

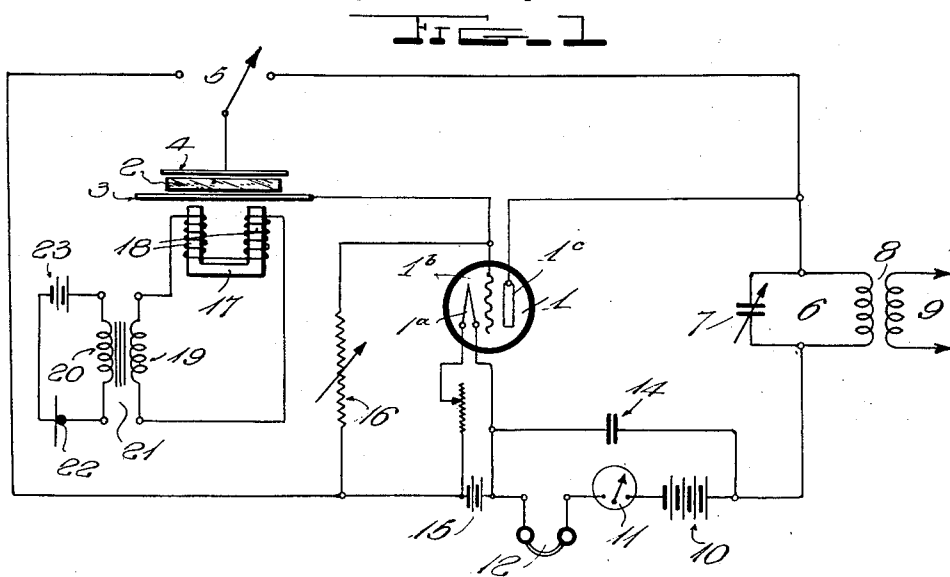
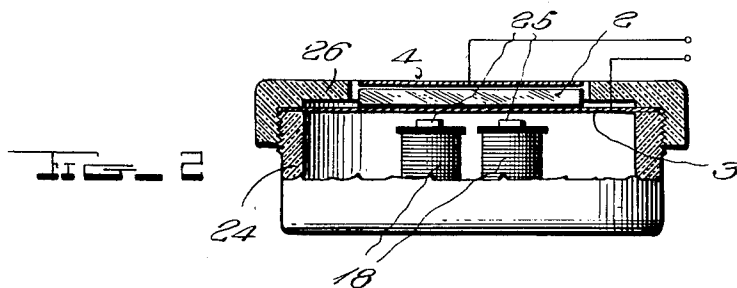
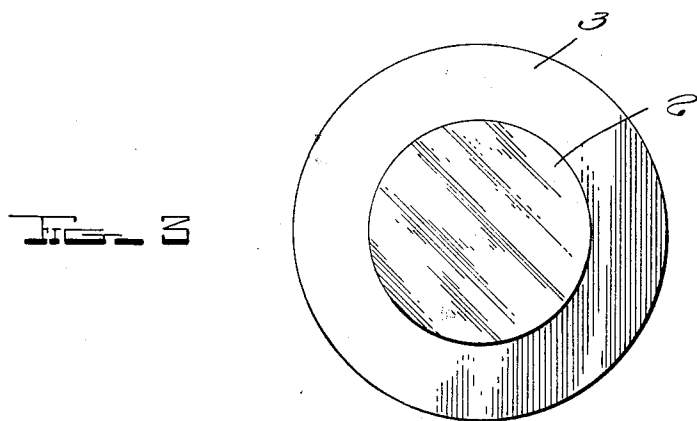
Feb. 6, 1934.

A. HUND

1,945,690

FREQUENCY CONTROL AND MODULATION SYSTEM

Original Filed April 10, 1926



INVENTOR.

August Hund,
BY John B. Brady
ATTORNEY.

