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R. H. WORRALL

CRYSTAL CALIBRATOR APPARATUS

Filed June 8, 1927

FIG. 1

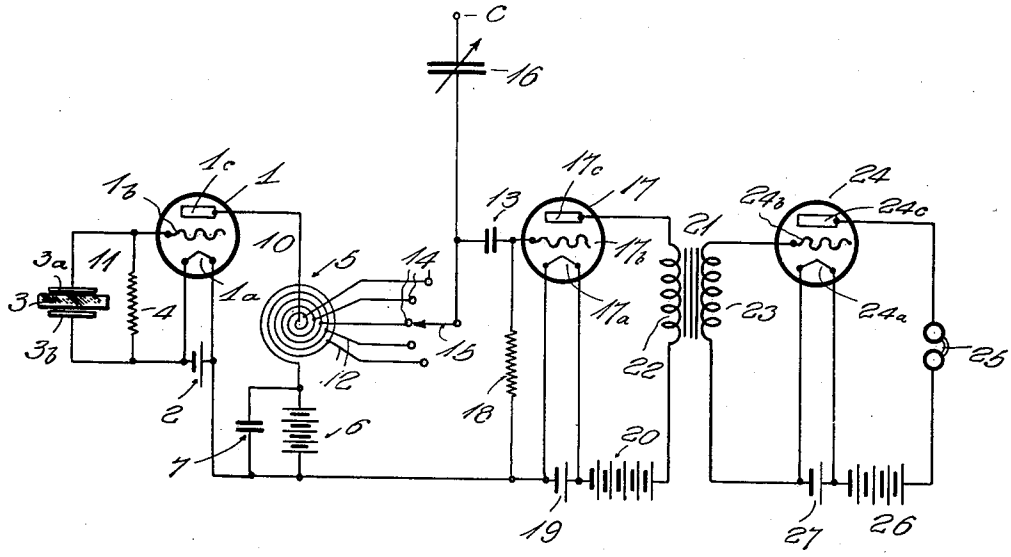
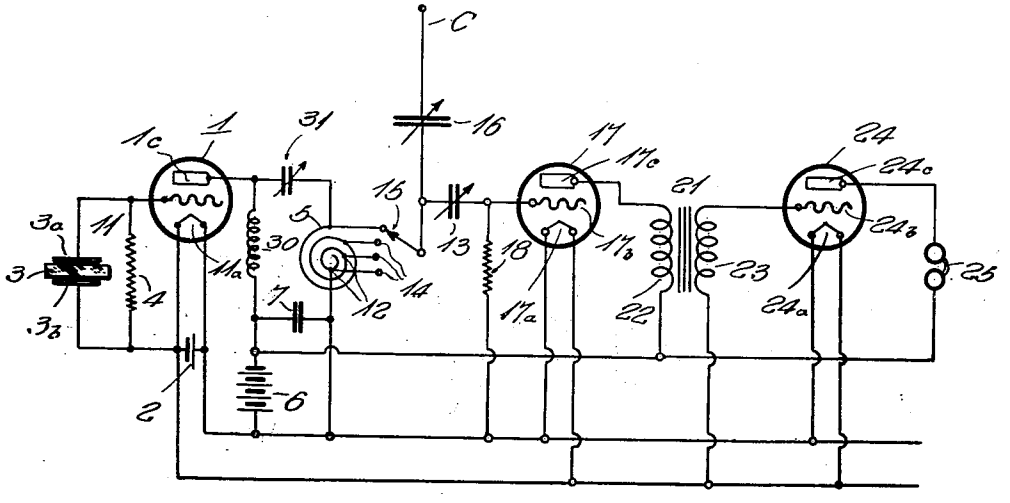


FIG. 2



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Patented June 12, 1928. 1,673,173

UNITED STATES PATENT OFFICE.

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CRYSTAL-CALIBRATOR APPARATUS.

Application filed June 8, 1927. Serial No. 197,465.

My invention relates broadly to crystal controlled calibrators and more particularly to a circuit arrangement for a piezo electric crystal controlled calibrator system.

One of the objects of my invention is to provide a coupling circuit arrangement for a piezo electric crystal controlled calibrator whereby the maximum number of harmonic frequencies may be derived from the piezo electric crystal controlled oscillator.

Another object of my invention is to provide a circuit arrangement for coupling a piezo electric crystal controlled oscillator in a crystal calibrator system to an electron tube detector circuit, with means between the oscillator and the detector for selecting predetermined harmonic frequencies of the piezo electric crystal element and impressing the energy thus derived, simultaneously with the oscillations of a circuit whose frequency is being determined, upon the detector circuit.

Other and further objects of my invention reside in the arrangement of the coupling circuit between the piezo electric crystal controlled oscillator, the circuit whose frequency is being measured and the detector circuit, whereby harmonics are accentuated or eliminated, as will be pointed out more fully in the specification hereinafter following by reference to the accompanping drawings, in which:

My invention is directed to that type of crystal calibrator described more particularly in copending application Serial No. 197,495, filed June 8, 1927, by Raymond B. Owens.

Figure 1 diagrammatically illustrates one arrangement of the crystal controlled calibrator circuit constructed in accordance with the principles of my invention; and Fig. 2 shows a modified wiring diagram embodying the principles of the crystal calibrator circuit of my invention.

In the crystal calibrator circuit arrangement which I have devised, I employ a combined conductive and capacitive coupling circuit between the crystal controlled oscillator and the detector circuit for stabilizing the operation of the oscillator and permitting the efficient transfer of selected harmonic frequencies from the oscillator to the detector.

