US 20060001192A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2006/0001192 A1

Oohashi et al. (43) Pub. Date: Jan. 5, 2006

(54) STRUCTURE OF PARTS MADE FROM PLURAL COMPOSITE PIECES AND METHOD OF BUILDING THOSE PARTS

(75) Inventors: **Katsuhide Oohashi**, Mito (JP); **Shigeo Amagi**, Tokai (JP); **Osamu Miyo**, Hitachi (JP)

Correspondence Address:
CROWELL & MORING LLP
INTELLECTUAL PROPERTY GROUP
P.O. BOX 14300
WASHINGTON, DC 20044-4300 (US)

(73) Assignee: **Hitachi, Ltd.**, Tokyo (JP)

(21) Appl. No.: **11/167,791**

(22) Filed: **Jun. 28, 2005**

(30) **Foreign Application Priority Data**

Jul. 2, 2004 (JP) 2004-196197

Publication Classification

(51) **Int. Cl.**
B29C 39/10 (2006.01)

(52) **U.S. Cl.** **264/279**; 264/279.1

(57) **ABSTRACT**

A pre-mold part is formed by pre-molding the insert part composed of composite materials composed of metal, ceramic, resin or any combination of those materials with the pre-mold part composed of thermo plastic resin having crystallinity, and then, the pre-mold part is inserted into the over-mold part composed of thermo plastic resin. After applying the heat treatment with the temperature lower than the crystalline melting point of the pre-mold part to the pre-mold part surrounding the insert part formed as the composite mold part surrounding the pre-mold part, the insert molding is completed finally. Mold parts having high-reliable insert parts enable to establish firm contact between the insert part and the resin surrounding the insert part without no gap at the interface between those parts can be obtained by a low-cost production method.

