

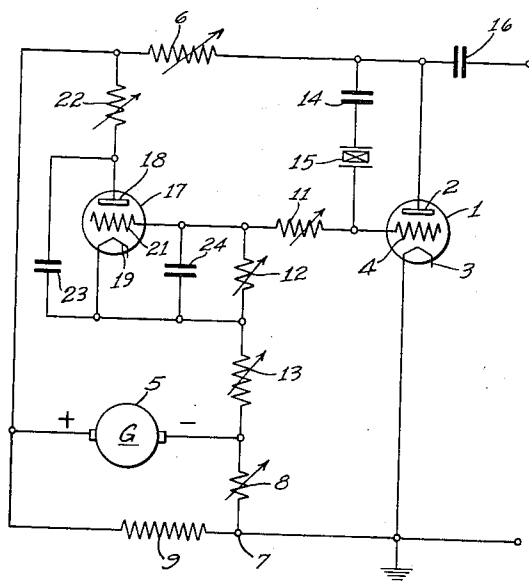
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AUTOMATIC AMPLITUDE CONTROL FOR OSCILLATOR CIRCUITS

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AUTOMATIC AMPLITUDE CONTROL FOR
OSCILLATOR CIRCUITS

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My invention relates to electric discharge tube oscillators controlled by electromechanical vibrators and, in particular, relates to the provision of an automatic arrangement for regulating the amplitude of the oscillations produced by the tube.

Oscillators in which an electromechanical vibrator such as a piezo-electric crystal of quartz or other suitable material is connected between the anode and the grid of a tube containing at least three electrodes, and in which electrical oscillations of substantially the natural frequency of vibration of the vibrator are produced in the circuit of the principal electrodes are well known in the prior art. Such arrangements operate quite satisfactorily where only moderate amounts of power output are required from the tube. However, when such arrangements are employed to produce large power outputs, for example, by employing relatively high plate supply voltages, considerable irregularities and variances were found in the operation of different vibrators. In some cases, the vibrators oscillate so violently as to be overheated; in other cases, relatively feeble oscillations only can be produced.

One object of my invention is to provide an ancillary arrangement by which the amplitude of the oscillations of the electromechanical vibrator can be controlled and regulated to prevent such over-violent or under-powered oscillations.

Another object of my invention is to provide a piezo-electrically-controlled oscillator with automatic means for regulating the amplitude of oscillation of the piezo-electric crystal at will.

Other objects of my invention will become apparent upon reading the following description taken in connection with the single figure of drawing which is a schematic diagram of a circuit embodying the principles of my invention.

Referring in detail to the drawing, an electrical discharge tube 1 having an anode 2, a cathode 3 and at least one control electrode 4, and which may be for many purposes of the high vacuum type, is supplied with current from a source of direct-current 5 through a resistor 8, this current being preferably derived from a tap point 7 on a potentiometer comprising two resistor sections 8, 9 which are connected across the terminals of the direct-current source 5. The tube 1 may, with advantage for many purposes, be of the variable Mu type well known in the art. The relative magnitudes of the resistors 8, 9 are so proportioned as to impress between the cathode 3 of the tube 1 and its control electrode 4 a suitable negative bias voltage in a manner well known in the

radio art. Resistors 11, 12 and 13 are serially connected between the negative terminal of the direct-current source 5 and the control electrode 4 of the tube 1. Between the anode 2 and the control electrode 4 are connected a capacitor 14 in series with an electromechanical vibrator such as a piezo-electric crystal 15 of a type well known in the radio art. A load circuit may be connected through a capacitor 16 between the anode 2 and the cathode 3. The circuit arrangement so far described is a conventional one for producing electrical oscillations between the anode and cathode of the tube 1.

In order to provide for automatic regulation of the amplitude of the vibrations of the vibrator 15 in accordance with my invention, I provide a second electrical discharge tube 17 which may in many cases be of the high vacuum type and which has an anode 18, a cathode 19 and at least one control electrode 21. The anode 18 is connected through a resistor 22 to the positive terminal of the direct-current source 5, and the cathode 19 is connected to the common junction of the resistors 12 and 13 previously mentioned as positioned in the grid circuit of the tube 1. A capacitor 23 is preferably connected in shunt between the anode and the cathode of the tube 17. The control electrode 21 is connected to the common junction of the resistors 11 and 12 previously mentioned in the control electrode circuit of the tube 1. A capacitor 24 is connected in shunt to the resistor 12.

