

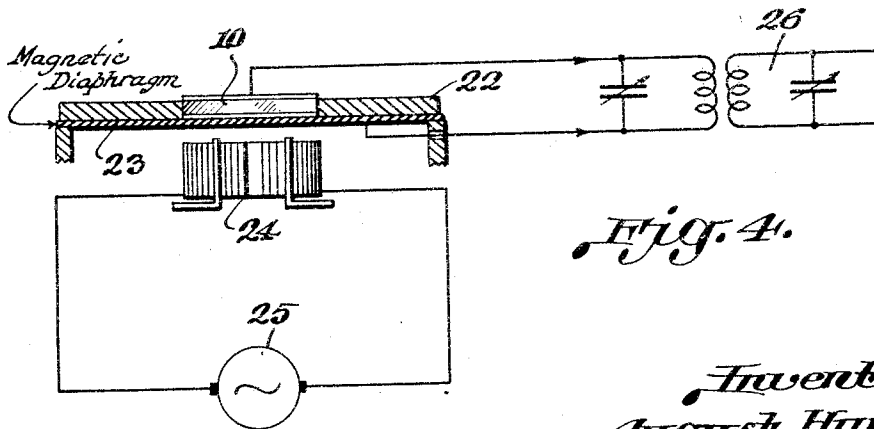
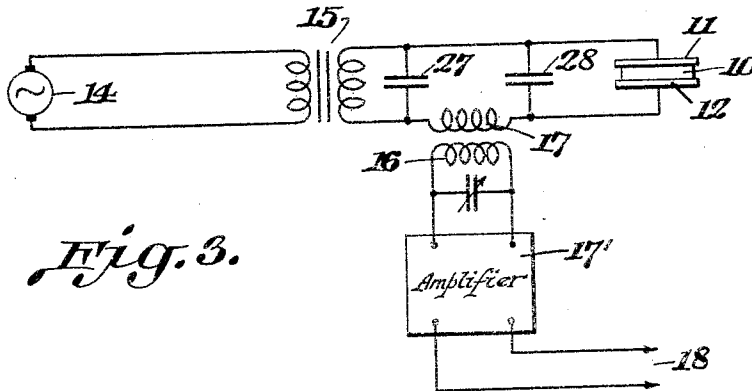
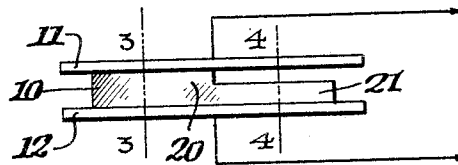
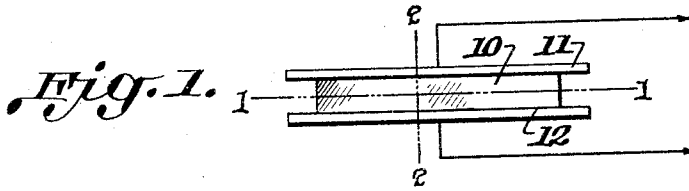
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METHOD AND APPARATUS FOR GENERATING ELECTRICAL OSCILLATIONS

Filed March 5, 1929



by

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METHOD AND APPARATUS FOR GENERATING ELECTRICAL OSCILLATIONS

Application filed March 5, 1929. Serial No. 344,563.

My invention relates broadly to a system of generating electrical oscillations and more particularly to a system for generating oscillations by means of piezo electric effects.

5 One of the objects of my invention is to provide a method and apparatus for generating electrical oscillations by piezo electric effects and without the employment of an electron tube oscillating circuit.

10 Another object of my invention is to provide a piezo electric system for generating electrical oscillations which may be operated independently of an electron tube oscillating circuit heretofore required in the art.

15 Still another object of my invention is to provide a method and apparatus for generating electrical oscillations of a selected frequency by initially supplying to a piezo electric crystal system an alternating current
20 of a frequency which corresponds to the beat frequency between the natural frequencies existing in a particular piezo electric crystal element.

A still further object of my invention is
25 to provide a constructoin of piezo electric crystal element having a plurality of natural frequencies wherein the crystal is ground to produce those frequencies having a predetermined beat note therebetween, which
30 beat note may be supplied to the piezo electric crystal element for deriving a selected frequency from the crystal and producing sustained oscillation without the aids of an electron tube circuit as heretofore required in the
35 art.

Still another object of my invention is to provide a system for generating oscillations from piezo electric crystals wherein alternating current of commercial frequency may
40 be supplied to a piezo electric crystal control circuit for deriving from the piezo electric crystal system electrical oscillations of high frequency for supply to any desired form of utilization circuit.

45 My invention will be more clearly understood from the following specification and the accompanying drawing, in which:

Figure 1 is a diagrammatic view illustrating a piezo electric crystal element ground
50 in accordance with the principles of my in-

vention; Fig. 2 illustrates a piezo electric crystal element ground in a different manner for producing oscillations in accordance with the principles of my invention; Fig. 3 is a diagrammatic circuit arrangement
55 showing the principles involved in the system of my invention; and Fig. 4 illustrates a modified method of driving the piezo electric crystal element ground in accordance with the principles of my invention.

60 In carrying out my invention I employ the piezo electric effects of quartz crystals. It is well-known that piezo electric crystals have the ability of sustaining electrical oscillations in an electrical circuit. A piezo electric
65 crystal may vibrate in a plurality of different modes and at a plurality of different frequencies. The crystal may vibrate simultaneously along different axes at different frequencies.

