June 13, 1939. W. RUNGE ET AL 2,161,980

ELASTICALLY OSCILLATING OSCILLATOR

Filed Oct. 11, 1933

Fig. 1

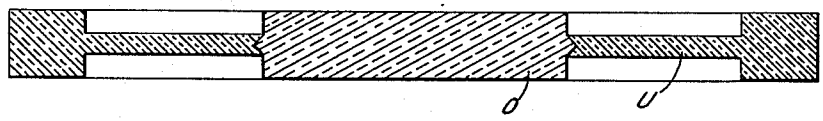
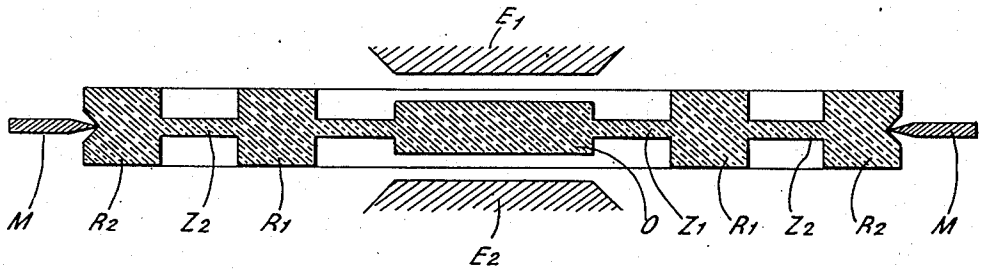


Fig. 2



INVENTORS
WILHELM RUNGE
HANS OTTO BOOSENSTEIN
BY
ATTORNEY

Patented June 13, 1939

2,161,980

UNITED STATES PATENT OFFICE

2,161,980

ELASTICALLY OSCILLATING OSCILLATOR

Wilhelm Runge and Hans Otto Roosenstein, Berlin, Germany, assignors to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application October 11, 1933, Serial No. 693,078
In Germany October 12, 1932

9 Claims. (Cl. 171—327)

This invention relates to elastically oscillating oscillators, or resonators with small damping action.

It has been found in the practical operation with elastically oscillating oscillators and resonators that they lose a considerable amount of energy mostly about their supporting points which dissipates into the surrounding space. Since in general an undesirable increase in damping is thereby produced, the supporting points of such systems are placed in the known manner into the oscillation nodes of the desired frequency. As an example may be mentioned the tuning fork which is supported at the point of junction of the two tines. That also here a considerable amount of energy can be withdrawn over the support can be noted from the sound radiation which occurs when the fork is set with its handle upon a suitable resonant board.

In oscillators and resonators with extremely low damping action, in particular in piezo-electric or magneto-striction oscillators as used in the high-frequency field, this method of support meets with mechanical difficulties since it is a difficult matter to arrange the point of support so as to coincide with sufficient accuracy with the oscillation nodes. Furthermore, in most of the cases the nodal movement is not equal to zero although it is a minimum. If the oscillator is supported at these places for instance clamped or carried upon knife edges, such bearing easily causes a considerable increase in damping.

In accordance with the invention these energy losses are limited to a minimum value in an arrangement in which the oscillator or resonator is fixedly connected with its support while the shape of the support is such that in comparison with the oscillator it can be considered to be of soft springiness. Due to the rigid connection between oscillator and its support the losses which are produced by the impacts between these two parts, are eliminated while at the place of transition between oscillator and support due to the suddenly changing elastic wave resistance which occurs at this place, a nearly total reflection of the oscillations occurs preventing the elastic oscillations to be transferred at considerable extent from the oscillator to the support. The springy mounting of the support is chosen in order to suppress undesirable side phenomena, for instance oscillations of a different kind than the desired one. The principles underlying the present invention will be more readily understood by reference to the following description, which is accompanied by a drawing wherein Figs. 1 and 2 show two embodiments of the invention.

Fig. 1 shows the construction of an oscillating quartz plate as often used in the high-frequency field, as modified in accordance with the invention. In this case the actual quartz oscillator O is conceived as an annular disk, while the support forms a thin annular disk U rigidly connected to the quartz by means of suitable binding material. At the place of transition U between the quartz and support, the material is reduced to a great extent in order to render the reflection of the oscillation more favorable at this place. At any case it must be endeavored to make the dimensions of the reduced place small in comparison with the wave length of the elastic oscillation in the material of the oscillator.

A particularly simple embodiment is obtained when the oscillator together with its support is cut by means of an angular-shaped grinding stone from a block of the same material. Due to the entire elimination of energy losses in the connecting material between oscillator and support a further damping reduction is thereby obtained. The damping is furthermore reduced if as shown in Fig. 1 the support of the oscillator is laid in a point which coincides as much as possible with the oscillation nodes (neutral zone) of the elastic oscillations.

