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ELECTRIC WAVE CIRCUIT

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FIG. 1

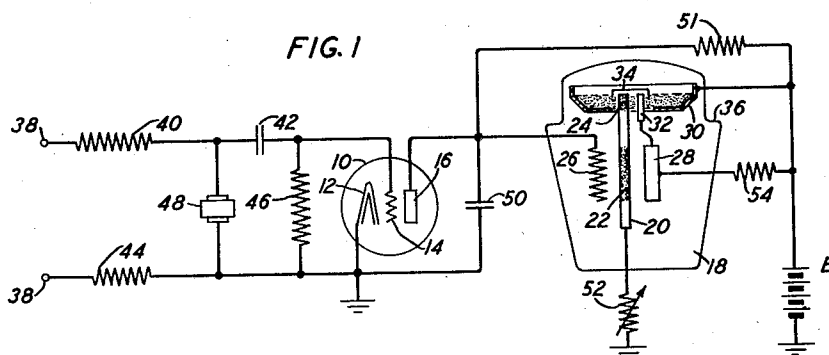


FIG. 2

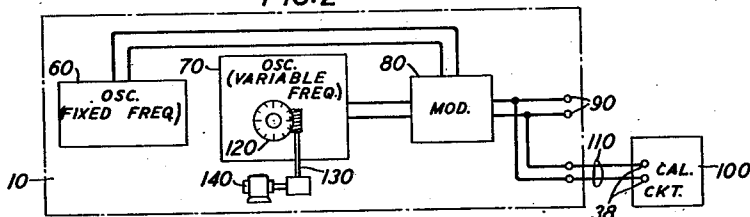
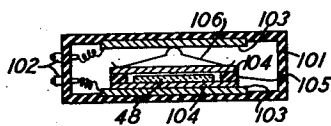


FIG. 3



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ELECTRIC WAVE CIRCUIT

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4 Claims. (Cl. 177-311)

This invention relates to an electric wave circuit, and, more particularly, to a circuit arrangement providing a visual indication of the application of an electric wave of given frequency at its input terminals.

An object of the invention is to provide a visual indication of the presence in an electric wave varying over a band of frequencies of one or more separate frequencies.

A feature of the invention comprises a circuit including an electromechanical vibrator having resonances at widely spaced or separated frequencies.

Another feature comprises such a circuit including an electron discharge device providing a visual indication of a change in the input to one of its electrodes.

A circuit in accordance with this invention comprises an electron discharge device or so-called electron ray tube designed to indicate visually by means of a fluorescent target the effect of a change in the input voltage to its input control grid, a second electron discharge device having its output circuit coupled to the input circuit of the first device and having its input circuit coupled to an electric wave source through an electromechanical vibrator, specifically, a piezoelectric crystal. The potentials on the electrodes of the discharge devices and the constants of the circuit components associated therewith are so chosen that when a frequency at which the vibrator is antiresonant is impressed upon the vibrator, the electron ray tube is caused to give a visual indication of such fact, or, if desired, the arrangement may be such that the application of a frequency to the resonator at which it is resonant will be visually indicated.

A more complete understanding of this invention will be obtained from the detailed description which follows, taken in conjunction with the appended drawing, wherein:

Fig. 1 shows an electric wave circuit embodying this invention;

Fig. 2 shows in schematic an oscillator with which the circuit of Fig. 1 may be associated for calibration purposes; and

Fig. 3 shows a preferred mounting for the crystal or electromechanical vibrator included in the circuit of Fig. 1.

The visual indicating circuit of this invention is shown by Fig. 1. It comprises a vacuum tube 10 having an indirectly heated cathode 12, an input control grid 14 and an anode 16; and an electron ray tube 18 to indicate visually by means of a

fluorescent target the effect of changes in the control voltage on its input grid.

The electron ray tube comprises an indirectly heated cathode 20 having two electron emitting portions 22, 24, an input control grid 26, an anode 28, a target electrode 30 coated on its inner surface with a fluorescent material so that it will glow when electrons impinge thereon, a ray control electrode 32, constituting an extension of the anode 28, and a cathode light shield 34. The electrodes of the tube 18 are enclosed by an evacuated glass envelope 36. The operation of an electron ray tube of this type available commercially as the RCA-6E5 and 6G5 type tubes, is well known and need not be described in detail.

