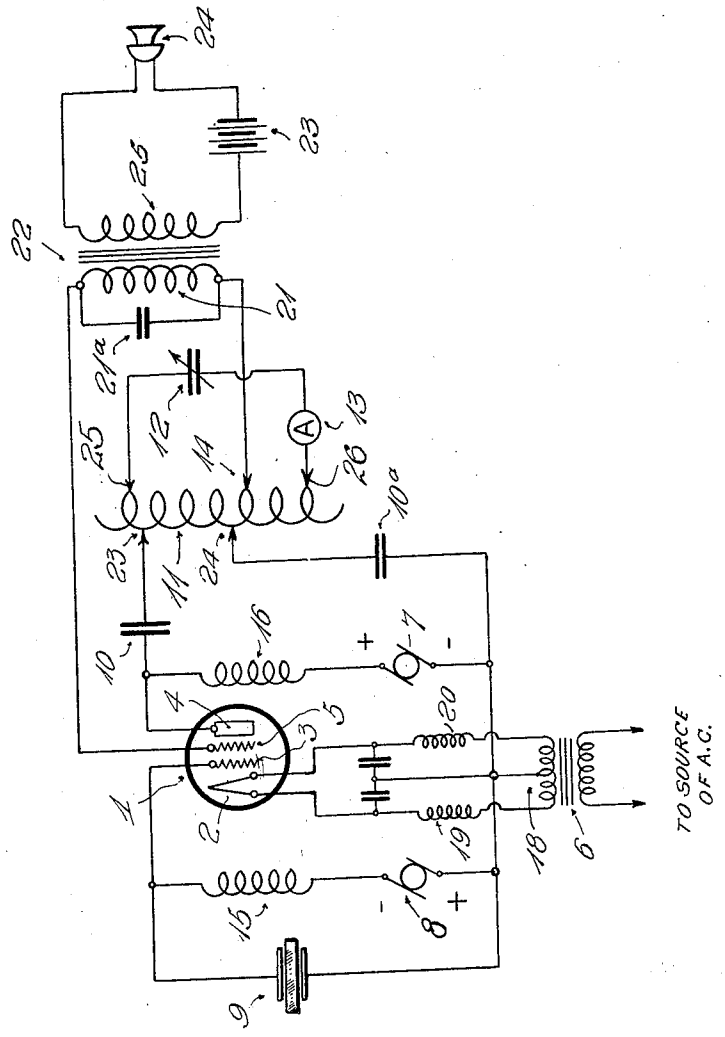
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COMBINED OSCILLATOR AND MODULATOR SYSTEM

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COMBINED OSCILLATOR AND MODULATOR SYSTEM

Application filed December 18, 1928. Serial No. 326,881.

My invention relates to circuit arrangements in general and more specifically to thermionic tube circuit arrangements for producing high frequency electrical energy.

An object of my invention is to provide a circuit arrangement utilizing a thermionic tube having more than three electrodes whereby the additional electrodes are employed to further modulate and amplify the generated energy.

Another object of my invention is to provide a combined oscillator and modulator circuit arrangement wherein a mechanically vibratile element is employed in combination with a thermionic tube having four or more electrodes and whereby the mechanically vibratile element is protected from an overload condition.

Still another object of my invention is to provide a circuit arrangement for generating oscillations of electrical energy of uniform frequency and of greater amplitude than has heretofore been possible wherein a single thermionic tube is employed as a combination oscillator and modulator.

Other and further objects of my invention are to provide certain improvements in the circuit arrangements employing thermionic tubes for generating and modulating high frequency electrical energy wherein the thermionic tube has more than three electrodes and whereby the additional electrodes serve to increase the efficiency of the system.

A better understanding of the oscillator system of my invention can be had by referring to the specification following and to the accompanying drawing which is a schematic circuit diagram showing the embodiments of my invention.