70 In the sustaining of electrical oscillations a piezo electric element expands and contracts periodically along the different axes thereof and the energy which is generated may be conducted from the piezo electric
75 crystal element by contact plates which establish connection with opposite faces of the piezo electric crystal element. Stresses are set up in the piezo electric crystal element in accordance with the vibration thereof. Potentials may be generated by the piezo electric crystal element by subjecting the piezo electric crystal element to periodic pressure changes applied upon the contact plates.

80 Heretofore, it has been customary to arrange an electron tube system with the input and output circuits of the electron tube system coupled for the production of oscillations and then sustain the oscillations thus produced at constant frequency by cooperation of a piezo electric crystal element with
85 the oscillator circuits.

I have discovered means as set forth herein for producing electrical oscillations from a piezo electric crystal without the association
90 of an electron tube oscillator circuit with the piezo electric crystal element. I so grind the piezo electric crystal element that the frequencies along different axes thereof are so related as to produce a predetermined beat

frequency. I then arrange an electrical circuit in such manner that a frequency corresponding to the beat frequency may be supplied to the piezo electric crystal element.

5 The resultant effects are that the piezo electric crystal element is driven at constant frequency for deriving in an associated electrical circuit a frequency corresponding to one of the natural frequencies of the piezo electrical crystal element.

10 Referring to the drawing, Figure 1 illustrates a piezo electric crystal 10 with an upper contact plate 11 and a lower contact plate 12. The piezo electric crystal is ground so
15 that its natural frequency along axis 1—1 is related to the natural frequency along axis 2—2 so as to produce a predetermined beat frequency. The piezo crystal is connected in an electrical circuit as shown in Figure 3
20 where a source of alternating current from the supply 14 is utilized to impress energy from transformer energy 15 upon the piezo electric crystal to contact plates 11 and 12 at a frequency corresponding to the frequency
25 difference between the frequencies along the two axes of the crystal represented in Figure 1. I provide radio-frequency by-pass condensers 27 and 28 connected in shunt with the secondary winding of transformer 15 and
30 also in shunt with piezo electric crystal element 10 as shown. Electrical oscillations are delivered to tuned circuit 16 coupled through transformer circuit 17 with the piezo crystal circuit, the derived frequency being one of
35 the frequencies for which the piezo electric crystal is ground. This selected frequency is sustained in the circuit 16, the energy amplified by electron tube amplifier system represented at 17' and delivered to an output circuit
40 having terminals represented at 18.

Instead of grinding the crystal of a size where the major and minor axes have the desired frequency difference, I may grind the crystal in stepped formation as represented
45 in Figure 2, where the crystal 10 has one portion 20 of greater thickness than the adjacent portion 21, the crystal vibrating along different axes produced by the conjoint effect of the applied beat frequency.

50 I have found that the beat frequency may be impressed upon the piezo crystal either electrically as shown in Figure 3 or mechanically as represented in Figure 4 where the crystal 10 is centered by means of a rim member 22 upon a magnetic diaphragm 23 which
55 may be subjected to the constant frequency vibration under influence of electromagnets 24 excited from generator 25, impressing the beat frequency upon the crystal for deriving
60 sustained oscillations in the circuit 26.

The oscillations may be amplified by a suitable electron tube system, but it is unnecessary to connect the piezo crystal in an electron tube oscillator circuit. The sustained oscillations are maintained at a constant fre-

quency determined by the natural frequency of the piezo crystal and are stabilized in the associated circuits without undue influence of the electrical circuits upon the crystal frequency.

70 While I have described my invention in certain of its preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

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

1. The method of generating high frequency oscillations which comprises, subjecting a piezo electric crystal element, adapted to sustain oscillations at a beat frequency of its plurality of natural frequencies, to cyclic variations corresponding to said beat frequency and deriving oscillations of a frequency corresponding to one of the plurality of natural frequencies of said crystal element.

2. The method of generating high frequency oscillations which comprises subjecting a piezo electric crystal element, adapted to sustain oscillations at a beat frequency of its plurality of natural frequencies, to oscillations corresponding to said beat frequency and, deriving from said piezo electric crystal element electrical oscillations having a frequency corresponding to one of the natural frequencies of said piezo electric crystal element.

3. The method of generating high frequency oscillations which comprises vibrating a piezo electric crystal element, adapted to sustain oscillations at a beat frequency of its plurality of natural frequencies, at a rate corresponding to said beat frequency and deriving from said piezo electric crystal element sustained oscillations corresponding to the frequency of one of said natural frequencies.

4. The method of producing sustained high frequency oscillations which comprises impressing upon a piezo electric crystal element, adapted to sustain oscillations at a beat frequency of its plurality of natural frequencies, electrical impulses at a rate corresponding to said beat frequency, and deriving from said piezo electric crystal element sustained high frequency oscillations corresponding to one of the natural frequencies of said piezo electric crystal element.

5. In a system for producing high frequency oscillations, a piezo electric crystal element ground to a multiplicity of differing natural frequencies, said frequencies differing from each other by a beat frequency, means for impressing electrical energy at a rate corresponding to said beat frequency upon said piezo electric crystal element, and means connected with said piezo electric crystal element for deriving sustained elec-

trical oscillations corresponding to one of the natural frequencies of said piezo electric crystal element.

6. In a system for generating electrical
5 oscillations, a circuit including a piezo-electric crystal having two natural frequencies of vibration the difference between which is equal to a certain beat frequency, a source
10 having a frequency equal to said certain beat frequency, the frequency and operation of said source being independent of said crystal, said source being coupled to said circuit
15 whereby voltage of said certain beat frequency is impressed upon said crystal, and a second circuit tuned to one of said natural frequencies, said second circuit being coupled to said first mentioned circuit and operable to derive therefrom current of the frequency to which it is tuned.

20 In testimony whereof I affix my signature.
AUGUST HUND.

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