

May 20, 1952

J. D. HOLMBECK

2,597,797

CRYSTAL HOLDER

Filed April 19, 1949

FIG. 1

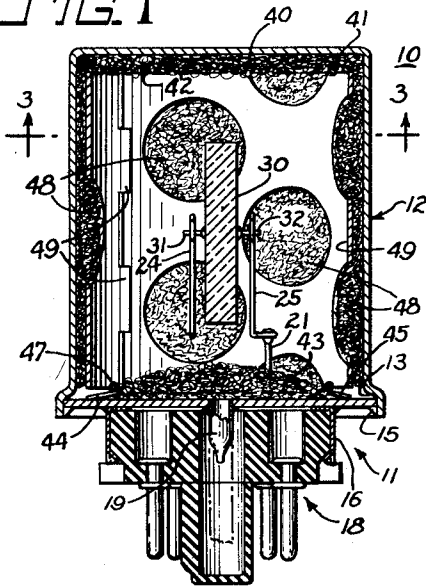


FIG. 2

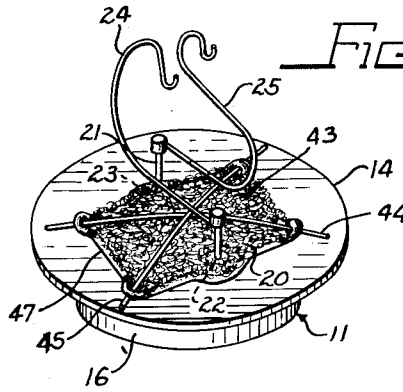


FIG. 3

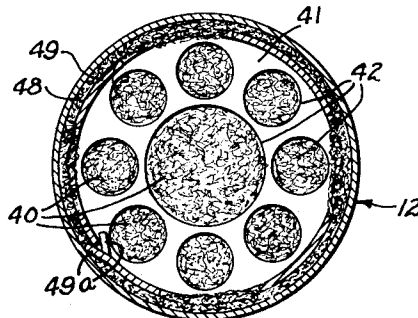


FIG. 4

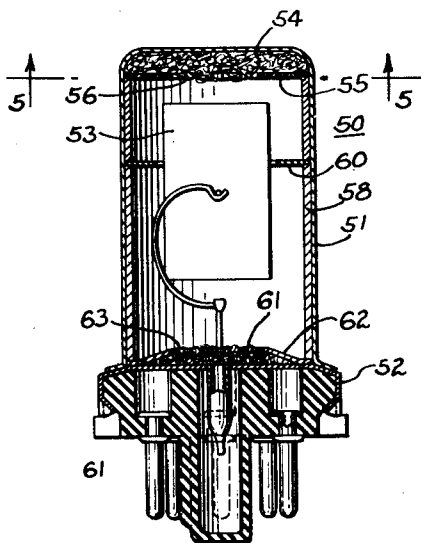
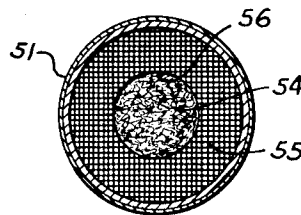


FIG. 5



Inventor
John D. Holmbeck

Carlson, Pitman, Hubbard & White
Attys.

UNITED STATES PATENT OFFICE

2,597,797

CRYSTAL HOLDER

John D. Holmbeck, Sandwich, Ill., assignor to The James Knights Company, Sandwich, Ill., a corporation of Illinois

Application April 19, 1949, Serial No. 88,360

6 Claims. (Cl. 171-327)

1

The present invention relates to holders for piezoelectric crystals.

In spite of the present high state of development in the field of crystals and holders, difficulty is often experienced in obtaining uniformly high activity or output to meet the specifications of military and commercial users. It is particularly difficult to obtain predictable performance after the crystal is mounted in a holder. Even when manufacturing conditions are carefully controlled it is almost always necessary for a certain proportion of mounted crystals in each lot to be discarded or laboriously "re-worked" in an attempt to bring the performance up to standard.

