Feb. 24, 1942. J. B. ATWOOD 2,274,466

TEMPERATURE COMPENSATED CRYSTAL HOLDER

Filed Nov. 24, 1939

Fig. 1

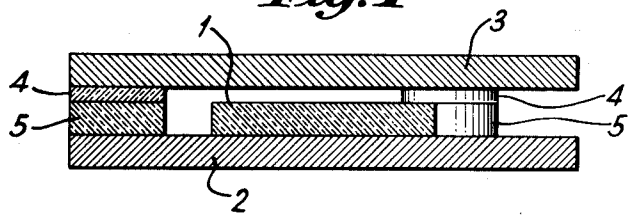



Fig. 2

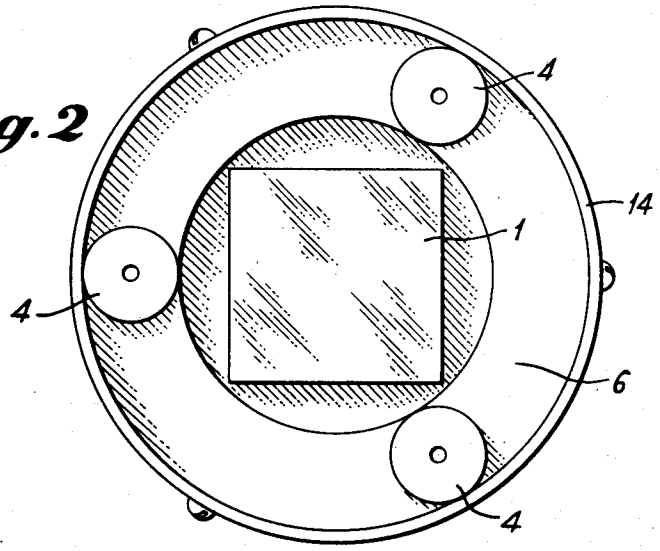
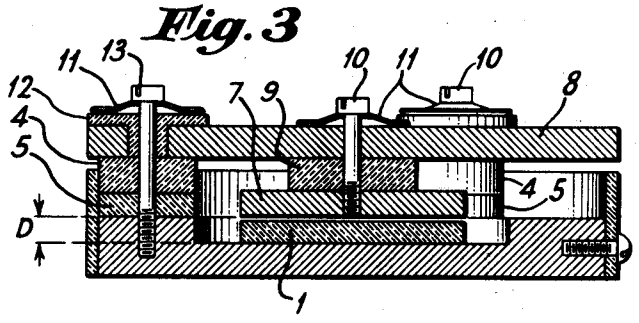



Fig. 3




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Patented Feb. 24, 1942 2,274,466

# UNITED STATES PATENT OFFICE

2,274,466

## TEMPERATURE COMPENSATED CRYSTAL HOLDER

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Application November 24, 1939, Serial No. 305,912

6 Claims. (Cl. 171—327)

This invention relates to a new and novel temperature compensated crystal holder.

An object of this invention is to provide an improved crystal holder which will maintain constant crystal frequency, regardless of temperature changes.

A feature of this invention is the selection of material for the electrode spacers from the same piece of quartz and also cutting it at the same angle as the crystal element is cut.

Another feature of this invention is the proportioning of the crystal spacer thickness so that a stable crystal frequency is obtained.

It is well known that the frequency of a quartz crystal will change with changes in the air gap of the holder. The most common cause of this change in air gap is a rise or drop in the temperature whereby the various parts of the holder expand or contract non-uniformly to produce an undesirable variable air gap. If the expansions and contractions of the crystal holder parts can be compensated, an improvement in crystal stability will be obtained.

In the past, various types of temperature compensation have been proposed. These have been mainly some form of bi-metallic strip arranged to support the crystal electrode to produce the required results. Such type of crystal holders are generally expensive to build, bulky and rather cumberscme to adjust.

This invention compensates for the undesirable expansion and contraction due to temperature changes, as mentioned above, and in its simplest form, the holder is fundamentally the same as the well-known types of crystal holders which consist of two electrodes separated by fused quartz spacers, the spacers being made thick enough to provide the desired air gap.

By my invention, the fused quartz spacers are divided into two parts, one part consisting of fused quartz and the other part consisting of what is known as "angle quartz," the latter being cut at the same angle and from the same piece of mother crystal as the active crystal element located within the holder. I have found that piezo-electric crystal holders which consist of two electrodes separated by fused quartz spacers that are thick enough to provide an air gap of the desired thickness have a temperature coefficient of expansion of $0.5\times10^{-6}$/C.° while the quartz crystal may be from $8\times10^{-6}$/C.° to $13\times10^{-6}$/C.°, depending upon the angle at which it is cut from the mother crystal. This results in an air gap which will vary with the temperature, due to the different coefficients of expansion, however, if the spacers are combined to make a single composite spacer and also by suitable proportion of thickness no variation of the air gap will occur.

This invention will best be understood by referring to the accompanying drawing, in which:

Fig. 1 shows a crystal holder with composite fused quartz and angle quartz spacers;

Fig. 2 is a plan view of a preferred embodiment of this invention with the cover and binding members removed, in which the spacers and holder are proportioned to give substantially complete temperature compensation; and

Fig. 3 is a cross-sectional view of the entire holder.

