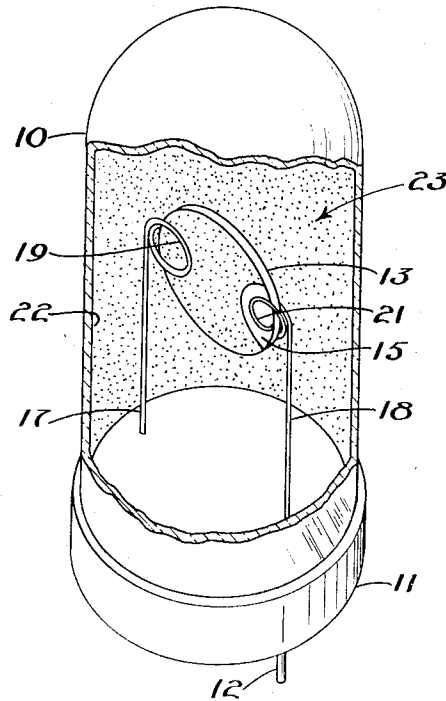


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MEANS FOR PREVENTING AGING EFFECTS
IN PIEZOELECTRIC CRYSTALS
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MEANS FOR PREVENTING AGING EFFECTS IN PIEZOELECTRIC CRYSTALS

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5 Claims. (Cl. 29—25.35)

This invention relates generally to means for preventing aging effects in piezoelectric crystals and relates particularly to a means for preventing change of resonant frequency due to sublimation of plated material on a crystal.

Piezoelectric crystals are widely used to control the frequency of radio oscillators because of their unsurpassed stability. Their stability is affected to a limited extent, however, by many factors. They are perhaps affected most of all by temperature variation but this can be controlled by temperature regulating devices. They are also affected by other quantities, as for example, the adherence of charged dust particles to the crystal surfaces and oxidation of the metallic plated material. The effects of dust can be controlled by mounting the crystal in a vacuum. The vacuum also greatly increases the Q of the crystal by eliminating air friction which is a further desirable effect.

However, it is found that after all the above precautions are taken that a crystal still does not have perfect stability and that its frequency increases slightly with age. Although this increase is very small, being in the order of one part in 10,000,000 per month, it is still larger than desired for some applications. For example, it is necessary in single sideband reception that the inserted carrier be within 10 cycles of the actual carrier. It is seen that at ultra high frequencies such as 500 megacycles, a drift of 1 part in 10,000,000 per month is a drift of 50 cycles per month of the carrier frequency.

One of the causes of instability is the sublimation of the plated metallic material on the crystal which is usually gold, silver or aluminum. The sublimation decreases the mass of the plated material and therefore increases the resonant frequency of the crystal. The amount of mass lost by sublimation is a function of the crystal operating temperature, vapor pressure of the plated material, and the volume of the container. It is therefore the principal object of this invention to prevent frequency instability of crystals due to sublimation of metallic surface material.

This invention prevents sublimation of the crystal plated material by providing a coating of the same material over the internal surface of the crystal container. The container surface is then heated above the crystal's operating temperature until sufficient sublimation occurs to cause a saturated vapor state in the container after which the temperature is reduced to its operating value. Saturated vapor then surrounds the crystal surface material and prevents loss of mass by sublimation.

Further advantages, objects and features of this invention will be apparent to a man skilled in the art upon a further study of this specification and drawing, in which:

The figure is a cutaway isometric view of one embodiment of this invention.

Now referring to this invention in more detail, the figure shows a container or envelope 10 that might be made of glass which has a base 11 that is attached to envelope 10 in the conventional manner. Plug contacts

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12 extend from base 11 and mate with a conventional tube socket (not shown).

A piezoelectric crystal 13 is supported from base 11 by the supports 17 and 18 which extend through sealed openings in envelope 10. Most of both surfaces of crystal 13 are plated with a metallic material 14. A small unplated area 15 is left free on each side. A contacting portion 19 of support 17 is attached to plated material 14 on crystal 13 as by soldering. The portion of support 17 which engages the opposite side of the crystal does not touch a plated portion. A contacting portion 21 of support 18 engages an unplated area 15 on the first side and engages a plated portion on the opposite side. Thus, a potential can be impressed on the crystal by supports 17 and 18.