It is an object of the present invention to provide an improved crystal holder which substantially eliminates the tendency for erratic and unpredictable operation and enables uniformly high output to be achieved. More particularly it is an object to provide an improved crystal holder in which means are provided for preventing super-sonic reflections or vibrations between the crystal and the walls of the holder.

Other objects and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawing, in which:

Figure 1 is a vertical section of a crystal holder constructed in accordance with the present invention and including a crystal mounted therein.

Fig. 2 is a detailed perspective view of the base portion of the holder of Fig. 1.

Fig. 3 is a horizontal section taken along the line 3-3 of Fig. 1.

Fig. 4 is a vertical section illustrating an alternative embodiment of the improved crystal holder.

Fig. 5 is a horizontal section taken along the line 5-5 in Fig. 4.

While the invention is susceptible of various modifications and alternative constructions and uses, I have shown in the drawing and will herein describe in detail only two preferred embodiments of the invention. It is to be understood, however, that I do not intend to limit the invention by such disclosure, but aim to cover all modifications and alternative constructions and uses falling within the spirit and scope of the invention as expressed in the appended claims.

Turning now to Fig. 1 the holder 10 is of the shell type having a base 11 and a cup-shaped cap 12. The cap has an enlargement at its lower end providing an annular recess 13. As shown in Fig. 2 the base 11 includes a circular disc or base plate 14 which is dimensioned to fit into the re-

2

cess after which the joint may be filled with solder or the like as indicated at 15 to make a durable and tamperproof unit. The base 11 also includes a downwardly extending cylindrical skirt 16 for receiving a plug 18 suitable for plugging into a standard tube socket. The plug is preferably of the type allowing room for an evacuation tube 19 through which the air may be withdrawn and a gas such as nitrogen injected.

For the purpose of mounting the crystal within the holder the base plate 14 includes a pair of upright supporting posts 20, 21 which are insulated from the plate by means of fused insulating beads 22, 23. Mounted at the top of the posts 20, 21 are flexible supporting wires 24, 25 which are of C shape and lie in planes spaced from one another so that the crystal may be accommodated between them. The crystal indicated at 30 is preferably of the type having electrodes plated on its opposed surfaces. Connection is made thereto by means of outwardly projecting wires 31, 32 which are in turn soldered to the upper ends of the C-shaped supporting wires 24, 25.

During the course of my investigation to determine the reasons for erratic output of mounted crystals, I found that the activity in almost all cases could be greatly increased by arranging opposite the edges or faces of the crystal a tuft of insulating material and in particular glass wool. In carrying out the present invention therefore a layer of glass wool is arranged at the top of the holder as indicated at 40, being held in place by means of a foraminous disc of insulating material or the like 41. The openings 42 in the disc as shown in Fig. 3 are preferably so large that practically all of the area of the glass wool is presented to the crystal. At the lower end of the crystal and mounted on the base 11 is an additional tuft of glass wool 43. The latter is held in place by means of a pair of resilient cross wires 44, 45. In the present instance the cross wires are anchored to the base by inserting the ends under an anchoring wire 47. The latter is soldered to the base plate 14 but includes eyelets bent up away from the base of the plate at the corners to receive the cross wires.

It has been found that further improvement in activity may be obtained, particularly in crystals vibrating in the thickness shear or flexural modes, by providing a layer of glass wool opposite the faces of the crystal and preferably extending around the entire wall of the holder. In the present instance the layer of glass wool is indicated at 48 and is maintained in place by means of a foraminated cylinder of fiber 49

formed from a flat blank. The edges thereof are locked together by means of offset tabs 49. It will be apparent that the cylinder 49 not only serves to hold the layer of glass wool 48 in place but also to engage the edge of the disc 41 which supports the insulating layer 40. As a result of the foregoing the inside surface of the holder is almost entirely baffled with insulation. Insulating materials other than glass wool were found to give promising results. A batting of vegetable fiber such as cotton was found to act in a manner comparable to glass wool although it is not recommended since not chemically inert. Even finely shredded metallic wool may be used with good effect, and while the practical tests were performed using steel wool, equally satisfactory operation may be achieved using metals in the non-ferrous category.

