Feb. 4, 1936. E. L. KOCH 2,029,488

NEGATIVE RESISTANCE CRYSTAL CONTROLLED OSCILLATOR

Filed April 16, 1932

Fig. 1.

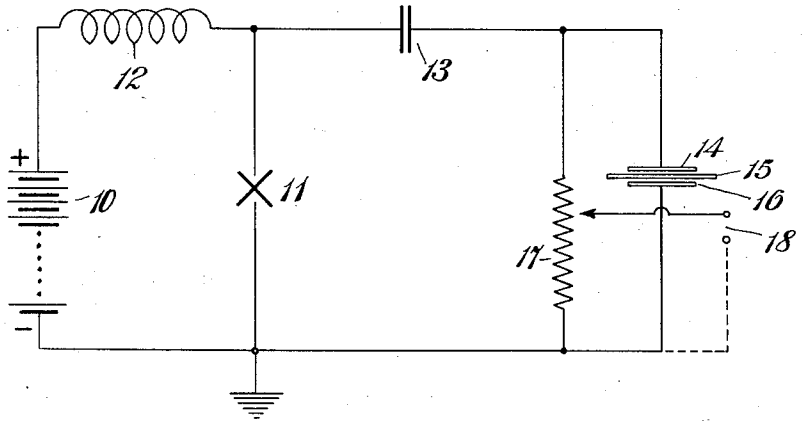
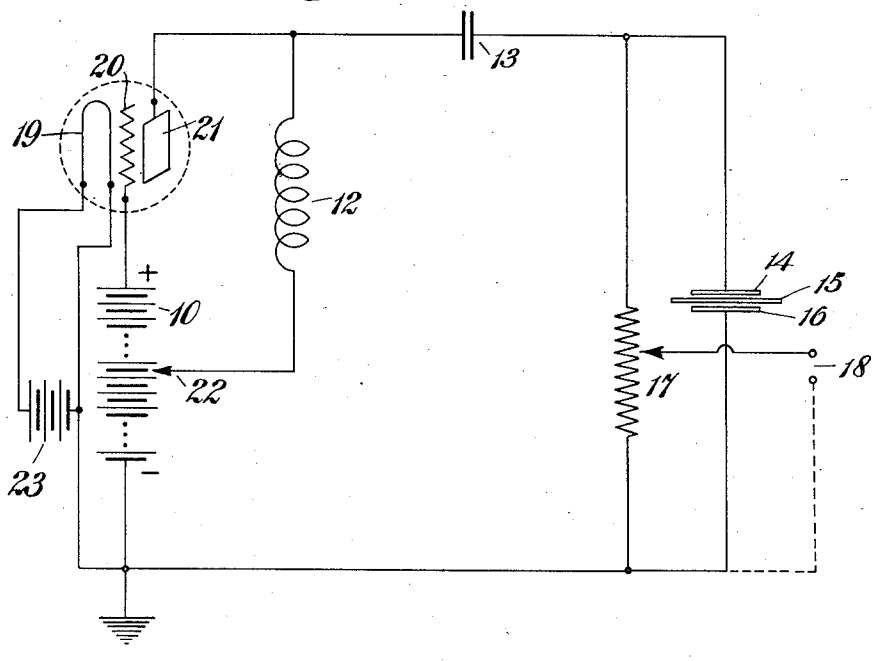


Fig. 2.



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NEGATIVE RESISTANCE CRYSTAL CONTROLLED OSCILLATOR

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Application April 16, 1932, Serial No. 605,643

3 Claims. (Cl. 250—36)

This invention relates to improvements in negative resistance crystal controlled oscillators as commonly used in connection with radio systems for various purposes and more particularly relates to the application of crystal control to any form of negative resistance device.

Existing types of crystal controlled oscillators are of the regenerative type requiring a circuit containing inductance and capacity tuned to approximately the natural period of the crystal.

In the present invention the generated frequency of the crystal is practically entirely dependent on its inherent natural mechanical period and is not subject to changes in the tuned circuit containing inductance and capacity.

