SPECIFICATION

Electronic device and method of fabricating the same

The present invention relates to an electronic device assembled compactly in a small electronic watch or a similar apparatus as well as a method of fabricating such a device.

Generally, in an electronic device like an electronic watch a problem is encountered in reducing the space occupied by the module comprising a display device such as a liquid crystal display (LCD) or light-emitting diodes (LED), and electronic parts for driving the display device, such as semiconductors, capacitors, and battery. Also, another problem is encountered in simplifying the assembly of such electronic device or module and reducing the number of parts for assembly.

To overcome these problems, several attempts have recently been made which effectively utilize a semiconductor integrated circuit element (hereinafter referred to as an IC) comprising a plurality of active and passive elements interconnected in the IC, but problems occur in such attempts.

For example, in an electronic watch using an IC as disclosed in U.S. Patent Specification No. 3,986,335, an IC is enclosed by resin and the resin enclosure is provided with a portion receiving electronic parts (for example, a LED display device, a crystal oscillator, a variable capacitor, and a battery as a power source) which are attached externally of the IC. A compact module is made by electrically interconnecting these electronic parts and the IC with lead conductors. In this specification, the term 'lead conductor' means a member made of conductive material, formed in a strip so that electronic parts may be connected to the strip, thereby to form an electrical connection between the electronic parts through the conductive member.

This type of electronic watch, however, has defects which will now be described.

(1) In this type of module, the LED display is received into a cavity in the resin enclosure of the IC from the front surface of the enclosure and other electronic parts, such as a crystal oscillator, a variable capacitor and a battery, are received from the rear of the enclosure. The electronic parts attached externally of the IC are inserted from both the front and the rear of the resin enclosure of the IC and the terminals of said electronic parts are fixedly soldered to respective lead conductors on the opposite side to the side of insertion.

Accordingly this type of module is disadvantageously constructed thereby complicating the mounting operation and increasing the number of man-hours necessary to fabricate the device.

Also since this type of module is constructed by mounting the externally attached electronic parts individually on the resin enclosure of the IC, an inspection after assembly consumes much time and provides many obstacles against mass production, while high reliability products cannot be produced at low cost.

The complexity of this type of assembly and the intricacy of the inspection work after the assembly apply similarly to the module for an electronic watch of the type wherein a ceramic wiring base plate is used and various electronic parts are received in a housing formed from ceramic or similar materials.

(2) Since each of the electronic parts in this type of module is large, the area for receiving these parts is enlarged, resulting in a large resin enclosure. Hence in the enclosure of the IC in the resin and, after the enclosure by the resin, the stress produced by the difference in thermal expansion coefficient between the resin of the electronic part receiving portion and the lead conductors, and the thermal strain during the setting of resin is directly transmitted to the IC which degrades the properties and reliability of the IC.

Also, while this type of module needs a high-reliability resin with excellent moisture proof properties, shock resistance, chemical stability, etc. for enclosing the IC, the resin having this kind of property has disadvantageously inferior moulding properties and mould releasing properties so that an intricately-shaped mould for receiving intricately shaped electronic parts cannot be accurately worked nor provide moulding properties suitable for mass-production. On the other hand, when resin for the enclosure is used which has excellent mechanical strength, moulding properties and mould releasing properties when forming an intricately shaped mould for receiving the electronic parts, the resin having these properties is inferior in its moisture proof properties and chemical stability so that it disadvantageously degrades the performance of the IC. Hence it is difficult to provide the conventional type of module with an enclosure satisfying these two contradictory requirements.

(3) In this type of module, when the display device such as an LED display, etc. is received in a cavity in the resin enclosure of the IC and connected electrically to the exposed lead conductors, a problem is encountered which makes the assembly of a high reliability module difficult. Since the lead conductors are fixedly embedded only at one end in the resin enclosure of the IC which is to be electrically connected to the external terminal of the display device, such as an LED display device, and float at the other end (in a cantilever condition), their mechanical strength is low so that they may be bent or misaligned, thereby causing difficulties in operation or they may even be cut off when the display device is mounted on it and ohmically adhered thereto by press-bonding or soldering for electric connection to the external terminals.

When an LCD capable of indicating time at any time with small power consumption is used as the display device for this kind of IC resin enclosure, the LCD disadvantageously cannot be permanently integrated into the module as the display device. Since an LCD has a different

lifespan from an LED, ohmic bonding to the lead conductors in the resin enclosure by soldering or similar operations, as is performed in the case of use of an LED, needs to be avoided when an LCD is applied to this type of module, it is necessary to interconnect them electrically through an elastic conductor, like a zebra-connector, with mechanical pressure (depressing force) for permitting the replacement by a new LCD after the end of the life of the old one. However, in the mounting of the LCD with such a depressing force, each lead conductor in the resin enclosure is in the cantilever condition, and so is not flat because it is bent by the depressing force so that the display element cannot be provided with an ohmic contact of high reliability.

Also since the conventional type of module needs a large space for receiving a display device like said LED, it provides an obstacle against obtaining a compact module.

(4) This type of electronic watch receives, in its case, the module containing and electrically interconnecting the LED and the IC, battery, capacitor, crystal oscillator, etc. for driving the LED.

However, since the module is completely separated from the case, which is made of metal or plastics material in this type of watch, the size of the watch, particularly the thickness thereof, is enlarged, while the weight and cost are increased.

As a countermeasure against these defects, a proposal has been presented in which the frame of the module and the case of watch are formed by resin and integrated with each other.

However in this type of watch a block containing the IC chip and receiving the externally mounted electronic parts such as a capacitor, battery, crystal oscillator, and the case of the watch are formed by the same resin so that the resin for enclosing the IC chip needs to have high reliability in moisture proof properties, shock resistance. On the other hand the resin satisfying these requirements is inferior in moulding properties and mould releasing properties so that the block receiving intricately shaped electronic parts and the case of the watch cannot be accurately worked ant the moulding properties suited for mass-production are not obtained. Further, when resin superior in moulding properties and mould releasing properties is used for forming an intricately-shaped mould for the block and the case of the watch, the resin satisfying these properties is inferior in its moisture proof properties and chemical properties and disadvantageously degrades the performance of the IC. Accordingly, it is difficult in the this type of electronic watch to obtain a resin which satisfies these two contradictory requirements and it is impossible to obtain high performance and a resin of high reliability.

According to one aspect of the present invention, there is provided an electronic device comprising a semiconductor integrated circuit element, an enclosure embedding said element therein, lead conductors connecting said element and electronic parts of said device, and a block having a receiving section receiving therein at least one of said electronic parts, the lead conductors extending from said enclosure to said block and each having portions respectively buried in said enclosure and block, at least some of the lead conductors having portions exposed from said enclosure and from said block for making a connection between a display device and said element, said portions being held with the two ends thereof buried in said block and/or said enclosure, the block having a hole exposing a part of at least one of said lead conductors buried in said block, said at least one electronic part being electrically connected to said at least one of said lead conductors through said hole of the block.

The enclosure and the block may be integrally combined into a single body, or the block may be spaced from the enclosure and connected thereto by the lead conductors. In either case the block and the enclosure may be made of the same material or made of different materials. In the latter case it is preferably that the block is made of thermoplastic material and the enclosure is made of thermosetting material.

The display element may be located on the enclosure by a reference groove, for receiving the display device, formed in the block surrounding the enclosure. Alternatively the display device may be placed on a part of the block other than where the element is provided. In this case, the block under the display device may be provided with grooves or holes for receiving electronic parts other than the element.

According to a second aspect of the present invention, there is provided a process of manufacturing an electronic device comprising:

embedding a semiconductor integrated circuit element in an enclosure;

embedding lead conductors in a block and in the enclosure so that the lead conductors extend from the enclosure to the block and each have portions respectively buried in the enclosure and block, at least some of the lead conductors having portions exposed from the enclosure and from the block and held with the two ends thereof buried in the block and/or the enclosure for connection to a display device thereby connected to the element;

the block having a receiving section receiving at least one of a plurality of electronic parts; and

connecting said at least one electronic part through a hole in the block to a lead conductor buried in the block

The block and the enlosure may be formed in a number of ways:

(i) they may both be formed by a transfer moulding method using a single mould having cavities corresponding to the block and the enclosure.

(ii) the block may be formed by a transfer moulding method using a first mould and the enclosure formed by a transfer moulding method using a second mould.

(iii) the block may be formed by an injection moulding method using a first mould and the

enclosure formed by a transfer moulding method using a second mould.

(iv) the block may be formed by a transfer moulding method using a first mould and the enclosure formed by an injection moulding method using a second mould.

(v) the block may be formed by an injection moulding method using a first mould and the enclosure formed by an injection moulding method using a second mould.

(vi) the block and the enclosure are formed by a transfer moulding method with a plurality of resin injection systems, each system having a plurality of runners for injecting resin into a plurality of cavities from a respective source.

In any of these methods, the block and the enclosure may each be formed by either thermoplastic or thermosetting material; as appropriate to the intended method and use.

By the use of different resins the different requirements of the block and the enclosure may both be satisfied.

According to a third aspect of the present invention, there is provided an electronic watch comprising:

(a) a package comprising a plurality of lead conductors extending in a plane from a central portion to a peripheral portion thereof surrounding said central portion, an integrated circuit element and a plurality of electronic parts forming an electronic watch circuit, the integrated circuit element being fixed on one of said plurality of lead conductors at said central portion and electrically connected to the others thereat, an enclosure of insulating material embedding said integrated circuit and portions of said lead conductors at said central portion, and a block of insulating material embedding other portions of said lead conductors at said peripheral portion, parts of said lead conductors being exposed in spaces between said enclosure and said block, said block having at least one receiving groove exposing a part of at least one of said lead conductors;

(b) a display device including an upper display surface and a lower surface with a plurality of electrodes for receiving electronic signals from the electronic watch circuit;

(c) connection means electrically connecting the electrodes of the display device to said lead conductors exposed in said spaces, said connection means fitting within said spaces; and

(d) at least one electronic part of the electronic watch circuit being located in said receiving groove, said electronic part being electrically connected to the exposed part of said at least one lead conductor.

The present invention wil now be described in greater detail, by way of a series of examples, with reference to the accompanying drawings, wherein:—

Fig. 1 is a perspective view showing a package used in a first example of an electronic watch;

Fig. 2 is a top plan view of said package;

Fig. 3 is a bottom view of said package

Fig. 4 to 14 are respective sectional views of the package as viewed in the direction of arrows of Fig. 2;

Fig. 15 is an exploded perspective view showing the assembling of the electronic watch according to the first example;

Fig. 16 is a perspective view showing the electronic watch after assembling;

Fig. 17 is a perspective view as viewed from the rear of the electronic watch shown in Fig. 16;

Fig. 18 is a plan view showing a lead frame used for the fabrication of the electronic watch according to the first example (the term "lead frame" meaning a member of conductive material, a part of which may be used to form a lead conductor or a group of lead conductors);

Figs. 19 and 20 are plan views for explaining a fabricating method for an electronic watch according to the first example;

Figs. 21 to 26 are plan views showing the lead frame for fabricating the electronic watch according to the first example;

Figs. 27 and 28 are sectional views showing the peripheral portion of a lead conductor for a switch in a package used for an electronic watch according to the first example;

Figs. 29 to 33 show alternative arrangements of parts of the first example, Figs. 29 and 32 being sectional views and Figs. 30, 31 and 33 being plan views respectively;

Fig. 34 is an exploded view showing an LCD mounting frame in a liquid crystal display type of electronic watch according to an alternative form of the first example and respective parts of the electronic watch;

Fig. 35 is a sectional view of main portions similar to Fig. 34;

Figs. 36(a) and 36(b) are explanatory views showing known switch portions of a liquid crystal display type of electronic watch;

Fig. 37 is a sectional view showing a known switch portion and battery fixing portion which may be used in the first example in a light-emitting dode type of electronic watch;

Fig. 38 is a perspective view showing the package of a second example of an electronic watch;

Figs. 39 to 45 are plan views or rear views showing the process for fabricating the package according to the second example;

Fig. 46 is a schematic assembly drawing showing the assembly of an electronic watch (module) according to the second example;

Figs. 47 to 49 are schematic perspective views showing alternative arrangements of parts of the second example;

Figs. 50 to 56 are explanatory views of a third example of an electronic watch, Fig. 50 being a perspective view showing a package, Figs. 51 to 55 being plan views or rear views showing the process for fabricating the package, and Fig. 56 being a schematic assembly drawing showing the assembly of a module for an electronic watch;

Fig. 57 is a perspective view showing a package of a fourth example of an electronic watch;

Figs. 58 to 61 are plan views or rear views showing the process for fabricating the package shown in Fig. 57;

Fig. 62 is an exploded perspective view showing the assembly of electronic watch (module) according to the fourth example;