In piezo electric crystal controlled oscillator systems the generated signaling energy is of substantially constant frequency. This constant frequency may be likewise obtained by using mechanically vibratile elements other than quartz crystals having piezo electric properties. For the purpose of illustration throughout the following specification, the piezo electric element or crystal will be referred to as a mechanically vibratile element. The combined oscillator and modulator system of my invention employs a thermionic tube of the type having more than three electrodes. Such a thermionic tube is illustrated in the accompanying drawing. Referring to the thermionic tube and associated circuits in detail the operation and advantages will be clearly understood. Thermionic tube 1 is of the type having a cathode 2, inner grid electrode 3, anode 4 and outer grid electrode 5. The special relationship of these electrodes in the tubes is in the order named, the auxiliary grid electrode 5 being intermediate cathode 2 and anode 4. In the circuit here described the inner grid 3 may be referred to as the control grid electrode, and outer grid 5 may be referred to as the auxiliary grid electrode. Cathode 2 is heated to incandescence and caused to liberate electrons. The energy for causing such liberation of electrons may be derived from an alternating current source associated with the primary winding of transformer 6. The secondary terminals of transformer 6 are connected to the two cathode terminals. Anode 4 is supplied with a potential of positive polarity in respect to cathode 2. This potential is derived from source 7. Control electrode 3 of thermionic tube 1 is supplied with a potential from source 8. This potential is of the proper value and polarity in respect to cathode 2 to obtain the desired operational characteristics. The characteristic curve of the tube may be altered by this source of energy in the manner desired for best results. As shown in the drawing, source 8 may conveniently be connected to apply to control grid 3 a potential negative with respect to cathode 2, which will be suitable for operation in many cases. Mechanically vibratile element 9 is connected in the input circuit of thermionic tube 1, the connections leading to cathode 2 and control electrode 3. Element 9 has natural frequency characteristics corresponding approximately to the fundamental frequency to be generated or a multiple frequency thereof. Anode 4 is connected to inductance 11 by means of capacity 10. Capacity 12 is connected in parallel with inductance 11 through ammeter 13 and taps 25 and 26. Auxiliary electrode 5

is electrically connected to adjustable contact member 14 through winding 21 of transformer 22. Contact member 14 is associated with inductance 11. Capacity 10*a* is connected in series with the connection between cathode 2 and inductance 11. High frequency choke coils 15, 16, 19 and 20 are adapted to exclude high frequency energy from sources 8, 7 and transformer 6. Capacities are connected in series across the cathode terminals, and the center point of this connection is connected to sources 7 and 8 and to the electrical center 18 of the secondary of transformer 6. The primary winding 25 of transformer 22 is connected in series with source of electrical energy 23 and microphone 24. Microphone 24 may be replaced by any source desired to modulate the generated energy.

The operation of the combined oscillator and modulator system of my invention is as follows: Sources 7 and 8 are caused to energize electrodes 4 and 3 respectively subsequent to the energization of cathode 2 by transformer 6. Oscillations of electrical energy take place in the output circuit, which oscillations are sustained by element 9 in the input circuit. Contact member 14 is connected with inductance 11 at a position in respect to the electrical distribution of high frequency energy whereby a potential difference exists between electrode 5 and cathode 2. Tap 14 is adjusted to a position different from that of tap 24 so that the modulated radio frequency potential applied to auxiliary grid 5 is superimposed upon and is substantially in phase with and will add to the modulated radio frequency potential applied to anode 4. In certain positions of tap 14, these radio frequency potentials add and in other positions they subtract, a particular kind of regenerative effect is thus produced. Capacity 21*a* serves to bypass the high frequency energy and may be of any value suitable to the particular application and design of the system. The phase relation of electrodes 3 and 5 is maintained the same. Both of these electrodes are positive at the same instant and negative at the next instant. This is in effect to provide a feed back of the energy from the output circuit to the input circuit. This method for causing such transfer of energy or feed back affords greater efficiency and increases the energy output of the oscillator. The direct current resistance between cathode 2 and anode 4 depends to a large extent upon the potential from transformer 22 impressed upon auxiliary electrode 5. Thermionic tubes having more than four electrodes may likewise be employed to advantage. The auxiliary electrodes, similar to auxiliary electrode 5, would be associated with the inductance in the output or anode circuit. Many modifications are possible, including the use of two or more of such multi-electrode thermionic tubes connected in an electrically balanced circuit arrangement. Connections are established with the inductance included in the anode output circuit and the auxiliary electrodes whereby a potential difference of the generated energy exists. This method provides a balanced circuit arrangement wherein the proper phase relation exists at all times and whereby high frequency energy of greater value may be generated. The increased energy in the output circuit does not depend upon the ability of the crystal or other mechanically vibratile element to adequately withstand such increased energy. Therefore the generated energy will be of a constant frequency and substantially uniform irrespective of the power generated. It is obvious that one advantage of the oscillator system of my invention lies in the fact that the crystal or other mechanically vibratile element employed to maintain the frequency constant, is not subjected to an overload notwithstanding the increased amount of power generated. This feature affords a combined oscillator and modulator system well suited to be employed for generation of harmonic frequencies having an amplitude of appreciable value for further amplification and wherein the generated energy is modulated in accordance with the lower frequency or source of audio frequency variations.