Taps are arranged to enable selected portions of the inductance coil 5 to be connected between the oscillating circuit and the detector circuit. The taps are placed in such manner as to assist in transferring the maximum number of harmonics to the detector circuit as well as increasing the efficiency of the circuit which gives a maximum amount of energy transfer to the detector circuit at such points along the inductance as will permit the selective transfer of a predetermined harmonic frequency.

Referring to the drawings in detail reference character 1 designates an electron tube arranged as an oscillator. Electron tube 1 includes filament electrode 1^a, grid electrode 1^b and plate electrode 1^c. An input circuit for the oscillator is provided as represented at 11 and includes the piezo electric crystal element 3 which is disposed between the electrodes 3^a and 3^b. A high resistance 4 is shunted across the grid and filament and is employed for securing grid bias or any of the well known methods for securing a proper grid bias may be employed. The output circuit 10 of the oscillator includes coil 5 having a high value of inductance and a low distributed capacity. The output circuit also includes a source of potential 6 shunted by condenser 7. The cathode 1^a is heated from battery 2. The inductance 5 is provided with a plurality of tapped sections 12 that lead to contact plates 14 over which the switch 15 is arranged to slide. The detector tube 17 has its input circuit connected to the output circuit of the oscillator. The grid electrode 17^b connects to one side of condenser 13, the other side of which connects to the switch member 15. A high resistance 18 is connected across grid electrode 17^b and filament electrode 17^a. Filament electrode 17^a is heated from battery 19. The output circuit of the detector 17 extends from plate electrode 17^c through primary winding 22 of audio frequency transformer 21 to the source of potential 20. The secondary winding 23 of the transformer system 21 connects to the input circuit of the amplifier stage that includes electron tube 24. The input circuit of electron tube 24 includes grid electrode 24^b, secondary winding 23 of transformer 21 and filament electrode 24^a. The filament electrode 24^a is heated from battery 27. The output circuit of the audio frequency amplifier includes plate electrode 24^c, telephone receivers 25 and battery 26. A variable capacity 16 is arranged in the lead

to the coupling wire C, and one side of the variable capacity 16 connects to the detector circuit by a combination of conductive and capacitive coupling with a variable capacitive coupling between the coupling wire and the calibrator system for eliminating undesired harmonics.

In Fig. 2 the power supply circuit for the oscillator has been illustrated as including battery 6 and choke 30. Shunted around the power supply circuit I have shown in the form of a parallel feed circuit, an inductance coil circuit including the inductance coil 5 and a variable condenser 31. Condenser 13 has been indicated as variable in its capacity value. By reason of the high inductance to capacity ratio in the output circuit of the oscillator and a correct value of grid potential as impressed by the grid leak 4, harmonic frequencies can be derived from the piezo electric crystal system. The taps arranged at 12 are selected at predetermined positions for the derivation of groups of harmonics of predetermined frequency characteristics enabling the detector circuit to be connected to the most advantageous point for the detection of these desired harmonics. The coupling wire C that is placed in close proximity to the circuit whose frequency is to be measured, operates to check the unknown frequency and transfers the energy to the circuit intermediate the oscillator and detector. A beat note is secured in the detector circuit that may be amplified through any number of stages of amplification connected with the output circuit of the detector. The combination of conductive and capacitive coupling between the oscillator and the detector and the variable coupling feature between the coupling wire and the detector system has been found to be extremely practical and successful in operation.

While it is highly essential that a proper potential or grid bias be impressed upon the grid element of the tube in order to secure the correct wave form for producing harmonics in the plate circuit and coil 5, there are many methods already existent for doing this, therefore, one method is shown, that is, the grid leak method of bias. When it is known that harmonics may be obtained from an inductance of the proper type by conductive or capacitive coupling or both, it will be possible to adapt many types of conductive or capacitive coupling or both to obtain the required results. The circuit of my invention conveys these harmonics by means other than inductive coupling to a detector system.

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 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. A piezo electric crystal controlled calibrator comprising an oscillator circuit, a piezo electric crystal connected with said oscillator circuit, a detector circuit and means coupling said detector circuit with said oscillator comprising a coil having a relatively large inductance and low distributed capacity, said coil being tapped at a plurality of predetermined points for the impression of harmonic frequencies derived from said piezo electric crystal element upon said detector.

2. A piezo electric crystal controlled calibrator comprising an oscillator, a detector, and a signal receiving circuit, a piezo electric crystal element connected to said oscillator, and means disposed between said oscillator and said detector comprising a coil having a large inductance to capacity ratio, said coil having a plurality of tapped points therein at positions corresponding to the circuit conditions for the derivation of harmonics of the frequency of said piezo electric crystal element for impressing harmonic frequencies upon said detector.

3. A piezo electric crystal controlled calibrator system, an oscillator, a detector, and a signal observing circuit connected with said detector, a coupling wire including a variable capacity connection interposed therein and connected with said detector, a combined conductive and capacitive coupling system between said oscillator and said detector, a piezo electric crystal element connected with said oscillator, said coupling system including a winding having a large inductance to capacity ratio, said winding being tapped at a plurality of positions corresponding to the circuit conditions for the derivation of harmonic frequencies from said piezo electric crystal element for impressing the harmonic frequencies upon said detector.

4. A piezo electric crystal controlled calibrator comprising an oscillator, a detector, a signal observing circuit connected with said detector, a coupling wire including a variable condenser disposed in series therein, said coupling wire operating to collect high frequency energy from a circuit whose frequency is being determined for impression upon said detector, a piezo electric element connected with said oscillator and a coupling system between said oscillator and said detector, said coupling system being arranged for sustaining harmonic frequencies derived from said piezo electric crystal element, and switching means for including predetermined portions of said coupling system between said oscillator and detector for transferring selected harmonic frequencies from said oscillator to said detector.

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