Feb. 18, 1958 G. F. FISHER ET AL 2,824,219

PIEZOELECTRIC CRYSTAL ASSEMBLY

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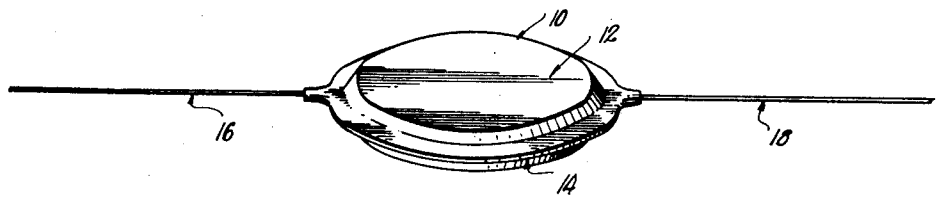


Fig. 1.

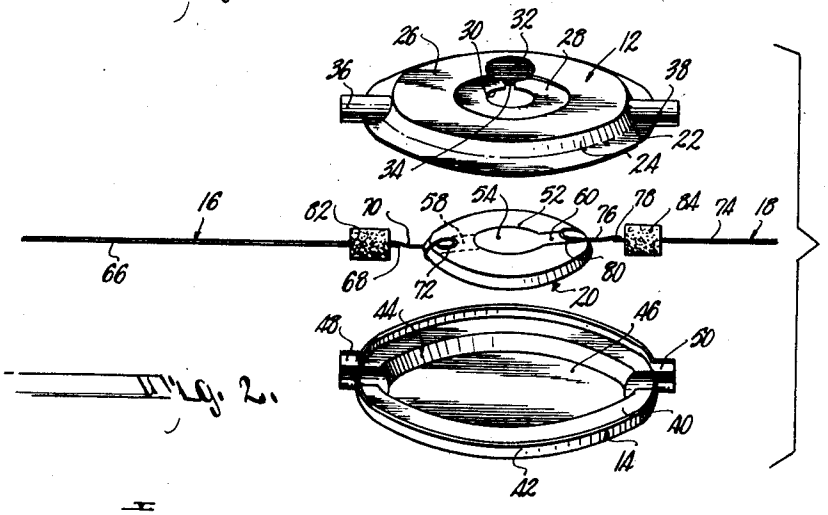


Fig. 2.

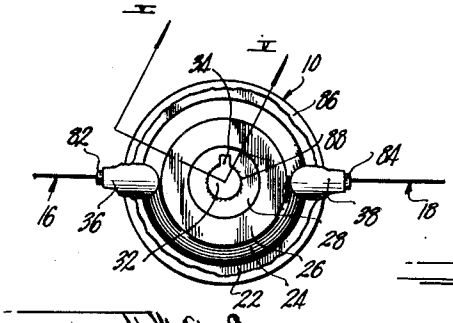


Fig. 3.

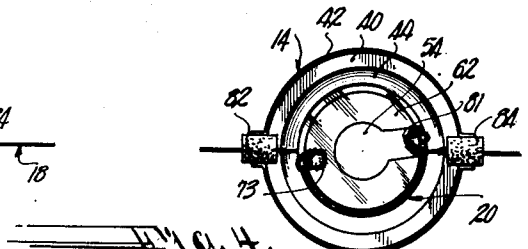


Fig. 4.

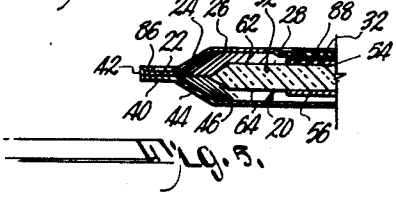


Fig. 5.

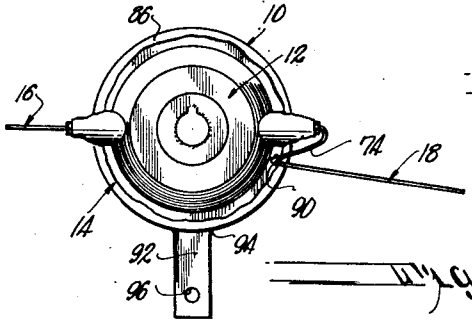


Fig. 6.

