

ELECTRONIC COMPONENT HAVING A RESONATOR ELEMENT
ARRANGED IN AN HERMETICALLY CLOSED HOUSING AND METHOD
FOR MANUFACTURING SUCH AN ELECTRONIC COMPONENT

The present invention concerns an electronic component having a resonator element in a hermetically sealed or closed case. Said case includes a main part with a base and at least one side wall of annular shape, and a cover fixed onto the main part. At least one portion of the cover is transparent to a determined wavelength of a light beam to allow the resonator element to be optically adjusted.

The invention also concerns a method of manufacturing an electronic component. The method includes the steps of making the main part of the case by stacking and securing sheets of hard material, such as ceramic material, and mounting a resonator element in a housing of the case prior to closing the case with a cover. The sheets are worked to define a base and at least one side wall.

The resonator element can be for example a piezoelectric resonator, such as a quartz resonator to be connected to an oscillator circuit. Most quartz resonators of small dimensions, which are used for example in electronic or electromechanical watches, are quartz tuning fork resonators. These quartz resonators are usually enclosed in cases in vacuum, in the case of generating low frequency signals supplied by the oscillator circuit, or in an inert gas atmosphere.

Generally, such resonators are mounted in ceramic cases for example, which are relatively flat. These cases generally include a main part of parallelepipedic shape inside which a resonator is mounted, and a rectangular cover fixed onto the main part. If the resonator is enclosed in vacuum in the case, said resonator can be adjusted optically through the transparent cover.

In this connection, JP Utility Model No. 54-35870 can be cited, which discloses an electronic component with a resonator element, which is arranged in a first housing of a main part of a case. This first housing is hermetically sealed by a transparent cover fixed using a preform on an annular edge of the first housing of the main part. An integrated oscillator circuit is arranged in a second housing of the main part of the case, which is separated from the first housing by a base. The second housing is closed by an opaque cover fixed onto an annular edge of the second housing of the main part. The integrated circuit is electrically connected to the resonator element through the base of the main part of the case.

One drawback of such an electronic component disclosed in JP Utility Model No. 54-35870 is that, in the event of lateral shocks on each cover, cracks can occur in

the cover or the material fixing the cover onto the main part, thus inducing a loss of sealing. These lateral shocks can occur during various manipulations, particularly during operations for assembling said electronic component in an electronic apparatus or on a printed circuit board. As the resonator element usually has to remain enclosed in vacuum in its case or in an inert gas atmosphere, the adjustment of the resonator element to generate signals of a determined frequency from the oscillator circuit may be impaired. The resonator can even stop oscillating. In order to minimise these problems, the corners and side faces of the covers have to be ground in accordance with special processes. Of course, this substantially increases the cost of such covers.

Another drawback of the electronic component of JP Utility Model No. 54-35870 is solely connected to the sealing method. Indeed, the technique commonly employed for sealing the case is to stack the various elements in a cavity of a metal plate, namely the preform on the main part of the case, and the cover on the preform. Thus, the three elements are accurately positioned. In order to do this, the mechanical tolerance of the cavity has to be very high so as to position the three elements properly.

It is thus a main object of the invention to overcome the drawbacks of the prior art by providing an electronic component having a resonator element hermetically enclosed in a case whose cover is protected from lateral shocks. Moreover, the manufacturing time and costs for such an electronic component with a protected case cover can be minimised.

The invention therefore concerns an electronic component cited hereinbefore which is characterised in that the cover is fixed onto a rim of the lateral wall of the main part, which is made of a hard material, such as a ceramic material, such that a part of the rim at least partially surrounds the lateral surface of the cover in order to ensure protection of the electronic component against lateral shocks.

One advantage of the electronic component according to the invention is that with such a rim or flange, one part of which partially surrounds the lateral surface of the cover to protect it from lateral shocks, the electronic component can be handled without any risk. Preferably, one portion of the rim completely surrounds the lateral surface of the cover. This allows the resonator element to be kept hermetically enclosed in its housing by the cover in an inert gas atmosphere or preferably in vacuum. Likewise, the positioning of the cover with respect to the main part of the case no longer depends on the mechanical tolerance of cavities used in the method for closing the case. This thus reduces the risk of poor alignment of the cover on the rim.

