

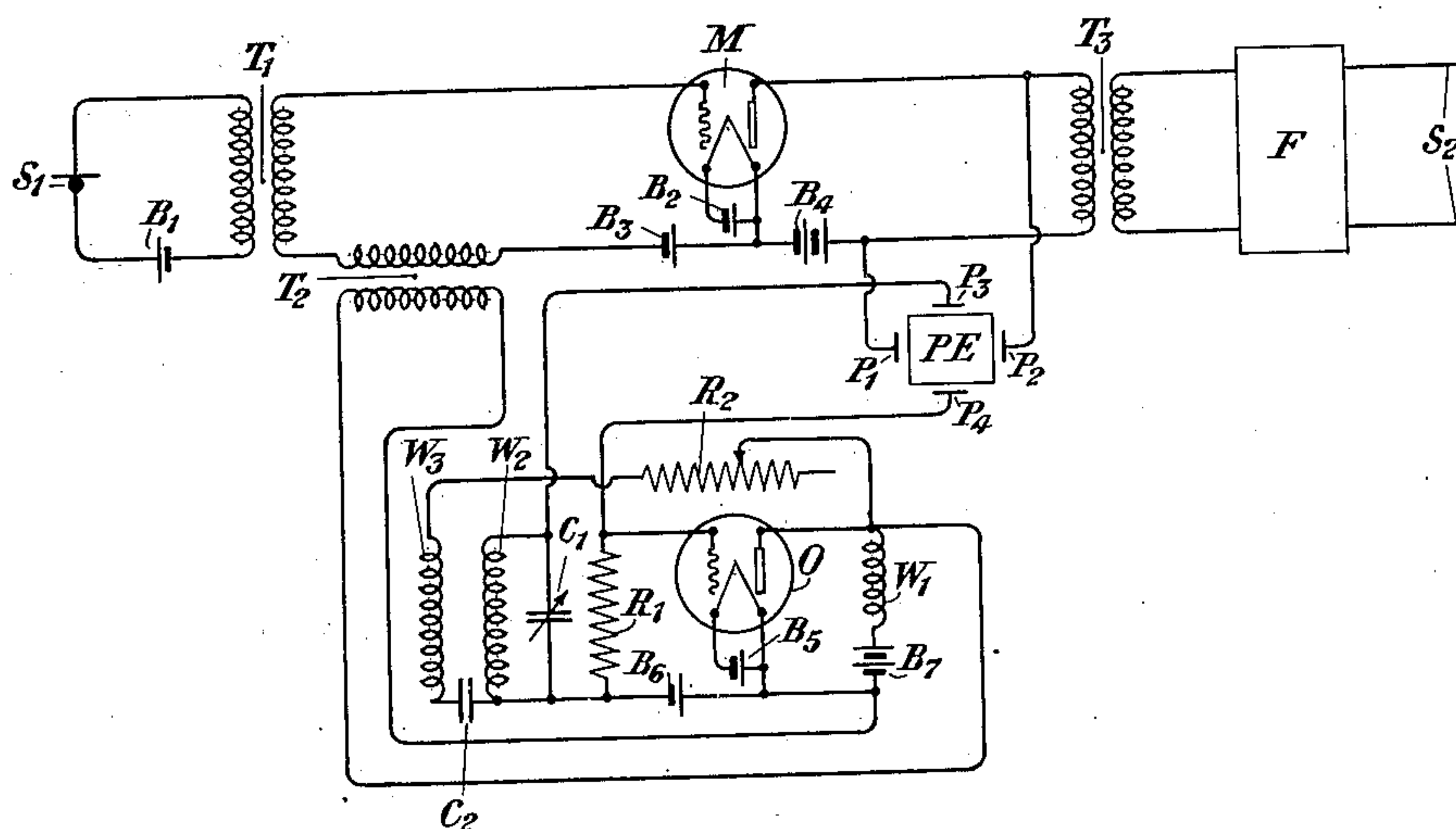
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J. EHRLICH

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SIGNALING SYSTEM

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INVENTOR.
Jefferson Ehrlich
BY *JEH*
ATTORNEY

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JEFFERSON EHRLICH, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

SIGNALING SYSTEM

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This invention relates to signaling systems, and particularly to arrangements in such systems involving piezo-electric devices employed for frequency stabilization as well as for energy absorption.