Fig. 63 is a plan view showing the watch module of a fifth example of an electronic watch;

Fig. 64 is a longitudinal sectional view taken along the arrow A—A of Fig. 63;

Fig. 65 is a longitudinal sectional view taken along the arrow B—B of Fig. 63;

Figs. 66 and 67 are longitudinal sectional views showing alternative arrangements of the watch module in the fifth example;

Fig. 68 is a perspective view showing a watch module in a sixth example of an electronic watch;

Fig. 69 is a longitudinal sectional view taken along the arrow A—A of Fig. 68;

Fig. 70 is a perspective view showing the neighbourhood of the external lead conductors of the IC according to the sixth example;

Fig. 71 is a plan view showing a lead frame of a seventh example;

Fig. 72 is an enlarged view of the neighbourhood of the plate nut shown in Fig. 71;

Figs. 73 and 74 are plan views showing other forms of plate nut of the seventh example;

Fig. 75 is a plan view showing an IC chip and other parts bonded to the lead frame shown in Fig. 71 and enclosed by resin;

Fig. 76 is a plan view showing a module for an electronic watch in which electronic parts are mounted on the frame shown in Fig. 75;

Fig. 77 is a longitudinal sectional view taken along the arrow A—A of Fig. 76;

Fig. 78 is an enlarged view of the neighbourhood of the plate nut shown in Fig. 77;

Fig. 79 is a plan view showing the arrangement of the resin injection routes in a transfer moulding machine in an eighth example;

Figs. 80(a) to 80(d) are perspective views for the description of the intersecting portion of the injection routes, (a) showing the lower mould, (b) pin, (c) the lower mould when the pin is raised and (d) the lower mould when the pin is lowered, respectively;

Fig. 81 is a perspective view (as viewed from below) showing the intersecting portion of the injection routes of the upper mould;

Figs. 82(a) and 82(b) are sectional views showing the conditions of fastened mould, (a) showing the condition of raised pins and (b) the condition of lowered pins respectively;

Figs. 83(a), 83(b) and 83(c) are sectional views showing the order of the resin injecting process sequentially, (a) showing the process of injecting resin A, (b) the process of lowering pins and (c) the process of injecting resin B;

Fig. 84 is a plan view showing the injection route of a second arrangement of the eight example;

Fig. 85 is a plan view showing an electronic watch of a ninth example;

Fig. 86 is a rear view of the electronic watch of Fig. 85.

Fig. 87 is a plan view showing a watch module including a watch case, the module being a part of the electronic watch according to the ninth example;

Fig. 88 is a plan view showing a decorative plate mounted on the surface of the watch module; and

Fig. 89 is a plan view showing a back cover mounted on the back surface of the watch module.

EXAMPLE I

The first example which is an electronic watch using an IC, will now be described with reference to Figures 1 to 37. These figures illustrate embodiments of the present invention.

Referring to Figs. 1 to 3, the package 1 of this example is a unit in which an enclosure 2 of an IC (not shown) is joined with a block 3 capable of receiving various electronic parts through lead conductors formed from a sheet of lead frame. Although the enclosure 2 and the block 3 are spaced from each other and formed separately, they are both formed by the use of resin material.

The surface of the resin block 3 into which portions of the lead conductors are fixedly embedded is provided with grooves and holes for receiving the electronic parts and electrically connecting their external terminals to the lead conductors. A hole 3A receives the battery, groove 3B receives the crystal oscillator, hole 3C receives a capacitor for temperature compensation and hole 3D receives a trimmer capacitor. The holes 3E and 3F receive chip capacitors and the groove 3G receives a lamp for illumination at night or has a luminous β light plate inserted in place of the lamp between the enclosure 2 and the display, e.g. a liquid crystal display (LCD) set thereon. Also fitting portions 3H to 3L are for fixedly attaching to the package 1 the frame by means of which the LCD, forming the display element, is mounted. The two holes 3H and 3J are provided with a slope. Holes in the form of notches 3K and 3L are formed with a slope on the side wall of the package 1.

The holes 3M and 3N are for electrically connecting the respective external terminals of the crystal oscillator to lead conductors, a portion of the lead frame being exposed within the holes 3M and 3N. The holes 3P and 3Q are for electrically connecting each external terminal of a trimmer capacitor to a lead conductor, a portion of each lead conductor being exposed within the holes 3P and 3Q. The holes 3R and 3S are for electrically connecting each external terminal of a lamp to lead conductors, a portion of the lead frame being exposed within the holes 3R and 3S.

Also, the surface of the enclosure 2 in the package 1 is recessed relative to that of the block 3. This portion is formed as a guide groove to facilitate the mounting of the LCD.

In addition, a small L-shaped groove 3G' provided on the enclosure 2 side in the groove 3G is for both location and guidance of a light diffusing plate relative to the enclosure 2.

The package 1 is provided with a groove for both locating and guiding an external terminal, between the groove or hole for receiving each electronic part and the hole for electrically connecting the external terminal thereof to a lead conductor, the groove being capable of receiving various electronic parts.

The various grooves or holes are for receiving various electronic parts in the package 1 and for the combined receiving locating and guiding of the external terminals of the electronic parts to electrically connect them to respective lead conductors. By providing this type of groove or hole on the package 1, the thickness of the package can be reduced while various electronic parts can be conveniently mounted and assembled in the package 1.

After mounting and assembling of various electronic parts in the package 1, where adjustment is needed in the properties of these electronic parts, the portion for receiving this type of electronic part is made as a through hole to permit the adjustment of the part from the opposite side of the package to the mounting and assembly side (see for example, the hole 3D for receiving a trimmer capacitor). Therefore, even after the various electronic parts are fixed to and mounted on the package 1, they can be subjected to adjustment in their properties easily and without mounting them removably on the package 1.

As shown in the exploded perspective view of Fig. 15, the holes or grooves provided in the block 3 of the package 1 receive a crystal oscillator 5, a temperature compensating capacitor 6, a trimmer capacitor 7, chip capacitors 8 and 9 and a lamp 10 from the front side of the package 1.

Then, from the same side, each of the external terminals is spot welded, soldered or silver pasted to a respective lead conductor on the exposed surface thereof. Also a battery 11 is inserted from the rear side of the package 1 so as to be pressed against a lead conductor for electrical connection thereto.

Next, after mounting a light diffusing plate 12 on the IC enclosure 2 in the package 1, conductive zebra-connectors 13 and 14 are mounted on the lead conductors, interposed between the enclosure 2 and the block 3, and on these connectors 13 and 14 is mounted an LCD 15. This LCD 15 is fixed to the package 1 by the use of an LCD mounting frame 16. The frame 16 includes a number of switch portions to provide one terminal of each of the switches, while providing a versatile member serving to hold the battery 11.

The mounting of frame 16 is accomplished by depressing, toward the package 1, four arms 16B extending downwards from the periphery 16A of the frame member of the LCD mounting frame 16 and elastically hooking the claws at the lower ends of the arms 16B over the edge of the block 3 onto the rear surface of the package 1. In this case, two of said arms 16B fit into holes 3H and 3J in the package 1 and the remaining two are fitted in holes 3K and 3L, which are provided with a sloped abutment surface, in the outer periphery of the package 1.

The module of the electronic watch which is mounted and assembled as described is shown from the front in the perspective view of Fig. 16 and the module as viewed from the rear side is shown in the perspective view of Fig. 17.

After the adjustment of the trimmer capacitor 7, etc. from the rear side as required, the electronic watch according to this example is obtained by placing this module in a watch case.

As described above, the electronic watch according to this example receives, in the package 1 containing the IC, from the front side of the package, the electronic parts, i.e. the crystal oscillator 5, the temperature compensation capacitor 6, the trimmer capacitor 7, chip capacitors 8 and 9 and the lamp 10, but not the Interchangeable battery 11 (which needs to be interchanged by removing the rear of the watch case) and this construction permits each external terminal of an electronic part to be spot-welded, soldered , or silver-pasted to exposed surfaces of the lead frame from the front side of the package 1.

Thus the electronic parts having external terminals fixed to lead conductors may be assembled from a main surface side, i.e. the front (or rear) side, of the resin member in which a part of said lead conductors are embedded. Thus, an electronic watch may comprise a package 1 consisting of a resin block embedding a portion of the lead conductors electrically interconnecting a plurality of electronic parts and an IC which is enclosed by resin, the electronic parts, such as a capacitor, a crystal oscillator, having external terminals fixed to respective lead conductors and being assembled from only one side of the package 1.

This example thus:

(1) simplifies the assembly of the electronic watch and the inspection work thereafter, since the various electronic parts are set in the package 1 from one side (either the front side or rear side) of the package and the external terminals of said electronic parts are electrically connected, for example, soldered, to the lead conductors exposed in the package 1 at the side receiving these electronic parts,

(2) simplifies the replacement of the battery and other parts, and permits such a replacement operation without adversely affecting the various electronic parts, since the battery which needs to be interchanged can be mounted from the rear side (or front side) of the package 1 which is opposite ato the assembling side of the electronic parts,

(3) permits the adjustment of electronic parts, such as the trimmer capacitor, with ease and high precision and without adversely affecting other electronic parts, since the adjustment of the electronic parts after completion of the assembly can be carried out on the rear side (or front side) of the package 1 which is opposite to the assembling side of the electronic parts,

(4) permits the assembly of the electronic watch consistently in the same direction without turning the package 1 upside down, since the various electronic parts are set in the package 1 from one side thereof. Accordingly the assembling operation and inspective measurement become very simple, while consistent flow processes and automatic mechanical assembly become possible. Hence a saving in man-power in the fabricating process is attained, whilst a considerable reduction in cost of production is accomplished, resulting in the provision of economical devices.

Also the electronic watch according to this example is an electronic device in which:

(1) the enclosure 2 of a semiconductor integrated circuit element, having an unstable surface, i.e. a surface subject to contamination, is completely separated from the block 3 receiving the externally mounted electronic parts (for example, crystal oscillator, capacitor, battery and display device such as an LCD or LED) to prevent interference by the deformation or strain of the block 3 with the characteristics of the semiconductor element within said enclosure 2; and

(2) the block 3 spaced from the enclosure 2 is joined therewith by lead conductors moulded from a lead frame while maintaining their spatial positions, and in addition, the electronic parts received in the block 3 are electrically connected to the elements within the enclosure 2.

Therefore:

(a) The deformation or strain of the block 3 does not affect the element within the enclosure 2 thereby preventing the characteristics of such elements from degradation.

(b) Materials for enclosing the semiconductor element and moulding the block can be suitably selected for attaining respective objects. Hence materials (resin, glass) for enclosing can be used which are chemically stable with good moisture proof properties, few unfavourable impurities such as sodium or chlorine, particularly few impurities liable to move as ions, i.e. materials with the property of being highly adhesive to the lead conductor. On the other hand materials (resin, ceramic,) for moulding the block 3 can be used which have excellent mechanical strength, good moulding properties, mould releasing properties, thermal deformation properties, thermal stability and shock resistance and can be subjected to precision work and also having a small difference between their thermal expansion coefficient and that of the lead conductors. Also low cost materials can be selected, differing from those for the enclosure. Further since the materials for enclosing the semiconductor element can be selected separately from the materials for moulding the block 3, the degree of freedom of selecting a material for use is enlarged.

Generally thermosetting materials are used for enclosing the semiconductor element and thermoplastic materials can be utilized for moulding the block 3.

(c) Opaque black resin can be used for the material for enclosing the semiconductor element and transparent resin can be used for moulding the block 3, which facilitates the assembly of the externally mounted electronic parts and provides a high value of product.

Further the electronic watch according to this example is formed such that the both ends of the lead conductor 4T (shown in Figure 18) are supported by the IC enclosure 2 and the block 3, and the LCD 15 makes ohmic contact with the lead conductor through zebra-connectors 13 and 14 by a mechanical depressing force. Accordingly since this ohmic contact is made stable by the use of the lead conductor 4T having both ends supported, it provides very high reliability and an easy assembly. It is because both ends of the lead conductors 4T are embedded in the resin enclosure 2 and the resin block 3 thereby being mechanically reinforced that, in the mounting of the LCD 15, the lead conductors 4T are not deflected, deformed nor displaced even when pressure is applied.

Also the module according to this first example utilizes the space between the two ends of each lead conductor for locating and receiving the zebra-connectors 13, 14 and the LCD 15. Thus useless space is eliminated and a very compact module is constructed.

(A) Detailed description of lead frame

Referring to Fig. 18, a plate is made of about 0.15 mm thick ferro-nickel alloy sheet to form lead frames containing each external lead conductor and wiring lead conductor of the externally mounted electronic parts of the IC. Further the plate 4 shown in the figure is partially cut away for the convenience of illustration and shows only two lead frame cells. Generally the plate 4 is shaped to have any number of lead frame cells.