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PIEZOELECTRIC CRYSTAL ASSEMBLY

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1 Claim. (Cl. 310—9.4)

This invention relates generally to piezoelectric crystal assemblies and, more particularly, to an improved assembly of such type possessing important advantages over prior assemblies from the standpoints of miniaturization, ruggedness, simplicity of assembly and manufacturing economy.

One of the most important objects of the invention is to provide a piezoelectric crystal assembly of substantially flat, disc-like configuration whose dimensions have been minimized to present a miniaturized but rugged and operational efficient component adapted for mounting in electrical circuitry in substantially the same manner as is common with electrical condensers, resistors and the like.

Another important object of the invention is to provide such an assembly utilizing a metallic housing in surrounding relationship to the piezoelectric element so that the latter can be fully shielded by the grounding of such housing.

Another important object of the invention is to provide such a metallic housing for a piezoelectric element which has an opening conveniently disposed for depositing additional amounts of metal or the like upon the surface of the crystal element for final adjustment of the frequency of the latter after it has been assembled within the housing, together with closure means for quickly and conveniently sealing such opening after such final frequency adjustment has been completed.

Other important objects of the invention including important details of construction, will be made clear or become apparent as the following description of the assembly of this invention progresses.

In the accompanying drawing:

Figure 1 is a perspective view of a completed assembly made in accordance with the invention;

Fig. 2 is an exploded, perspective view of the principal, structural parts of the assembly after fabrication but before same have been assembled into a completed unit;

Fig. 3 is a top plan view of a completed unit made in accordance with the invention;

Fig. 4 is a top plan view of the unit in partially assembled condition with one of the sections of the housing not yet in place;

Fig. 5 is a fragmentary cross sectional view taken on line V—V of Fig. 3; and

Fig. 6 is a top plan view of a unit illustrating certain modifications contemplated by the invention.

Heretofore, piezoelectric crystal assemblies have characteristically been subject to one or more of the disadvantages of being heavy, bulky and space consuming or fragile in nature. This invention, accordingly, will be seen to evidence utility in overcoming all of such common disadvantages of conventional crystal assemblies. The combination of structure contemplated by this invention present an assembly which may be handled, mounted and connected into electrical circuitry in a manner generally analogous to those prevailing in respect of other conventional types of small electrical components. Manifestly, this results, not only in savings from elimination of unnecessary parts, such as mounting sockets and the like as used with conventional crystal assemblies, but also in substantial savings in materials used for manufacture of the assembly itself and in the labor required for its mounting and connection in electrical apparatus.

Referring now to the accompanying drawing, the numeral **10** broadly designates a piezoelectric crystal assembly made in accordance with the invention and including a pair of opposed housing sections broadly designated **12** and **14**, a pair of conductors broadly designated **16** and **18**, a piezoelectric crystal element broadly designated **20**, and certain other parts hereinafter more fully identified. Housing sections **12** and **14** are each essentially pan-like in character and are preferably formed of aluminum or some other strong but light and electrically conductive metal. Section **12** includes an outer, annular rim portion **22** from which is laterally offset at an angle an annular, frusto-conical portion **24** which, in turn, carries a circular, central portion **26** preferably having a circular indented portion **28** in which a substantially T-shaped cut has been made to present an opening **30** and a complementary closure piece **32** for opening **30** which is integrally connected with indented portion **28** by a radially extending stub **34**. At opposite edges of section **12**, a pair of substantially semi-cylindrical, channel forming portions **36** and **38** are impressed in rim portion **22** and a part of frusto-conical portion **24**, as most clearly illustrated in Fig. 2. Channel forming portions **36** and **38** are adapted to pass conductors **16** and **18** from the exterior of the sectioned housing **12—14** to the interior thereof.