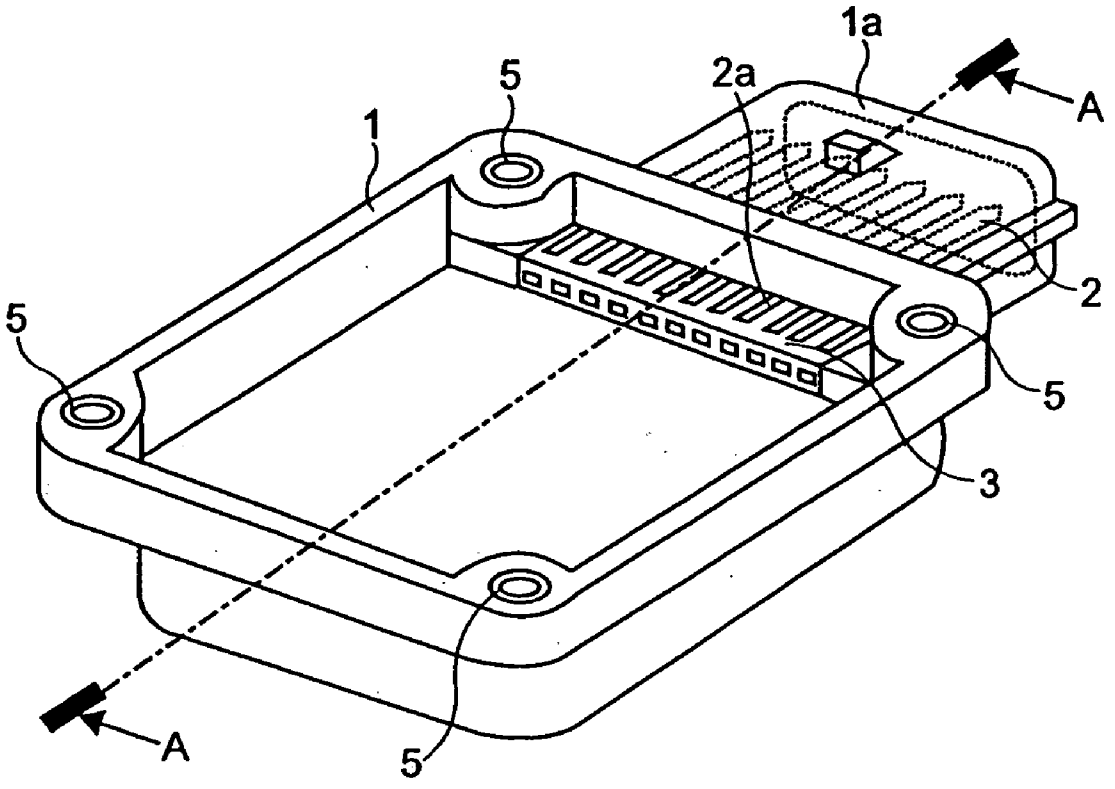


FIG. 1

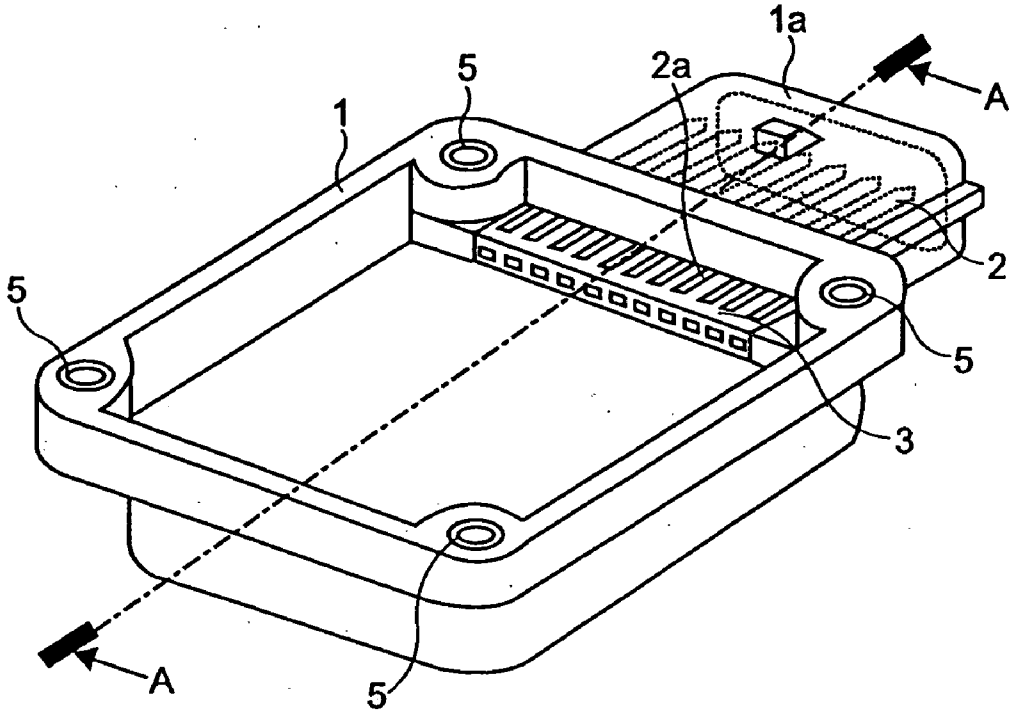


FIG. 2

A-A

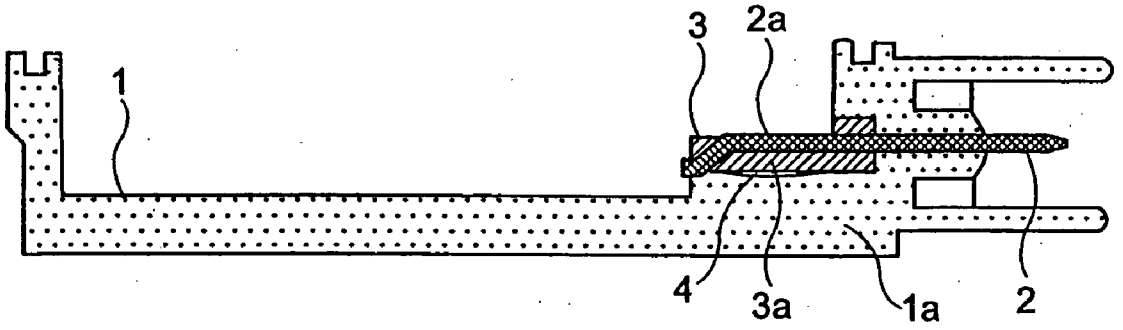