After die bonding the IC chip 17 to tab 4U (Fig. 19), the lead conductors 4T are electrically connected to the pad electrode on the surface of the IC chip through thin metal wires 18, e.g. by thermal pressing or supersonic bonding. The lead conductors 4T and the tab are interconnected through a dam 4V to maintain the mechanical strength. The dam 4V acts as a stopper for preventing resin flow during resin moulding.

Each lead conductor 4T in the lead frame has its width reduced adjacent the dam 4V and has a small width where connected to the dam 4V, as shown in Fig. 21. By this shape the dam 4V is lengthened and the punching dimension in the cutting-off of the dam is thereby enlarged. Thus the possibility of breakage of the lead conductor 4T or cutting blade during punching is reduced and the dam 4V is easily cut off.

Alternatively the lead frame may be constructed by simply connecting the lead conductors 4T′ (shown in Fig. 22) by the dam 4V′. However this type of lead frame makes the pitch dimension z between the lead conductors 4T′ small, and when the pitch dimension z becomes less than about 0.8 mm, cutting-off the dam becomes difficult. This is because, when the dam

is cut off for the electrical separation of the lead conductors 4T' after moulding, the punching dimension of the dam cutting punch needs to be reduced and this is difficult in present production engineering so that the lead conductor 4T' tends to be damaged by buckling or shock caused by the punch during cutting-off of the dam. The previous arrangement avoids these types of damage.

Also portions of the dam 4V in the lead frame, as shown in Fig. 23, are left after the cutting-off of the dam and the remaining dam portion 4V'' is utilized as a lead conductor. This is necessary to provide connections which, within a predetermined space, permit many lead conductors to be provided in the small area occupied by the lead frame.

Lead conductors 4M and 4N, 4C and 4C', 4P and 4Q, 4E and 4E', 4F and 4F', 4R and 4S directly connect the crystal oscillator 5, the temperature compensation capacitor 6, the trimmer capacitor 7, the chip capacitors 8 and 9 and the lamp 10 respectively to the external lead conductor 4T of the lead frame.

The lead conductors 4M and 4N connected electrically to the external terminals of the crystal oscillator 5 are preferably arranged to be spaced as far as possible from the lead conductors which are electrically connected to an LCD segment terminal. Hence as shown in Fig. 24, the lead conductor 4C (electrically connected to the terminal V_{DD} of the power source) is interposed between lead conductors 4M and 4T'' and the lead conductor 4Q (electrically connected to the terminal V_{DD} of the power source) is interposed between lead conductors 4N and 4T''. Accordingly, lead conductors 4M and 4N are electrically separated from lead conductors 4T'' so that parasitic capacitance is not produced between these lead conductors and coupling, which otherwise tends to be produced between the lead conductors 4M and 4N electrically connected to the external terminal of the crystal oscillator 5 and the lead conductor 4T'' electrically connected to the LCD segment terminals, is not generated. Hence malfunction of the LCD 15 is not caused by the coupling.

In Fig. 18, the lead conductor shown as 4A is intended to make electric contact with the negative terminal of the battery 11, and the lead conductor 4A' is to make electric contact with the positive terminal of the battery.

A resin injection port 4W is for use when enclosing the IC chip and the periphery thereof by resin, the port 4W being provided with double wings 4W' and 4W'' as shown in Fig. 25. In the formation of the block 3, the double wings 4W' and 4W'' become embedded in the block 3 (shown by alternate long and short dash lines in Fig. 25).

This resin injection port 4W is provided with a runner for a metal mould into which resin is injected in the formation of the resin enclosure 2, when the resin enclosure 2 (shown by alternate long and two short dash lines in Fig. 25) and the block 3 are formed in the separate resin moulding operations. The resin injection port 4W in the lead frame and the runner in the metal mould prevent resin leakage to other portions when forming the resin enclosure 2. This resin injection port 4W is partly left behind in the package when the unnecessary portions of the lead frame such as the dam and the outer frame, are cut off after resin moulding. The remaining portion of the resin injection port 4W makes contact with the block 3 at only one surface so that it may tend to peel off. Therefore according to this embodiment, the double wings 4W' and 4W'' are provided to be fixedly embedded in the block 3. Hence the resin injection port 4W is firmly held by the package 1 through the double wings 4W' and 4W'' without peeling off from the package 1. Also the resin injection port 4W, through the double wings 4W', 4W'', serves to reinforce the block 3. The cavity portion (see Fig. 11) of the block 3 in the port area is reinforced to increase the mechanical strength of the block 3 and prevent the block 3 and the port area from breakage.

Since it is difficult for this type of lead frame to provide crossing wires, a number of lead conductors are connected to the terminals V_{DD} by wiring within the IC chip. Thus, by the use of single layer lead conductors formed by one sheet of plate-shaped lead frame, an electronic watch can be obtained which has it various electronic parts electrically connected to the IC chip (Fig. 31).

Alternatively, the terminals V_{DD} of the power supply are electrically interconnected at the pad electrodes on the chip or at the lead conductors by the use of bonding wire or jumper wire rather than by wiring within the chip, or by electrically interconnecting the lead conductors for the terminals V_{DD} of the power source by the use of jumper wire 25 after enclosing by resin (see Fig. 32). As a further alternative the tab 4U itself may form the terminal V_{DD} of the power source and be designed so that the tab hanging lead conductors are used for the lead conductor for the terminals V_{DD} of the power source (see Fig. 33). The IC chip 17 and the peripheral portions of the lead conductors 4T and the thin metal wire 18 are enclosed by resin to form the enclosure 2. Then the block 3 having holes and grooves for receiving the externally mounted electronic parts is formed so as to embed a portion of the lead conductors in resin (Fig. 20).

Three lead conductors 4X shown in Fig. 18 are the lead conductors for the switch terminals, and also play the part of a hanging lead for making the outer frame 4', of the lead frame support various lead conductors. Two lead conductors 4Y also act as hanging leads.

Each hanging lead portion 4X, as partially shown in Fig. 26, is provided, where connected to the outer frame 4', with an L-shaped slit 4*h* and a straight slit 4*j*.

These slits 4*h*, 4*j* are provided to produce local weak portions in the hanging lead and to absorb deformation forces due to thermal contraction produced in the resin moulding, for example in the

formation of the block 3, and thus prevent the whole lead frame from deforming. Also, since the hanging lead having this type of slit makes the deformation of the whole lead frame negligibly small, holes 4*d* to 4*f* (Fig. 18) in the lead frame 4 can be used for both locating and transporting the lead frame 4 and the package 1 after the forming work of the package 1 to facilitate rationalization and automation of operation.

A portion of each hanging lead 4X and 4Y in the lead frame is an extension of a lead conductor for the terminal V_{DD} of the power source. Thus any leads used exclusively for hanging leads are not needed so that the lead conductors can be arranged within the lead frame as much as possible. Also since each hanging lead becomes an extension of the lead conductor for the terminals V_{DD} of the power source, inspection and selection can be carried out without cutting off the outer frame 4' of the lead frame and inspector can be carried out during the production process and with a simple operation.

Holes 4*a* to 4*c* (Fig. 18) are holes provided in the outer frame 4' of the lead frame 4, Holes 4*a* and 4*b* are for preventing thermal deformation of the plate 4 in the resin moulding to form the package 1 and for improving the accuracy of forming the lead conductor pattern in the fabrication of the lead frame. Hole 4*c* is a feed hole used for the intermittent transport of the plate unit by one cell or frame unit, and hole 4*g* is for holding the plate 4 in the case of surface treatment (plating process) of the exposed surface of the lead conductors after the formation of the package 1.

Considering the shape of the lead frame, the gap between the outer frame 4' of the lead frame and the block 3 is generally selected to be somewhat larger than the minimum possible due to the production dimension of the metal mould for forming the package 1, the production dimension for forming the lead frame and in addition the alignment of the metal mould with the lead frame. Thus in the formation of the block 3 by resin, resin flow is produced in the gap to form a resin projection of fin in the outer circumference of the block 3, this projection easily peeling off in the handling of the package 1 to provide resin scrap which is often unfavourable for the production of this type of electronic device requiring clean processes.

This can be prevented by the arrangement shown in Fig. 29 in which the block 3 is formed such that a portion of the outer frame of the plate 4 is included in the block 3. In this case the side wall of the block 3 is formed with a step or shoulder, but the above-mentioned resin scrap is not produced. Further in the same figure, a metal mould 19 is for resin moulding to form the block 3.

Also another arrangement for preventing the production of this type of resin scrap is shown in Fig. 30 in which slits 20 and 21 are provided in the outer frame 4' of the lead frame 4 and the outer frame portion 22 connected to the lead conductor pattern is embedded in the package 1 during the formation of the package 1, this outer frame portion 22 and the lead conductor pattern being interconnected by the hanging lead conductor 23, and the outer frame portion 22 and the outer frame 4' provided with the slits 20 and 21 being interconnected by hanging lead conductors 24 for mechanical support. Further the area surrounded by the alternate long and short dash line in the same figure shows the area in which the package 1 is formed.

(B) Detailed description of the fabricating method of package 1

Since the enclosure 2 is separated from the block 3 in the fabrication of this type of package 1, various fabricating methods can be employed to select the moulding method which is the one most suitable for use.

The fabricating method of the package 1 and other parts will now be described.

(1) After the enclosure 2 is formed, around the IC chip on the lead frame and enclosing it, the block 3 is formed. Since the IC chip has an unstable surface, the enclosure is preferably carried out before the block 3 is moulded. Alternatively, the block 3 may be formed with the lead frame embedded therein and then the IC chip is mounted on the lead frame and enclosed.

In this method two moulds are needed for enclosing the IC chip and for moulding the block. The dam, which prevents the lead frame between the enclosure 2 and the block 3 from the resin flow during moulding, is not needed.

This is because the enclosure 2 (or the block 3), moulded beforehand, plays the part of a stopper against the resin flow which may come out of the metal mould in the subsequent moulding of the block 3 (or the enclosure 2).

Thus according to this method, the cutting operation of the dam of the lead frame is not needed and a simple-shaped lead frame is advantageously used.

(2) If the lead frame does not have a dam in the method described above at (1), unnecessary portions such as resin fins produced in the moulding of the enclosure 2 need to be removed. In this case, the lead frame may be deformed. To prevent the lead frame from deformation, the lead frame may still be provided with a dam when forming the enclosure 2 and the block 3 according to the method of (1).

(3) Alternatively, the lead frame is provided with a dam and also the enclosure 2 and the block 3 are formed at the same time or by the use of one metal mould for moulding. This is accomplished by providing separately a pressure injection port for resin for moulding the enclosure 2 and a pressure injection port for resin for moulding the block 3. This is particularly useful for the formation of the enclosure 2 and the block 3 by use of suitable respective resins.

Of course the package 1 may be fabricated by the use of the same resin for moulding both the enclosure 2 and the block 3. However the use of

different resin for the enclosure 2 and the block 3 is often useful.

Resin with excellent moisture proof properties, chemical stability, etc. is preferably used for moulding the enclosure 2. For example epoxy resin is preferably used.

On the other hand resin with a high mechanical strength, excellent mould releasing properties, and small thermal deformation is preferably used for moulding the block 3.

This method provides high productivity since it can use one metal mould to mould both the enclosure 2 and the block 3.

The enclosure 2 and the block 3 can be formed by one resin using a transfer moulding method.

However when the resin for moulding the enclosure 2 is different from the one for moulding the block 3, an intricate-shaped metal mould with many cavities is needed so that the price of the metal mould becomes very high and the requirement for easy model change is not satisfied. Hence the simply-shaped enclosure 2 is preferably formed by resin moulding by the transfer moulding method and the intricate-shaped block 3 is preferably formed by resin moulding by the injection moulding method. By employing such moulding methods the number of cavities in the metal mould for forming the block, which needs an intricate shape, can be reduced. Thus the block 3 can be produced by the use of a metal mould which is economical and easily subjected to model change.

Another arrangement of this example employs lead conductors of a tape carrier system and does not need the installation of the dam. In this arrangement, the IC chip is electrically connected to the lead conductors and provides the resin enclosure of the IC and the resin block by resin moulding.

Also since the use of the lead conductors of a tape carrier system provides a small wiring dimension, the wiring can be specified with a high degree of freedom. Thus it is not always necessary to minimize the length of the lead conductors and the total number of lead conductors for reducing the area occupied by the lead conductors (wiring) through the overlapping of the display device such as the LCD and the IC, i.e. the main element driving the display device. Hence an arrangement assembled without overlapping of the display device and the IC for driving the display device does not have a large area of lead conductors (wiring) and can provide an extremely thin type of electronic device.