The height of the part of the rim which surrounds the lateral surface of the cover is preferably equal to or greater than the thickness of the cover fixed onto a rim shoulder, so that no edge of the cover projects from the upper face of the rim. A space can also be left between this part of the rim and the lateral surface of the cover to ensure better protection. In this way, lateral shocks occurring against the rim do not directly propagate on the cover. Thus, a transparent cover, for example of glass, can be used, obtained simply by scribing and breaking a conventional sheet of glass. This reduces the manufacturing costs of such an electronic component, since it is no longer necessary to work in a special manner the edges and angles of the cover made of glass or another material that may be friable or breakable.

In order to secure the cover to the rim, a first annular layer of gold plating is first of all deposited on the rim, as well as a second annular layer of gold plating deposited at the periphery of an inner face of the cover. A preform of a metal alloy is arranged between the two annular layers of gold plating to weld the cover by heating and pressing the cover against the rim. The metal alloy of the preform used can be composed of tin and gold.

If the resonator element has to be enclosed in vacuum, a getter type material, such as a layer of titanium or chromium, can be evaporated in the housing. After having hermetically sealed the resonator element housing, the layer of chromium or titanium can be activated particularly heated by a laser beam to act as a vacuum pump.

The invention therefore also concerns a method of manufacturing the aforesaid component, which is characterised in that the method includes a second series of steps of placing the cover on the rim of the main part, one part of which surrounds the lateral surface of the cover, said cover being positioned on the rim by the part of the rim surrounding the lateral surface of the cover, and fixing the cover onto the rim by heating metal layers arranged on the rim and the cover.

The objects, advantages and features of the electronic component having a resonator element, and its manufacturing method, will appear more clearly in the following description of at least one non-limiting embodiment of the invention in conjunction with the drawings, in which:

- Figure 1 shows a top view of the electronic component according to the invention, and
- Figure 2 shows a cross-section along the line A-A of Figure 1 of the electronic component according to the invention.

In the following description, none of the parts of the electronic component, which are well known to those skilled in this technical field, will be described in detail here.

Electronic component 1 is shown in a simplified manner in Figures 1 and 2. It includes a resonator element 5 mounted in a first housing 8 of a case of parallelepipedic form. The case includes a main part 2 with a lateral wall of annular shape 3 and a base 20, and a cover 4 fixed onto a shoulder of a rim 7 of lateral wall 3 to hermetically seal in vacuum housing 8 of the main part. This case can be for example 5 mm long, 3.2 mm wide and 1.08 mm high.

It's to be noted that the rim 7 defines an upper part of the lateral wall 3 with a shoulder on which the cover 4 is fixed.

Lateral wall 3, and base 20 of main part 2 of the case are preferably made of ceramic material in accordance with a conventional technique. In order to do this, several ceramic sheets are normally worked, stacked and fixed on top of each other to make base 20 and lateral wall 3 above and below the base.

A part of rim 7 entirely surrounds the cover of rectangular shape so as to protect it from any lateral shocks affecting the electronic component. The height of the part of rim 7 which surrounds cover 4 is greater than or equal to the thickness of the cover once fixed to said rim. In this way, no edge of the cover projects outside the case.

Owing to this rim 7 of main part 2, the electronic component can be handled without any risk. A space 22 separates the lateral surface of cover 4 of the part of rim 7 that surrounds it. The space can be of smaller dimensions than the thickness of the cover. This space 22 prevents any lateral shocks that may occur against said rim and which are capable of damaging the cover, from directly propagating to the cover.

Cover 4 of rectangular shape can advantageously be a glass cover, which is obtained simply by scribing and breaking a conventional sheet of glass. Since the cover is protected by a part of rim 7, it is no longer necessary to work the edges and corners of the cover in a special way, which reduces the manufacturing costs of such an electronic component.

In order to fix cover 4 on rim 7, a first annular layer of gold plating 10 is deposited by evaporation, or by another method, on the inner side of rim 7, in particular on the shoulder, and a second annular layer of gold plating 11 is deposited by evaporation or another method, on the periphery of an inner face of cover 4. This second annular layer 11 is not shown in Figure 1 to avoid overloading the drawing. An annular metal alloy preform 9 is deposited between the two annular layers of gold plating 10 and 11 in order to be able to weld cover 4 onto the shoulder of the rim 7 by

vacuum heating and pressing cover 4 against rim 7. This preform is for example made of an eutectic alloy of gold and tin so as to have a melting temperature higher than the temperature used in the subsequent processes for assembling electronic component 1.