Referring now in detail to Fig. 1 of the drawing, the crystal 1 is shown resting upon the bottom electrode 2 with the top electrode 3 spaced to give the desired air gap by means of two quartz spacers, the top spacer 4 being that of fused quartz and the bottom spacer 5 being that of angle quartz, which is made from the same piece of quartz as crystal 1 and likewise cut to have the same thickness and also cut at the same angle. It will be seen by this arrangement that there will be very little change in the air gap with temperature as there is left only a thin fused quartz spacer of low coefficient of expansion.

The preferred embodiment of this invention is shown by Figs. 2 and 3, in which a more complete holder arrangement is shown. The crystal 1 is supported within a base 6 of the holder. This member is preferably made of metal, so as to serve as the lower electrode of the crystal. An upper electrode 7 is located above crystal 1 and is supported from a top holder or cover member 8. Electrode 7 is spaced from member 8 by means of a fused quartz spacer 9 of any convenient thickness. A screw 10 is threaded into electrode 7 and has located under its head a spring collar 11 arranged to take up difference in expansion of the assembled parts. The holder top 8 is preferably that of a circular plate and is separated from base 6 by means of a plurality of composite crystal spacers 4 and 5, which are of similar material as that mentioned above in connection with Fig. 1. An insulating bushing 12 insulates screw 13 from short-circuiting members 8 and 6, and is also provided with spring washers 11 to take up the difference of expansion of the various parts. It will be noted that in order to maintain accurate temperature compensation, the spacer 5 is of the same thickness as the quartz crystal 1 and made from the same piece and like-

wise cut at the same angle. The dimension D indicated by the arrows on member 6 is that of a compensating dimension which may be of any shape, such as, for example, a rim cut from member 6, a separate ring, or a spacer, and is equal to the thickness of the top electrode 7, if made of the same material as electrode 7. However, if the materials are different, the dimensions must be proportioned to give the same amount of expansion with temperature for each. The fused quartz spacer 4 is of the same thickness dimension as quartz spacer 9, except for a slight increase, which increase is the amount of the desired air gap. If desired, the crystal holder may be surrounded by a thin insulating casing 14 which is arranged to encircle base 6, and having a height such that it is slightly shorter than the combined height of spacers 4 and 5 and base plate 6.

Although this holder is shown as circular in shape, it is to be understood that it may take any other shape. Likewise, the spacers 4 and 5 may be substituted by a composite ring of metal and two kinds of quartz which is of the same outside diameter as base member 6. Therefore, this invention should not be limited to the precise arrangement shown.

What is claimed is:

1. A temperature compensated crystal holder comprising two electrodes, a piezo-electric crystal element interposed between said electrodes, one of said electrodes having a depressed space equal in depth to the thickness of the other electrode, temperature compensating means including a plurality of spacing members to provide an air gap between said crystal and at least one electrode, one of said spacing members made from the same piece of crystal as said crystal element and having the same thickness, a second quartz spacing member placed to abut said first mentioned spacing member.

2. A temperature compensated crystal holder comprising two electrodes, a piezo-electric crystal element interposed between said electrodes, one of said electrodes acting as a base plate, a cover plate for said holder, temperature compensating means comprising a composite spacing column extending from the electrode which acts as a base plate, said composite column including a metal and at least two different kinds of quartz, the thickness of said column being so proportioned as to maintain the air gap of said crystal constant.

3. A temperature compensated crystal holder comprising two electrodes, a piezo-electric crystal element interposed between said electrodes, one of said electrodes acting as a base plate, a cover plate for said holder, temperature compensating means comprising a composite spacing column extending from the electrode which acts as a base plate, said column including a metal and at least two different kinds of quartz, the thickness of said column being proportioned to maintain the air gap of said crystal constant, and spring tension means located above said composite column to take up the difference in expansion of the materials of said composite column.

4. A temperature compensated crystal holder comprising two electrodes, a piezo-electric crystal element interposed between said electrodes, one of said electrodes acting as a base plate, a cover plate for said holder, temperature compensating means comprising a composite ring-like spacing column extending from the electrode which acts as a base plate, said column including a metal and at least two different kinds of quartz, the thickness of said column being proportioned to maintain the air gap of said crystal constant, a threaded member passing through said composite spacing column, and a spring tension member arranged on said threaded member to take up difference in expansion of the material of said composite column.

5. A temperature compensated crystal holder comprising two electrodes, a piezo-electric crystal element interposed between said electrodes, one of said electrodes acting as a base plate, a cover plate for said holder, temperature compensating means comprising a composite spacing column extending from the electrode which acts as a base plate, said column including a metal and at least two different kinds of quartz, the thickness of said column being proportioned to maintain the air gap of said crystal constant, a threaded member passing through said composite spacing column, a screw passing through said column, an insulating bushing for insulating said screw from said cover plate, and a spring tension member interposed between said cover plate and the head of said screw to take up the difference in expansion of the materials of said composite column.

6. A temperature compensated crystal holder comprising two electrodes, a piezo-electric crystal element interposed between said electrodes, one of said electrodes having a depressed space equal in depth to the thickness of the other electrode, temperature compensating means secured to the electrode which has a depressed space, said compensating means including a plurality of spacing members to provide an air gap between said crystal and the other electrode, one of said spacing members made from the same piece of crystal as said crystal element and having the same thickness, a second quartz spacing member placed to abut said first mentioned spacing member.

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