A further arrangement of this example employs a lead conductor moulded from one sheet of lead frame and has the display device spaced from the IC so that the display device, such as an LCD, does not overlap the IC. Compared with the arrangement employing lead conductors formed from a tape carrier system, this arrangement has the same advantage in the production of the thin type of electronic device, but it has the disadvantage that the wiring (lead conductors) occupies a larger space. However it can provide a compact electronic device with the crystal oscillator, various capacitors and the battery, beneath the display device.

The arrangement in which the display device and the IC are spaced from each other without overlapping provides a thin type of electronic device whether it employs the above-described lead conductors of a tape carrier system or lead conductors moulded from one sheet of lead frame. Thus this type of electronic device is preferable for a thin electronic watch.

In the resin moulding of the enclosure 2 and the block 3, the portions of the lead conductors which are exposed (the area to which the external terminals of the electronic parts are connected) may be covered with a thin resin film. This film needs to be removed after resin moulding, and it is sometimes difficult to do this. Hence an arrangement is also possible in which the lead conductors which become covered with the resin film are provided with a coating which permits the resin film to peel off easily.

(C) Detailed description of package 1

Although the package 1 according to this example has already been described with reference to Figs. 1 to 14, it will now be described in more detail.

(1) The battery receiving portion is a through hole 3A (Fig. 1) and the lead conductor 4A making contact with the negative terminal of the battery is bent around the side wall of the block 3 to be depressed by the LCD mounting frame 16 (Figs. 6, 15 and 16). The lead conductor 4A' making contact with positive terminal of the battery is drawn out of the middle of the block 3 and bent along the side wall of the hole 3A (Fig. 6). These lead conductors 4A and 4A' are formed from one sheet of lead frame.

Thus (a) since the battery receiving portion is provided in the block 3 as a through hole 3A, the mechanical strength is high. (b) The electric contact between the negative terminal of the battery and the lead conductor 4A is reinforced by the LCD mounting frame 16 so that the thickness of the block 3 can be the same as that of the battery to provide a thin electronic watch. (c) The hole 3A, i.e. the battery receiving portion can, if required, be provided on the upper surface with a shoulder 3A' for supporting the battery (Figs. 1 and 3). Hence the battery is easily inserted and replaced.

(2) The groove 3G of the lamp receiving portion is enlarged. Hence in the arrangement using a β light plate in place of a lamp, the β light plate can be mounted on the package 1 in this groove before or after the assembling of the module. Thus, the β light plate can be built in the package 1 without the removal of the LCD from the package 1 after mounting the LCD.

The lead conductor for the switch is drawn out of the middle of the side wall of the package 1 and cut off, as shown in Fig. 27, the cross-sectional surface being made the switch contact surface. Hence the construction is simple and does not

produce any failures even with frequent operations of the switch. Also it has a high mechanical strength and occupies a small space so that a compact package 1 is obtained. Further, using this type of lead conductor for the switch can simplify the construction of a metal mould for moulding the package 1.

As shown in Fig. 28, a lead conductor for a switch may be constructed such that the package is provided with a through hole, the lead conductor having the switch contact surface being exposed within said through hole and other portions of the lead conductor being embedded in the package 1. In another arrangement, the lead conductor for the switch may be drawn out of the middle of the side wall of the package and bent at that portion.

Further in Figs. 27 and 28, a crown for operating the switch is shown by the alternate long and two short dashes line.

In another arrangement of an electronic watch according to this first example, the IC and the crystal oscillator, fixed capacitors, (the externally mounted electronic parts of the IC which do not require adjustment) are electrically connected to the lead conductors and then these elctronic parts are moulded by resin to provide the package.

This arrangement does not need the provision of the grooves and holes for receiving these electronic parts so that an extremely compact module is obtained.

Further in this arrangement, only the trimmer capacitor and similar parts which need adjustment in their properties may be fitted in the through holes provided in the package 1 and mounted subsequently on the package 1. Also in the package 1 having a lamp and other parts built therein, transparent resin is preferably used for moulding the package 1 in which the lamp is embedded.

Referring to Figs. 34 and 35 a disk-shaped block 38 is made of resin. An enclosure 39 is mounted in the middle of the block 38. The lead conductors 40 for the IC 39' in the enclosure 39 are exposed between the enclosure 39 and the block 38 and each end of the lead conductors 40 extends into the block 38 to form a wiring plate (conductive plate). Portions of lead conductors 40 protrude directly or indirectly through other parts into the capacitor groove 41, the trimmer capacitor groove 42, the crystal oscillator groove 43, the lamp groove 44 and the battery hole 45, each provided on the upper surface of the block 38, to form the terminal for connection of a respective electronic part. A capacitor 46 is inserted in said capacitor groove 41, a trimmer capacitor 47 in said trimmer capacitor groove 42, a crystal oscillator 48 in said crystal oscillator groove 43, a lamp 49 in said lamp groove 44 and a battery 50 is inserted from below into said battery hole 45.

Zebra-connectors 51 are respectively mounted on the lead conductors 40 at the two sides of the enclosure 39, and on these zebra-connectors 51 are mounted the liquid crystal panel 52. Also on the liquid crystal panel 52 is laid the LCD fixing frame 53 and four arms 55 to 58 which extend downwards from the periphery of the frame portion 54 of the LCD fixing frame 53 and hook their respective lower end claws 59 to 62 elastically on the lower surface of the block 38 to fix the liquid crystal panel 52 to the block 38. Two supports 55 and 56 fit in the holes 63 and 64 provided in the block 38 and the other two arms 57 and 58 fit in the grooves 65 and 66 formed by notches provided on the outer periphery of the block 38.

Also, from one side of the frame portion 54 of the LCD fixing frame 53 extends a plate-shaped battery holder (support portion) 67, one end of which projects above said battery hole 45 and makes contact with the upper surface of the battery terminal plate 68 projecting into the upper end of the battery hole 45.

Three switch portions 69 to 71 project horizontally from the frame portion 54 of the LCD fixing frame 53 and then bend downwards. These switch portions 69 to 71 are resilient and extend into switch grooves 72 to 74 provided on the outer periphery of the package 38. Also, from these switch grooves 72 to 74 project switch pieces 75 connected to the lead conductor extending in the package 38. Each of the switch pieces 76, 77 (mounted on the case, not shown, which covers the whole package) has an externally operable crown at 76, 77 as shown in Fig. 35, by means of which each of the switch portions 69 to 71 may be deflected to make contact with the corresponding switch piece 75.

Further, the window within the frame portion 54 of said LCD fixing frame 53 has a sufficient size for viewing the digital display portion 78 on the liquid crystal panel 52 from above. The arms 55 to 58, extending from the frame portion 54, the switch portions 69 to 71 and the battery support plate 67 are all formed from one sheet of metal plate, preferably a spring steel plate.

Thus, pieces of the LCD fixing frame can also act as resilient switch contacts and a battery support plate. Thus the number of parts can be reduced and the number of man-hours required for assembly, and also the cost, can be reduced.

Also, the LCD fixing frame according to this example is easily mounted and removed, the assembly thereof is simple. Also since it is formed from a suitable metal plate, for example spring steel plate, its bending strength is high so that the switch portions cannot be broken.

In an alternative arrangement, the end of the arms may be a press fit into holes in the package.

Generally a liquid crystal display type of electronic watch has a switch for inputting control signals from outside the watch and a switch for causing a lamp to light so as to illuminate a digital display surface. Each of these switches has one electrode which is electrically connected to one of the electrodes of the battery. In general, this electrode of the battery is electrically connected to the entire metal case of the watch. Each of these switches has a crown mounted on the metal case

as the other electrode. Thus the package on which respective electronic parts, such as the LCD, are mounted is provided with a switch plate opposite to the end of said switch member. The arrangement and construction of this switch plate shown in Fig. 36(a) (b), are known. In the construction shown in Fig. 36(a) (b), are known. In the construction shown in Fig. 36(a) the switch plate 27 is of metal plate fixedly soldered to the upper edge of a ceramic plate 26 adjacent the end of the switch member 28. In the construction of Fig. 36(b), one end of a supporting base plate 29 formed by a tape carrier (in which polyamide tape is provided on its front and rear surfaces with conductive layers having a desired pattern and connected to each other by conductors extending through the polyamide tape at predetermined positions and further semiconductor elements are fixed to the predetermined portion) or by a lead frame bent to provide an upright portion as the switch plate 30 adjacent which the end of the switch member 31 is located.

However, the former construction needs the switch plate 27 in addition to the ceramic plate 26 which increases the number of parts, while having the disadvantage that it is difficult to solder the switch plate 27 to the ceramic plate 26.

Moreover, since the thin polyamide resin occupies the main portion of the tape carrier, the latter construction has little rigidity and needs a guide for making the switch plate 30 upright, thereby increasing the number of parts. Also a lead frame of phosphorus bronze plate (PBP) or ferro-nickel alloy plate has the disadvantage of having a low beinding strength and being liable to breakage.

On the other hand, as shown in Fig. 37, in the case of a light-emitting diode (LED) type of digital watch a construction is known in which the end of the pressure plate 34 for a battery 33 mounted in a package 32 is bent to form a switch plate 35 which is located adjacent the end of a conductor plate 36, while the end of a switch member 37 is located in the neighbourhood of the switch plate 35. In this arrangement, the pressure plate 34 for the battery is formed by metal, the end thereof being arranged to make contact with the end of the conductor plate 36 when the former is subjected to an external force. Hence, the watch case does not have to be made of metal. Since a portion of the pressure plate 34 for the battery also plays the part of the switch plate 35, additional space for mounting the switch plate is not needed and a compact construction is obtained.

On the other hand, in the liquid crystal display (LCD) type of electronic watch in which the liquid crystal needs to be fixed to the supporting base plate, a construction may be employed in which the liquid crystal display is fixedly held by one end of a member, the other end of which is directly or indirectly fixed to the package.

EXAMPLE II

A second example, an electronic watch using an IC, will now be described with reference to Figures 38 to 49 of the drawings. These figures illustrate embodiments of the present invention.

First a package will be described in which the enclosure of the IC, according to this example is completely separated from the block receiving the externally mounted electronic parts, and joined to the block by lead conductors moulded in one sheet of lead frame.

As shown in Fig. 38, the package 79 according to this example is one in which the enclosure 80 enclosing the IC (not shown) is connected to the block 81 receiving the external electronic parts by the lead conductors, but the enclosure 80 and the block 81 are arranged separately from each other and moulded by the use of resin material. Lead conductor portions 82*a* to 82*f* are exposed as shown. The block 81 is moulded from resin and is provided on one surface with grooves and holes for receiving electronic parts. The hole 83 receives a battery, the groove 84 receives a crystal oscillator, the groove 85 receives a temperature compensation capacitor, the groove 86 receives a trimmer capacitor and the groove 87 receives a chip capacitor. The groove 88 and 89 are for electrically connecting the external terminals of the crystal oscillator to the lead conductors, the grooves being provided at their bottom ends with an exposed portion of the appropriate lead conductor. The grooves 90 and 91 are for electrically connecting the two external terminals of the trimmer capacitor to the lead conductors. The four threaded through holes 92 are for fastening a display device fixing plate to the package 79, the groove 93 is for receiving a lamp, and the grooves 94 and 95 are for electrically interconnecting the external terminals of the lamp to the lead conductors. Further an LCD is used for the display device and is mounted on the resin enclosure 80 of the IC using zebra-connnectors fitted in the guide groove 96 of the resin block 81.

Next an example of the fabricating method of this type of package 79 will be described, the numbers referring to the stages of the process.

(1) The lead frame 82 shown in Fig. 39 is prepared as the starting material. This lead frame 82 is made of about 0.15 mm thick ferro-nickel alloy plate and is formed with respective external lead conductors of the IC and wiring lead conductors for the externally mounted electronic parts.

The lead frame portion 82*g* is electrically connected to the pad electrode on the surface of the IC chip, the wiring lead conductors 82*b* and 82*c* are connected to the positive and the negative terminals of the battery respectively, and the wiring lead conductors 82*d*, 82*c* and 82*f* are for the switches, the tab 82*g* is die bonded to the IC chip terminals 82*h*, 82*j*, 82*k*, 82*z*, 82*m*, 82*n*, 82*p*, 82*q*, 82*r* and 82*s* are terminals of the lead conductors through which the crystal oscillator, the temperature compensation capacitor, the trimmer capacitor, the chip capacitor and the lamp are respectively electrically connected to the lead frame. A dam 82*t* is for preventing resin flow in

the resin moulding.

Further the lead frame 82 is partially cut away for the convenience of illustration.

(2) After die-bonding of the IC chip 97 to the tab 82*g* in the lead frame 82, the pad electrodes of the IC chip 97 and the lead conductor 82*a* of the lead frame 82 are interconnected with thin metal wire 98 of, for example, gold or aluminium, (Fig. 40). This is readily accomplished by well known wire bonding methods such as thermal welding, or supersonic bonding.

