"HERMETICALLY SEALED PACKAGE"

The present invention relates to a hermetically sealed package and although it is not so restricted it relates more particularly to a package in which an integrated-circuit chip or the like is sealed.

Conventional hermetically sealed packages may be of the "TO-5" or "TO-8" type. Such a package consists of an hermetically sealed base which fixes a number of terminal pins to a metallic shell by an hermetic glass, and a metallic can which is fixed hermetically to the hermetically sealed base by resistance welding, cold welding or soldering. This package has the advantage that the hermetic seal is strong and complete, but it has the disadvantage that it is expensive and that there is a limit to the number of terminal pins which can be provided.

There are many other known hermetically sealed packages but these packages are complex to manufacture and are expensive. Moreover, these other packages are liable to leak since the hermetic seals of these packages are not strong and complete.

According to the present invention, there is provided an hermetically sealed package comprising a shell having a through hole; a can which is fixed hermetically to said shell to form an hermetically sealed space therewith; a circuit board which extends through the through-hole, the circuit board having a fixed part which is hermetically fixed in the through hole by fixing material, a sealed part which is disposed in the said hermetically sealed space, and a projecting part which extends outwardly of the hermetically sealed space; and a circuit

pattern on atleast one surface of the circuit board, said circuit pattern extending from the sealed part and through the fixed part to the projecting part.

The fixing material may be a non-conductive fixing material.

Alternatively, the shell and the can may be of electrically conductive material, there being provided at least one insulating film which extends at least throughout the fixed part, the or each insulating film having an electrically conductive film formed thereon which is sealed hermetically in the through hole by means of conductive fixing material.

Each of the opposite sides of the circuit board may be provided with a said insulating film and conductive film, the conductive films being in electrical contact.

The circuit pattern and the or each conductive film may have respective electrode portions which are separated by the insulating film to form at least one capacitor.

The circuit board may carry a quartz vibrator which is disposed in the sealed space.

The package of the present invention does not require terminal pins,and a large number of external lead electrodes may be taken out from it. The construction permits the hermetic seal to be made strong and complete, and with substantially no risk of a leakage. Moreover, the package can be produced at a low cost.

The invention is illustrated, merely by way of example, in the accompanying drawings which illustrate a quartz oscillator utilizing a hermetically sealed package according to the present invention. In these drawings:-

Figure 1 is an elevation of the package partly in section;

Figure 2 is a sectional viewtaken along the line II-II of Figure 1;

Figure 3 is a sectional view taken along the line III-III of Figure 1;

Figure 4 is a circuit diagram of a quartz oscillator used in the package;

Figure 5 is a rear elevation of the package omitting a can which forms part of the package;

Figure 6 is a rear elevation of a circuit board of the package showing a circuit pattern on the rear surface of the circuit board;

Figure 7 is an elevation of an insulated film which is provided on the rear surface of the circuit board;

Figure 8 is an elevation of a metallic film which is provided on the rear surface of the circuit board;

Figure 9 is an elevation of the circuit board showing a circuit pattern on the front surface thereof;

Figure 10 is an elevation of insulated films which are provided on the front surface of the circuit board;

Figure 11 is an elevation of an upper conductive film, comprising a metallic film which is provided on the front surface of the circuit board; and

Figure 12 is an elevation of an upper insulating film on the front surface of the circuit board.

An embodiment of a quartz oscillator utilizing a hermetically sealed package according to the present invention is described below with reference to the accompanying drawings.

Referring to Figures 1-3 and Figure 5, 1 is a circuit board made of ceramics or the like. One end portion of the circuit board 1 is constituted by a sealed part 1a which is sealed hermetically by the said hermetically sealed package. The opposite end portion of the circuit board 1 is constituted by a projecting part 1b which projects out from the hermetically sealed package. The middle portion of the circuit board 1 is constituted by a fixed part 1c to which a shell of the hermetically sealed package is fixed.

Figures 6-12 illustrate the formation of circuit patterns, capacitors and other components on the circuit board 1.

Figures 9-12 illustrate the formation of a circuit pattern 2 on a front surface of the circuit board 1.