UNITED STATES PATENT OFFICE

1,945,690

FREQUENCY CONTROL AND MODULATION
SYSTEM

August Hund, West Orange, N. J., assignor, by
mesne assignments, to Wired Radio, Inc., New
York, N. Y., a corporation of Delaware

Application April 10, 1926, Serial No. 101,202
Renewed September 3, 1931

14 Claims. (Cl. 179—171)

My invention relates broadly to modulation circuits and more particularly to a frequency control system for modulation circuits.

a piezo electric crystal element can be arranged to sustain only the characteristic frequency of the piezo electric crystal element. Heretofore in the art a piezo electric crystal oscillatory system has been employed for exciting a signal transmission circuit, and modulation of the signaling current is brought about by a separate modulation circuit independent of the high frequency generator.

One of the objects of my invention is to provide a piezo electric frequency controlled modulation system where the constant frequency characteristics of piezo electric plates are employed for sustaining a carrier frequency which is modulated in accordance with lower frequencies.

Another object of my invention is to provide means for modulating a piezo electric oscillator system by directly impressing low frequency mechanical vibrations upon the piezo electric device.

Another object of my invention is to provide a piezo electric oscillator and modulator system where the constant frequency oscillations of a piezo electric crystal are modified by superimposing audio frequency vibrations upon the constant frequency oscillations sustained by the piezo electric system.

A further object of my invention is to provide a piezo electric crystal oscillating system having means for directly applying mechanical vibrations to the piezo electric crystal modified in accordance with speech vibrations for correspondingly modulating the high frequency output of the piezo electric crystal system.

One embodiment of my invention as herein disclosed and specifically claimed is in some respects similar to a different species of my invention as disclosed in my co-pending application, Serial No. 109,785, filed May 17, 1926. In that application some of the similar features of the two species are more or less broadly claimed.

My invention will be more clearly understood by reference to the following specification and the accompanying drawing in which:

Figure 1 is a diagrammatic view illustrating the principle of my invention; Fig. 2 is a view partially in cross-section and partially in side elevation illustrating the piezo electric crystal apparatus of my invention; and Fig. 3 is a plan view showing the arrangement of a piezo electric plate supported upon a vibratory diaphragm.

The constant frequency oscillations generated by piezo electric plates have been used for controlling signal transmission circuits for maintaining constant the carrier frequency transmission system. The frequencies sustained by piezo electric plates are substantially constant and a wide change in such frequencies can only be brought about by utilizing a piezo electric crystal ground to a different characteristic frequency. An electrical circuit under control of

In my copending application, Serial No. 90,934, filed February 26, 1926, I have described the results of certain of my experiments with respect to piezo-electric crystal oscillators wherein it has been shown that by a slight variation in spacial relation between one electrode and one surface of the piezo-electric crystal, the frequency sustained by that crystal may be shifted. In that application I also disclosed my discovery that by subjecting the piezo-electric crystal to mechanical strain by the introduction of positive pressure against the crystal, that the frequency of operation may be shifted to a desired degree.

By my invention herein disclosed I provide certain specific means and a method for directly modifying the frequency or the amplitude of the oscillations which are sustained by a piezo electric crystal element in an electron tube circuit by subjecting the piezo electric crystal element to mechanical vibrations modified in accordance with sound waves. Oscillograph records clearly show that both frequency and amplitude modulation is present in such circuits. Frequency modulation, therefore, as well as amplitude modulation, may be regarded as inherent in the operation of devices constructed in accordance with the instant disclosure. I support the piezo electric crystal element between a pair of conductive plate members, one of which may be constructed of magnetic material and subjected to movement under control of an electromagnetic system. An electron tube circuit is provided for sustaining the oscillations generated by the piezo electric crystal element by subjecting the piezo electric crystal element to rapid mechanical vibration. By operation of the electromagnetic vibratory system the high frequency output of the piezo electric crystal element may be modulated. By arranging the electromagnetic control system in a voice frequency or microphone circuit the piezo electric crystal may have mechanical vibrations thereon, and correspondingly the high frequency current sustained in the associated electron tube circuit is modulated and may be amplified by

means of a power amplifier and then impressed upon the signal transmission circuit.

