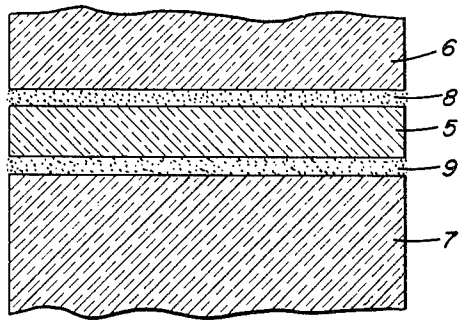
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ULTRASONIC COUPLING MEANS FOR PIEZOELECTRIC CRYSTALS

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ULTRASONIC COUPLING MEANS FOR PIEZO-ELECTRIC CRYSTALS

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This invention relates to ultrasonic coupling means for piezoelectric crystals as used, for example, in radar delay lines.

Where it is desired to couple a piezoelectric crystal to a solid support for transmission of high frequency or, more particularly, ultrasonic vibrations, the nature of the bonding material becomes of considerable importance. Many commonly used bonds are found to be unsatisfactory for this type of transmission. In the case of metals employed as solders, considerable difficulty is involved in finding a metal having the proper purity and flow characteristics, and in devising a technique of application suitable for the high temperatures and inert or reducing atmospheres required. In the case of plastics a lack of match in acoustical impedances is the outstanding difficulty.

In addition to the materials above mentioned, it has been proposed to use phenyl salicylate, acetyl phenyl salicylate and triphenylmethane as bonding agents for piezoelectric crystals. The chief defects of these substances lies in the low melting point of the phenyl salicylate, the lack of chemical stability in both salicylates, and the lack of physical stability in the triphenylmethane, the bond being weak, or becoming so, with time.

The bonds as hereinafter described overcome satisfactorily the difficulties of prior art bonds for use with ultrasonic vibrations.

The objects of the invention are included in the provision of a bond which has strong physical adherence to the surface of piezoelectric crystals and the supporting base throughout the temperature range of use; which has a satisfactory chemical stability through the heat range of use; which possesses a sharp melting point above the maximum temperature of use but sufficiently low to permit easy application; which exhibits the phenomenon known as supercooling to permit easy application; which has an impedance sufficiently high to provide a close acoustical match to the crystal; which is capable of providing an acoustical band-width of adequate dimensions; which is capable of withstanding vibration at an amplitude and frequency yielding 10 G stress per vibration for a total of at least ten million vibrations without deterioration; and which is electrically non-conducting.

Other objects and features will become apparent on consideration of the following description taken in conjunction with the single figure of drawing disclosing the relationship of crystal to the base substance.

As appears from the drawing, the piezoelectric crystal may take the form of the plate **5**. The bond or coupling means for obtaining an adequate physical integration with the supporting acoustical transmission material **6**, **7** is indicated by numerals **8**, **9**.

The bond substances are preferably one of the aromatic compounds benzil ($C_6H_5COCOC_6H_5$) or para-methoxybiphenyl ($C_6H_5C_6H_4OCH_3$), these chemicals meeting satisfactorily the necessary requirements for bonds subjected to ultrasonic vibrations. Both of these substances have melting points between 90° C. and 100° C. so that temperatures up to 85° may be reached in the crystal unit without harm to the bond. Both chemicals are physically and chemically stable and the chemical stability is not destroyed by short exposures to temperatures as high as 130° C. Both of these chemicals develop an acoustical band-width which measures between one-eighth and one-half of the center frequency. Both chemicals are electrically non-conducting. Both chemicals effect a strong bond which is permanent and which, when subjected to vibration at a frequency and amplitude to give 10 G stress, is maintained for at least ten million total vibrations, where G is the gravitational constant.

In applying this substance to the base material, the adjoining crystal and base surfaces should be flat and preferably roughened as by lapping with size 600 grit. These surfaces may be plated if desired. After cleaning the surfaces, they are heated in air to a point somewhat above 100° C., and a small amount of the chemical placed on one of the surfaces to be united. The surfaces then are joined, subjected to a small pressure as for example, ten pounds, and allowed to cool to room temperature.

It is apparent from the above description that the bond junction may be easily made, particularly since the melting points of the chemicals are below 100° C. and no special ambient gas conditions are required. Also, maintenance of the acoustical bond up to 85° is entirely adequate, this being five degrees below the lowest melting point of 90°, for para-methoxybiphenyl. In certain respects, para-methoxybiphenyl is preferred since it has good super-cooling properties making bond formation relatively easy. Also this compound has better mechanical strength and band width. An additional advantage of both chemicals lies in their non-conductance of electricity so that the electrodes are not shorted and the bonding material may thus be used in excess, if desired. Also, the bond, as described, readily transmits either compressional or transverse vibrations, and has noteworthy life in use.

Variations may, of course, be made in the precise disclosure as hereinabove set forth, and hence no limitation is implied other than may be required by the following claims.

What is claimed is:

1. A coupled piezo-electric unit for high frequency vibrations comprising a piezoelectric crystal, an acoustical transmitting material, and a bond connecting said crystal and material selected from the group consisting of para-methoxybiphenyl and benzil.

2. A coupled piezo-electric unit for high frequency vibrations comprising a piezoelectric crystal, an acoustical transmitting material, and a bond connecting said crystal and material consisting of para-methoxybiphenyl.

3. A coupled piezo-electric unit for high frequency vibrations comprising a piezoelectric crystal, an acoustical transmitting material, and a bond connecting said crystal and material consisting of benzil.

4. A coupled piezo-electric unit for high frequency vibration comprising a piezoelectric crystal, an acoustical transmitting material, and a permanent bond connecting said crystal and material consisting of an aromatic compound having a melting point between 90° C. and 100° C., a chemical stability not destroyed by short exposures to temperatures in excess of 100° C. and not over 130° C., an acoustical band width measuring between one-eighth and one-half of the center frequency, and insulating resistance to flow of electric current.

5. A coupled piezo-electric unit for high frequency vibrations comprising a piezoelectric crystal, an acoustical transmitting material, and a permanent bond connecting

said crystal and material consisting of a fused mass of an aromatic compound having a melting point between 90° C. and 100° C., a chemical stability not destroyed by short exposures to temperatures in excess of 100° C. and not over 130° C., an acoustical band width measuring between one-eighth and one-half of the center frequency, and insulating resistance to flow of electric current.

6. The coupled piezo-electric unit for high frequency vibrations as defined in claim 2 with said para-methoxy-biphenyl being in the form of a fused mass.

7. The coupled piezo-electric unit for high frequency vibrations as defined in claim 3 with said benzil being in the form of a fused mass.

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