Oct. 25, 1949. W. S. ERWIN 2,485,722

CRYSTAL

Filed Jan. 31, 1945

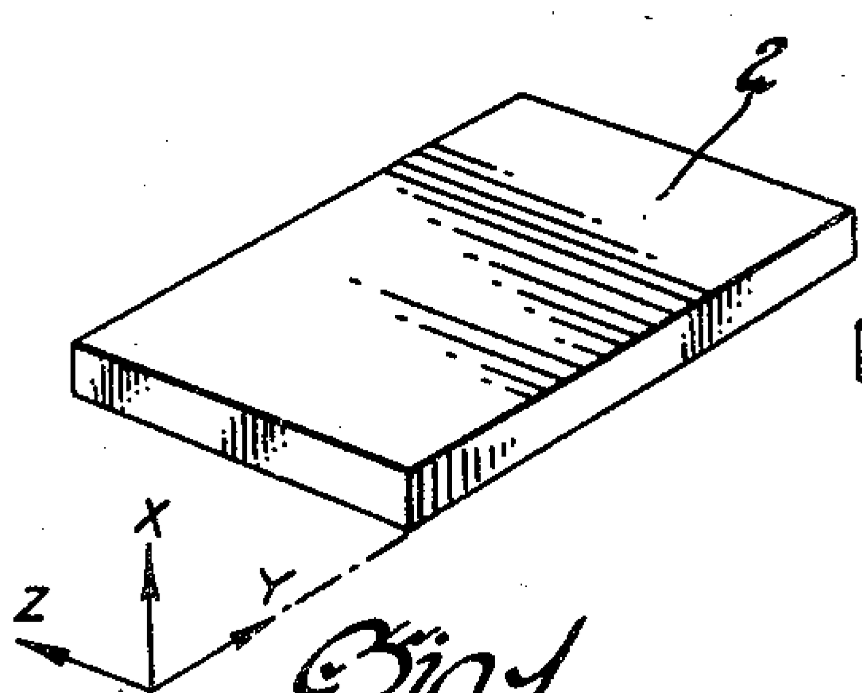

Fig. 1

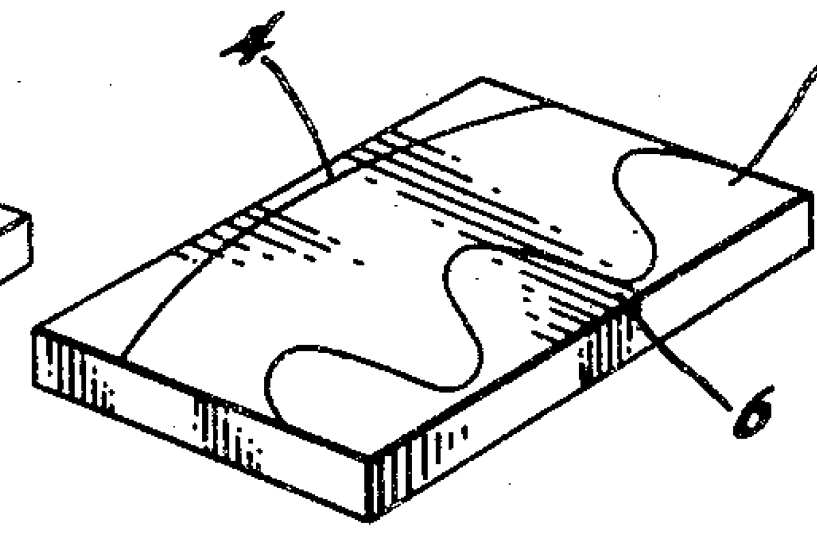

Fig. 2

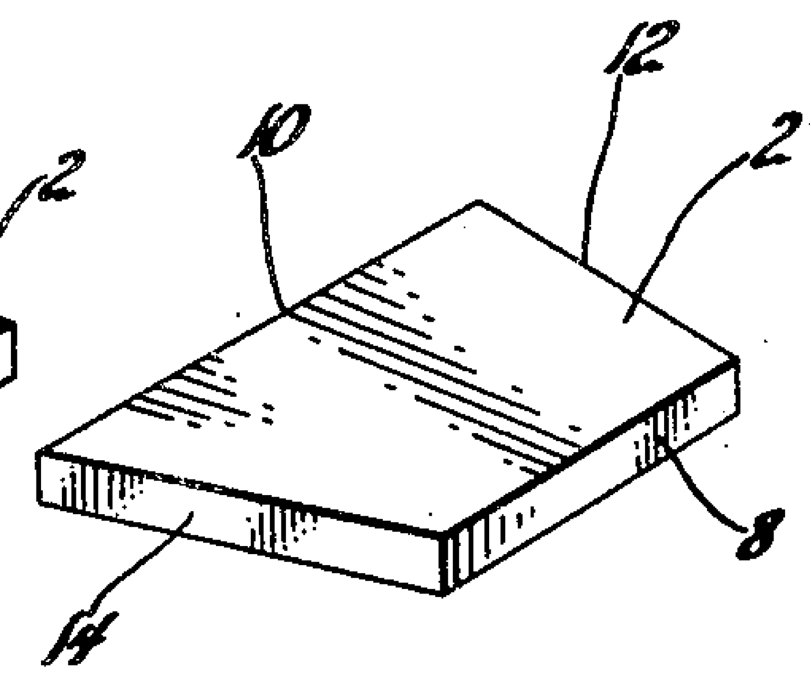

Fig. 3

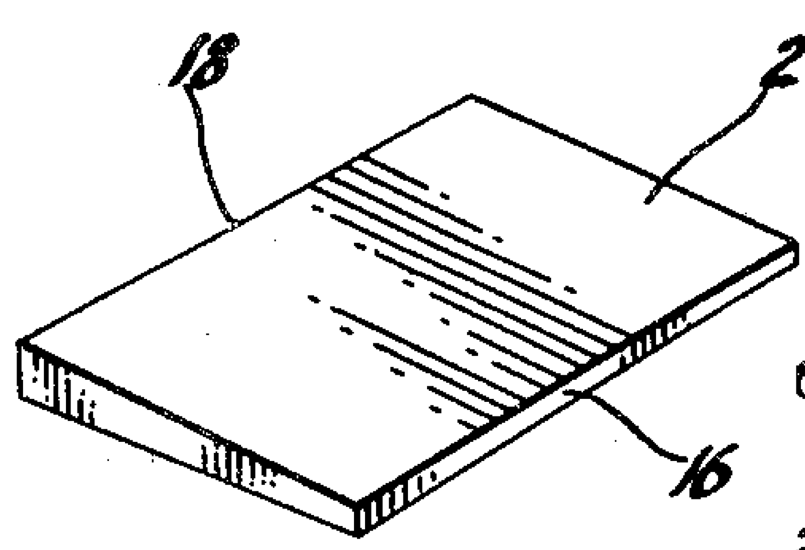

Fig. 4

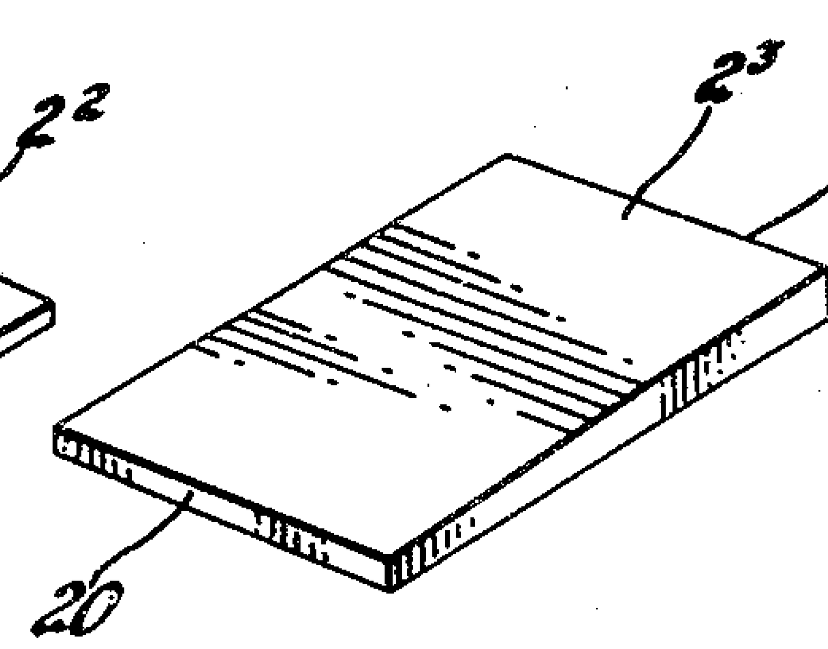

Fig. 5

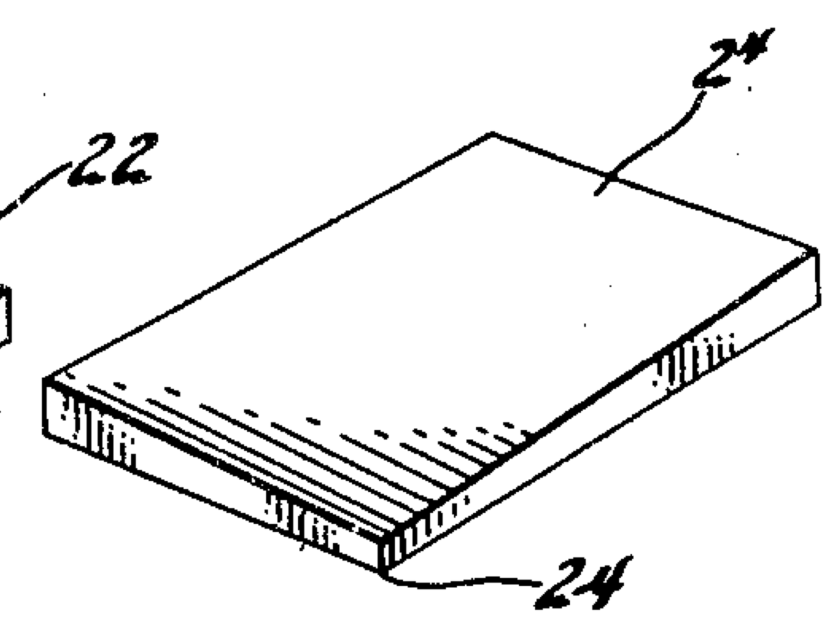

Fig. 6

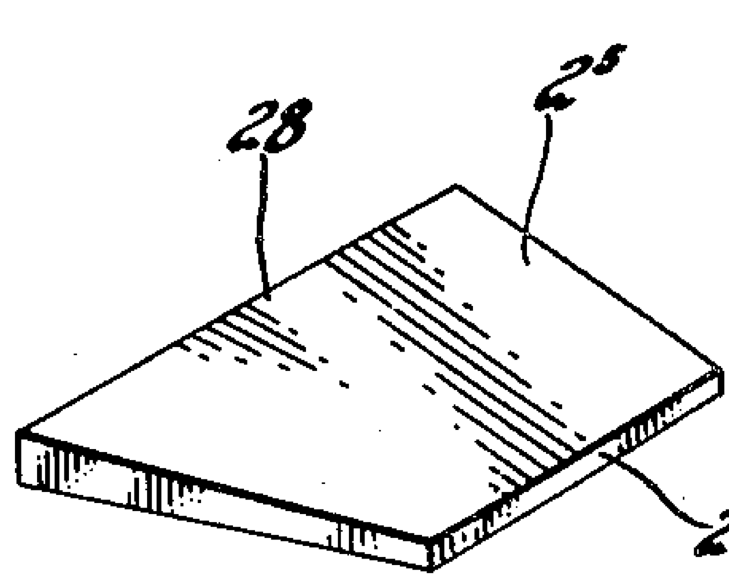

Fig. 7

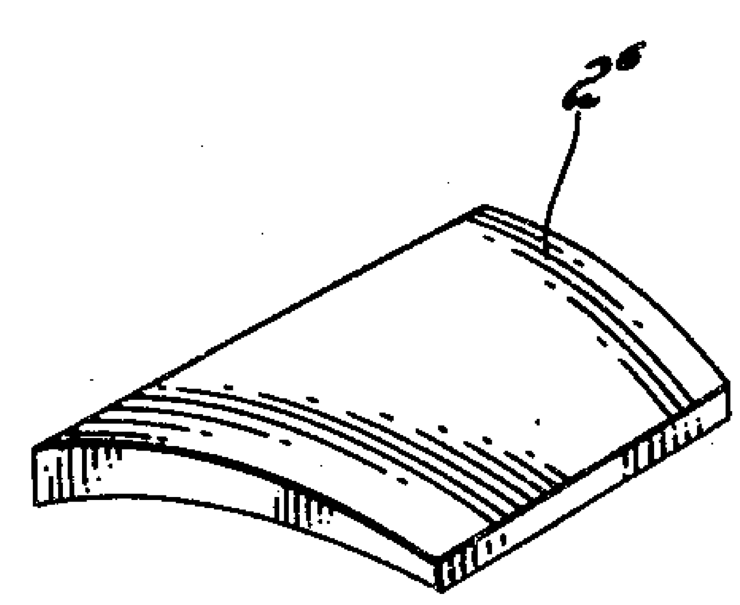

Fig. 8

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Application January 31, 1945, Serial No. 575,387

3 Claims. (Cl. 171—327)

This invention relates to vibration producing or oscillating means and more specifically to that branch of the art known as piezo-electric crystals. One of the main uses for crystals is, of course, to control electronic oscillators in which the crystal is vibrated at its natural or resonant frequency and thus provides a very stable oscillator frequency controller. However, there are uses for crystals in which the same are not vibrated at a resonant frequency but at frequencies off resonance and used to impart such mechanical vibration to other structures. As an example of this latter use there may be mentioned that set forth in Patent Number 2,431,233 entitled "Supersonic measuring means" issued November 18, 1947, in the name of Wesley S. Erwin assigned to a common assignee.