Referring to the drawing in more detail, reference character 1 designates an electron tube having filament electrode 1^a, grid electrode 1^b and plate electrode 1^c interconnected by input and output circuits. The piezo electric element 2 is supported upon the magnetic plate or diaphragm 3 by which electrical connection is established with the lower surface of the piezo electric crystal element. The upper surface of the piezo electric crystal element is touched by means of a contact plate 4 which may be connected through switch system 5 for placing the piezo electric crystal element in shunt with the grid and plate electrodes 1^b and 1^c or in shunt with the grid and filament electrodes 1^b and 1^a. The output circuit includes a resonance system 6, having a condenser 7 and an induction 8 coupled to an output circuit 9. The output circuit also includes the source of potential 10, the indicating ammeter 11 and head set 12 with a by-pass condenser 14 shunted therearound for by-passing radio frequency oscillations which are developed in the electron tube circuit. A battery 15 is provided for heating the cathode 1^a, and a grid leak 16 is shunted across the grid electrode 1^b and filament electrode 1^a for controlling the oscillatory condition of the electron tube 5. The diaphragm 3 is controlled by means of the electromagnetic driver, having a magnetic system 17 and electromagnetic windings 18 associated therewith. The electromagnetic windings 18 are arranged in a control circuit where a transformer 21 has its primary winding 20 connected in series with a source of potential 23 and a microphone 22, while winding 19 connects with the magnetic windings 18.

The arrangement of the piezo electric crystal apparatus is shown more clearly in Fig. 2 where the piezo electric crystal 2 is shown centrally positioned with respect to a cap member 26 which fits upon the casing 24 of the electromagnetic driver with the bobbins 18 wound upon the pole pieces 25. Piezo electric plate 2 may be in the form of a disc which rests upon the magnetic diaphragm 3 by which the piezo electric plate is vibrated. Various forms of vibrating devices may be employed and I have illustrated the electromagnetic devices shown merely for the purpose of explaining the principles of my invention, and it will be understood that other constructions of vibrating devices may be readily employed. The low frequency vibrations are superimposed on the high frequency vibrations generated by the piezo electric plate and serve to modulate the high frequency oscillations. The modulation system may be employed both in telegraphy and telephony, and the control circuit may be used in association with a variety of forms of signaling systems, such as wired radio circuits and space radio circuits, and I desire it to be understood that no limitations upon the invention 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 a system for generating and modulating high frequency oscillations, the combination of an electron tube having grid, filament and plate electrodes, input and output circuits interconnecting said electrodes, a piezo electric crystal element arranged to be connected with said circuits for sustaining therein high frequency oscillations in accordance with its characteristic

frequency, and electromagnetic means positioned directly adjacent said piezo electric crystal element for subjecting said piezo electric crystal element to mechanical vibrations of a lower order of frequencies than the characteristic frequency of said piezo electric crystal element for modulating the high frequency oscillations generated in said circuit.

2. In a high frequency system the combination of an electron tube having grid, filament and plate electrodes, input and output circuits interconnecting said electrodes, a piezo electric crystal for sustaining oscillations in said electron tube circuits at the characteristic frequency of said piezo electric crystal, and contact electrodes for connecting said piezo electric crystal into said electron tube circuits, and an electromechanical vibrator beneath said crystal for varying the pressure exerted upon said piezo electric crystal in accordance with sound vibrations for modulating the high frequency current sustained by said piezo electric crystal.

3. In a high frequency system the combination of an electron tube having grid, filament and plate electrodes, input and output circuits interconnecting said electrodes, a piezo electric crystal connected in said circuits for sustaining oscillations therein at the characteristic frequency of said piezo electric crystal, and a pair of plate members one of which supports said piezo electric crystal and is mechanically vibratable therewith in response to electromagnetic signalling impulses whereby the amplitude of the high frequency oscillations sustained by said piezo electric crystal is varied.

