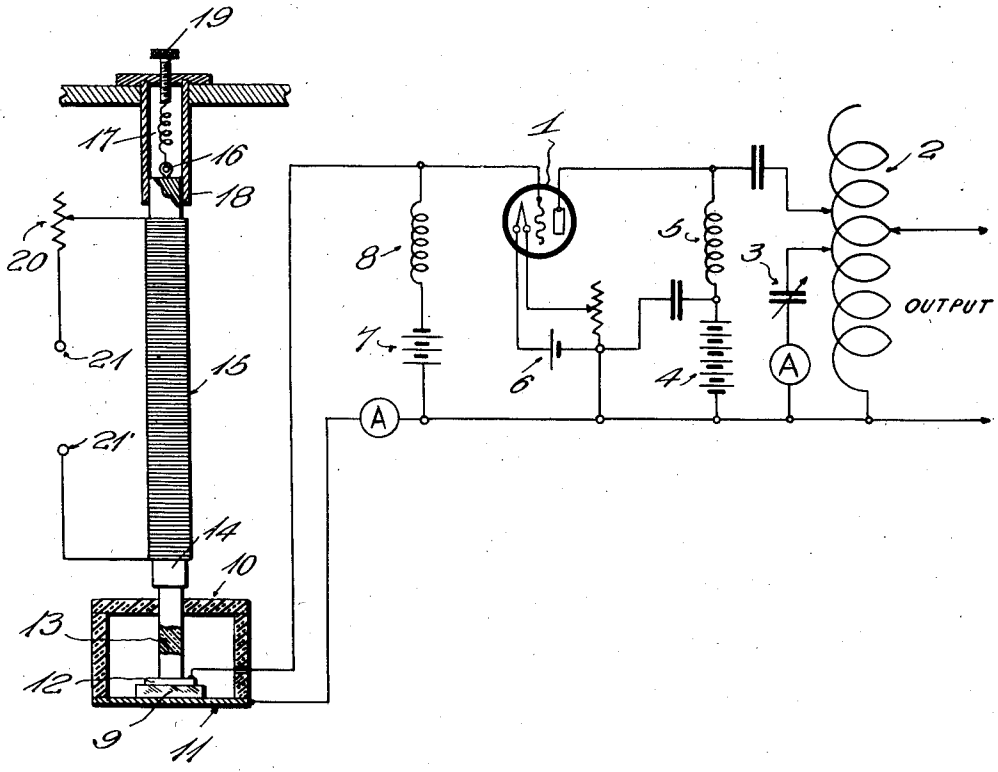
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FREQUENCY MODULATION OF HIGH FREQUENCY OSCILLATION GENERATORS

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FREQUENCY MODULATION OF HIGH FREQUENCY OSCILLATION GENERATORS

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My invention relates broadly to high frequency oscillation generators, and more specifically to high frequency oscillation generators employing piezo electric element frequency stabilizing means.

One of the objects of my invention is to provide means for frequency modulating the high frequency oscillations generated by a piezo electric element frequency controlled oscillation generator.

Another object of my invention is to provide means associated with the piezo electric element of a piezo electric element frequency stabilized high frequency oscillation generator for frequency modulating the high frequency oscillations generated.

Still another object of my invention is to provide an arrangement whereby the signals of a piezo electric element frequency controlled transmitting system may be frequency modulated.

A still further object of my invention is to provide a piezo electric element employed to govern the frequency of oscillation of a high frequency oscillation generator with means whereby the element is subject to pressure periodically.

In the operation of a high frequency signal transmitter it is often highly desirable to slightly modulate the carrier frequency instead of transmitting the constant unmodulated continuous wave, primarily because it is often difficult to receive the unmodulated continuous wave signal on account of interference from other similar unmodulated signals and also because a slightly modulated high frequency is less affected by fading. Previously, attempts have been made to employ energy modulation of frequency stabilized signal transmitting sets. Energy modulation often results in extremely unpleasant characteristics and it is difficult to confine the emitted signal within the required frequency band. Energy modulation is not practical where the signal transmitter is to be operated near the signal receiving apparatus simultaneously because of excessive interference caused in the receiving set. Frequency modulation has been found very satisfactory in that no interference is obtained from signal transmitters employing it, in receiving sets nearby. Frequency modulation also has the advantage that the percentage breadth of the frequency band covered by a signal emitted by a certain piezo electric element frequency controlled transmitter which is frequency modulated at a certain low frequency is the same at all frequencies. For example, in case oscillations of 4000 kilocycles frequency are frequency modulated so as to extend over a band of 100 cycles and the frequency of the oscillations is then multiplied in the usual manner to a frequency of 8000 kilocycles the 8000 kilocycle oscillations will be extended over a band of 200 cycles.

According to my invention a pressure applying member is positioned against a face of a contact member in electrical relation with the piezo electric element. A rod of material having marked magnetostriction or magnetic properties is positioned against the pressure applying member and in the field of an inductive winding excited by a low frequency alternating current or periodically interrupted direct current. This rod is caused to alternately expand and contract by the action of the magnetic field upon it. The pressure applying member thus periodically transmits pressure, the magnitude of which may be varied within certain limits by varying the current through the winding, from the periodically expanding and contracting rod to the piezo electric element. On account of the extremely low decrement of the piezo electric element the frequency of the current supply to the magnet must not be too high. The best results are obtained when a current having a frequency between 10 and 30 cycles per second is employed. A current having a frequency of 25 cycles produces very satisfactory results since a variation of about 100 cycles in a signal of 4000 kilocycles frequency is obtained.

