

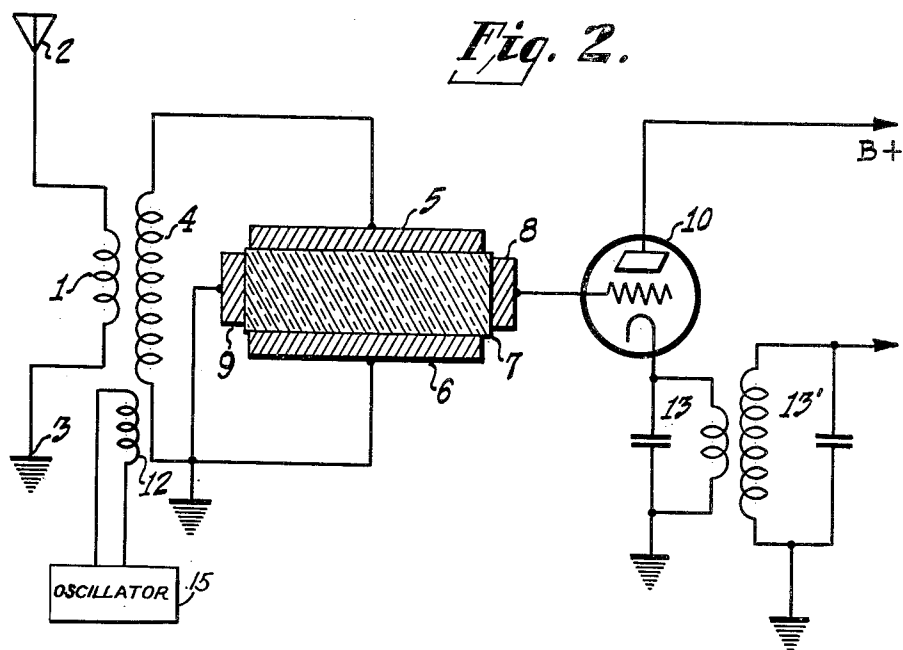
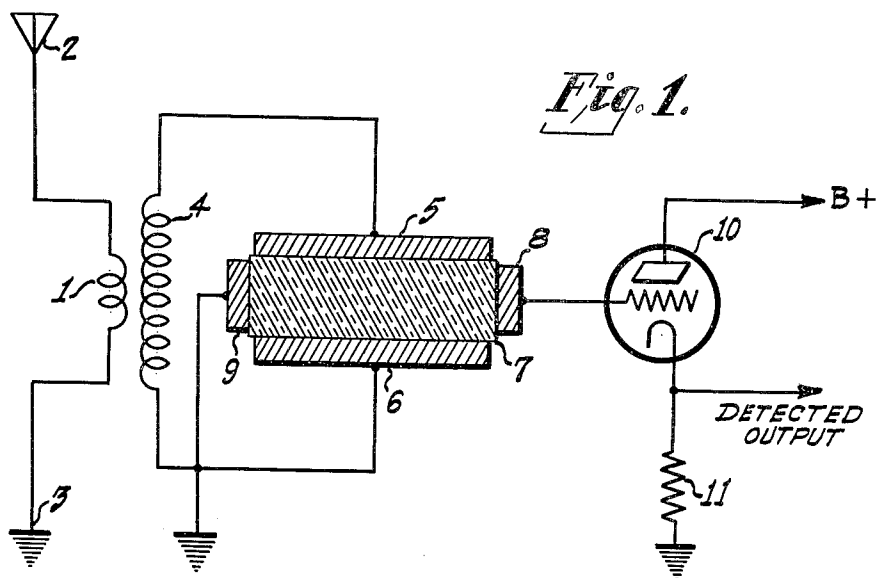
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SQUARE LAW DETECTOR

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SQUARE-LAW DETECTOR

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6 Claims. (Cl. 250—31)

This invention relates generally to apparatus for the reception of amplitude modulated signals and particularly to an improved square-law detector employing a piezo-electric device.

The invention utilizes the square-law force of attraction between the charged plates of a condenser, or between parallel conductors carrying the same current, to obtain the non-linear characteristic necessary for satisfactory detection of amplitude modulated signals. Briefly, the mechanical energy corresponding to the side band energy in amplitude modulated signals is applied to distort a piezo-electric crystal along its mechanical axis. The resultant distortion generates electrical voltages between electrodes disposed normal to the electrical axis of the crystal. The electrical voltages thus generated are proportional to the energy derived from the signal sidebands, and may be applied to the control electrode of a conventional thermionic tube.

It is not essential that the piezo-electric crystal be resonant at the signal carrier frequency, although a resonant crystal may be employed to provide modulated beat frequency signals between a modulated carrier and a source of local oscillations.

Among the objects of the invention are to provide an improved method of and means for detecting amplitude modulated signals. Another object of the invention is to provide an improved method of and means for detecting amplitude modulated signals wherein the electrical energy corresponding to the signal sidebands is converted to mechanical energy to distort a piezo-crystal, and the resultant distortion of the crystal provides electrical charges upon electrodes associated therewith which charges are characteristic of the signal modulation component.