As stated above, the circuit board 1 consists of a sealed part 1a, a fixed part 1c and a projecting part 1b. The circuit pattern 2 is formed on the front surface of the circuit board 1 as illustrated in Figure 9. The circuit pattern 2 comprises leads 3, two external lead electrodes 4a, 4b, and

three capacitor electrodes 5a, 5b, 5c. The circuit pattern 2 is made of a conductive paste by silk-screening or by some other method, and is then fixed or fired at an appropriate temperature to provide a hard conductive surface or joint. The conductive paste is made of a powder of tungsten or the like in a suitable vehicle. Two apertures 6 extend through the circuit board 1 and four cut-outs 7 are made at the edges of circuit board 1. The leads 3a extend to the apertures 6 and cut-outs 7 and can be electrically connected to a circuit pattern on the rear surface of the circuit board 1 because the conductive paste of the leads 3a is applied by silk-screening and extends through the apertures 6 and the cut-outs 7. The circuit pattern 2 is formed so as to extend from the sealed part 1a and through the fixed part 1c to the projecting part 1b.

After forming the circuit pattern 2 shown in Figure 9, three insulating films 8a, 8b, 8c as shown in Figure 10 are formed on the circuit pattern 2. The insulating films 8a, 8b,8c are made of an insulating paste by silk-screening or by some other method, and are then fixed or fired. The insulating paste is made of powdered alumina or the like in a suitable vehicle. The insulating film 8a is formed on the circuit pattern 2 so as to cover both the fixed part 1c of the circuit board 1 and the capacitor electrode 5a. The width of the insulating film 8a, i.e. vertical dimension as seen in Figure 10, is greater than the width of the fixed part 1c. The insulating films 8b, 8c respectively cover the capacitor electrodes 5b, 5c and are made a little

larger than the electrodes 5b, 5c. The insulating film 8a is formed by silk-screening up to the edges of the circuit board 1 so as to extend through cut-outs 9 at the edges of the fixed part 1c.

On the insulating films 8a, 8b, 8c there is formed an upper conductive film 10, as shown in Figure 11. The upper conductive film 10 comprises electrodes 11a, 11b, 11c leads 12, and a metallic or other film 13.. The upper conductive film 10 is made of a conductive paste by silk-screening, and is then fixed or fired in the same manner as the circuit pattern 2. The metallic film 13 is aligned with the fixed part 1c of the circuit board 1, and is formed up to the edges of the circuit board 1 so as to extend through the cut-outs 9. The electrode 11b is used both as a capacitor and as a means of die-bonding an integrated-circuit chip 14. (Figures 1 and 2). If thin-film capactors are not necessary on the circuit board 1, the electrodes 5a, 5b, 5c, 11a, 11b, 11c and the insulating films 8b, 8c are not necessary, and the width of the insulating film 8a can be a little greater than the width of the fixed part 1c.

An upper insulating film 15, as shown in Figure 12, is formed on the upper conductive film 10. The upper insulating film 15 is made of an alumina paste by silk-screening, and is then fired or fixed. The upper insulating film 15 prevents a fixing material, such as solder, from flowing along the leads when a shell, as described later, is fixed to the metallic film 13.

Figures 6-8 illustrate the formation of the circuit pattern on the rear surface of the circuit board 1. A circuit pattern 16, as illustrated in Figure 6, is formed on the rear surface of the circuit board 1. The circuit pattern 16 comprises leads 17, four lead electrodes 18, and two independent electrodes 19. The circuit pattern 16 is made of conductive paste in the same manner as described above. The independent electrodes 19, and leads 17a are formed so as to extend respectively into the apertures 6 and the cut-outs 7 at the edges of the circuit board 1, and the leads 17a are connected to the leads 3a of the front surface of the circuit board 1.

An insulating film 20, which is illustrated in Figure 7, is made of the alumina paste and is formed on the circuit pattern 16 by silk-screening. The insulating film 20 is formed to cover the fixed part 1c. The width of the insulating film 20, i.e. its dimension in the vertical direction as seen in Figure 7, is equal to the width of the insulating film 8a on the front surface of the circuit board 1, but the width of the insulating film 20 can be a little larger than the fixed part 1c. If the insulating films on both surfaces of the circuit board 1 are the same width, any bending of the circuit board 1 during firing will be small.