5 Resonator element 5, enclosed in vacuum in housing 8 of main part 2, is preferably a piezoelectric resonator, which includes a quartz tuning fork. This conventional quartz tuning fork is formed of two parallel arms 5a and 5b to vibrate in bending mode, which are held on their base by a bridge 5c. Layers of metallisation are deposited on each arm 5a and 5b and on bridge 5c to form two groups of electrodes
10 6a and 6b so as to subject them to electrical fields capable of vibrating said arms 5a and 5b. Bridge 5c is fixed in a corner of housing 8 on two studs 12 integral with base 20 and lateral wall 3 to leave a space for arms 5a and 5b to vibrate in housing 8 between base 20 and cover 4.

For further details as to the embodiment or operation of such a resonator, the
15 reader may refer to the teaching drawn from EP Patent Application Nos. 1 111 770 A1 and 1 303 042 A1.

The adjustment or setting of the quartz resonator is carried out in a conventional manner on the finished product, i.e. when the cover hermetically seals housing 8 of the case under vacuum. For this adjustment, cover 4 includes at least
20 one portion transparent to a determined wavelength of a light beam, such as a laser beam. This cover can preferably be made of glass as described hereinbefore, or also of silicon, which is transparent to wavelengths greater than $1.3 \mu\text{m}$. The laser beam used in this case has a wavelength equal to or greater than $1.3 \mu\text{m}$.

In the embodiment shown in Figures 1 and 2, electronic component 1 further
25 includes a second housing 18 in main part 2, which is delimited by lateral wall 3 and base 20. This second housing 18 is arranged on an opposite face of the base to housing 8 of resonator element 5. An integrated circuit 15 having a stage oscillator is fixed onto base 20 in second housing 18.

Several metal pads of oscillator circuit 15, which are not shown, are connected
30 in a known manner by metal wires 16 to inner metal pads of the case. These inner metal pads of the case, which are not shown, are arranged on an annular support 17 integral with lateral wall 3 and base 20. These inner metal pads are connected by connection paths, which are not shown, to external connection pads 13 arranged on both sides of electronic component 1.

35 Second housing 18 is filled with a resin 19 to encapsulate integrated circuit 15 so as to protect it mechanically and from light. In this manner, the finished electronic

component 1 is configured like an SMD ("surface mounting device") type component so that it can be mounted for example on a printed circuit board.

Oscillator circuit 15 is also connected to quartz resonator 5 through base 20 by two connection paths 14 so as to produce signals at a frequency dependent on the resonator setting. These connection paths can be made of tungsten-nickel-gold.

In order to generate low frequency signals, quartz resonator 5 has to be vacuum enclosed in housing 8 so as to be adjusted or set on the finished electronic component by a laser beam as described hereinbefore. However, a residual pressure may remain in housing 8 of the order of 1 mbar. Consequently, a layer of chromium or titanium 21 can be deposited for example on a part of the inner face of cover 4 as getter type material. This chromium or titanium layer 21 can act as a vacuum pump when it is activated particularly by a laser beam through cover 4.

By activating this layer 21 by laser beam, particles of evaporated chromium or titanium can be deposited on the resonator and thus lower the oscillation frequency. Afterwards, it is possible to increase the frequency of the resonator to be adjusted by acting directly on the electrodes of the resonator.

It should be noted that this layer of chromium or titanium 21 could be deposited over the entire inner face of cover 4 acting as a primer layer for the gold plating layer 11. Moreover, the layer of chromium or titanium can also be placed at another location in housing 8, for example on base 20 or on resonator 5 provided that it is possible to activate it by a laser beam through cover 4 of the component.

From the description that has just been given, multiple variants of the electronic component can be designed by those skilled in the art without departing from the scope of the invention defined by the claims. The electronic component may include only the resonator element.

One could also envisage mounting the oscillator circuit in the same housing as the quartz resonator. This oscillator circuit can also include a real time clock function (RTC) or other functions.