One of the input terminals 38 is connected through the series-connected resistance 40 and a condenser 42 to the input grid of tube 10. The other input terminal is connected through a second resistance 44 to the cathode of tube 10 and to ground. A high resistance 46 is connected across grid 14 and cathode 12, and an electromechanical vibrator or piezoelectric crystal 48, for example, a quartz crystal, is connected between the inner ends of resistances 40, 44. A condenser 50 is connected between the cathode 12 and anode 16. Potential for the anode 16 is supplied through a resistance 51 from the positive terminal of the source B, for example, a battery, whose negative terminal is connected to ground.

The grid of tube 18 is connected directly to the anode of tube 10; the cathode 20 is connected through the grid biasing variable resistor 52 to ground; the anode 28 is connected through the resistance 54 to the positive terminal of source B, the target electrode 30 being connected directly to the positive terminal of source B.

In a circuit constructed in accordance with the invention, the components had the following values:

Condenser 42	-----microfarad--	.001
Condenser 50	-----do-----	.06
Resistance 40	-----ohms--	100,000
Resistance 44	-----do-----	20,000
Resistance 46	-----megohms--	10
Resistance 51	-----do-----	1
Resistance 54	-----do-----	1

When an alternating current wave, for example, of radio frequency, is impressed across the terminals 38, it appears across the resistance 40, the crystal 48 and the resistance 44 in series. The radio frequency current flowing in this series circuit produces a voltage across the crystal, and this voltage is applied to the grid of the tube 10

through condenser 42. The input capacity of tube 10 is effectively across the crystal as is the resistance 46, the impedance of the condenser 42 being low at radio frequencies. The resistance 46 being of a very high value, the combination of the condenser 42, the resistance 46 and the input capacity of tube 10 represents a small capacity in parallel with the crystal. This has the same effect as using a crystal holder having a larger capacity, and influences the response frequencies very slightly. At frequencies removed from crystal resonance, the impedance of the crystal will be low compared to that of the resistance 40 so that only a small proportion of the voltage across the terminals 38 appears across the grid-cathode circuit of tube 10. At the frequency or frequencies at which the crystal is antiresonant, the impedance of the crystal is very high and the greater part of the voltage appearing across terminal 38 will be impressed across the grid-cathode circuit of the tube 10. Grid rectification occurs and the grid 14, because of energy stored in condenser 42, assumes a direct current negative potential almost equal to the peak alternating current voltage appearing across the crystal. At the antiresonant frequency or frequencies of the crystal, therefore, the negative bias on the grid 14 is very considerably increased and the current in the cathode-anode circuit decreases correspondingly. Such decrease in the cathode-anode current decreases the potential drop in resistance 51 and increases the potential drop across the anode-cathode impedance of tube 10, charging condenser 50 to a higher potential. The input grid 26 of tube 18 is thereby made more positive than for those frequencies at which the impedance of the crystal is low. This change in the potential of the grid 26 may be quite large because tube 10 acts as a direct current amplifier as well as a rectifier. If the initial potential on the grid 26 has been such as to just maintain the potential on the anode 28 and the ray control electrode 32, such that the shadow angle on the target 30 is substantially zero degrees, rendering the grid 26 more positive will result in an increase in the cathode-anode current of tube 18. This produces a decrease in the potential of the anode 28 and of the ray control electrode 32 with a consequent increase of the shadow angle on the target 30, that is, the electron ray tube will give a visual indication of the fact that a radio frequency has been impressed at terminals 38 of a frequency at which the impedance of the crystal is very high. The adjustable resistance 52 is used to set the potential of the cathode 20 at a slightly more positive value than that of the grid 26, this adjustment being made at an input frequency to terminals 38 removed from the frequency at which the crystal is antiresonant and being such that the shadow angle on the target 30 is substantially zero degrees. The cathode-anode current of tube 18 flows through resistance 54 and is small compared to the cathode-target anode current, the cathode potential, i. e., potential drop across resistance 52, being substantially independent, therefore, of the cathode-anode current.

If a source of continuously variable radio frequency is connected to the terminals 38, the electron ray tube 18 will give a visual indication of such fact only at the frequency or frequencies at which the crystal is antiresonant. At the antiresonant frequency or frequencies, however, the shadow angle will become very large.

The circuit arrangement of Fig. 1 is adapted

to be associated with a radio frequency oscillator whose output varies in frequency continuously over a preassigned band, to provide an automatic and visual indication of its calibration, for example, at a frequency in the lower portion and at a frequency in the upper portion of the band. As shown in schematic in Fig. 2, such an oscillator 10 may comprise an oscillator 60 having a fixed or single frequency output, an oscillator 70 having a frequency output variable or adjustable over a preassigned band, and a modulator 80 in which the oscillator outputs are combined to produce a beat frequency at the output terminals 90 determined by the frequencies delivered by the fixed and variable oscillators. The calibration circuit 100, shown in detail in Fig. 1, is connected across output terminals 90 through conductors 110.