Finally it is also possible by a second application of the inventive idea to cause the remaining energy which would be dissipated across the support into the surrounding space to be again reflected towards the quartz oscillator. An arrangement accomplishing this is shown in Fig. 2. In this arrangement the actual quartz oscillator O is conceived as an annular disk which together with its supports R_1, R_2, Z_1, Z_2, Z_3 is cut by means of an angular-shaped grinding stone from a quartz block of the same material in any useful direction of the electrical axis. In this case the support is formed of one or several concentric rings R_1, R_2 etc. separated by means of thin intermediate rings Z_1, Z_2 etc. It must be thought of as a mechanical equivalent of an electrical filter chain consisting of capacities and inductances. The electrodes E_1 and E_2 exciting the oscillator are suitably placed at a short distance from the quartz plate. The functioning of this suspension is such that the slight movement transmitted from oscillator O to the intermediate ring Z_1 is nearly entirely reflected back to the oscillator O at the place of transition of Z_1 and R_1. To the extent to which this action does not take place an utmost small movement of ring

R_1 occurs, which is transmitted to the intermediate ring Z_2 and again reflected by R_2 at the place of transition of Z_2 and R_2. Thus from the transmitted oscillation energy only an extremely small fraction passes to ring R_2. In choosing suitable dimensions this energy is so small that the support of ring R_2 for instance by means of a knife edge M, remains without appreciable influence upon the damping of the oscillator O. The frequency determining formula is represented by the well-known quartz crystal equations, and owing to the improved support of this invention the frequency can be determined more accurately than when crystals are supported by other methods known in the prior art.

The still remaining damping of such oscillator is caused to a considerable portion by the friction of the gas surrounding the oscillator. Therefore, it will be advantageous if the oscillator is used in a rarefied space.

We claim:

1. Elastically oscillating oscillator having a small damping action comprising an oscillator cut from a block of material in such a manner that said block provides the support for said oscillator.

2. Elastically oscillating oscillator having a small damping action comprising a central piezo-electric oscillator cut from a block of material in such a manner that said block provides the support for said oscillator.

3. Elastically oscillating oscillator having a small damping action comprising a central disk-like piezo-electric oscillator having a plurality of concentric rings cut from a block of material in such a manner that said concentric rings provide the support for said oscillator.

4. Elastically oscillating oscillator having a small damping action comprising a piezo-electric oscillator cut from a block of quartz material in such a manner that said quartz provides the support for said oscillator.

5. A piezo-electric resonator comprising a vibrating portion and a flexible member integral with said portion, said flexible member serving to mount the resonator on a support.

6. A crystal resonator comprising a vibrating portion, a connecting element and a base portion.

7. A crystal resonator comprising a vibrating portion, a connecting element, and a base portion, the connecting element being of less thickness than the vibrating portion.

8. A resonator comprising a vibrating portion, a connecting element and a base portion all formed from a single crystal.

9. A resonator comprising a vibrating portion, a connecting element and a base portion, all formed from a single crystal, the connecting element being of less thickness than the vibrating portion.

WILHELM RUNGE.
HANS OTTO ROOSENSTEIN.

DISCLAIMER

2,161,980.—*Wilhelm Runge* and *Hans Otto Roosenstein*, Berlin, Germany. ELASTICALLY OSCILLATING OSCILLATOR. Patent dated June 13, 1939. Disclaimer filed May 24, 1940, by the inventors; the assignee, *Telefunken Gesellschaft fur Drahtlose Telegraphie, m. b. H.*, consenting.

Hereby disclaim claims 1, 5, 8, and 9 of said patent, and disclaim from the scope of claims 4, 6, and 7 all resonators except those wherein the vibrating or oscillating portion is centrally located with respect to the support or base portion.

[*Official Gazette June 25, 1940.*]

DISCLAIMER

2,161,980.—*Wilhelm Runge* and *Hans Otto Roosenstein*, Berlin, Germany. ELASTICALLY OSCILLATING OSCILLATOR. Patent dated June 13, 1939. Disclaimer filed May 24, 1940, by the inventors; the assignee, *Telefunken Gesellschaft fur Drahtlose Telegraphie, m. b. H.*, consenting.

Hereby disclaim claims 1, 5, 8, and 9 of said patent, and disclaim from the scope of claims 4, 6, and 7 all resonators except those wherein the vibrating or oscillating portion is centrally located with respect to the support or base portion.

[*Official Gazette June 25, 1940.*]