A piezo-electric device may be employed to absorb energy of a definite frequency. Energy absorption by a piezo-electric device takes place at or near its resonant frequency by virtue of the fact that the impedance of the device is very low at or near its resonant frequency, while at other frequencies substantially different from its resonant frequency its impedance is very high. Thus, if a piezo-electric device be connected to a transmission circuit transmitting a plurality of frequencies, current will be transmitted through the piezo-electric device if one of the components in the transmission circuit has a frequency substantially the same as the resonant frequency of the piezo-electric device.

A piezo-electric device may also be employed for maintaining the frequency of an alternating current constant within very narrow limits. Such a device may, therefore, be connected to an electrical oscillator, the piezo-electric device then maintaining the frequency of sustained oscillations substantially constant. Accordingly, a piezo-electric device connected to an electrical oscillator maintains the frequency of sustained oscillations free from fluctuations caused by disturbances or stray fields at or near the generating system.

An electrical oscillator may transmit current to a modulator in order that voice frequency signals or the like may be modulated upon the current of the oscillator. If a piezo-electric device be connected to the output circuit of the modulator, current of the frequency of the device may become absorbed. Thus, if the piezo-electric device has a natural period corresponding to the frequency of the current of the oscillator, energy of this current will be transmitted through the piezo-electric device, thereby minimizing the effect of this current on the output of the modulator. If, however, there are substantial variations in the frequency of the current of the oscillator sufficient to bring its frequency out-

side the resonant range of the piezo-electric device, difficulty may be experienced in the process of energy absorption. Clearly, if the frequency of the oscillator departs substantially from the resonant range of the piezo-electric device, substantially no current will be transmitted therethrough. That the resonant range of a piezo-electric device is extremely narrow is well known in the art. Accordingly, it becomes necessary to stabilize the frequency of the current of the oscillator. The stabilization may be effected by means of a second piezo-electric device connected to the electrical oscillator, oscillations sustained by the oscillator being therefore maintained constant within very narrow limits. Thus, a piezo-electric arrangement may be effected embodying two piezo-electric devices, one connected to the electrical oscillator for the purpose of frequency stabilization, and the other to the modulator for the purpose of energy absorption.

One piezo-electric structure or device may be utilized simultaneously for purposes of energy reduction or absorption as well as for frequency stabilization. Where two or more crystals are employed in a signaling system for similar purposes or for distinctly different purposes, it is necessary that these crystals be synchronized in order that their frequency characteristics be identical, or that their frequency characteristics bear some fixed relationship. Synchronization is not necessary if a single piezo-electric device is employed simultaneously for different purposes. Accordingly, a single piezo-electric device may have a number of pairs of terminals, one pair being connected to an electrical oscillator, for example, in order to maintain the frequency of oscillations substantially constant, the other pair being connected to, for example, a modulator in order to suppress or absorb current of a definite frequency, preferably current of the frequency of the electrical oscillator. Moreover, each pair of terminals may be connected in series with a small inductive or capacitative reactance, or in parallel with a large inductive or capacitative reactance, to provide for small changes in the frequency charac-

teristic of the piezo-electric device. Also, an adjustable air gap may be associated with the piezo-electric device to similarly provide a small variation in the response frequency of the device.

It is one of the objects of this invention to provide a piezo-electric structure which may be employed simultaneously for energy absorption and for frequency stabilization.

It is another object of this invention to provide a piezo-electric structure having two sets of terminals, one set being connected to an electrical oscillator in order to maintain the frequency of oscillations substantially constant, the other set of terminals being connected to a transmission circuit for the suppression of current of a frequency corresponding to the natural period of the piezo-electric structure.

It is another object of this invention to associate an electrical oscillator with a signaling source so that energy of the signaling source may be modulated upon the current of the oscillator, a piezo-electric device being associated with the system not only to maintain the frequency of the oscillator constant within narrow limits but also to by-pass, absorb and effectively suppress energy of the frequency of the oscillator after modulation.

While this invention will be pointed out with particularity in the appended claims, the invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing, showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, a microphone S_1 is shown, representing a source of signals. The microphone S_1 is connected in a series circuit with a battery B_1 and the primary winding of the transformer T_1 . The transformer T_1 couples the source of signals to a modulating system having a three-element thermionic tube M , including a filament, a grid and a plate, the filament being heated to an electron-emitting temperature by a battery B_2 . The input circuit of the thermionic tube M includes the grid and filament of the tube M , a battery B_3 , the secondary winding of a transformer T_2 and the secondary winding of the transformer T_1 , the battery B_3 rendering the grid of the tube M suitably biased with respect to the filament.