One could also envisage mounting the resonator element in cases whose main part can be made of metal or glass, as has already been proposed for conventional tuning fork resonators. In such case, the part of the rim may only partially surround the lateral wall of the cover for example the four corners of the cover.

The resonator element can be adjusted prior to fixing the cover onto the rim of the lateral wall of the case. Finally, the housing including the resonator element can contain no getter type material.

CLAIMS

1. Electronic component (1) including at least one resonator element (5) arranged in a housing (8) of a case, which includes a main part (2) with a base (20) and at least one lateral wall (3) of annular shape, and a cover (4) fixed onto the main part to hermetically seal the housing of the case, at least one portion of the cover
5 being transparent to a determined wavelength of a light beam to allow the resonator element to be optically adjusted, characterised in that the cover (4) is fixed onto a rim (7) of the lateral wall (3) of the main part, which is made of a hard material, such as a ceramic material, such that one part of the rim entirely surrounds the lateral surface of the cover (4) to ensure protection of the electronic component against lateral shocks.
- 10 2. Electronic component (1) according to claim 1, characterised in that the height of the part of the rim (7) surrounding the lateral surface of the cover (4) is larger than or equal to the thickness of the cover fixed onto the rim.
3. Electronic component (1) according to claim 1, characterised in that the transparent cover (4) is a glass cover.
- 15 4. Electronic component (1) according to claim 1, characterised in that the rim (7) of the main part (2) of the case receiving the cover includes a first annular layer of gold plating (10), in that the periphery of an inner face of the cover includes a second annular layer of gold plating (11), and in that the cover (4) is welded onto the rim using a metal alloy preform (9) arranged between the two annular layers of gold
20 plating, the metal alloy being able to be formed of tin and gold.
5. Electronic component (1) according to any one of claims 1 to 4, characterised in that it includes a space (22) between the lateral surface of the cover (4) and the part of the rim (7) surrounding the cover, the space being substantially of smaller dimensions than the thickness of the cover.
- 25 6. Electronic component (1) according to claim 1, wherein the housing (8) of the main part (2) of the case, which includes the resonator element (5) is vacuum sealed, characterised in that the resonator element is a quartz resonator able to be adjusted by a laser beam through the transparent portion of the cover (4), said quartz resonator being in the form of a turning fork with two parallel arms (5a, 5b) connected
30 to each other by a bridge (5c) and carrying electrodes (6a, 6b) to make them vibrate, and in that the main part of the case includes at least one stud (12) secured to the base (20) onto which the tuning fork is fixed, said electrodes being electrically connected through the main part of the case to external connection terminals (13).
- 35 7. Electronic component (1) according to claim 1, characterised in that it includes an oscillator circuit (15) electrically connected to the resonator element (5).

8. Electronic component (1) according to claim 7, characterised in that the oscillator circuit (15) is arranged in a second housing (18) of the main part (2), which is delimited by the lateral wall (3) and the base (20), the second housing being arranged on an opposite face of the base to the housing (8) of the resonator element (5), in that said oscillator circuit, which is encapsulated in the second housing by a resin (19), is electrically connected to external connection terminals (13) of the electronic component, and in that the base of the main part of the case includes electrical connection paths (14) for electrically connecting the oscillator circuit and the resonator element.
9. Electronic component (1) according to claim 1, characterised in that a getter type material is arranged in the housing (8) of the resonator element (5) to act as a vacuum pump when it is activated.
10. Electronic component (1) according to claim 9, characterised in that the getter type material is a layer of evaporated titanium or chromium (21) in the housing (8) of the resonator element, preferably on a part of the inner face of the cover (4), and in that this layer of titanium or chromium is capable of being activated by means of a laser beam through the transparent portion of the cover (4) to act as a vacuum pump and lower the oscillation frequency of the resonator element.
11. Method of manufacturing an electronic component according to any one of the preceding claims, the method including a first series of steps consisting in making the main part of the case by stacking and fixing sheets of hard material, such as a ceramic material, worked to define a base and at least one lateral wall, and mounting a resonator element in a housing of the case, characterised in that the method includes a second series of steps consisting in placing the cover on the rim of the main part, one part of which entirely surrounds the lateral surface of the cover, said cover being positioned on the rim by the part of the rim surrounding the lateral surface of the cover, and fixing the cover onto the rim by heating metal layers arranged on the rim and the cover.