Another object of the invention is to provide an improved method of and means for detecting amplitude modulated signals wherein said signals are applied to electrodes normal to the mechanical axis of a piezo crystal, and voltages are derived from other electrodes normal to the electrical axis of said crystal, said derived voltages being characteristic of the signal modulation. An additional object of the invention is to provide an improved method of and means for deriving beat frequency modulated signals wherein amplitude modulated and unmodulated signals are applied to electrodes normal to the mechanical axis of a piezo crystal which is resonant at the beat frequency of said signals, and voltages are derived from other electrodes disposed normal to the

electrical axis of said piezo crystal, said voltages being characteristic of the modulated beat frequency of said signals.

The invention will be further described by reference to the accompanying drawing of which Figure 1 is a schematic circuit diagram of one embodiment thereof and Figure 2 is a schematic circuit diagram of a second embodiment thereof. Similar reference characters are applied to similar elements throughout the drawing.

Referring to Figure 1, a typical radio detector circuit employing the teachings of the invention includes, for example, an untuned antenna coil 1 connected between an antenna 2 and a ground terminal 3. The antenna coil 1 is coupled aperiodically to a secondary winding 4 which is terminated in two conductive electrodes 5, 6 which are disposed on the surface of, and normal to, the mechanical axis of a piezo crystal 7. One terminal of the secondary winding 4 is grounded. A second pair of electrodes 8, 9 are disposed upon the surface of the crystal 7 normal to the electrical axis thereof. One of the second pair of electrodes 9 is connected to ground, and the remaining electrode 8 of the second pair is connected to the control electrode of a thermionic tube 10. Modulated signals derived from the antenna coil 1 are applied to the first pair of electrodes 5, 6 to distort the crystal 7 in accordance with the sideband signal energy. The resultant distortion of the crystal 7 provides electrical charges upon the second pair of electrodes 8, 9 which may be employed to provide corresponding anode current variations in the thermionic tube 10. Output from the thermionic tube 10 may be derived, for example, from across a cathode resistor 11 connected between the cathode terminal of the tube and ground.

Referring to Figure 2, the device may be employed as a first detector in a superheterodyne type receiver wherein the amplitude modulated signal energy is mixed with oscillations derived from a local oscillator to provide modulated beat frequency signals for intermediate frequency amplification. Amplitude modulated signals induced in the antenna coil 1 are applied through the secondary winding 4 to a first pair of electrodes 5, 6 disposed on the surface of, and normal to, the mechanical axis of the piezo crystal 7. Similarly, the resultant distortion of the piezo crystal provides electrical charges on a second pair of electrodes 8, 9 which are connected in the control electrode circuit of a first detector tube 10 in the same manner as described in Figure 1. A coupling coil 12 connected to a source of local oscil-

lations 15, having a frequency which differs by a predetermined amount from the carrier frequency of the received signals, is coupled to the secondary winding 4. The resultant electrical charges developed by the second pair of electrodes 8, 9 will be characteristic of the beat frequency modulated by the signal modulation frequencies. The piezo electric crystal may be made resonant to the beat frequency although this is not essential.

Output may be derived from the cathode circuit of the tube 10 by means of a pair of tuned networks 13 and 13'. One of the networks 13 is connected between cathode and ground; the other network 13' is coupled to the first network. Both networks are resonant at the selected beat frequency.

It should be understood that output may be derived from the thermionic tube circuits illustrated in Figures 1 and 2 in any other way known in the art, and that the particular connections illustrated herein are merely illustrative of practical embodiments of the invention.

The invention thus described comprises a square-law detector providing extremely high fidelity detection of amplitude modulated signals over extremely wide ranges of signal modulation energy. It should further be understood that any type of piezo crystal may be employed, and that various types of electrode elements and mountings known in the art may be utilized to advantage.

I claim as my invention:

1. An electromechanical non-magnetic modulator for amplitude modulated signals comprising a dielectric element having mechanical vibratory and electrical axes, electrostatic driving means disposed adjacent said element in a plane normal to said mechanical axis thereof and responsive to the square of the magnitudes of said signals for providing mechanical vibration of said dielectric element, and means responsive to said mechanical vibration of said element for deriving electrical voltages characteristic of a predetermined modulation component of said signals.

2. An electromechanical non-magnetic modu-

lator for amplitude modulated signals comprising a dielectric element having mechanical vibratory and electrical axes, electrostatic driving means disposed adjacent said element in a plane normal to said mechanical axis thereof and responsive to the square of the magnitudes of said signals for providing mechanical vibration of said dielectric element, and electrostatic pickup means disposed adjacent said element in a plane normal to said electrical axis thereof responsive to said mechanical vibration of said element for deriving electrical voltages characteristic of a predetermined modulation component of said signals.

3. Apparatus of the type described in claim 1 including means for coupling additionally a source of unmodulated signals to said driving means.

4. An electromechanical non-magnetic detector for amplitude modulated signals comprising a dielectric element having mechanical vibratory and electrical axes, electrostatic driving means disposed in operable relation to said element in a plane substantially normal to said mechanical axis thereof, means providing a resonant circuit including said driving means whereby said element is responsive to the square of the magnitudes of said modulated signals for providing mechanical vibration of said element, electrostatic pickup means disposed in operable relation to said element in a plane substantially normal to said electrical axis thereof for deriving voltages characteristic of a predetermined modulation component of said signals, and means responsive to said derived voltages for detecting said signal modulation.

5. Apparatus of the type described in claim 4 including means for coupling an additional source of signals to said resonant circuit and said driving means.

6. Apparatus of the type described in claim 4 including an additional frequency source, means coupling said additional source to said driving means, and means for tuning said detecting means to derive a modulated beat frequency signal.

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