Because of the striking improvement in crystal output which resulted from the use of glass wool in the manner shown, additional studies were made to determine the basic reasons for the improvement. A series of "test" crystals of various modes of vibration were constructed in accordance with the most up-to-date techniques and an auxiliary crystal of the same frequency was made up which may be termed an "exploring crystal." The terminals of the latter were connected to a voltmeter capable of measuring the voltage set up by vibrating induced therein. The test crystal was then placed in a conventional oscillator circuit and caused to vibrate at a resonant frequency while the exploring crystal was moved from point to point in the immediate vicinity. When a test crystal was used having an extensional mode vibration, placing the exploring crystal in line with the direction of vibration produced a high reading on the voltmeter. This indicated clearly that supersonic vibrations were being set up in the air opposite the crystal edges with sufficient intensity to cause strong sympathetic vibration in the exploring crystal. Other test crystals vibrating in the flexural mode and the thickness shear mode were used. In each instance it was found that maximum pickup was obtained by placing the exploring crystal opposite a vibrating surface of the crystal. Based upon these and other observations it appears clear that a reduction in crystal activity occurs as a result of the supersonic waves set up in the air or other gaseous medium surrounding the crystal. It seems clear that for a certain spacing between the crystal and wall of the holder the waves reflected therefrom strike the crystal totally or partially out of phase and the vibration becomes self-cancelling. This effect is a maximum when the spacing is an odd multiple of one-quarter wave length at crystal frequency. Because of the extremely short wave length of crystals ground to communications frequencies, the effect is rather critically dependent on atmospheric changes and other extraneous effects such as shock and vibration. This accounts in large measure for the unpredictable and erratic behavior of crystals previously considered defective.

It has been known in the past that supersonic vibrations could be set up in the air surrounding a crystal. However it has not been well appreciated that such vibrations may be of extremely high intensity, high enough to be strongly reflected from the walls of a crystal holder even though such walls may be spaced many wave lengths away from the crystal. Up until the present time no practical means had been de-

vised for positively insuring the elimination of such reflections or reverberations regardless of the frequency of the crystal and the nature and spacing of the interior surfaces of the crystal holder.

Where the crystal is provided with a heating element and temperature regulator such as a bi-metallic strip it will be apparent that the layer of glass wool performs the additional function of thermal insulation. The present arrangement is especially desirable since radio equipment for military purposes is designed for operation at increasingly high temperatures and it is necessary for the crystal to be calibrated and operated at a temperature higher than the highest ambient temperature to eliminate frequency drift.

That the above principles are applicable to a wide range of crystal holders will be clear by referring to the alternative embodiment disclosed in Fig. 4. Here the holder 50 has a cap or shell 51 and a base 52. It will be assumed that the crystal 53 is one vibrating in the extensional mode so that we are primarily interested in any reflections along the vertical axis of the crystal, in other words, at the top and bottom edges thereof. Here the supersonic absorber includes a tuft of glass wool 54 which is maintained in place by a circular disc 55 of metal gauze having a large aperture 56 therein. The disc 55 is retained at the top of the holder by means of a cylindrical insert 58 which is C-shaped in cross section and preferably stressed to spring outwardly against the side walls of the cap. If desired a ring 60 of insulating material such as mica can be supported about the crystal by the insert 58 to prevent the crystal from being displaced laterally due to shock or vibration. Below the crystal and on the base 52 is arranged a tuft of glass wool 61 which may be held in place by means of the crossed spring wires disclosed in Fig. 2 or by a thin disc 62 of flexible material having a large opening 63 therein as illustrated.

