Nov. 12, 1935. R. LEE 2,020,950

KEY CLICK FILTER

Filed Sept. 23, 1933

Fig. 1.

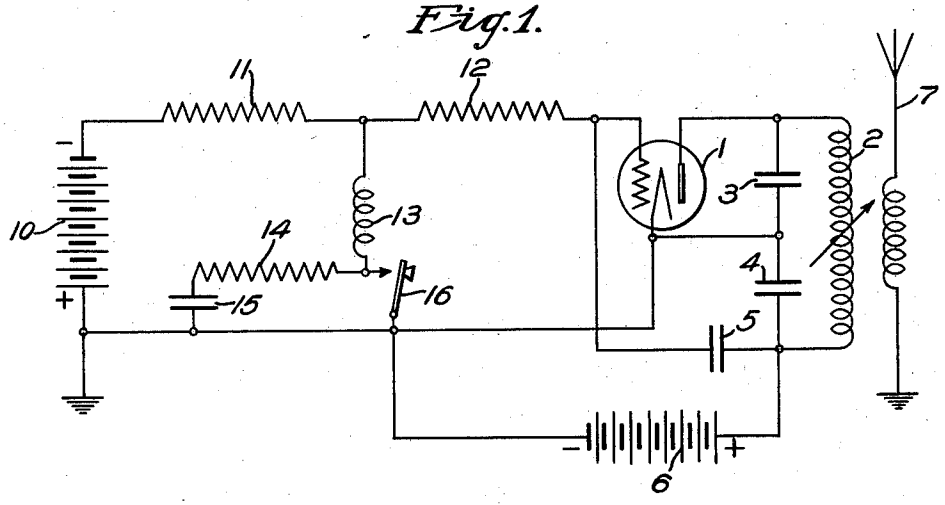
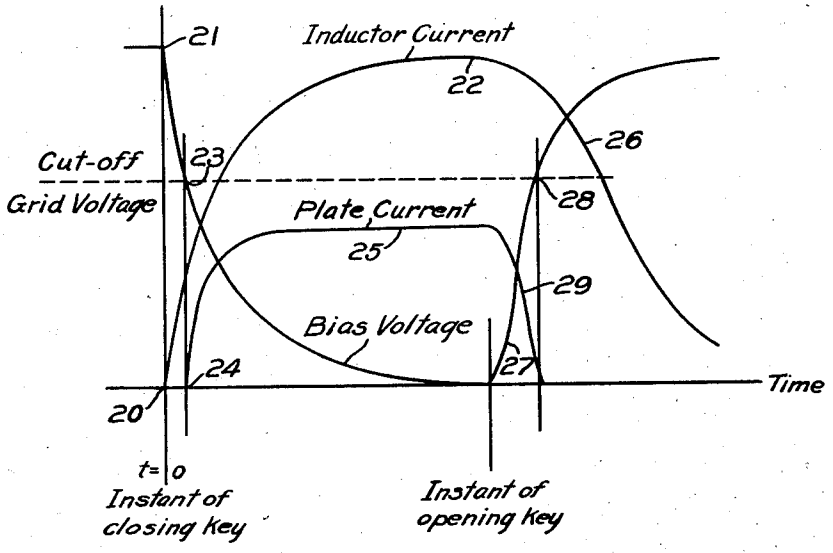


Fig. 2.



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KEY CLICK FILTER

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6 Claims. (Cl. 250—17)

This invention relates to radio sending systems and particularly to an arrangement for preventing undesirable noises when keying.

It is an object of this invention to cause the change in antenna current in response to the operation of the key to be less abrupt than has heretofore been the case without diminishing the total energy delivered during the time the key is in the position corresponding to the delivery of radiation.

It is a further object of my invention to so arrange the elements of the keying filter that more desirable results are obtained.

Other objects of my invention and the details of the construction will be evident from the following description and the accompanying drawing in which Figure 1 is a diagrammatic representation of a sending system embodying my invention, and Fig. 2 shows curves to which reference will be made which explains the operation of the device.

In Figure 1, the vacuum tube 1 is an oscillator supplying a tank circuit which comprises an inductor 2 and condensers 3 and 4, one or more of these elements being adjustable. The cathode of the tube 1 is connected to the junction of condensers 3 and 4 and these two condensers in series are in shunt to the inductor 2. The feedback connection is through a condenser 5 which prevents the positive potential from the B battery 6 reaching the grid of the tube 1. An antenna 7 is inductively coupled to the inductance 2 in any conventional way.

The positive terminal of a grid-biasing battery 10 is connected to the cathode of the tube 1 and to ground. Through a resistor 11 and a grid leak 12 the negative end of the battery 10 is connected to the grid of the tube 1. Between the resistors 11 and 12 a connection to ground is provided which includes an inductor 13, a resistor 14 and a condenser 15 arranged in series in the order named. The condenser 15 and the resistor 14 are in shunt to a key 16. The grounded side of the condenser 15 and key 16 is connected to the cathode of the tube 1 and to negative terminal of the battery 6.

In the operation of the device, the tube 1 acts as a generator of oscillations to energize the tank circuit and deliver energy to the antenna 7, except during the times when the grid potential is so negative that the tube 1 will not oscillate. The negative potential is impressed upon the grid from the battery 10. During the time that the key 16 is open, the battery 10 charges the condenser 15 and when the charging action has been completed, the potential of the grid and of the element of the condenser 15 connected to the grid is the same as the negative terminal of the battery 10.

When the key 16 is closed, the condenser 15 discharges through the resistor 14.