The primary winding of the transformer T_2 is connected to an oscillator to be described hereinafter, this oscillator supplying to the input circuit of the vacuum tube M current of a definite frequency, often known as the carrier frequency. The output circuit of the vacuum tube M comprises the plate and filament of this tube, a battery B_4 and the primary winding of a transformer T_3 , the battery B_4 providing the necessary operating potential for the plate of tube M . Trans-

former T_3 couples the output circuit of tube M with a filter F , which may be of any well known type, preferably of the type disclosed in the patent to G. A. Campbell, No. 1,227,113, dated May 22, 1917. Filter F is connected to an output circuit S_2 . It is to be understood, however, that an amplifier of any well known type, preferably of a vacuum tube type, may be connected between transformer T_3 and the output circuit S_2 , within the scope of the invention.

An oscillating circuit providing current of the carrier frequency includes a thermionic tube O having a filament, a grid and a plate, the filament being heated to an electron-emitting temperature by a battery B_5 . The grid is connected to the filament of this vacuum tube through a resistance R_1 and a battery B_6 , battery B_6 aiding to maintain the grid of tube O at a suitable potential with respect to its filament. The necessary operating potential for the plate of tube O is provided by battery B_7 , the interconnecting circuit including battery B_7 , a choke coil W_1 and the plate and filament of the vacuum tube O . A tuned circuit including a winding W_2 and a condenser C_1 represents the known form of frequency-determining element for an electrical oscillator. As is well known in oscillator circuits, the periods of sustained oscillations may be changed by varying the magnitude of the capacity C_1 , or the magnitude of the inductance W_2 , or both. Energy is fed from the output circuit of the tube O to the input circuit through an adjustable resistance R_2 , a winding W_3 and a condenser C_2 . The amplitude of the current fed from the output circuit of tube O to the input circuit may be controlled by manipulation of the movable contact of resistance R_2 . Condenser C_2 prevents the application of the potential of battery B_7 to the input circuit of tube O . The energy of the output circuit is fed into the input circuit by virtue of the inductive relationship existing between windings W_3 and W_2 . The primary winding of transformer T_2 is connected to the plate and filament of tube O so that current of the carrier frequency may be transmitted therethrough to the input circuit of the modulator tube M .

A piezo-electric structure or device is designated by the reference characters PE. This piezo-electric structure has two sets of terminals, P_1 and P_2 , and P_3 and P_4 . Terminals P_1 and P_2 are connected in shunt with the primary winding of transformer T_3 in the output circuit of the modulator tube M . Terminals P_3 and P_4 are connected between the grid of the oscillator tube O and the upper terminal of winding W_2 . In this system, oscillations are sustained by the oscillator O , the frequency of these oscillations being maintained constant by the piezo-electric structure PE. Current of the

carrier frequency is transmitted through transformer T_2 to the input circuit of the modulator tube M along with the signals originating in the source S_1 . As a result of modulation there appears in the output circuit of the tube M current of the carrier frequency as well as side bands of the carrier frequency corresponding to the signaling currents originating in the source S_1 .

Inasmuch as the piezo-electric device is connected across the output circuit of the modulator tube M, and inasmuch as this device is arranged to have a resonant frequency corresponding to the frequency of the oscillations sustained by the oscillator, the piezo-electric device will present a path of low impedance for current of the carrier frequency, this impedance being low as compared to the impedance in the output circuit of the vacuum tube M for currents of other frequencies. Accordingly, current of the carrier frequency will be transmitted through the piezo-electric device so that its energy may be absorbed, and its effect upon the output of the modulator after transmission through transformer T_3 and filter F will be substantially suppressed.

Thus, a single piezo-electric device is shown herein having two sets of electrodes, one set being connected to an electrical oscillator so that the frequency of sustained oscillations may be maintained substantially constant, while the other set is connected to a circuit transmitting currents of a great many frequencies, so that current of a frequency substantially the same as the frequency of vibration of the piezo-electric device may be substantially suppressed. The longitudinal vibrations of the piezo-electric device are employed for one purpose, i. e., frequency stabilization, while the transverse vibrations are employed for another purpose, i. e., energy reduction or absorption, or vice versa. The piezo-electric device is arranged to vibrate simultaneously in two modes at the same frequency for these two distinct purposes.

It is to be distinctly understood that the oscillator circuit shown herein represents but one arrangement to which a piezo-electric device may be applied to maintain the frequency of sustained oscillations constant within very narrow limits. Obviously, other circuit arrangements may be employed instead thereof within the scope of the invention.

It is to be further understood that while a single piezo-electric device has been shown herein, embodying two pairs of electrodes between portions of the piezo-electric device at which the vibrations are identical, the two pairs of electrodes may be connected between portions of the piezo-electric device at which the vibrations are substantially different, vibrations of one frequency being employed for frequency stabilization, vibration of the

other frequency being employed for energy reduction or absorption, or vice versa, within the scope of this invention.