As is well known, the frequency output of the variable oscillator may be adjusted by hand by movement of a frequency setting dial 120 and be successively adjusted to successively different and preassigned frequencies, the dial markings indicating the frequencies appearing at terminals 90. When it is desired that the output of the oscillator 10 be continuously variable over a preassigned frequency band, it is usually found more convenient to operate the frequency setting dial through suitable gearing 130 driven by a motor 140. Let it be assumed that the oscillator 60 has such a fixed frequency output and the oscillator 70 has such a frequency variable output that the band of frequencies appearing at the terminals 90 covers the range between approximately 50 kilocycles at the lower end and approximately 2,500 kilocycles at the upper end. Frequencies of 150 kilocycles and 2,500 kilocycles might be selected as appropriate frequencies at which to check the calibration of the oscillator as it is being used. If the crystal 48 is antiresonant at these frequencies, the electron ray tube will give a visual indication of the input to circuit 100 at these frequencies in the manner already described. Should the dial reading initially not be "150" or "2500," the oscillator can be adjusted until these dial settings and the visual indications correspond. Thereafter, as the oscillator is used the operator is provided with a constant visual check on the calibration.

A mounting for the electromechanical vibrator or crystal 48 is shown in Fig. 3. The crystal is preferably of the AT-cut type and is mounted so as to be free to vibrate along any axis. In a particular case by choice of appropriate dimensions for the plate, antiresonances at two widely separated frequencies, that is, 150 kilocycles and 2,500 kilocycles, were obtainable. The mounting is a type frequently employed. It comprises a frame or hollow block 101 of insulating material having terminals 102 and terminal plates 103 embedded therein. Between the terminal plate is an assembly comprising a pair of metallic plates 104 spaced apart by a spacer member 105 of insulating material and defining a chamber for the crystal 48, and a spring or pressure member 106 whereby the assembly is maintained in position between the plates 103. The crystal is unconstrained, with a slight clearance between its top surface and the top plate 104 and between its lateral edges and the spacer member. The entire assembly may be enclosed if desired.

What is claimed is:

1. In an electrical circuit, a piezoelectric crystal having antiresonances at two widely spaced radio frequencies, an electron discharge device coupled

to said crystal so that the output of said device decreases abruptly at such antiresonant frequencies, and means to give a visual indication of such decreases as a wave continuously variable from a frequency below the lower and to a frequency above the higher of the two frequencies is impressed on said crystal.

2. A calibration circuit for an oscillator comprising electromechanical vibrating means having antiresonances only at a frequency at the low frequency end and at a frequency at the high frequency end of the oscillator's frequency range, means connecting said vibrating means to the oscillator so that the output of the oscillator is impressed on the vibrating means, and means coupled to said vibrating means and responsive to the high impedance condition of said vibrating means at said antiresonances for giving a visual signal when the output of the oscillator passes through the frequencies at which the antiresonances occur.

3. An electric circuit for indicating the presence of a particular frequency in a multifrequency electric wave, comprising input terminals across which said electric wave may be impressed, a resistor and a piezoelectric crystal connected in series across said terminals, said crystal being antiresonant at said particular frequency and said resistor being of a resistance high compared to the impedance of said crystal at all frequencies other than that at which the crystal is antiresonant, a condenser and a second resistor connected in series across said crystal, said condenser having a low impedance to electric waves of a frequency at which the crystal is antireso-

nant and said second resistor being of a relatively high resistance, a variable impedance device connected across said second resistor, the impedance of said device changing abruptly in response to change in potential across said second resistor that occurs at crystal antiresonance, and an indicating device responsive to the change in the impedance of said variable impedance device.

4. A calibration circuit for an oscillator whose frequency output is continuously variable over a broad band of frequencies, that comprises a single piezoelectric crystal in series with a resistor across the output terminals of the oscillator, said crystal having antiresonances only at a frequency at the low frequency end and at a frequency at the high frequency end of the oscillator's frequency range, the impedance of said resistor being high relative to that of said crystal except at the antiresonant frequencies, a condenser and a second resistor connected in series across said crystal, said condenser being of low impedance to waves of a frequency at which the crystal is antiresonant, and said second resistor being of a relatively high resistance, the potential across said second resistor changing abruptly in response to the application of the frequencies of antiresonance to said crystal, and variable impedance means connected across said second resistor and responsive to the changes in potential thereof, said variable impedance means including a device providing a visual indication of such response.

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