The potential of the lower end of the inductor 13 becomes zero at once regardless of the time required for the condenser 15 to discharge because there is a direct connection from the lower end of the inductor 15 to ground. The upper end of the inductor 13 is at the potential of the negative end of the battery 10 at the moment the key 16 is closed. A current, therefore, flows through the inductor 13 but it is not a steady current. This current increases exponentially in accordance with the usual law for the current through a circuit including a steady source of direct current potential, a resistor and an inductor in series. The potential across the inductor is proportional to the rate of increase in this current. The grid potential of the tube 1 is at first equal to the potential of the battery 10 minus the drop across the inductor 13. As this drop becomes smaller because the rate of increase of the current becomes slower, the potential of the grid of the tube which becomes less negative and the tube which therefore, becomes more conductive. When the grid potential of the tube passes the cut-off point, this tube begins to oscillate and thus to draw grid current. This grid current produces a drop through the resistor 12 which somewhat offsets the effect of the drop through the inductor 13. The combined effect of the tube is to make the rate of building up of oscillations in the tube 1 less abrupt than it has been with prior arrangements.

This behavior of the apparatus upon closing the key 16 will be more readily understood by reference to Fig. 2 in which the horizontal coordinates represent time and the vertical coordinates represent the quantities indicated against the several curves. Thus, the point 20 indicates the moment at which the key was closed. It will be observed by noticing the point 21 that at this moment the grid bias is a maximum while the inductor current is zero. By the inductor current is meant that current through the inductor 13. It will be seen that this current increases according to a familiar exponential law and reaches a steady value at a time represented by the point 22. As soon as the bias voltage which has been decreased according to an exponential curve became less than the cut-off voltage, as represented at the point 23, the oscillations began, as is

shown by the fact that the plate current curve starts at the point 24. These increase rapidly and reach a steady value as indicated by the horizontal portion of this curve at 25.

When the key is again opened, current from the battery 10 charging the condenser 15 flows through the inductor 13. The inductor current which had been flowing steadily through resistor 11, inductor 13 and the key 16 is now the charging current for this condenser and flows from the battery through resistor 11, inductor 13 and resistor 14 into the condenser. This current is at first a maximum and diminishes as indicated by the curve 26 according to the law for a circuit including resistance, inductance and a capacity. The potential of the grid of the tube 1 will differ but slightly from the potential of the junction of resistor 11 and inductor 13, the slight difference being due to the grid current flowing over the resistor 12 The grid potential is represented by the curve 27. When, as shown at 28, this exceeds the cut-off voltage, the plate current which has been diminishing as indicated by 29 ceases to produce an effect and the portion of curve 27 above the point 28 is exponential. The diminution in plate current as indicated by the part 29 of the plate current curve is rapid and reaches zero when the curve 27 passes the cut-off voltage. It will, therefore, be seen that both the increase and diminution in plate current is gradual.

The grid circuit including the key 16, inductor 13, resistor 12, the grid cathode capacity and resistance is sufficient to so damp oscillations occasioned by keying that the modulation produced thereby never exceeds one-third of the modulation produced by keying and diminishes below one-fourth thereof in the minimum time between operations of the key.

I claim as my invention:

1. In a keying system, a vacuum tube including a grid, means for controlling the bias on said grid including a condenser, a source of direct current voltage, connections including an inductor for charging said condenser from said source, keying means for discharging said condenser, a connection from the terminal of said inductor remote from said condenser to said grid, said keying system elements being confined to the input circuit only of said tube.

2. In a keying system, a vacuum tube including a grid, means for controlling the bias on said grid including a condenser, a source of direct current, voltage connections including an inductor for charging said condenser from said source, keying means for discharging through a non-inductive path, said condenser, a connection from the terminal of said inductor remote from said condenser to said grid, an output circuit for said tube including a direct current path, said keying system elements and said direct current path comprising distinct circuits.

3. In a keying system a vacuum tube including a grid and a cathode, means for controlling the bias on said grid including a condenser, a source of direct current voltage, a charging circuit including said source of voltage and an inductor for charging said condenser from said source, keying means for discharging said condenser through a path exterior to said inductor, a connection from the terminal of said inductor remote from said condenser to said grid, a direct connection from said keying means to said cathode, and an output circuit for said tube including a direct current path, said keying system elements being external to said direct current path.

4. In a keying system a vacuum tube including a grid, means for establishing a bias on said grid including a condenser, a source of electromotive force, a charging circuit including said source for charging said condenser from said source, key-controlled connective means for discharging said condenser, circuit means for controlling the potential of said grid by the state of charge of said condenser, said last-named circuit means including an inductance not included in the discharging connective means, an output circuit for said tube including a direct current path, said keying circuit elements being external of said direct current path.

5. In a keying system a vacuum tube having a grid, a condenser, a source of direct current potential, an inductor, connections for charging said condenser from said source through said inductor and key controlled connections for discharging said condenser independently of said inductor, connections from said condenser through said inductor to said grid, an output circuit for said tube including a direct current path, said charging circuit being external of said direct current path.

6. In a keying system a vacuum tube having a cathode, a grid and an anode, means for impressing potentials upon said grid including a source of direct current potential, a condenser, a charging circuit from said source to said condenser including an inductor and sufficient resistance to render said circuit incapable of sustained oscillations, a discharge circuit for said condenser including a key and at least a portion of said resistance but excluding said inductor, a grid circuit including said key, said inductor, the grid-cathode impedance and sufficient resistance to render said grid circuit incapable of sustained oscillation, an output circuit for said tube including a direct current path, said condenser charging circuit being external of said direct current path.

REUBEN LEE.