When using either of the embodiments discussed above it is not necessary to use any care in spacing the crystal surfaces from the walls of the holder, nor is it necessary to make adjustments or perform measurements as when using vibration reflectors shown in the prior art. On the contrary it is sufficient to insert the glass wool or other porous absorptive material as the holder moves down the production line and preparatory to mounting the crystal. The cost of the materials involved is negligible. As a result of the improved operation, even the most exacting military specifications may be consistently met, and the necessity for either discarding a crystal or for re-working it in an attempt to obtain increased output is eliminated.

In the following claims the term "dead air space" refers to the space immediately surrounding the crystal and would obviously include such space regardless of whether the gas included in the crystal is air or some other gas and without limitation to any particular pressure therein.

I claim as my invention:

1. A holder for a piezoelectric crystal comprising in combination a cup-shaped cap and a base, said base having electrodes mounted thereon for supporting the crystal centrally within the holder, a layer of fibrous insulating material substantially covering the inner walls of the cap portion, and a layer of fibrous absorbing material substantially covering the surface of the base portion to prevent reflection and reverberation of supersonic vibrations within the holder.

5

2. A crystal holder for a piezoelectric crystal comprising in combination a shell type enclosure, electrodes for freely suspending the crystal centrally within the holder, the enclosure being of such size and shape as to define a relatively narrow dead air space surrounding said crystal and a relatively thin layer of fibrous insulating material substantially covering the inner walls of the enclosure to prevent reflection and reverberation of supersonic vibrations within the holder.

3. A holder for a piezoelectric crystal comprising a cup-shaped cap and a base, said base having electrodes for supporting the crystal centrally within the holder, a layer of fibrous insulating material capable of absorbing supersonic vibrations inside the end of the cap, a foraminated disk arranged adjacent the insulating material for supporting the same, a cylindrical layer of fibrous insulating material arranged about the walls of the cap, a foraminated cylinder of thin sheet material for retaining the insulating material against the walls of the holder and for retaining said supporting disk in place against the end of the cap so that supersonic vibrations either laterally or axially of the crystal are prevented from reflection and reverberation within the holder.

4. In a crystal holder for mounting a piezoelectric crystal, a cap and a base arranged to fit together for total enclosure of the crystal, supporting electrodes on said base for supporting the crystal centrally within the holder and spaced from the walls thereof, said cap having its inner surface covered with a layer of fibrous material capable of absorbing supersonic vibrations, said base portion having a layer of fibrous insulating material arranged thereon below the crystal and means including a resilient wire having its ends engaged by said base portion for overlying the layer of fibrous material thereon and retaining it in place.

6

5. A piezoelectric device comprising a hollow shell holder, a crystal supported centrally within the holder and having vibrating surfaces as well as non-vibrating surfaces, the enclosure being so formed and of such size relative to the crystal as to define a relatively narrow dead air space completely surrounding said crystal, and porous absorptive material mounted on the walls of the holder and disposed directly opposite only the vibrating ones of said crystal surfaces for direct reception and suppression of supersonic vibrations within the holder.

6. A holder for a piezoelectric crystal comprising, in combination, a shell-type enclosure, means for supporting a crystal generally centrally within said enclosure, said holder being so dimensioned as to provide a relatively narrow dead air space surrounding said crystal, said supporting means having members for engaging the crystal at spaced points while leaving the crystal surfaces substantially free of obstruction so that said surfaces are free to vibrate in said dead air space, and a layer of porous insulating material arranged adjacent the walls of said enclosure and opposite the vibrating surfaces of the crystal for preventing reflection and reverberation of supersonic vibrations within the holder.

JOHN D. HOLMBECK.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,967,184	Clapp	July 17, 1934
2,131,826	Thomas	Oct. 4, 1938
2,371,613	Fair	Mar. 20, 1945
2,412,030	Baldwin	Dec. 3, 1946
2,415,832	Mason	Feb. 18, 1947
2,438,345	Miller	Mar. 23, 1948