Housing section **14** includes an annular rim portion **40** of dimensions substantially the same as those of rim portion **22** of section **12**, an annular flange or band portion **42** extending laterally from the circumferential edge of rim portion **40** in one direction, an annular, frusto-conical portion **44** extending laterally from the inner edge of rim portion **40** at an angle in a directiton opposite to that to which band portion **42** extends from rim portion **40**, and a circular, central portion **46** carried by frusto-conical portion **44** and closing the same. It may be noted that central portion **26** of section **12** and central portion **46** of section **14** are preferably substantially flat in order that the overall housing **12—14** may have a flat, disc-like configuration for conservation of mounting space. Section **14** is provided with a pair of channel forming portions **48** and **50** essentially similar to portions **36** and **38** of section **12**, except that portions **48** and **50** are stamped into band portion **42** of section **14** as well as rim portion **40** and frusto-conical portion **44** thereof. The manner in which the channels defined by portions **36, 38, 48** and **50** communicate with the cavities of sections **12** and **14**, and therefore, the interior chamber defined by sections **12** and **14** when in assembled condition, will be particularly clear from Fig. 2.

Although various shapes of substantially flat, plate-like pieces of quartz or other piezoelectric material can be used as the crystal element **20** without departing from the invention (it being noted that the generally circular shape of sections **12** and **14** can even be altered to accommodate elements **20** of different shape, if desired), the preferred form of element **20** is illustrated and comprises a circular disc-like plate **52** of quartz cut from the mother crystal at an angle adapting the same for operation in a high frequency, thickness shear mode of vibration. Here again, although it is to be understood that the type of plate **52** described is currently deemed best adapted for accomplishment of the miniaturization objectives of the invention, other cuts of quartz or crystals of

other materials could obviously be used with some advantage being realized from the structural combination.

Plate 52 is provided with a pair of thin, metallic electrode coatings 54 and 56 respectively deposited on the opposite major faces of the element 20. As will be clear from the drawing, each of electrode coatings 54 and 56 includes a contacting strip portion 58 and 60 respectively, it being noted that strip 58 extends from the main body of electrode 56, which is centrally disposed upon its major face of element 20 to one side of the circumferential edge of element 20, while strip 60 extends from the main body of electrode 54 toward the opposite circumferential edge of element 20. The major faces of element 20 upon which electrode coatings 54 and 56 are disposed are respectively identified by the numerals 62 and 64 in Fig. 5.

Conductor 16 preferably includes a length 66 of tinned, reasonably flexible although resilient wire to one end of which is attached by soldering or the like as at 68, a relatively shorter length 70 of highly resilient wire, such as Phosphor bronze, having a two-turn coil 72 formed therein. The adjacent turns of coil 72 are normally disposed in interengagement with each other and are, accordingly, adapted to frictionally grip element 20 when the latter is inserted therebetween, as most clearly indicated in Figs. 2 and 4. It will be understood that a portion of length 66 of conductor 16 extends into the channeling or passage formed by portion 36 of section 12 and portion 48 of section 14 when the sections 12 and 14 are in assembled condition. Length 70 of conductor 16 is, therefore, disposed substantially entirely within the interior chamber of sectioned housing 12—14. Similarly, conductor 18 includes a length 74 and a length 76 respectively corresponding to lengths 66 and 70 of conductor 16, lengths 74 and 76 being joined by soldering or the like as at 78, and a coil 80 similar to coil 72 being provided upon length 76. Preferably, coils 72 and 80 are also bonded to element 20 after insertion of the latter by means of any suitable cementitious material, as indicated at 73 and 81. Conductor 18 is adapted to pass through the channeling of portions 38 and 50 in the same manner as described for conductor 16 with respect to channel forming portions 36 and 48.

Conductors 16 and 18 are respectively provided with cylindrical supporting sleeves 82 and 84, which are of electrical insulating, and preferably resilient material such as rubber, plastic or the like. As will be clear from the drawing, sleeve 82 is adapted to be received within channel forming portions 36 and 38 when section 12 is emplaced upon section 14 with rim portion 22 of the former within band portion 42 and in abutment with rim portion 40 of the latter. Similarly, sleeve 84, through which conductor 18 passes, is accommodated by channel forming portions 38 and 50. It is significant that portions 36 and 38 of section 12 are of dimension such that they fit within the part of corresponding portions 48 and 50 of section 14 which are formed from band portion 14 thereof.

