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QUARTZ CRYSTAL OSCILLATOR

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Fig. 1

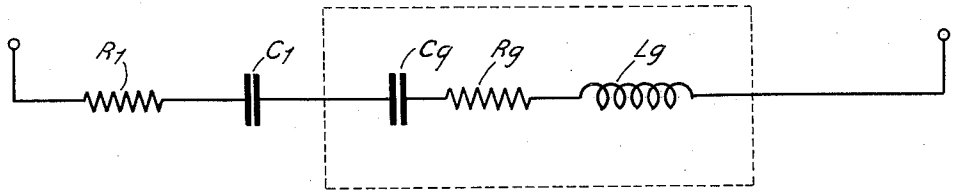


Fig. 2

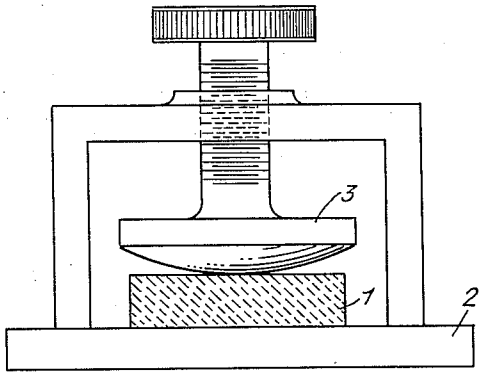


Fig. 3

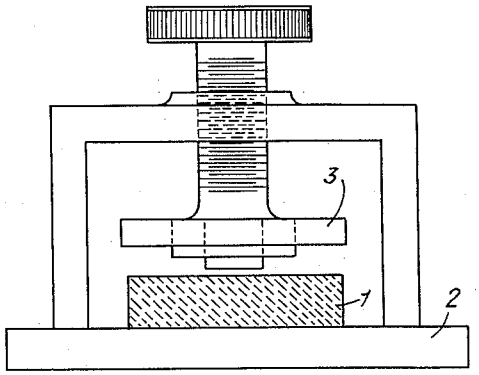
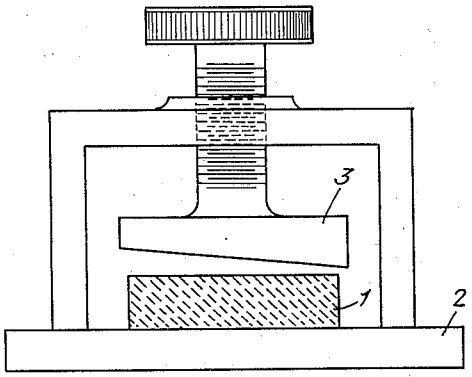


Fig. 4



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QUARTZ CRYSTAL OSCILLATOR

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Application February 5, 1934, Serial No. 709,714
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4 Claims. (Cl. 171—327)

This invention relates to an electrode arrangement for quartz oscillators.

It is known that in the operation of oscillating quartz crystals, if the electrodes parallel to the quartz crystal are at a certain distance, certain damping effects are liable to arise as a result of the column of air between the electrodes and the crystal, and these damping actions are liable to attain such proportions that the crystal will no longer oscillate. This invention which overcomes this objection will be more thoroughly understood by referring to the accompanying drawing in which,

Fig. 1 is a circuit diagram of a substitute scheme of a circuit arrangement;

Fig. 2 is a side view of a crystal holder having an adjustable electrode with a convexed surface;

Fig. 3 is a side view of a crystal holder having an adjustable electrode with graduated or stepped surfaces;

Fig. 4 is a side view of a crystal holder having an adjustable electrode with a slanting electrode surface facing the crystal.

From a physical viewpoint the above mentioned action can be explained by the substituted scheme of a crystal arrangement as shown in Fig. 1 wherein there is shown connected in series with the quartz crystal scheme comprising capacity Cg, inductance Lg, and resistance Rg, there is a capacity Cl which represents the capacity of the electrodes, and a resistance Rl which corresponds to the supplementary damping occasioned by the column of air. The frequency of oscillation produced by a quartz crystal in a given setting or holding arrangement depends upon the quartz itself and to a substantial extent upon the electrode capacity Cl, the amplitude of the vibrations being extensively influenced by the damping resistance Rl.

It is a well known fact that frequency variations caused by temperature changes of the crystal can be compensated by a change in distance, that is to say, by variation of the condenser Cl. This, however, is attended with this serious difficulty that by the variation of the electrode distance, i. e., capacity Cl there is produced also a considerable change in resistance Rl, so that whenever relatively great changes in temperatures, i. e., condenser Cl occur certain critical values of Rl will be exceeded where the oscillability of the crystal is seriously impaired.

According to the invention the electrodes are so formed that between the quartz and at least one of the electrodes there will be different distances at different places so that no such standing air waves will arise as between parallel planes. With the use of such an electrode arrangement the frequency can then be continuously changed by means of the capacity Cl, i. e., the electrode distance while the change in resistance Rl plays only a subordinate part.

Figs. 2–4 show exemplified embodiments of forms of electrodes according to the invention. Quartz crystal 1, for instance, is supported upon the bottom electrode 2, whereas the other electrode 3 which is adjustable is so formed that certain parts thereof are at different distances from the crystal surface. Where circular crystals are used, forms of electrodes may be employed which, for instance, may be produced by the rotation of any desired curve, say, the form of a shallow hemisphere, Fig. 2, of a cone, set-off or graduated shape, Fig. 3. It will be understood that forms other than those presenting rotation symmetry as in Fig. 4 are feasible. The points where the air distances are of critical value, i. e., the points of maximum damping, are a function of the wave lengths that are produced. For instance, to make graduated or stepped electrodes generally usable for different quartz crystals the height of the steps could be made variable according to the wave length, say, by several rings adapted to be screwed into one another as shown in Fig. 3.

In a similar way suitably formed electrodes for other crystal shapes could be used, for instance, square or polygonal or crystals with lemniscate form.

We claim:—

1. A piezo-electric crystal holder comprising a plurality of electrodes, at least one of said electrodes having its face which faces said crystal, arranged in steps of different surface areas, said steps being variable to alter the frequency of said crystal.

2. A piezo-electric crystal holder comprising fixed and movable electrodes, said movable electrode having a convexed surface facing the crystal and arranged so that the distance between said crystal and the electrode surface is made different at different places for the purpose of preventing damping by air cushions which surround said crystal.

3. A piezo-electric crystal holder comprising fixed and movable electrodes, said movable electrode having a tapered surface arranged so that the distance between said crystal and the electrode surface is made different at different places for the purpose of preventing damping by air cushions which surround said crystal.

4. A piezo-electric crystal holder comprising a plurality of electrodes, at least one of said electrodes having its face which faces said crystal, arranged in steps, each of said steps secured to each other, said steps being variable to alter the frequency of said crystal.

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