The circuit arrangements of my invention may be employed to receive high frequency signaling energy wherein the incoming signaling energy is rectified and amplified. The incoming signaling energy would be associated with the control electrode and cathode of the thermionic tube and a connection from the output circuit associated with the auxiliary electrodes constituting means for obtaining regeneration. A source of locally generated energy could be associated with transformer 22 and caused to produce a beat frequency with the frequency of the incoming signal.

Other modifications of the circuit arrangement of my invention are possible. Mechanically vibratile element 9 may be replaced by an inductance-capacity circuit without departing from the spirit of my invention. The energy in such circuit will be of a low value in respect to the energy in the anode or output circuit. Additional circuit arrangements wherein the output of a generator may be associated with the input circuit of such a circuit as shown herein will afford an amplifier having great possibilities and a method for controlling the amplitude of the energy in strict accordance with the source of low frequency or audio frequency signaling energy.

While I have shown a piezo electric crystal element in the circuit arrangement of my invention, I desire that it be understood that

this element may be replaced by a mechanical oscillator composed of such metal or alloys as nickel and other metals which when influenced by alternating current will exhibit magnetostrictive properties which in turn will hold the frequency constant.

Many modifications of my invention are possible and I desire that it be understood that my invention is not to be restricted to the foregoing specification or the accompanying drawing, and that no limitations upon my invention are intended except as are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In an electron tube system, an electron tube having cathode, anode, control grid and auxiliary grid, an input circuit connected between said control grid and said cathode, a source of anode potential connected between said anode and said cathode, a tapped output inductance connected between said anode and said cathode, a tuned path connected in shunt with said inductance, a source of voltages of variable audio frequencies, a transformer having a primary winding connected to said source of variable audio frequencies and having its secondary winding connected between said auxiliary grid and a tap on said output inductance disposed intermediate the points of connection of said tuned path with said inductance, whereby the output delivered from the anode of said tube in varied in accordance with the variations of said audio-frequencies.

2. In an electron tube system, an electron tube having cathode, anode, control grid and auxiliary grid, an input circuit connected between said control grid and said cathode, a piezo electric crystal element connected to said input circuit, a source of anode potential connected between said anode and said cathode, a tapped output inductance connected between said anode and said cathode, a tuned circuit connected between taps disposed adjacent opposite ends of said inductance, a source of voltages of audio-frequencies, a transformer having a primary winding connected to said source of audio-frequencies and having its secondary winding connected between said auxiliary grid and a tap on said output inductance intermediate the connections of said tuned circuit with said inductance, whereby the output delivery from the anode of said tube is varied in accordance with said audio-frequencies.

3. In an electron tube system, an electron tube having cathode, anode, control grid and auxiliary grid, an input circuit connected between said control grid and said cathode, a piezo electric crystal element connected to said input circuit, a source of anode potential connected between said anode and said cathode, an inductance, taps adjacent one end of said inductance and connected between said anode and said cathode, separate taps adjacent opposite ends of said inductance beyond the limits of the aforesaid taps, a source of voltage of audio-frequencies, a transformer having a primary winding connected to said source of voltage of audio-frequencies and having its secondary winding connected between said auxiliary grid and a tap on said output inductance at a point separate from any other tap thereon, whereby the output delivered from the anode of said tube is varied in accordance with said variations in said audio-frequencies.

4. In an electron tube system, an electron tube having cathode, anode, control grid and auxiliary grid, said auxiliary grid being disposed intermediate said cathode and said anode, an input circuit connected between said control grid and said cathode, an electromechanical vibrator disposed in said input circuit, a source of anode potential connected between said anode and said cathode, an output inductance, taps adjacent one end of said inductance connected between said anode and said cathode, a tuned path resonant to the frequency of said electromechanical vibrator connected between taps adjacent opposite ends of said inductance and beyond the limits of the aforesaid taps, a source of voltage of audio-frequencies, a transformer having a primary winding connected to said source of voltage of audio-frequencies and having its secondary winding connected between said auxiliary grid and a tap on said output inductance intermediate the taps connected with said tuned path, whereby the output delivered from the anode of said tube is varied in accordance with variations in said audio-frequencies.

In testimony whereof I affix my signature.

JOHN A. WILLOUGHBY.