As the application of piezo electric crystals to known arrangements of control is well known, it will not be described in detail. General arrangements usually consist of an ordinary three-element tube having the crystal connected across its input and having a tuned tank circuit connected to its output or plate circuit. Such arrangements depend upon the inherent grid to plate capacity of the tube for obtaining feedback.

The present invention consists of the use of a piezo electric crystal in connection with a negative resistance device such as an arc, dynatron or a negative resistance tube such as that shown in the pending application Serial No. 537,539 filed May 15, 1931. The crystal is used in such a manner that the usual tuned circuit containing inductance and capacity is dispensed with entirely permitting the crystal to actually oscillate at its natural frequency and almost entirely free from external influence. The result is that the crystal is more completely the single controlling factor in the determination of oscillation frequency than has hitherto been the case.

Two embodiments of the invention will be described in the following specification in which:

Figure 1 is a circuit diagram illustrating the invention employing an arc or gas-filled two-element tube having a negative characteristic, and

Figure 2 is a circuit diagram showing a dynatron as the negative resistance device.

Referring to Figure 1, 10 is a suitable source of energy for the arc 11 (which may be a two-element gas filled tube).

The numeral 12 denotes a radio frequency choke coil, 13 a blocking condenser to keep the voltage of 10 off the crystal electrode 14. The numeral 15 denotes the crystal proper and 16 is the remaining electrode thereof which is connected to the minus side of the source of energy 10.

A potentiometer 17 may be placed in shunt with the crystal to provide suitable means for obtaining variable output voltage.

The output may be taken from the terminals 18 and obviously some other means for obtaining a variable output voltage may be employed besides the potentiometer as shown. The output may be taken off the crystal electrodes or terminals 14, 16.

In Figure 2 the connections and arrangement are substantially the same as shown in Figure 1, 19, 20 and 21 being the filament, grid and plate respectively of the dynatron tube. In this circuit the radio frequency choke 12 serves as the plate return to the energy source 10 and may be provided with the variable tap 22. The usual source of energy 23 is provided for the filament 19.

It will be observed from the two examples above given that the piezo electric crystal 15 will cause the system as a whole to oscillate at the natural frequency of the crystal, the only requirement being that the value of the negative resistance of the tube or other device be low enough to enable it to supply the losses in the crystal, i. e. capable of returning to the crystal, each half cycle, as much energy as the crystal expended during the previous half cycle, which condition is necessary for sustained oscillations.

As the operation of the various component parts of the two circuits shown herein by way of example and the operation of the piezo electric crystal are well understood by those skilled in the art a detailed description is not necessary. For the operation of other negative resistance devices other than the dynatron and arc herein shown and described reference may be had to the pending application hereinbefore mentioned and although the invention has been disclosed in connection with the specific details of preferred embodiments thereof it must be understood that such details are not intended to be limitative of the invention except insofar as set forth in the accompanying claims.

What is claimed is:

1. In combination, an output circuit including a source of energy, a negative resistance device including a radio frequency choke, a piezo electric crystal means for energizing said device from said source of energy, a condenser in series with said crystal, said condenser and crystal series being connected in shunt with said negative resistance device with the condenser positioned between said crystal and a positive electrode in said device, and a potentiometer in parallel with said

crystal and output terminals for said combination connected to said potentiometer.

2. In combination, an output circuit including a negative resistance device comprising a filament, a grid, a plate and a radio frequency choke, a source of energy connected to said grid and said filament, said radio frequency choke connecting said plate to said source of energy, a condenser connected to said plate, a piezo electric crystal in series with said condenser and connected to the negative side of said source of energy, and a voltage divider in multiple with said crystal and connecting with the output terminals of said combination for controlling the potential output thereof.

3. In combination, an output circuit including a negative resistance device comprising a filament, a grid, a plate, a piezo electric crystal and a radio frequency choke, a source of energy connected to said grid and said filament, a connection through said choke from one pole of said source of energy to said plate and a connection between said piezo electric crystal and said source of energy, a condenser, said piezo electric crystal being in series with said condenser connected to said plate and to the negative side of said source of energy, the condenser being positioned between said crystal and the plate, and a potentiometer shunted against said crystal, the negative resistance of said device being of a value low enough to supply energy to said crystal during any half cycle equal to the energy expended in the crystal during the previous half cycle.

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