(3) The IC chip 97 is resin enclosed by a transfer moulding method (Fig. 41). Epoxy resin or similar materials with excellent moisture proof properties, chemical stability, are used for the resin.

In this case since resin fins 80' are formed around the enclosure 80; the removal of the resin fins is carried out together with the cutting-off of the dam 82*t* (Fig. 42).

(4) The block 81 receiving the externally mounted electronic parts is formed by an injection moulding method, or a transfer moulding method (Fig. 43); resin with excellent mechanical strength, moulding properties, mould releasing properties, low thermal deformability, is used. Grooves and holes for receiving the electronic parts are provided in this block 81. Hole 83 receives the battery. Also, grooves 84, 85, 86, 87, 93 receive the crystal oscillator, the temperature compensation capacitor, the trimmer capacitor, chip capacitor and the lamp respectively. Grooves 88, 89, 90, 91, 94 and 95 are for the electrical connection of said electronic parts, the lead conductors 82*b* to 82*s* and 82*z* being exposed at the bottom of the groove.

(5) The outer frame portion of the lead frame 82 is cut off to obtain the package 79 as shown in Figs. 44 and 45.

Next, the assembling of the electronic watch according to this example will be described. As shown in the schematic assembly drawing of Fig. 46, the holes and grooves in the resin block 81 of the package 79 receive respectively the crystal oscillator 99, the temperature compensation capacitor 100, the trimmer capacitor 101, the chip capacitor 102, the lamp 103 and the battery 104. Each terminal of these parts (excepting the battery) is fixedly secured to the exposed surface of the appropriate lead conductor by spot welding, solder, or silver paste. Before or after this assembly process the lead conductor extending along the side wall of the block 81 are bent. Then an LCD 106 and an LCD fixing plate 107 are mounted, with intervening zebra-connectors 105, on the resin enclosure 80 of the IC in the package 79, and fastened to the resin block 81 by the use of screws 108 and screw fasteners 109 to obtain the module 110.

Figs. 47 and 48 are schematic perspective views of packages in the electronic device of other arrangements of this example. In these figures are shown the resin enclosures 111 of ICs, and the resin block 112 for receiving the external electronic parts. Fig. 47 shows two ICs and the resin enclosures thereof 111 built in a predetermined portion of the resin block 112. Fig. 48 shows the package in which three enclosures 111 and the block 112 consisting of two parts are integrally combined by the lead conductor formed by one sheet of the lead frame.

Also, Fig. 49 is a schematic perspective view showing yet another arrangement of this second example. This figure shows an electronic device in which the lead conductors 114 are conducted out to the periphery of the resin enclosure 113 enclosing the IC, and the outer ends of the lead conductors 114 are embedded in the block 115. A connector, for example, a zebra-connector, is interposed on the lead conductors 114 between the enclosure 113 and the block 115 to connect the IC to the other electronic parts and to a display device such as an LCD. The block 115 mechanically reinforces the lead conductors 114 to prevent deflection thereof, while locating spatially the enclosure 113 and forming the receiving portion for the externally mounted electronic parts.

Accordingly an electronic device may be provided in which:

(1) the enclosure of the semiconductor IC having an unstable surface is completely separated from the block receiving the electronic parts mounted externally of the enclosure (for example, a crystal oscillator, a capacitor or a battery), so that deformation or strain of the block does not interfere with the properties of the IC element in said enclosure, and

(2) the enclosure and the block spaced therefrom are combined by the lead conductor, while maintaining their spatial positions, and in addition the electronic parts received in the latter block are electrically connected to the IC in the enclosure.

This example has generally similar advantages to the first example.

The following method may be used to fabricate this device.

(i) Since the surface of the semiconductor element is unstable, the enclosure is preferably formed before the block is moulded. The semiconductor element is mounted on the lead frame and enclosed, and then the block is formed. On the other hand, another method may be employed wherein, after the block is formed with the lead frame embedded, the semiconductor element is mounted on the lead frame and enclosed.

In this method, two metal moulds for moulding, i.e. a metal mould for enclosing the semiconductor element and a metal mould for moulding the block are needed. However, in this method, a dam is not necessary on the lead frame between the enclosure of the semiconductor element and the block for preventing resin flow during moulding work. This is because the enclosure (or the block) previously moulded acts as stopper against the resin flow flowing out of the metal mould in the subsequent moulding of the block (or the enclosure). Thus by means of this method, the

work of cutting off the dam on the lead frame is not needed and a simple-shaped lead frame can be advantageously used.

(ii) The absence of the dam on the lead frame in method (i) necessitates the cutting-off of unnecessary portions, such as resin fins produced in the enclosing of the IC and in this case the lead frame may be deformed. To prevent this a dam may still be provided on the lead frame as in method (i).

(iii) Alternatively, the dam is provided on the lead frame and the enclosure and the block are formed at the same time by the use of one metal mould. This method is particularly useful when the resin pressure injection port for the enclosure can be provided separately from the resin pressure injection port for moulding the block. Since this method uses one metal mould to mould the enclosure of the IC and the block at the same time, it has high versatility and productivity.

EXAMPLE III

An electronic watch using an IC, being a third example will now be described with reference to Figs. 50 to 56. These figures illustrate an embodiment of the present invention. First a package will be described according to this example in which the enclosure and the block are formed in an integral unit.

Referring first to Fig. 50, the package 116 is characterised in that the resin enclosure 117 enclosing the IC (not shown) and the resin block 118 having receiving portions for the external electronic parts are formed simultaneously, and the lead conductors make ohmic contact by mechanical pressing force with an LCD or similar display device, the ends of the exposed conductor portions 119*a* for the ohmic contact being embedded respectively in the resin enclosure 117 and the resin block 118 to be supported by them with high mechanical strength and to provide a high reliability contact.

The surface of the resin block 118 is provided with grooves and holes for receiving electronic parts. The hole 120 receives a battery, the groove 121 receives a crystal oscillator, the groove 122 receives a temperature compensation capacitor, the groove 123 receives a trimmer capacitor and the groove 124 receives a chip capacitor. Also the grooves 125 and 126 are for electrically connecting the external terminals of the crystal oscillator and the lead frame 119, the bottom of each groove being provided with an exposed portion of lead conductor. Four threaded through holes 129 are for fastening an LCD fixing plate to the package 116. The groove 130 receives a lamp and the grooves 131 and 132 are for electrically connecting the external terminals of the lamp to the lead conductors.

Each of two guide grooves 133 receives a zebra connector to electrically connect the LCD to the lead conductor 119*a* on which the LCD is mounted, and these parts are pressed together by the LCD fixing plate to engage with each other. The lead conductors 119*a* are supported at both ends by the resin enclosure 117 and the resin block 118 and neither bent nor broken by the ohmic contact of the LCD, despite said pressure which permits a good ohmic contact without adversely affecting the aligning and flatness of the LCD plate.

Next, an example of a fabricating method of this type of package will be described, the numbers referring to the stages of the process.

(1) The lead frame 119 shown in Fig. 51 is prepared as the starting material. This lead frame 119 is made of about 0.15 mm thick ferro-nickel plate and formed with lead conductors for respective externally mounted electronic parts and for the IC. Lead conductor 119*g* is the lead conductor electrically connected to the pad electrode on the surface of the IC chip, the lead conductors 119*b* and 119*c* are the lead conductors to be connected to the positive and the negative terminals of the battery, the lead conductors 119*d* to 119*f* are wiring lead conductors for switches, terminals 119*h* and 119*j*, 119*k* and 119*z*, 119*m* and 119*n*, 119*p* and 119*q*, 119*r* and 119*s* are the lead terminals for electrically connecting the external leads of the IC to the crystal oscillator, the temperature compensation capacitor, the trimmer capacitor, and the chip capacitor and for connecting the lamp respectively. Lead conductor 119*t* is the dam for preventing the resin flow in the resin moulding. Further, the lead frame 119 shown in the drawing is partially cut away for the convenience of illustration.

(2) After die bonding of the IC chip 134 to the tab 119*g* on the lead frame 119 the pad electrode on the IC chip 134 and the lead conductors 119*a* of the lead frame 119 are interconnected by thin wires 135 of metal, for example gold, or aluminium, (Fig. 52). This is easily accomplished by a well known technique such as thermal welding or supersonic bonding.

(3) The resin enclosure 117 is formed by resin enclosure of the IC chip 134 through a transfer moulding method and the resin block 118 is formed simultaneously which has a receiving portions for receiving the electronic parts (Fig. 53). Further, since in said resin moulding, resin fins are formed between the resin enclosure 117 and the resin block 118, they are removed when the dam is cut off.

(4) The outer frame of the lead frame 119 is cut off to obtain the package 116. A plan view of the package 116 is shown in Fig. 54 and the rear view in Fig. 55.

Next the assembly of the electronic watch according to this example will be described. As shown in the schematic assembly drawing of Fig. 56, the crystal oscillator 136, temperature compensation capacitor 137, trimmer capacitor 138, chip capacitor 139 lamp 140 and battery 141 are inserted in respective grooves and holes in the resin block 118 and respective terminals of these parts (other than the battery) are fixedly secured to the exposed surface of the lead conductors by spot welding, solder, or silver paste.

Before or after this assembly process, certain lead conductor portions extending beyond the side wall of the resin block 118 are bent.

Then zebra connectors 142 are positioned on the lead conductors 119*a*, and the LCD 143 and the LCD fixing plate 144 are fixed to the package 116 by the use of screws 145 and screw fasteners 146 to provide the module 147.

The module 147 according to this example uses the resin enclosure 117 and the resin block 118 for supporting the lead conductors 119*a* at both ends and in addition utilizes the space between these ends for receiving the zebra-connectors 142, for connection of the LCD 143. Hence the module is constructed to be extremely compact with very little useless space.

EXAMPLE IV

A fourth example of the present invention, an electronic watch using an IC, will now be described with reference to Figs. 57 to 62. These figures illustrate an embodiment of the present invention. First, a package will be described which is provided by the integrated combination of the resin block receiving the electronic parts mounted externally of the IC and the lead conductors moulded from one sheet of the lead frame. Referring to Fig. 57, the package 180 comprises a resin block 182 for receiving the IC (not shown) in its enclosure and the external electronic parts and is integrated with the lead conductors.

Also, exposed portions of the lead conductor are shown at 183*a* to 183*d*. The resin block 182 is provided on one surface with grooves and holes for receiving the electronic parts. The hole 184 is for receiving the battery, the groove 185 is for receiving the crystal oscillator, the groove 186 is for receiving the temperature compensation capacitor, the groove 187 is for receiving the trimmer capacitor, the groove 188 is for receiving the chip capacitor, the grooves 189, 190 are for electrically connecting the external terminals of the crystal oscillator to the lead conductors, the grooves being provided on the bottom with exposed portions 183*b* to 183*s* (Fig. 58) of the lead conductors, the grooves 191 and 192 are for electrically connecting both external terminals of the trimmer capacitor to the lead conductors, four threaded through holes 193 are for fastening the display device fixing plate to the package 180, the groove 194 is for receiving the lamp, and the grooves 195 and 196 are for electrically connecting the external terminals of the lamp to the appropriate lead conductors. Further an LCD is used for the display device and mounted over the IC with zebra-connectors engaged in guide grooves 197 in the resin block 182.

Next, an example of the fabricating method of this type of the package 180 will be described in greater detail.

(1) The lead frame 183 shown in Fig. 58 is prepared as the starting material. This lead frame 183 is made of approximately 0.15 mm thick ferro-nickel alloy plate or similar conductive material and formed with wiring lead conductors for the IC and the externally mounted electronic parts.

Lead conductors 183*a* are electrically connected to the IC, lead conductors 183*b* and 183*c* are for connecting the IC to the positive and the negative terminals of the battery respectively, the lead conductors 183*d* to 183*f* are for switches and lead conductors 183*h* and 183*j*, 183*k* and 183*z*, 183*m* and 183*n*, 183*p* and 183*q*, 183*r* and 183*s* are respectively the terminals of the lead conductor through which the crystal oscillator, temperature compensation capacitor, trimmer capacitor, chip capacitor and lamp are electrically connected thereto. Lead conductor 183*t* is the dam for preventing the resin flow in the resin moulding.

(2) The resin block 182 for receiving the externally mounted electronic parts is formed by injection moulding or transfer moulding (as shown in Fig. 59). Resin with excellent mechanical strength, moulding properties, mould releasing properties, low thermal deformation, is used. One portion of the resin block 182 is formed with resin fins which are removed when the dam is cut off.