A metallic film 21, which is illustrated in Figure 8 and which is made of the conductive paste, is formed on the insulating film 20 by silk-screening. The metallic film 21 is formed up to the edges of the circuit board 1 so as to

extend into the cut-outs 9 when the metallic film 21 is formed by silk-screening. The metallic film 21 is connected to the metallic film 13 on the front surface of the circuit board 1. The metallic films 13, 21 are formed in alignment with the fixed part 1c of the circuit board 1. As the width of the metallic film 21 is equal to the width of the metallic film 13, bending of the circuit board during firing is prevented.

If the circuit pattern 16 is not necessary on the rear surface of the circuit board 1 and only the circuit pattern 2 is formed on the front surface thereof, on the rear surface it is necessary to ensure that only the metallic film 21 is provided, and the metallic film 21 must be connected to the metallic film 13 on the front surface of the circuit board 1.

The circuit board 1, on the front surface of which there have been deposited the circuit pattern 2, the insulating films 8a, 8b, 8c, the upper conductive film 10 and the insulating film 15, and on the rear surface of which there have been deposited the circuit pattern 16, the insulating film 20 and the metallic film 21, is then completed by firing in a hearth. In this embodiment, the conductive parts of the circuit patterns and the metallic films are plated with nickel.

Referring now to Figures 1-5, the integrated-circuit chip 14 is bonded by conductive paste on the capacitor electrode 11b which is used for die-bonding. Pads on the integrated- circuit chip 14 and lands of the circuit pattern 2 are wired together by wire-bonding.

On the circuit board 1, three thin-film capacitors 22, 23, 24 are formed as before. The capacitor 22 consists of the electrodes 5a, 11a and the insulating film 8a which is disposed between the electrodes 5a, 11a. The capacitor 23 consists of the electrodes 5b, 11b and the insulating film 8b which is disposed between the electrodes 5b, 11b. The capacitor 24 consists of the electrodes 5c, 11c and the insulating film 8c which is disposed between the electrodes 5c, 11c.

On the rear surface of the circuit board 1, a quartz vibrator 25 is supported by two supporting members 26, 27. The supporting members 26, 27 are fixed to the independent electrodes 19. The capacitors 22-24 and the quartz vibrator 25 are connected as shown in Figure 4. The external lead electrodes 4a and 4b respectively constitute V_{DD} and V_{SS} terminals. The external lead electrodes 18 on the rear surface of the circuit board 1 constitute output terminals, reset terminals and the like.

28 is a shell having a through hole 28a (Figure 3) at its centre. Fixing material 29 extends through and fills the through hole 28a and is secured to the fixed part 1c of the circuit board 1. In this embodiment the shell 28 is made of a metal which is copper, Kovar (trademark) or the like, the fixing material 29 is a solder or a brazing material, and the shell 28 and the circuit board 1 are fixed hermetically by soldering or brazing. As the metallic films 13, 21 which are formed at the fixed part 1c extend to the edges of the

circuit board 1, and are formed around the circuit board 1, the shell 28 and the circuit board 1 are fixed hermetically by the fixing material 29 around the circuit board 1, and the hermetic seal is strong and complete. This is because the fixing material 29 extends through and fills the through hole 28a of the shell 28 to the circuit board 1, and extends around the circuit board 1. Moreover, since the horizontal dimension of the through hole 28a as seen in Figure 1 is big, the width of the fixed part 1c is big, and the length of the hermetic seal around the circuit board is small, the hermetic seal between the shell and the circuit board is strong and complete.

A housing or can 30 covers the sealed part 1a, and is fixed to a flange of the shell 28. The can 30 and shell 28 together form an hermetically sealed space 31 in which the sealed part 1a is disposed, the projecting part 1b extending outwardly of the space 31. In this embodiment, the can 30 is also made of a metal such as copper or Kovar. The can 30 and the shell 28 are fixed hermetically by resistance welding, cold welding or soldering. This hermetic seal between two metals is reliable, and there is little risk of leakage. The sealed part 1a of the circuit board 1 is shielded electro-magnetically by the hermetically sealed package, since the metallic films 13, 21 of the fixed part 1c of the circuit board 1 are connected to the V_{DD} terminal 4a at a contact point 31', and a voltage of the shell 28 and the can 30 is at earth potential.