The mode of operation of the above-described circuit to regulate the intensity of the vibration of the vibrator 15 is as follows: It will be noted that any current which flows from the generator 5 through the tube 17, resistor 22 and resistor 13 will produce a voltage drop tending to make the control electrode 4 of the tube 1 more positive. It will also be noted that the voltage drop through the resistor 13 will thus be opposite in direction to the voltage impressed upon the control electrode 4 by the current flow in the resistor 8. It will likewise be noted that the resistor 12 is traversed by the electric current resulting from rectification of the electric oscillations on grid 4. Thus the grid voltage applied to tube 17 is proportional to the strength of the oscillations. Now suppose that some change occurs which temporarily increases the amplitude of oscillation. The result of this will be an increased rectified current traversing resistors 8, 13, 12, 11 and control grid 4 and cathode 3 thereby increasing the negative potential at grid 4. The negative potential on grid 21 will have been increased which in

turn will decrease the current through resistors 22 and 13. The decrease of current in resistor 13 will decrease the bucking potential thereof and allow the negative potential on control grid 4 to go still farther negative thereby tending to bring the amplitude of oscillation back to the normal state. The action of capacitors 23 and 24 is to by-pass high frequency currents which might be present due to stray fields and etc. and make tube 17 react only to the D. C. potentials impressed.

It will readily be seen that any decrease in the strength of the vibrations in vibrator 15 from a given value decreases the negative bias applied by the resistor 12 to the control electrode 21 of tube 17, thereby increasing the positive bias applied by the resistor 13 to the control electrode 4 and thus increasing the strength of the oscillations produced by the tube 1. In short, the reaction of the circuits of ancillary tube 17 is such as to tend to neutralize any variance of the strength of the vibrations of crystal 15 from a given normal value.

The initial adjustments of the above-described system to determine the above-mentioned normal value may be made as follows: With the tube 17 and the vibrator 15 removed from circuit, the magnitude of the resistance 8 should initially be adjusted to reduce the plate current of the tube 1 to a very low value. The resistors 13 and 22 should then be adjusted to produce a bias which would cause tube 1 to operate as a class A amplifier when not producing oscillations. Then connecting the crystal 15 in position, the resistors 11 and 12 should be adjusted so that the plate current of tube 17 has a relatively small value when the crystal 15 vibrates with the desired or normal amplitude.

The ancillary tube 17 and its circuits are applicable not only to regulate the intensity of vibrations of the tube 1 when it is operated with a crystal control, but may likewise be used to control the amplitude of its oscillations when the vibrator 15 is removed and the tube connected to oscillate in an ordinary feedback connection or with an oscillation-excited grid circuit, both the latter connections being well known in the radio art.

While I have described a particular embodiment of my invention, its principles are of broader application in ways that will be readily evident to those skilled in the art.

I claim as my invention:

1. In combination, an electrical discharge tube having at least two principal electrodes and a control electrode, means connected to supply power to said principal electrodes, an electromechanical vibrator connected in circuit between said control electrode and one of said other principal electrodes, a resistance means connected between said control electrode and the other of said principal electrodes, a second electrical discharge tube having at least two principal electrodes and a control electrode connected to cause current flowing between its principal electrodes to traverse a portion of said resistance means,

means for connecting another portion of said resistance means to impress a bias voltage between the control electrode and the principal electrode of said second electrical discharge tube, and means for supplying current to the principal electrodes of said second electrical discharge tube.

2. In combination with an electrical discharge tube having at least two principal electrodes and a control electrode, an electromechanical vibrator and a capacitor connected in shunt between one of said principal electrodes and said control electrode, resistance means having a plurality of sections connected between said control electrodes and the other of said principal electrodes, a direct current source connected to cause current flow between said principal electrodes, a second electrical discharge tube connected to said current source and having at least an anode, a cathode and a control electrode, means for connecting said anode to the positive terminal of said direct-current source, means for connecting said cathode to a first tap point on said resistance means, and means for connecting the last-mentioned control electrode to a second tap point on said resistance means which is nearer to the first-mentioned control electrode than is said first tap point.

3. In combination, a first electrical discharge tube having an anode, a cathode and a control electrode, means for connecting said anode to the positive terminal of a direct-current source, means for connecting said control electrode through a resistance-means to the negative terminal of said direct-current source, and means for connecting said cathode to a point intermediate in potential between the terminals of said direct-current source, a capacitor and a piezo-electric crystal connected between said anode and said control electrode, a second electrical discharge tube having an anode, a cathode and at least one control electrode, means for connecting said cathode to a first tap point on said resistance-means, means for connecting the last-mentioned control electrode to a second tap point on said resistance-means which is closer to the first-mentioned control electrode than is said first tap point, a capacitor shunting said tap points, and means for connecting the last-mentioned anode to derive current from the positive terminal of said direct-current source.

4. In combination with an electrical discharge tube having a principal electrode circuit and a control electrode circuit, means for supplying exciting current through an electromechanical vibrator to said control electrode circuit, a second electrical discharge tube having principal electrodes and a control electrode circuit, means for impressing a voltage varying with said exciting current on the last-mentioned control electrode circuit, and means for impressing a voltage varying with the current between the last-mentioned principal electrodes on the first-mentioned control electrode circuit.

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