Accordingly, the steps in assembling the unit 10 will obviously be understood to include insertion of the element 20 within coils 72 and 80 of conductors 16 and 18 respectively in such manner that strips 58 and 60 of electrodes 56 and 54 are in respective electrical contacting engagement with coils 72 and 80 of conductors 16 and 18, the emplacement of sleeves 82 and 84 upon conductors 16 and 18 respectively in the manner illustrated in Fig. 2, the emplacement of conductors 16 and 18, element 20 and sleeves 82 and 84 within section 14 in such manner that sleeves 82 and 84 are received by and extend slightly beyond portions 48 and 50 respectively of section 14, in substantially the condition illustrated in Fig. 4. When the preceding steps have been completed, section 12 is emplaced upon section 14 with rim portion 22 of section 12 within band portion 42 of section 14 and in abutment with rim portion 40 of the latter. Manifestly, section 12 is rotated during this step to dispose portions 36 and 38 thereof in alignment with portions 48 and 50 of section 14 and, therefore, in engagement with sleeves 82 and 84 respectively. Presuming that fine adjustment of frequency may be desired after the element 20 has been mounted within housing 12—14, the closure 32 will at this stage of assembly be left in the open condition illustrated in Fig. 2. With the sections 12 and 14 in the relationship described, the band portion 42 of section 14 is then crimped over rim portion 22 of section 12 as at 86, and portions 36 and 48 and portions 38 and 50 are respectively crimped about sleeves 82 and 84 to tightly hold the latter and provide a substantial seal for the housing 12—14 (neglecting for the moment the opening 30).

If no fine adjustment of the frequency of response of the element 20 is necessary, the closure 32 is then bent into co-planar relationship with portion 28 of section 12 and the opening 30 sealed by soldering or the like as indicated at 88. If such final adjustment is desired, however, additional metal may conveniently be deposited upon face 62 of element 20 through the access afforded by opening 30 until the desired frequency of response for element 20 has been attained, as is well understood in the art. Closure member 32 is then moved to its co-planar relationship with parts 28 and soldered as at 88, as above explained. When so assembled, the unit 10 meets all ordinary requirements relative to hermetical sealing. However, if further protection for the housing 12—14 is desired, or if further protection against the ingress of moisture into the chamber of housing 12—14 is desired, a coating of any suitable wax or other material, for instance Glyptal, may be coated upon the unit 10 including the portions of conductors 16 and 18 immediately adjacent housing 12—14.

It will now be apparent that the overall unit 10 provides a piezoelectric component for use in electrical apparatus possessing many advantages over the bulky, expensive and inconvenient crystal mounting structures heretofore existing and conventionally used.

Reference is now made to Fig. 6 wherein are illustrated two important possible modifications of the basic structure above described. The first of these contemplates the possibility of length 74 of conductor 18 being soldered to the metallic body of housing 12—14 as at 90 to effect a shielding of element 20 by housing 12—14 where conductor 18 is to be grounded. Another modified construction which is useful in some applications, is the attachment of a lug or bracket 92 to housing 12—14 by soldering or the like as at 94, lug 92 preferably being provided with a perforation 96 for use in rigidly mounting the unit 10 to a chassis or the like (not shown). It may be further noted that lug 92 is preferably of a good conducting metal so that, by grounding the lug 92 in connection with its mounting, the housing 12—14 may thereby also be grounded for shielding purposes, even though the grounding connection 92 between housing 12—14 and conductor 18 may or may not also be utilized.

It will now be obvious to those skilled in the art that many minor modifications or changes might be made from the precise structure described without materially departing from the true spirit or intention of the invention. Accordingly, it is to be understood that the invention should be deemed limited only by the scope of the appended claim.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

A piezoelectric crystal assembly comprising a pair of opposed, generally circular, pan-like sections each having a cavity therein; means interconnecting the sections in opposed relationship to present a housing having a chamber therewithin; a piezoelectric crystal element within the chamber; a plurality of electrode coatings on the element; a conductor for each electrode coating respectively extending from the exterior of the housing into the chamber thereof; and structure for each of said conductors

respectively securing the same to the element for supporting the latter in spaced relationship to the sections, said structures each being conductive and in electrical contacting relationship with the corresponding one of said coatings, one of said sections being provided substantially centrally thereof with an initially open aperture for the depositing of material on the element from outside the housing and with means including a closure member of configuration complementary to the aperture for sealing said aperture after said depositing of material upon the element has been completed.

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