(3) The outer part of the lead frame 183 is cut off to obtain the package 180. The front view of the package 180 is shown in Fig. 60 and the rear view in Fig. 61.

Next, as shown in the schematic assembly drawing of Fig. 62, a resin enclosure 181 embedding an IC is built in the resin block 182 in the package 180. By bonding the terminals of the IC to the lead conductors 183*a*, lead conductors are formed which extend from the enclosure to the block and have portions buried in the same. Then in each groove and hole of the resin block 182 are received the crystal oscillator 200, temperature compensation capacitor 201, trimmer capacitor 202, chip capacitor 203, lamp 204 and battery 205 each terminal of which (except the battery) is secured to the exposed surface of the lead conductor by spot welding, soldering or silver paste. Before or after this assembly process, each lead conductor extending to the side wall of the resin block 182 is bent. Then on the enclosure 181 in the package 180 in which these electronic parts are built, are mounted the LCD 207 and the LCD fixing plate 208 with intervening zebra-connectors 206. The LCD 207 and the LCD fixing plate 208 are fastened to the resin block 182 by the use of screws 209 and screw fasteners 210 to obtain the module 211.

In this example the enclosure 181 is spaced from the resin block 182 receiving the crystal oscillator 200, capacitors 201 to 203 and the battery 205, and the clearance between both parts is utilized for electrically connecting the LCD 207 to the IC through the zebra-connectors 206. The lead conductors are mechanically reinforced by the enclosure 181 and the resin block 182 so that the lead conductor 183*a* can not be deflected or displaced even when pressed during the mounting of the LCD 207. However the fact that the resin block 182 is spaced from the enclosure 181 has the effect of preventing degradation of

performance of the IC in the enclosure due to the resin block 182, the effect of enabling these parts to be moulded efficiently and in addition the significant effect of enabling the clearance produced to be utilized for mounting, locating and receiving said zebra-connectors 206, LCD 207, and of reinforcing mechanically the lead conductors 183*a*.

EXAMPLE V

Hereinafter an electronic watch, a fifth example, will be described with reference to Figs. 63 to 65. These figures illustrate embodiments of the present invention.

Referring to Fig. 63, an LCD 212 is used as the display device. The external terminals 212*a* of the LCD 212 make ohmic contact with the external lead conductors 213*a* in the package 213 through zebra-connectors 214 and this electric contact is made by pressing the LCD 212 through the fixing plate 215. The resin enclosure 216 in which the IC chip 217 is die bonded to an external lead conductor and wire bonded to other external lead conductors 213*a*, also forms the block and receives the externally mounted electronic parts, i.e. crystal oscillator 218, battery 219, various capacitors (trimmer, chip, temperature compensation). The frame member 216*a* and the reference wall body 216*b*, against which one end wall surface 212*a* of the LCD 212 abuts, are connected and integrated with the enclosure 216. In this frame member 216*a* is embedded one portion of a resilient member 220 which makes one end of the LCD 212 abut against the reference wall body 216*b* by pressing on the end wall surface 212B opposed to said wall body 216*b*. For this resilient member 220 is utilized a portion of the external lead conductor embedded in the package 213 and which is suitably bent to provide the property of a spring. The resilient member may, however, be a wedge-shaped part 220*a* (see Fig. 66) or an elastically resilient part 220*b* fastened by a screw (see Fig. 67).

Next the assembly of the watch module thus constructed will be described.

In the grooves and through holes in the frame member 216*a* which is an extension of the enclosure 216 of the IC 217, are received the crystal oscillator 218, the battery 219, various capacitors, and each terminal of these parts is secured to the exposed surface of a lead conductor 213*a* by spot welding, solder or silver paste. Before or after this assembly process, the exposed lead conductors 213*a* extending to the side wall of the frame member 216*a* are bent to form terminals for the switches and other parts.

Then the zebra-connectors 214 are mounted on the exposed lead conductors 213*a* and thereafter the LCD 212 is mounted on the zebra-connectors 214. Then LCD 212 is urged against the reference wall body 216*b*. This is accomplished by restraining the resilient member 220 while mounting the LCD 212 on the package 213 and releasing the resilient member 220 thereafter the mounting of the LCD 212. Since the resilient member 220 tends to return to its original condition due to its resilient properties, one end surface 212A of the LCD 212 abuts against the reference surface 216*b* as the resilient member 220 passes the other end surface 212B.

Next the fixing plate 215 is mounted on the LCD 212 and fastened to the package 213, by fasteners 221 to press the external electrode 212*a* of the LCD 212 and the exposed lead conductors 213*a* via the zebra-connectors 214 and electrically interconnecting these parts to complete the electronic watch module. Alternatively, the LCD 212 and the IC 217 may be electrically interconnected by the reference wall body 216*b* and the resilient member 220 thereby omitting the fixing plate 215.

Thus in the above described example, the LCD 212 can be located relative to the IC 217 with ease and high accuracy. Hence the external electrodes 212*a* of the LCD 212 make ohmic contact piece by piece with the respective exposed lead conductors 213*a*, through the zebra-connector 214, with high reliability of connection. Also since this arrangement permits the location of the LCD 212 only by the manipulation of the resilient member 220, the location of the LCD 212 can be made simple and easy, to permit a mechanical operation to be used.

This arrangement is particularly effective for an electronic device with compact dimensions in which the pitch between each external electrode of the LCD 212 and between each external lead of the IC 217 is small and each dimension of these parts is small.

EXAMPLE VI

An electronic wrist watch incorporating an LCD as the display element, being a sixth example, will now be described with reference to Figs. 68 to 70. These figures illustrate embodiments of the present invention.

In Figs. 68 and 69, an LCD 231 forming the display device is connected through its external electrode 231*a* to electronic parts adapted to drive the same. A block or frame 232 made of an organic resin or a similar material has grooves accommodating an enclosure 233 containing an IC for driving the LCD 231, the battery 234, the quartz oscillator 235, the trimmer condenser 236, the chip condenser 237, and the temperature correcting condenser 238. These components are mutually connected through external lead conductors 233*a* to 233*c* of the enclosure 233. The external lead conductors 233*a* to 233*c* are partially embedded in the enclosure 233 and the frame 232 and function as conductors for the connection of components 234 to 239 (239 denotes a lamp).

A part of each external lead conductor 233*a* is notched to form a tongue-like projection 233*b* adapted for connection to an external electrode 231*a* of the LCD 231. The electric connection to the external electrode 231*a* of the LCD 231 is thus achieved through a mechanical contact, making use of the resiliency of the external lead

conductors 233*a* and the projection 233*b*.

Fig. 70 shows a perspective view of a portion of the device around the external lead conductors 233*a* and 233*b* of the IC enclosure 233.

The LCD 231 is pressed onto the tongue-like projections 233*b* by means of a pressing plate 240. Fixture members 241 and 242 are provided for fixing the pressing plate 240 to the frame 232.

Consequently, the LCD 231 is electrically connected to the electronic parts for driving the same, without employing a separate connector such as a zebra-connector. Consequently, the IC enclosure 233 and the LCD can be mounted in a compact manner, although in this example they are superimposed as in the conventional arrangement.

Thus, the number of parts is reduced, and an improved ohmic contact is ensured, so as to render the electronic device compact and reliable. The electronic device is made compact because of the direct ohmic contact between the display device and the lead conductors, and the display device can be detached and replaced quite easily.

This example can be adopted in various electronic devices such as electronic wrist watches and desk-top calculators, incorporating display devices constituted by an LCD or an ECD (Electrochromic Display).

EXAMPLE VII

A seventh example will now be described in detail with specific reference to Fig. 71, which is a plan view of the lead frame of an electronic wrist watch according to the present invention.

This frame 243 consists of a plate of an iron-nickel alloy, having a thickness of about 0.15 mm in which are formed external lead conductors for an IC, lead conductors for external electronic parts and plate-like nuts 244. Also shown is a tab 245 to which an IC is to be die-bonded, external lead conductors 246 which are intended to be connected to pad electrodes on the IC chip surface, lead conductors 247 and 248 which are intended to be connected to the positive and negative terminals of the battery, and lead conductors 249 to 251 for switches. Pairs of lead conductors through which a quartz oscillator, a temperature correction capacitor, a trimmer capacitor, and a chip capacitor are connected to the external lead conductors of the IC or to the lamp are shown by leads 252, 253; 246*a*, 253*a*, 252*a*, 254; 246*b*, 246*c*; 246*d*, 246*e* and 249*a*, 255 respectively. A connecting piece 256 connects the frame body 257 of the lead frame 243 to the external lead conductor 246 and the plate-like nut 244.

For the sake of clarity, the lead frame 243 is illustrated with a part thereof broken away.

The lead frame 243 of this seventh example is characterized by having a plate-like nut 244. The plate-like nut 244 is shown in a larger scale in Fig. 72. This nut 244 is made of the same material as the external lead conductors 246 of the lead frame 243, lead conductors 247 to 255 and the connecting piece 256, i.e. made of an iron-nickel alloy. The peripheral portion of this nut is sealed and fixed by resin as hereinafter described. The nut 244 has a bore 244*c* the diameter *d* of which corresponds to the inner diameter of the threaded portion of a bolt or a screw. The length *z* of a notched part 244*b* is smaller than the outer diameter of the bolt or screw by a length equal to the diameter *d*. The length *z* of the notched part, number of the notched parts, and the shape of the same can be selected as desired, in accordance with the required uses of this plate-like nut 244.

Figs. 73 and 74 show other forms of the plate-like nut of the lead frame of this seventh example. Referring first to Fig. 73, the plate-like nut 244' is similar to that of Fig. 72, but is provided with slits 244'*a*. The slits 244'*a* are provided for enlarging the elastic limit of the plate-like nut 244', to increase the resilient cramping force which is thereby provided. The nut as shown in Fig. 74 has notched parts 244''*b* extending in a direction tangential to the bore 244''*c*, and peripheral slits 244''*a*.

Thus, the plate-like nut of the lead frame of this example can have various forms.

Fig. 75 is a plan view of the base portion of an electronic wrist watch module incorporating the lead frame of this example.

This module is fabricated in the following manner. An IC chip shown by broken lines in the figure is die-bonded to the tab 245 of the lead frame 243, and the pad electrodes on the IC chip surface are connected to the external lead conductors 246 of the lead frame 243 through a bonding wires. This structure is then sealed by a resin to form a resin-sealed body 258. Thus, in this example, the block and the enclosure are integrally combined. Finally, unnecessary parts of the lead frame such as the connecting piece 256 and the frame portion 257 are severed.

The resin-sealed body 258 accommodates in an airtight sealed manner the IC chip, and carries associated electronic parts such as the quartz oscillator, temperature correction capacitor, trimmer capacitor, chip capacitor, lamp, and battery. The grooves for accommodating these electronic parts are denoted by reference numerals 258*a* to 258*f*. The lead conductors exposed in these grooves constitute the terminals for the electric connections of these electronic parts.

The part of the resin-sealed body 258 adjacent each plate-like nut 244 is provided with a through bore. The lead frame portions around each plate-like nut 244 are sealed and fixed by the resin.

Referring to Figs. 76 and 77 the module is constructed as follows. A quartz oscillator, temperature correcting capacitor, trimmer capacitor, chip capacitor, lamp, and battery are received by corresponding bores and grooves of the resin-sealed body 258. The terminals of these parts are connected to the exposed lead conductors by means of spot welding, soldering or by a silver paste. An LCD 260 and a plate 261 for attaching the LCD are placed on the assembly thus formed, with intermediate zebra-connectors

259, and are fastened to the resin-sealed body 258 by means of screws or bolts 262 engaging the plate-like nuts 244, so as to form the module.

Fig. 77 shows the pad electrodes on the surface of an IC chip 263 connected to the external leads 246 via fine metal wires 264. The engagement of a plate-like nut 244 with the associated bolt 262 is shown on an enlarged scale in Fig. 78.

The lead frame of this example and electronic devices incorporating such a lead frame offer the following advantages.

1. It is not necessary to prepare and use separate nuts, because the nuts are formed on the lead frame, so that the number of parts of the electronic device, such as an electronic wrist watch is reduced.

2. The number of steps of the assembling process of the electronic devices is reduced due to the lead frame having plate-like nuts provided thereon.

3. In attaching the LCD, the fastening of the latter can be made gently, without incurring any malfunctions attributable to excessive tightening of the bolts or screws, due to the resilient nature of the plate-like nuts formed on the lead frame.

4. Consequently, this example achieves a reduced cost and size of the electronic device.

Thus, this example is an electronic device having a lead frame electrically connected to the electronic parts, including an IC, the portions of the lead frame around these electronic parts being sealed in an airtight manner, and the embodiment is thus suitable for use as a small-sized electronic device such as an electronic wrist watch.