In this embodiment, the fixing material 29 is constituted by a conductive fixing material such as a solder or a brazing material, but it can be constituted by a non-conductive material such as a low melting point glass. In such a case, it is possible that the metallic films 13, 21 and the insulating films 8a, 20 need not be formed on the circuit board 1. If the metallic can and the metallic shell are earthed and a non-conductive fixing material is used, the V_{DD} terminal 4a and the shell 28 can be connected by a lead wire.

The projecting part 1b of the circuit board 1 can be inserted into a connector which is not shown, and the lead wires can be soldered to the external lead electrodes of the projecting part 1b.

The frequency of the quartz oscillator 25 is adjusted by trimming the capacitor 22. Trimming of the capacitor 22 is effected by removing its upper conductive film by sand blasting or by a laser beam so as to reduce its capacitance.

The hermetically sealed package described above does not require terminal pins, is simple, and may be produced at low cost because the circuit board projects from the hermetically sealed package. Many external lead electrodes can be taken out from the hermetically sealed package, and more external lead electrodes can be taken from the hermetically sealed package by the formation of the circuit patterns on both surfaces of the circuit board.

Furthermore, the hermetic seal between the circuit board and the shell, and between the shell and the can are strong and complete, and leakage of the hermetically sealed package will rarely occur.

If a metallic shell and a metallic can are employed, the hermetic seal of the shell and the can, can be effected by resistance welding, cold welding or soldering and is very reliable. Moreover, if the shell and the can are earthed, an integrated-circuit chip or the like in the hermetically sealed package is shielded electro-magnetically, and is scarcely affected by stray capacitance.

C L A I M S

1. An hermetically sealed package comprising a shell having a through hole; a can which is fixed hermetically to said shell to form a hermetically sealed space therewith; a circuit board which extends through the through-hole, the circuit board having a fixed part which is hermetically fixed in the through-hole by fixing material, a sealed part which is disposed in the said hermetically sealed space, and a projecting part which extends outwardly of the hermetically sealed space; and a circuit pattern on at least one surface of the circuit board, said circuit pattern extending from the sealed part and through the fixed part to the projecting part.

2. A package as claimed in claim 1 in which the fixing material is a non-conductive fixing material.

3. A package as claimed in claim 1 in which the shell and can are of electrically conductive material, there being provided at least one insulating film which extends at least throughout the fixed part, the or each insulating film having an electrically conductive film formed thereon which is sealed hermetically in the through hole by means of conductive fixing material.

4. A package as claimed in claim 3 in which each of the opposite sides of the circuit board is provided with a said insulating film and conductive film, the conductive films being in electrical contact.

5. A package as claimed in claim 3 or 4 in which the circuit pattern and the or each conductive film have respective electrode portions which are separated by the insulating film to form at least one capacitor.

6. A package as claimed in any preceding claim in which the circuit board carries a quartz vibrator which is disposed in the sealed space.

7. An hermetically sealed package substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

8. A hermetically sealed package comprising: a shell having a through hole; a circuit board consisting of a sealed part, a fixed part and a projecting part, formed with a circuit pattern which extends from said sealed part through said fixed part to said projecting part on at least one surface thereof, and inserted into said through hole; a non-conductive fixing material fixing hermetically said fixed part of said circuit board into said through hole of said shell; and a can fixed hermetically to said shell, and sealing said sealed part of said circuit board together with said shell.

9. A hermetically sealed package comprising: a metallic shell having a through hole; a circuit board consisting of a sealed part, a fixed part and a projecting part formed with a circuit pattern extending from said sealed part through said fixed part to said projecting part on at least one surface thereof, and inserted into said through hole; at least one insulating film whose width is greater than the width of said fixed part formed on said circuit pattern to correspond with said fixed part; metallic films formed on said insulating film or on said fixed

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part, and formed around said circuit board; a conductive fixing material fixing hermetically said metallic films on said fixed part of said circuit board into said through hole of said metallic shell; and a metallic can fixed hermetically to said metallic shell, and sealing said sealed part together with said metallic shell.

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