The internal surface 22 of envelope 10 is plated with conductive material 14 which might be silver. Supports 17 and 18 are also plated with a conductive material. The space inside envelope 10 may be evacuated or filled with an inert gas.

All surfaces within envelope 10 may be covered with conductive material except for the small unplated area 15 on the quartz crystal. However, sublimation of quartz is negligible at the crystal operating temperature when compared to the sublimation of metallic material 14, and essentially all changes of mass of the crystal structure would be due to the sublimation of metallic material 14. Volume 23 tends to be primarily saturated by sublimation from material 14 on the envelope 22, rather than by sublimation from the smaller area of material 14 on crystal 13. Sublimation will cease when a saturated vapor state is reached throughout volume 23.

Sublimation at any single temperature decreases exponentially with time as the saturated vapor state is approached, and generally many years are required to substantially saturate the surrounding volume. Instability exists during this aging period when sublimation continually changes the mass of the crystal structure. It is desirable to immediately reach the saturated state so as to shorten the aging period. This may be done in several different ways.

One method is to introduce saturated vapor of material 14 from an external source after the evacuation but before sealing volume 23. This method has the advantage of preventing all sublimation from crystal 13 and pre-aging it immediately. A second method of quickly pre-aging a crystal is to seal volume 23 after evacuation and to preheat the unit to a temperature above the normal crystal operating temperature for a short period of time until sufficient sublimation occurs to form a saturated vapor when the temperature is lowered to the crystal operating temperature. The aging period is decreased as the temperature is increased and generally may be made relatively short. All sublimation will then occur during the high temperature period and none will occur thereafter to affect the resonant frequency of the crystal.

While a selected embodiment of this invention has been described, it will be understood that it is capable of many modifications by those skilled in the art and therefore changes in construction and arrangement may be made without departing from the spirit and scope of this invention, as disclosed in the appended claims.

I claim:

1. A method of preventing aging effects in a plated piezoelectric crystal mounted in an evacuated container comprising, plating substantially the entire inner surface of the container with the same metallic material which plates said crystal, mounting crystal which has surfaces plated with said metallic material in said container, evacuating said container after the steps of plating the container and mounting the crystal, and sealing said container so that the vapor produced by sublimation of said.

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metallic material occurs mainly from the plating on said container.

2. A method of preventing aging effects in a plated piezoelectric crystal mounted in an evacuated container comprising, plating the inner surface of the container with the same metal that plates said crystal, mounting a crystal which has surfaces plated with said metallic material in said container, evacuating said container after the steps of plating the container and mounting the crystal, sealing said container so that the vapor produced by sublimation of said metallic material occurs mainly from the plating on said container, and heating said container at a temperature higher than the crystal operating temperature for a predetermined period of time.

3. A method of preventing aging effects in a plated piezoelectric crystal mounted in an evacuated envelope comprising the steps of, plating the inner surface of the envelope with the same metallic material that plates said crystal, mounting a crystal plated with the same metallic material in said envelope, evacuating said envelope, after the steps of plating the container and mounting the crystal filling said envelope with sufficient vapor from said metallic material so that a saturated vapor exists in said envelope at said crystal's operating temperature, and sealing said envelope.

4. A method of preventing aging effects of a plated piezoelectric crystal mounted in a container comprising,

plating the inner surface of the container with the same metal that plates said crystal, mounting a crystal plated with said metallic material in said container, filling said container with an inert gas, after the steps of plating the container and mounting the crystal and sealing said container.

5. A method of preventing aging effects of a plated piezoelectric crystal mounted in a container comprising, plating the inner surface of the container with the same metal that plates said crystal, mounting a crystal plated with said metallic material in said container, filling said container with an inert gas after the steps of plating the container and mounting the crystal, sealing said container, and heating said container at a temperature higher than the crystal operating temperature to sublimate sufficient vapor to saturate the internal volume of said container at the operating temperature of said crystal.

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