4. A piezo electric crystal apparatus for sustaining high frequency oscillations comprising in combination a conductive plate member of magnetic material arranged to support a piezo electric crystal element, a second conductive plate member arranged to establish electrical connection with the upper surface of said piezo electric crystal element, and electromagnetic means for imparting movement to said magnetic plate member for varying the piezo electric effect of said piezo electric crystal for modulating the high frequency oscillations sustained by said piezo electric crystal element.

5. Piezo electric crystal apparatus comprising in combination an electromagnetically actuated sound reproducing diaphragm, a piezo electric crystal supported by said diaphragm, an electrical circuit for sustaining oscillations of a natural frequency of said piezo electric crystal, said circuit including said diaphragm as one of the electrodes of said crystal and a second electrode thereof, and means for varying the characteristics of the sustained oscillations in accordance with the movement communicated to said crystal by said diaphragm.

6. Piezo electric crystal apparatus comprising in combination a pair of contact plates, a piezo electric crystal element disposed between and supported by one of said contact plates, an electromagnetic control circuit for subjecting the crystal-supporting contact plate to mechanical movement, and an electrical circuit connected with said contact plates for sustaining oscillations of the characteristic frequency of said piezo electric crystal element while said oscillations are modulated in accordance with vibrations imparted to the crystal element through the crystal-supporting plate in response to variations in said electromagnetic control circuit.

7. The method of frequency control and modulation

lation in accordance with signals by means of a piezo-electric device freely vibrating between two electrodes, which consists in electromechanically shaking the crystal and at least one of its electrodes in accordance with signals, and simultaneously impressing upon said electrodes electrical oscillations the frequency of which is controlled by said piezo-electric device.

8. In a high frequency modulating system, means to modulate high frequency currents comprising a piezo-electric crystal having a pair of electrodes one of which, coacting with the crystal, is vibrationally responsive to low frequency signals and the other of which is supported by and in bouncing relation to the crystal, and means including an oscillating circuit connected with said electrodes for generation and transfer of the high frequency currents thus modulated.

9. In combination, an electronic device arranged to generate oscillations, a piezo-electric crystal arranged to control the frequency of the oscillations generated, a movable diaphragm mechanically coupled to said crystal and co-operating therewith as one of its electrodes, a second electrode for said crystal, an oscillating circuit including said electronic device and the two said crystal electrodes, and electro-magnetic means for actuating said diaphragm so as to modulate the frequency of the oscillations generated.

10. In a radio frequency system an oscillation generator, comprising an electron tube, means comprising a piezo-electric crystal for determining the oscillation frequency, means including an electrode supporting said crystal and vibratory in bouncing relation thereto in response to an audio frequency, and a second electrode, the two said electrodes cooperating with the crystal to

effect an amplitude variation of the oscillation frequency in accordance with said audio frequency.

11. In an oscillation generator, a piezo-electric crystal having an electrode bouncingly vibratory in respect thereto for controlling the oscillations of said generator, mechanical means for shaking said electrode and said crystal at an audio frequency and means for varying the amplitude of the oscillations generated under the control of said crystal.

12. An electronically actuated oscillator including a piezo-electric crystal having one electrode bouncingly vibratory in respect thereto and a second electrode included in an oscillatory circuit therefor, said crystal being adapted to control the frequency of the oscillations produced by said oscillator, and signaling means acting upon said crystal and the first mentioned electrode thereof to cause the oscillator at signaling instants to deliver output oscillations of variable amplitude.

13. An oscillator having a piezo-electric crystal freely supported by one of its electrodes and means for electromechanically vibrating said electrode in response to low frequency signals for bouncing the crystal in respect to said electrode so as to vary the characteristics of the oscillations produced.

14. A piezo-electric crystal oscillator having a crystal freely supported by one of its electrodes and means for electromechanically vibrating the crystal in response to signals and in relation to its electrodes whereby the frequency of said oscillator is modulated.

AUGUST HUND.

40

115

45

120

50

125

55

130

60

135

65

140

70

145

75

150