EXAMPLE VIII

An eighth example will now be explained with reference to Figs. 79 to 84 which illustrate the arrangement for the resin supply in a mould of a transfer moulding machine. These figures illustrate part of a process of manufacturing an electronic device according to the present invention.

In a first arrangement shown in Fig. 79, ports 265A and 265B distribute the resin, whilst the resin flows through runners 266A and 266B. These runners communicate with moulding cavities 268A, 268B through respective gates 267A and 267B. the parts 265A to 268A constitute a resin charging line, whereas another resin charging line is formed by parts 265B to 268B. These resin charging systems intersect each other at a point 269.

Figs. 80*a* to 80*d* show the portion of the lower mould 271 around the point 269 of the intersection.

As may be seen from Fig. 80*a*, the lower mould 271 is provided, at the portion where the passage 272 for a first resin A intersects the passage 273 for the second resin B, with a hole 274 receiving a cylindrical pin 275 as shown in Fig. 80*b*. The pin 275 is movable up and down, as shown in Figs. 80*c* and 80*d*.

In operation, when the resin A is charged, the pin 275 is lifted up to the level of the surface of the lower mould 271 as shown in Fig. 80*c*, while, when the resin B is charged, the pin is lowered to the level of the bottom of the passages 272 and 273.

Fig. 81 is a bottom perspective view of the portion of an upper mould around the area of the intersection.

The upper mould 276 has a groove 277 corresponding to the resin passage 272 of the resin A, but has no groove which would correspond to the passage 273 for the resin B.

The portion illustrated by one-dot-and-dash line 278 corresponds to the hole 274 of the lower mould.

Figs. 82*a* and 82*b* show the mould in the closed state, in which Fig. 82*a* shows the pin in the lifted position, while Fig. 82*b* shows the same in the lowered state.

Figs. 83*a* to 83*c* show the method of charging the mould with the resins.

Initially, the resin A is charged, with the pin 275 kept in the lifted position. In this state, the passage 273 for the resin B is completely closed by the pin 275 extending into the space where two passage intersect each other, whilst the passage 272 for the resin A is not closed by the pin 275, due to the provision of the groove 277 formed in the upper mould, which acts as an intermediate passage. Consequently, the resin A is made to flow into the cavity through the passage 272, without flowing into the passage 273 for the resin B.

The pin 275 is lowered (Fig. 83*b*), while the moulds are still kept in the closed state, when the resin A has solidified. Consequently, the passage 273 for the resin B is opened through the space which has been occupied by the pin 275 during the operation of Fig. 83*a*. Subsequently, the resin is charged through the passage 273, as illustrated in Fig. 83*c*. The moulds are separated after sufficient solidification of the resin B, and the moulded article is removed from the opened moulds.

Due to the provision of the pin adapted to project temporarily into the space where the two resin passages intersect, two kinds of resin can be moulded in one cycle of the moulding operation.

Fig. 84 shows a second arrangement of the resin charging system which is so arranged that two resin charging lines do not intersect each other. This arrangement has the advantage over the first arrangement that it does not necessitate the mechanism for moving a pin up and down. However, on the other hand, the length of the resin passages is rendered long, in order that the passages do not intersect, resulting in an enlarged size of the moulds. This is inconvenient, especially when a large number of articles are to be moulded at one time. The second arrangement is therefore inferior to the first arrangement when all aspects are taken into consideration.

EXAMPLE IX

An electronic wrist watch which is a ninth example will be described in detail, with reference to Figs. 85 to 89. These figures illustrate an embodiment of the present invention.

Referring to Figs. 85 to 89 a watch case 279 is a body made of a resin, formed in one piece with a block 280 which is also made of a resin and adapted to accommodate electronic parts provided externally of an IC. A decorative plate 281 has a thin plate member 281*b* having a good appearance. The portion of the decorative plate 281 adapted to lie over the display device of the watch is made of a transparent material such as glass, while other portions are made of a plastics material. In the case where the display device is formed by an LCD, this plate also plays the role of a retainer for the LCD. This decorative plate is attached to the surface of the watch module by means of, for example, a bonding agent.

A back cover 283, which is provided as required, has a hatch 283*a* for the access to the battery for the purpose of replacement of the latter, and is suitably fixed to the back of the watch module 282. It is possible to omit this back cover. In such a case, a cover member, which plays the role of the hatch for access to the battery, is screwed to the back of the watch module 282. Also shown are switches 284 and 285 and a wrist band 286.

The watch module 282 of this example is formed principally by a resin enclosure 287 in which an IC is sealed, a block 280 consisting of resin and accommodating external electronic parts, and a watch case 279 which is formed with the same resin as the block 280 and in one piece with the latter.

The block 280 and the enclosure 287 are connected through the external lead conductors 288 of the IC. At the same time, the enclosure 287 is made separate from the one-piece structure of the block 280 and the watch case 279. The above mentioned external lead conductors 288 are embedded in the block 280 and the enclosure 287, but are exposed at portions of the block where the external electronic parts are to be installed. The external electronic parts are a quartz oscillator, trimmer capacitor, chip capacitor, temperature correcting capacitor and battery. Thus the block 280 has grooves 280*a* to 280*e* which receive these electronic parts, and in which are exposed portions 288*a* to 288*e* of the external lead conductors through which the IC is electrically connected to these electronic parts.

Lead conductors 288*f* are connected to switches 284 and 285, while holes 280*f* are provided around the lead conductors 288*f*, for bringing the external lead conductors into and out of contact in accordance with the turning on and off of the switches 284 and 285.

An example of the process for manufacturing this watch module will now be described.

(1) Initially, a lead frame is prepared as the starting material. This lead frame consists of a plate made of a ferro-nickel alloy, having a thickness of approximately 0.15 mm, on which are formed external lead conductors 288 of the IC and the wiring conductors 288*a* to 288*f* of the electronic parts.

(2) Then, the IC chip is attached to the tab of the lead frame by means of die-bonding. Subsequently, the pad electrodes on the IC chip surface are electrically connected to the external lead conductors 288, through fine wires of gold, aluminium or similar metallic material, by means of a heat-pressing method, ultrasonic-wave bonding or a similar known method.

(3) The IC chip and the periphery of the external lead conductors are sealed in a resin, by means of a transfer moulding technique, so as to form a resin enclosure 287. Epoxy resins or similar resins having an equivalent moisture-proof nature and chemical stability to epoxy resins are preferably used as the sealing resin.

(4) The block 280 accommodating the external electronic parts, and the watch case 279 are formed by means of an injection moulding or a transfer moulding. Resins having excellent mechanical strength, mouldability, good separation from the mould and small thermal deformation are used.

(5) Finally, unnecessary frame portions and burrs of resin are removed to complete the watch module.

A process of assembling these components to form an electronic wrist watch will now be described by way of example.

Initially, the electronic parts, for example the quartz oscillator, trimmer capacitor, chip capacitor, temperature correcting capacitor, and battery are placed in respective grooves 280*a* to 280*e* of the block 280 of the watch module 282, as shown in Fig. 87. These electronic parts (excluding the battery) are then fixed to the exposed lead conductors 288*a* to 288*e*, by means of soldering, spot welding or silver paste. Subsequently to or before this fixing step, the lead conductors are bent at the desired portions and the switches 284 and 285 are mounted on the watch module 282, with a predetermined clearance from the lead conductors 288*f*.

Then, an LCD is placed on the external lead conductors 288, with interposed zebra-connectors, and, subsequently, the decorative plate 281, which also functions as the LCD retainer, is attached to the watch module 282 by means of a bonding agent. After or before this attaching of this decorative plate 281, the back cover 283 is attached to the watch module 282, thus completing the production of the electronic wrist watch.

The electronic wrist watch having the described construction offers generally the same advantages as the first example.

Thus this example, when applied to an electronic watch, has the advantages that various designs of watch cases, such as for male or female use, can be used with the same IC enclosure. Various designs can be made by changing the shape, colour and surface conditions of the decorative plate. This effect can suitably be combined with the possibility of various designs of the watch case, to multiply the possibility of different designs. The decorative plate is also adapted to play the role of the LCD retainer, while

the watch case is constructed in one-piece with the block accommodating the external electronic parts, as a part of the watch module. In addition, the back cover can be suitably received by and fixed to the block. Consequently, the fabrication of the watch is considerably facilitated and the number of parts is advantageously reduced, contributing greatly to reduce the cost and size, especially the thickness, of the electronic wrist watch.

The present invention is not limited to an electronic watch, but may be applied to various electronic devices, particularly where the assembly dimensions should be as small as possible in order to provide a compact device which is simple and inexpensive to manufacture.

Attention is drawn to UK Patent Applications 80.06521, 80.06522, 80.06523, and 80.06625, divided from this application and containing claims to arrangements of electronic devices and methods of fabricating such devices disclosed herein.

CLAIMS

1. An electronic device comprising a semiconductor integrated circuit element, an enclosure embedding said element therein, lead conductors connecting said element and electronic parts of said device, and a block having a receiving section receiving therein at least one of said electronic parts, and lead conductors extending from said enclosure to said block and each having portions respectively buried in said enclosure and block, at least some of the lead conductors having portions exposed from said enclosure and from said block for making a connection between a display device and said element, said portions being held with the two ends thereof buried in said block and/or said enclosure, the block having a hole exposing a part of at least one of said lead conductors buried in said block, said at least one electronic part being electrically connected to said at least one of said lead conductors through said hole of the block.

2. An electronic device according to claim 1, wherein said enclosure and said block are integrally combined into a single body.

3. An electronic device according to claim 1, wherein said block is spaced from the enclosure and connected thereto by the lead conductors.

4. An electronic device according to any one of the preceding claims, wherein said electronic parts have external terminals connected to respective lead conductors and are located in one main surface side of said block.

5. An electronic device according to any one of the preceding claims, wherein said block is provided with grooves and/or holes for receiving the electronic parts.

6. An electronic device according to Claim 5, wherein said grooves and/or holes additionally guide external terminals of said electronic parts.

7. An electronic device according to any one of the preceding claims, wherein said block and said enclosure are made of resin material.

8. An electronic device according to Claim 7, wherein said block and said enclosure are made of a thermosetting material.

9. An electronic device according to any one of the preceding claims, wherein said block and said enclosure are made of the same material.

10. An electronic device according to any one of Claims 1 to 6, wherein said block and said enclosure are made of different materials.

11. An electronic device according to Claim 7 or Claim 10, wherein said block is made of thermoplastic material and said enclosure is made of thermosetting material.

12. An electronic device according to any one of the preceding claims, wherein said electronic parts include a crystal oscillator, a capacitor, and a battery.

13. An electronic device according to any one of the preceding claims, wherein a hole is provided in said block to receive one of the electronic parts which requires adjustment of its characteristics, so that the adjustment of the characteristics of said part may be performed through said hole from the opposite side of the block to the side in which said part is located.

14. An electronic device according to any one of the preceding claims, wherein a groove extending to the side wall of said block is formed at a main surface of said block so that a light diffusing plate may be inserted therein from the side wall.

15. An electronic device according to any one of the preceding claims, wherein both ends of the exposed portions of said lead conductors are buried in the block.

16. An electronic device according to any one of Claims 1 to 14, wherein the two ends of the exposed portions of said lead conductors are buried in the block and in the enclosure respectively.

17. An electronic device according to any one of the preceding claims, wherein the exposed portions of said lead conductors comprise first lead conductor portions buried in the block and second lead conductor portions buried in the enclosure and each bonded to a corresponding first lead conductor portion.

18. An electronic device according to any one of claims 1 to 16, wherein said lead conductors are formed by one sheet of lead frame.

19. An electronic device according to Claim 18, wherein at least some of said lead conductors are exposed at the side wall of said block.

20. An electronic device according to Claim 18, wherein at least some of said lead conductors protrude from a side wall of said block and are bent at the outside of said block.

21. An electronic device according to Claim 18, wherein the surfaces of the lead conductors exposed for connection to the display device or to the said at least one electronic part are coated with films which tend to release resin.

22. An electronic device according to any one of Claims 1 to 17, wherein the conductive material of a tape carrier system, formed on an insulating

the watch case is constructed in one-piece with the block accommodating the external electronic parts, as a part of the watch module. In addition, the back cover can be suitably received by and fixed to the block. Consequently, the fabrication of the watch is considerably facilitated and the number of parts is advantageously reduced, contributing greatly to reduce the cost and size, especially the thickness, of the electronic wrist watch.

The present invention is not limited to an electronic watch, but may be applied to various electronic devices, particularly where the assembly dimensions should be as small as possible in order to provide a compact device which is simple and inexpensive to manufacture.

Attention is drawn to UK Patent Applications 80.06521, 80.06522, 80.06523, and 80.06625, divided from this application and containing claims to arrangements of electronic devices and methods of fabricating such devices disclosed herein.