My invention will be more fully understood from the specification hereinafter following and by reference to the accompanying drawing which illustrates an embodiment of my invention.

In the drawing, reference numeral 1 desig-

nates an electron discharge device having an inductance 2 connected in the anode circuit thereof. A condenser 3 is connected across certain turns of the inductance 2. A source 4 of anode current supply is connected through the choke coil 5 to the anode of the device 1. Source 7 of grid biasing potential is connected to the grid electrode of the electron discharge device 1 through the choke coil 8. Piezo electric element 9 is positioned in a housing 10 in contact with a wall 11 of conducting material and plate 12 which is also of conducting material. Connections are provided between the grid electrode of the electron discharge device 1 and the plate 12 and between the cathode circuit and the wall 11. An additional conducting plate may be provided on the bottom face of the piezo electric element in case the entire housing including the wall 11 is made of insulating material. A member 13, preferably of insulating material is positioned upon the contact plate 12 for applying intermittently varying pressure upon the piezo electric element 9. An element 14, which may be a rod of either nickel, iron or alloys thereof, or any metal or alloy having magnetic or magnetostriction properties, is positioned in the winding 15. The element 14 may be in the form of a tuning fork, instead of a straight rod, in which case a low frequency current is used to produce a fluctuating magnetic flux for sustaining the fork in vibration.

An eye screw 16 is provided on the rod member 14. A resilient element 17, such as a spring is attached to the eye screw 16 and the supporting member 19. By adjusting the member 19 the rod 14 may be caused to rest only lightly upon the piezo electric element 9. In the case of low frequency piezo electric elements it is highly desirable to be able to adjust the pressure upon the element since excessive pressure will block their operation. Piezo electric elements of various thicknesses may also be employed in the arrangement simply by adjusting the position of the supporting member 19. A tube 18 is provided to receive the end of the element 14 adjacent to the supporting member to mechanically stabilize the operation of the arrangement. Rheostat 20 is connected into circuit with the winding 15 to control the current flow in the circuit. A source of supply such as an alternating current generator or a periodically interrupted direct current or similar supply of regularly pulsating current is connected to the terminals 21 and 21'.

While I have described my invention in one of its preferred embodiments, I desire that it be understood that modifications may be made and that no limitations are intended other than 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 piezo electric control apparatus, the combination of, a piezo electric element, electrodes in contact with opposite faces of said piezo electric element, connections to said electrodes, and means for varying intermittently the pressure applied between said electrodes to said crystal along the direction perpendicular to the face of one of said electrodes.

2. In apparatus of the class described the combination of a piezo electric element, electrodes in contact with opposite faces of said piezo electric element, an electron discharge device, connections between said electrodes and said electron discharge device, and means for varying intermittently the pressure applied between said electrodes to said crystal along the direction perpendicular to the face of one of said electrodes, said means comprising a solenoid and a magnetic core therefor.

3. In apparatus of the class described the combination of a piezo electric element, electrodes in contact with opposite faces of said piezo electric element, and means operative upon said electrodes of said piezo electric element whereby the pressure exerted upon said piezo electric element is periodically varied along the direction perpendicular to the face of one of said electrodes, said means being electromagnetically actuated.

4. In apparatus of the class described the combination of an electromechanical vibrator, an electron discharge device, said electromechanical vibrator being connected to said electron discharge device, means for producing a periodically varying magnetic field, means for applying mechanical pressure directly to said electromechanical vibrator whereby the natural frequency of said electromechanical vibrator is altered, said last named means being actuated by said periodically varying magnetic field.

5. In apparatus of the class described the combination of an electromechanical vibrator, an electron discharge device, said electromechanical vibrator being connected to said electron discharge device, means for producing an intermittently varying magnetic field, means for applying pulsating mechanical pressure directly to said electromechanical vibrator whereby the natural frequency of said electromechanical vibrator is altered, said last named means being positioned in said magnetic field.

6. In apparatus of the class described the combination of a piezo electric crystal, electrodes in contact with opposite faces of said piezo electric crystal, a pressure applying member attached to one of said electrodes for transmitting mechanical pressure to said piezo electric crystal, means attached to said pressure applying member for causing said

pressure applying member to vibrate at a low frequency and to transmit mechanical vibrations to said piezo electric crystal.

7. In a frequency modulation system employing piezo electric control, an electron tube, a piezo electric crystal element, circuits connecting said piezo electric crystal element to said tube, a pair of electrodes in contact with opposite faces of said piezo electric element, a magnetostrictive member, means for periodically causing magnetostriction in said magnetostrictive member, one end of said magnetostrictive member being attached to one of said electrodes, whereby the pressure applied to said crystal between said electrodes is periodically varied.

8. In a frequency modulation system employing piezo electric control, an electron tube, input and output circuits therefor, a piezo electric crystal element, circuits connecting said piezo electric crystal element to the input circuit of said tube, a pair of electrodes in contact with opposite faces of said piezo electric crystal element, an inductance coil, a core member therefor having magnetostrictive properties, means for determining the position of one end of said core member with relation to one of said electrodes, the other end of said core member being attached to the other of said electrodes, and a source of varying current for said inductance, whereby the frequency of the output of said electron tube is subjected to small variations at a rate corresponding to the variation of the current applied to said inductance.

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