In that instance a crystal is vibrated or set into motion by an oscillator which may be tuned over a predetermined frequency range, thus vibrating the crystal mechanically at a number of different frequencies. The crystal is mounted in contact with a part or portion to which it is desired to impart this vibration and for certain purposes as set forth does drive the mechanical load in order to determine certain physical or structural characteristics of the same. In this case it is desired to work not at natural resonance but off crystal resonance and to depend entirely upon the mechanical drive from the crystal to the work or load and therefore, spurious vibrations of the crystal which may be caused by harmonics or modes within the crystal itself prevent the acquiring of accurate results. Since a mechanical part such as a crystal having regular configuration may be easily itself set into harmonic or spurious vibration, it is desired to so design the same that such a tendency is suppressed or attenuated.

It is therefore an object of my invention to provide a vibrating body having substantially no resonance frequency.

It is a further object of my invention to provide a piezo-electric crystal of such configuration that the same has substantially no resonant frequency vibrations.

It is a still further object of my invention to provide a piezo-electric crystal in which the exterior dimensions are not uniform in order that nodes of vibration may not be set up by the application of predetermined frequencies thereto.

With these and other objects in view which will become apparent as the specification proceeds, my invention will be best understood by reference to the following specification and claims and the

illustrations in the accompanying drawings, in which:

Figure 1 is a perspective view showing a usual regular crystal.

Figure 2 is a perspective view of the same crystal with some possible vibration modes indicated.

Figures 3, 4, 5, 6, 7 and 8 are perspective views showing different modified forms for so designing and constructing the crystal as to suppress the formation of undesirable modes which might be set up by frequencies of driving oscillation.

Referring now more specifically to the drawings, Figure 1 is a perspective view of a normal crystal 2 having uniform thickness along its X axis and uniform widths along its Y and Z axes. This is representative of crystals which are commercially available on the market and when used to impart vibrations to mechanical pieces at off resonant points frequently have set up therein spurious vibrations known as width or thickness modes which impress false indications on indicating means and thus prevent the obtaining of accurate measurements. Such modes as for example the 1st and 5th may be set up along lines 4 or 6 as indicated in Figure 2 when certain frequencies of vibration are applied either electrically or mechanically to the crystal.

In order to suppress the formation of such modes, one method would be to break up the continuity by distorting the normal uniform shape of the crystal. In Figure 3 the crystal 2′ is tapered so that elements along the Y axis have different lengths, the end 8 toward the right is shorter than the back edge 10. This, of course, makes the two opposite sides 12 and 14 nonparallel and thus breaks up the formation of modes along the Y axis. Another mode is suppressed as shown in Figure 4. In this case the X axis thickness is tapered for instance in the Z direction therefore making the forward face 16 of the crystal 2^2 narrower than the rear face 18. This suppresses the formation of the thickness modes.

In Figure 5 the crystal 2^3 has its X axis thickness tapered in the Y direction causing the front edge 20 to be much narrower than the rear edge 22. In Figure 6 there is shown a compound taper in which one corner of the crystal is thinner than in Figure 3 or in which the X axis thickness is progressive from the origin in both to the Y and Z directions. In this case the corner 24 of the crystal 2^4 is the thinnest of the four. Figure 7 also discloses a compound taper in that it is tapered to the right in thickness and also in width. It might be stated that when both dimensions of the Y axis and the **X axis** are tapered simultaneously one eliminates both width and thickness modes. Thus, in crystal **25** the edge **26** is both shorter and thinner than the rear edge **28**. The same result may also be obtained with a curved crystal as shown in Figure 8 in crystal **26** by tapering both the width and thickness of the crystal from right to left.

It will thus be evident that by manufacturing or producing crystals in the manner shown in Figures 3–8 that the uniformity of crystal dimensions are so varied as to break up the formation of either width or thickness modes and thus permit the usage of such a crystal between a source of electrical oscillations and means to which it is desired to impart mechanical vibrations or vice versa without the formation of spurious vibrations introducing erroneous readings into the indicating or measuring means.

I claim:

1. A piezo-electric crystal to impart mechanical vibration to a load said crystal being constructed with tapering width and thickness dimensions to suppress the formation of width and thickness modes to produce a substantially non-resonant transducer.

2. A piezo-electric crystal to impart mechanical vibration to a load, said crystal having one face shaped to conform to the surface of a part to be vibrated and constructed with tapering dimensions in two major axes directions to suppress the formation of modes in the respective dimensions tapered to produce a substantially non-resonant transducer.

3. An X-cut piezo-electric crystal which is tapered in the Y axis dimension to substantially eliminate Y axis resonant modes of vibration.

WESLEY S. ERWIN.

REFERENCES CITED

The following references are of record in the file of this patent:

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