And it is to be further understood that while one set of terminals of the piezo-electric device is coupled to an electrical circuit for the suppression of current at a frequency characteristic of the piezo-electric device, the same set of terminals may be employed to suppress additional currents of different frequencies all characteristic of the piezo-electric device, within the scope of the invention. However, different sets of terminals may be employed therefor, if desired, each set corresponding to current of one of the frequencies. The latter arrangements are believed to be obvious to one skilled in the art upon examination of the disclosed and described embodiment of the invention.

While this invention has been shown in one particular embodiment merely for the purpose of illustration, it is to be distinctly understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The combination of a piezo-electric device having two resonant periods, a transmission circuit transmitting a current having a period substantially the same as one of the periods of said device, means for rendering said device absorbent to current of said transmission circuit, an oscillator having a period substantially the same as the second period of said device, said piezo-electric device maintaining oscillations of said oscillator substantially constant at said second period.

2. The combination of a piezo-electric device having two natural frequencies, a transmission circuit transmitting current through said device at one of said frequencies in order that the transmitted current may become effectively suppressed, an oscillator, and means for maintaining the oscillations of said oscillator substantially constant at the other frequency of said device.

3. The combination of a piezo-electric structure, means for transmitting current therethrough for the substantial suppression of any components corresponding to the natural periods of said piezo-electric structure, an oscillator sustaining oscillations of a frequency substantially the same as one of the frequencies of said piezo-electric structure, and means for coupling said piezo-electric structure to said oscillator in order to maintain the frequency of said oscillations constant within very narrow limits.

4. The combination of a transmission circuit transmitting currents of a plurality of frequencies, an oscillator circuit, a piezo-electric structure having two natural vibra-

tory periods, means including said piezo-electric structure for substantially suppressing current in said circuit corresponding to one of the vibratory periods of said structure, and
 5 means including said piezo-electric structure for maintaining the vibratory period of said oscillator circuit substantially constant.

5. The combination of a complex source of current, an oscillator, and a piezo-electric device coupled to said complex source of current and to said oscillator, said piezo-electric device substantially suppressing current of said complex source corresponding in frequency to the natural period or periods of said
 10 device, said piezo-electric device also maintaining the frequency of oscillations of said oscillator substantially constant in accordance with one of its natural periods.

6. The combination of a complex source of
 20 current, an oscillator, a modulator for modulating the current of said complex source upon the waves of said oscillator, a piezo-electric structure coupled to said oscillator for maintaining the frequency thereof constant within narrow limits, and means for
 25 coupling said piezo-electric structure to said modulator in order to substantially suppress current of the frequency of said oscillator after modulation.

7. The combination of a source of voice frequency signals, an oscillator, a piezo-electric structure having two pairs of electrodes, one pair of electrodes of said structure being coupled to said oscillator in order to maintain
 30 its frequency constant within very narrow limits at a natural frequency of said piezo-electric structure, a modulator for modulating said voice frequency signals upon the waves of said oscillator, the other pair of terminals of said piezo-electric structure being
 35 coupled to said modulator for substantially suppressing current of the frequency of said oscillator after modulation.

8. In a signalling system, the combination
 45 of a source of voice frequency signals, an oscillator, a modulator for modulating the said voice frequency signals upon the current of said oscillator, and a piezo-electric structure connected to a pair of circuits extending respectively to said modulator and to said oscillator, said piezo-electric structure maintaining the frequency of said oscillator constant within narrow limits, said piezo-electric structure also suppressing current of the
 50 frequency of said oscillator after modulation.

9. The combination of a piezo-electric structure capable of vibrating independently along two axes, a complex source of current, means coupling said complex source of current to said piezo-electric structure in order
 60 to suppress current therein corresponding to its vibratory period along one of the axes, and an oscillator circuit coupled to said piezo-electric structure maintained constant in frequency within narrow limits in accordance

with the vibratory period of said structure along the other of its axes.

10. The combination of a piezo-electric structure having four terminals, between either pair of which independent vibrations
 70 may take place, a transmission circuit connected to one pair of terminals of said structure so that current characteristic of the vibrations therebetween may be suppressed, another circuit connected to the other pair of
 75 terminals of said structure so that current therein may be maintained constant in frequency in accordance with the vibratory period between the second pair of terminals.

In testimony whereof, I have signed my
 80 name to this specification this 9th day of September, 1927.

JEFFERSON EHRLICH.

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