CLAIMS

1. An electronic device comprising a semiconductor integrated circuit element, an enclosure embedding said element therein, lead conductors connecting said element and electronic parts of said device, and a block having a receiving section receiving therein at least one of said electronic parts, and lead conductors extending from said enclosure to said block and each having portions respectively buried in said enclosure and block, at least some of the lead conductors having portions exposed from said enclosure and from said block for making a connection between a display device and said element, said portions being held with the two ends thereof buried in said block and/or said enclosure, the block having a hole exposing a part of at least one of said lead conductors buried in said block, said at least one electronic part being electrically connected to said at least one of said lead conductors through said hole of the block.

2. An electronic device according to claim 1, wherein said enclosure and said block are integrally combined into a single body.

3. An electronic device according to claim 1, wherein said block is spaced from the enclosure and connected thereto by the lead conductors.

4. An electronic device according to any one of the preceding claims, wherein said electronic parts have external terminals connected to respective lead conductors and are located in one main surface side of said block.

5. An electronic device according to any one of the preceding claims, wherein said block is provided with grooves and/or holes for receiving the electronic parts.

6. An electronic device according to Claim 5, wherein said grooves and/or holes additionally guide external terminals of said electronic parts.

7. An electronic device according to any one of the preceding claims, wherein said block and said enclosure are made of resin material.

8. An electronic device according to Claim 7, wherein said block and said enclosure are made of a thermosetting material.

9. An electronic device according to any one of the preceding claims, wherein said block and said enclosure are made of the same material.

10. An electronic device according to any one of Claims 1 to 6, wherein said block and said enclosure are made of different materials.

11. An electronic device according to Claim 7 or Claim 10, wherein said block is made of thermoplastic material and said enclosure is made of thermosetting material.

12. An electronic device according to any one of the preceding claims, wherein said electronic parts include a crystal oscillator, a capacitor, and a battery.

13. An electronic device according to any one of the preceding claims, wherein a hole is provided in said block to receive one of the electronic parts which requires adjustment of its characteristics, so that the adjustment of the characteristics of said part may be performed through said hole from the opposite side of the block to the side in which said part is located.

14. An electronic device according to any one of the preceding claims, wherein a groove extending to the side wall of said block is formed at a main surface of said block so that a light diffusing plate may be inserted therein from the side wall.

15. An electronic device according to any one of the preceding claims, wherein both ends of the exposed portions of said lead conductors are buried in the block.

16. An electronic device according to any one of Claims 1 to 14, wherein the two ends of the exposed portions of said lead conductors are buried in the block and in the enclosure respectively.

17. An electronic device according to any one of the preceding claims, wherein the exposed portions of said lead conductors comprise first lead conductor portions buried in the block and second lead conductor portions buried in the enclosure and each bonded to a corresponding first lead conductor portion.

18. An electronic device according to any one of claims 1 to 16, wherein said lead conductors are formed by one sheet of lead frame.

19. An electronic device according to Claim 18, wherein at least some of said lead conductors are exposed at the side wall of said block.

20. An electronic device according to Claim 18, wherein at least some of said lead conductors protrude from a side wall of said block and are bent at the outside of said block.

21. An electronic device according to Claim 18, wherein the surfaces of the lead conductors exposed for connection to the display device or to the said at least one electronic part are coated with films which tend to release resin.

22. An electronic device according to any one of Claims 1 to 17, wherein the conductive material of a tape carrier system, formed on an insulating

tape so that it forms a wiring pattern, is used to provide the lead conductors.

23. An electronic device according to any one of the preceding claims, having a display device connected to the portions of the lead conductors exposed between the enclosure and the block.

24. An electronic device according to Claim 23, wherein the display device is connected to said exposed portions by pressure contact.

25. An electronic device according to Claim 23 or 24, wherein external electrodes of said display device are connected to said exposed portions of said lead conductors by zebra connector means.

26. An electronic device according to any one of Claims 23 to 25, wherein said display device is located on said enclosure by a reference groove formed in said block surrounding said enclosure and receiving said display device.

27. An electronic device according to any one of Claims 23 to 25, wherein said display device is placed on a part of said block other than where said element is provided.

28. An electronic device according to Claim 27, wherein said block under said display device is provided with grooves or holes for receiving the or an electronic part.

29. An electronic device according to any one of Claims 23 to 28, wherein said block is provided with at least one hole for attachment of a part serving to fix the display device to said block.

30. An electronic device according to Claim 23, wherein said display device has two or more external electrodes, the electric connections between said display device and said lead conductors being formed by directly clamping said external electrodes of the display device to said exposed portions.

31. An electronic device according to Claim 23, wherein said display device has two or more external electrodes, the connections between said display device and said lead conductors being formed by pressing the external electrodes of the display device against resilient portions integral with said exposed portions of said lead conductors.

32. An electronic device according to any one of claims 23 to 31, wherein said display device is a liquid crystal display.

33. An electronic device according to any one of the preceding claims, wherein said at least one electronic part include a battery for driving said element.

34. An electronic device according to Claim 33, wherein the battery is connected to lead conductors by pressure contact.

35. An electronic device according to Claim 33 or 34, wherein said block is provided with a hole receiving the battery, the hole terminating in a projection for supporting the battery at one main surface side in which the electronic parts having external terminals connected to the lead conductors are built.

36. An electronic device according to Claim 33 or 34, wherein said block is provided with a hole receiving the battery, a portion of a lead conductor being drawn out of the middle of the side surface of said hole.

37. An electronic device according to Claim 36, wherein said portion of a lead conductor drawn out of the middle of the side surface of the hole is bent so as to lie against the side surface of said hole.

38. An electronic device according to Claim 36, wherein said block is provided with a hole receiving the battery and a lead conductor connected with the battery is drawn out of the side of said block and bent so as to extend over said hole.

39. An electronic device according to any one of the preceding claims, wherein said element comprises a semiconductor chip having a plurality of bonding pad electrodes and is placed on one of said lead conductors, said bonding pad electrodes being electrically connected by connecting wires and/or one or more jumper wires to the lead conductors.

40. A process of manufacturing an electronic device comprising:

embedding a semiconductor integrated circuit element in an enclosure;

embedding lead conductors in a block and in the enclosure so that the lead conductors extend from the enclosure to the block and each have portions respectively buried in the enclosure and block, at least some of the lead conductors having portions exposed from the enclosure and from the block and held with the two ends thereof buried in the block and/or the enclosure for connection to a display device thereby connected to the element;

the block having a receiving section receiving at least one of a plurality of electronic parts; and

connecting said at least one electronic part through a hole in the block to a lead conductor buried in the block.

41. A process according to Claim 40, wherein said block and said enclosure are formed by a transfer moulding method using a single mould having cavities corresponding to said block and said enclosure.

42. A process according to Claim 40, wherein said block and said enclosure are formed by using a transfer moulding method with a plurality of resin injection systems, each system having a plurality of runners for injecting resin into a plurality of cavities from a respective source.

43. A process according to Claim 42, wherein at least some of said runners have an intersection space with pins for temporarily closing a part of said intersection space of said runners, and thus isolating said resin injection systems.

44. A process according to Claim 40, wherein said block is formed by a transfer moulding method using a first mould, and said enclosure is formed by a transfer moulding method using a second mould different from the first mould.

45. A process according to any one of Claims 41 to 44, wherein said block is formed from a thermosetting material and said enclosure is formed from a thermosetting material.

46. A process according to Claim 40, wherein

said block is formed by a transfer moulding method using a first mould, and said enclosure is formed by an injection moulding method using a second mould different from the first mould.

47. A process according to Claim 46, wherein said block is formed from a thermosetting material and said enclosure is formed from a thermosetting material.

48. A process according to Claim 46, wherein said block is formed from a thermosetting material and said enclosure is formed from a thermosetting material.

49. A process according to Claim 40, wherein said block is formed by an injection moulding method using a first mould, and said enclosure is formed by a transfer moulding method using a second mould different from said first mould.

50. A process according to Claim 49, wherein said block is formed from a thermoplastic material and said enclosure is formed from a thermosetting material.

51. A process according to Claim 49, wherein said block is formed from a thermosetting material, and said enclosure is formed from a thermosetting material.

52. A process according to Claim 40, wherein said block is formed by an injection moulding method using a first mould and said enclosure is formed by an injection moulding method using a second mould different from said first mould.

53. A process according to Claim 40 or Claim 52, wherein said block is formed from a thermoplastic material and said enclosure is formed from a thermoplastic material.

54. A process according to Claim 40 or Claim 52, wherein said block is formed from a thermoplastic material and said enclosure is formed from a thermosetting material.

55. A process according to Claim 40 or Claim 52, wherein said block is formed from thermosetting material and said enclosure is formed from a thermoplastic material.

56. A process according to Claim 40 or Claim 52, wherein said block is formed from a thermosetting material and said enclosure is formed from a thermosetting material.

57. A process according to any one of the preceding Claims 40 to 56, wherein the lead conductors are formed from a plate-like lead frame.

58. A process according to Claim 57, wherein dams bridging pairs of lead conductors are arranged in a side-by-side manner, the longitudinal dimension of each dam being larger than the distance between a given pair of said plurality of lead conductors.

59. A process according to Claim 57, wherein dams bridging pairs of lead conductors are arranged in a side-by-side manner, some of said dams being left intact when the remainder of the dams are cut out so that said dams left intact can be used to form at least one of the lead conductors.

60. A process according to any one of the preceding claims 57 to 59, wherein the display device is a liquid crystal device and the electronic parts include a crystal oscillator, and a capacitor; wherein a lead conductor intended to connect a power source to the crystal oscillator and a lead conductor intended to connect the power source to the capacitor are arranged adjacent to lead conductors connected to segment terminals of the liquid crystal display; and wherein the lead conductor connected to the external terminal of the crystal oscillator other than the terminal of the crystal oscillator connected to said lead conductor for the power source, and the lead conductor connected to the external terminal of the capacitor other than the terminal of the capacitor connected to said lead conductor for the power source, are arranged between said two conductors for the power source.

61. A process according to any one of the preceding Claims 57 to 60, wherein said lead frame is provided with a resin injection port used when the block is formed and in which a plurality of wing bodies forming part of said lead frame become embedded in the block.

62. A process according to any one of the preceding Claims 57 to 61, wherein a frame portion of said lead frame surrounds the external periphery of the lead conductors and the lead conductors are connected to the frame portion by means of a plurality of suspension leads.

63. A process according to Claim 62, wherein the frame portion of said lead frame surrounding the external periphery of the lead conductors has a plurality of slits at positions therein in the vicinity of said suspension leads.

64. A process according to Claim 63, wherein at least one of said suspension leads is integral with one of said lead conductors.

65. A process according to Claim 64, wherein at least one of said suspension leads is used as a lead conductor to be connected to the power source.

66. A process according to any one of the preceding Claims 40 to 65, wherein the exposed portion of the lead conductors to which the display device is to be connected, are coated with films which tend to release resin.

67. A process according to Claim 40, wherein the lead conductors are formed by a tape carrier type conductive body manufactured by forming a wiring pattern on an insulating tape.

68. An electronic device constructed substantially as herein described with reference to and as illustrated in the accompanying drawings.

69. A process of manufacturing an electronic device substantially as any one herein described with reference to and as illustrated in the accompanying drawings.

70. An electronic watch including an electronic device according to any one of the preceding Claims 1 to 39.

71. An electronic watch comprising:

(a) a package comprising a plurality of lead conductors extending in a plane from a central portion to a peripheral portion thereof surrounding said central portion, and integrated circuit element

and a plurality of electronic parts forming an electronic watch circuit, the integrated circuit element being fixed on one of said plurality of lead conductors at said central portion and electrically connected to the others thereat, an enclosure of insulating material embedding said integrated circuit and portions of said lead conductors at said central portion, and a block of insulating material embedding other portions of said lead conductors at said peripheral portion, parts of said lead conductors being exposed in spaces between said enclosure and said block, said block having at least one receiving groove exposing a part of at least one of said lead conductors;

(b) a display device including an upper display surface and a lower surface with a plurality of electrodes for receiving electronic signals from the electronic watch circuit;

(c) connection means electrically connecting the electrodes of the display device to said lead conductors exposed in said spaces, said connection means fitting within said spaces; and

(d) at least one electronic part of the electronic watch circuit being located in said receiving groove, said electronic part being electrically connected to the exposed part of said at least one lead conductor.

72. An electronic watch according to Claim 71, wherein said display device is located over said enclosure.

73. An electronic watch according to Claim 71 or Claim 72, wherein said spaces and receiving groove are formed in a main surface of said package.

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The following corrections were allowed under Section 117 on 7 December 1982:

Front page, Heading (72), Inventors *for* Mimato *read* Mimata *for* Simisu *read* Shimizu

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