure 5 employs an amplifier tube having a shield by-passed to ground between the grid and cathode to reduce capacity coupling. The use of such a tube obviates the necessity of neutralization. This modification is otherwise similar to that shown in Figure 1.

Figure 6 shows the application of our invention to an amplifier using a pentode tube. A split condenser across the cathode coil is used to establish a ground as shown in this circuit. Any of the other neutralizing systems described may be used.

In Figure 7 the application of our invention to push-pull operation of radio frequency amplifiers is shown. The amplifier is energized from source 7 coupled to the input circuit 6. In this figure the amplifier may be modulated by means of modulator transformer 18 connected in the anode supply circuit E_a , as shown in the left hand side of the figure or, alternatively, it may be modulated by means of a transformer connected in the lead to power supply E_{+2} forming a part of the cathode circuit, as shown in the right hand side of the figure. The modulating frequencies are applied to terminals X, X or Y, Y, or both, as desired. At the right of this

figure E— and E+4 denote opposite polarities of the power supply and E+2 and E+3 are intermediate taps. The circuits shown in Figure 7 may be used for superheterodyne reception of radio signals by applying a local source of radio frequency oscillations to terminals X, X or Y, Y.

Measurements made with the amplifier of our invention, using a type 807 transmitting beam power amplifying tube, indicate that such a tube may be made to operate in cathode coupled circuits at about 25 percent efficiency at 40 megacycles. Under these conditions, measurements show that the cathode tank or output impedance is in the order of 275 ohms.

Comparative measurements of the output voltage between a cathode coupled and a plate coupled amplifier indicate that the voltage developed across the tank circuit of the cathode coupled circuit is approximately 1½ times the voltage developed across the tank of a plate coupled amplifier when it was resistance loaded to give an equivalent output impedance. It was further noted that an increase in power in the amplifier grid tank circuit occurs when the plate voltage is applied to the amplifier. It is noted that this application of plate voltage causes a marked decrease of amplifier rectified grid current. This is because the grid to cathode impedance is very low without plate voltage but when the plate voltage is applied impedance rises due to the degenerative effects of the cathode coupling.

While we have particularly shown and described several forms of our invention it is to be understood that the invention is not limited to the forms illustrated but modifications may be made within the scope of the invention.

We claim:

1. A radio frequency amplifier comprising a thermionic discharge tube having an anode, a control grid and a cathode, an input circuit for said tube comprising a tuned circuit and a low impedance output circuit comprising a tuned circuit connected in series between said cathode and grid, means for connecting a source of potential to said anode and the junction between said tuned circuits and means for neutralizing the effect of the grid to cathode capacity of said discharge tube including a neutralizing condenser for applying to said cathode a voltage equal and opposite in phase to that on said grid.

2. A radio frequency amplifier comprising a thermionic discharge tube having an anode, a control grid and a cathode, an input circuit for said tube comprising a tuned circuit connected between said grid and ground and a low impedance output circuit comprising a tuned circuit connected between cathode and ground, means for connecting a source of signal modulated potential to said anode and means for neutralizing the effect of the grid to cathode capacity of said discharge tube including a neutralizing condenser for applying a voltage to said cathode equal and opposite in phase to that on said grid.

3. A radio frequency amplifier comprising a

thermionic discharge tube having an anode, a control grid and a cathode, an input circuit comprising a tapped inductance and a condenser connected across said inductance, one end of said inductance being connected to said grid and said tap grounded, a low impedance output circuit connected between said cathode and ground and a connection including a neutralizing condenser connected between the end of said inductance remote from said grid connection and said cathode.

4. A radio frequency amplifier comprising a thermionic discharge tube having an anode, a control grid and a cathode, an input circuit comprising a tapped inductance and a condenser connected across said inductance, one end of said inductance being connected to said grid and said tap grounded, a low impedance output circuit connected between said cathode and ground and a connection including a neutralizing condenser connected between the end of said inductance remote from said grid connection and said cathode and means for connecting a source of potential to said anode.

5. A radio frequency amplifier comprising a thermionic discharge tube having at least an anode, a control grid and a cathode, an input circuit comprising a tapped inductance and a condenser connected across said inductance, one end of said inductance being connected to said grid and said tap grounded, a low impedance output circuit connected between said cathode and ground and a connection including a neutralizing condenser connected between the end of said inductance remote from said grid connection and said cathode and means for connecting a source of signal modulated potential to said anode.

6. A radio frequency amplifier comprising a thermionic discharge tube having an anode, a cathode, a control grid and a screen grid, an input circuit comprising a tapped inductance and a condenser connected across said inductance, one end of said inductance being connected to said control grid and said tap grounded, an output circuit connected between said cathode and ground and a connection including a neutralizing condenser connected between the end of said inductance remote from said grid connection and said cathode, and means for connecting a source of signal modulated potential to said anode.

7. A radio frequency amplifier comprising a thermionic discharge tube having an anode, a cathode, a control grid and a screen grid, an input circuit comprising a tapped inductance and a condenser connected across said inductance, one end of said inductance being connected to said control grid and said tap grounded, an output circuit connected between said cathode and ground and a connection including a neutralizing condenser connected between the end of said inductance remote from said grid connection and said cathode, and means for connecting a source of signal modulated potential to said anode and said screen grid and decoupling means between said means and said screen grid.

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