FIG. 3

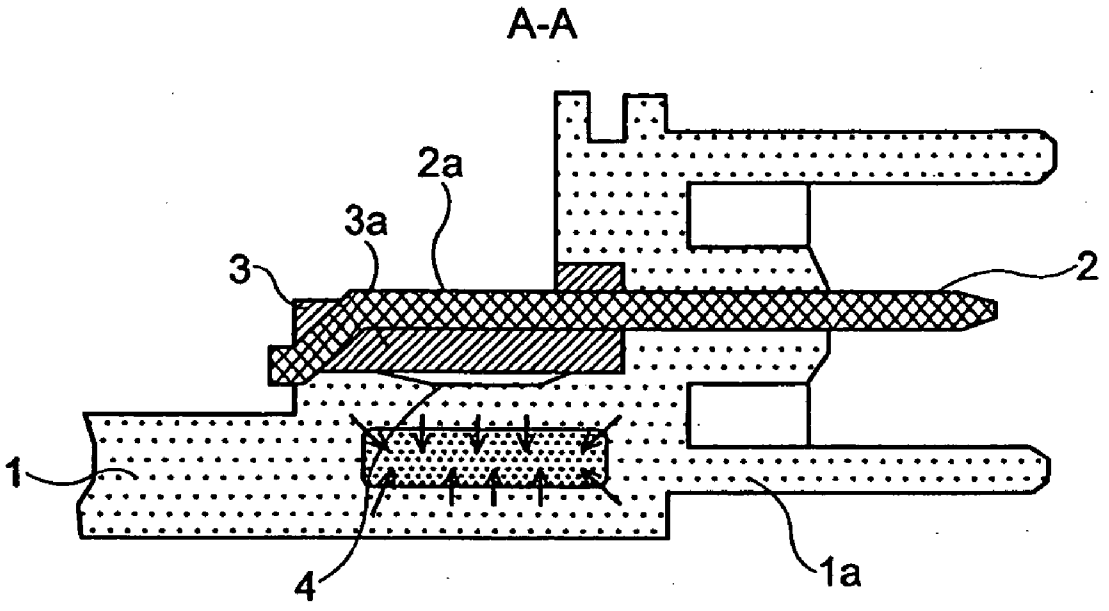


FIG. 4

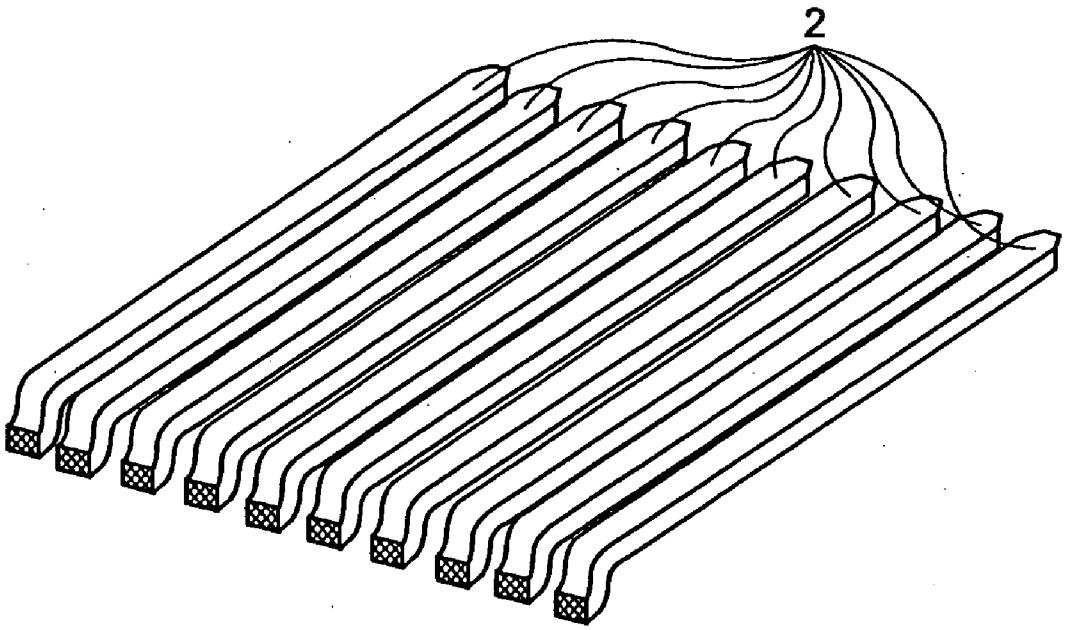


FIG. 5

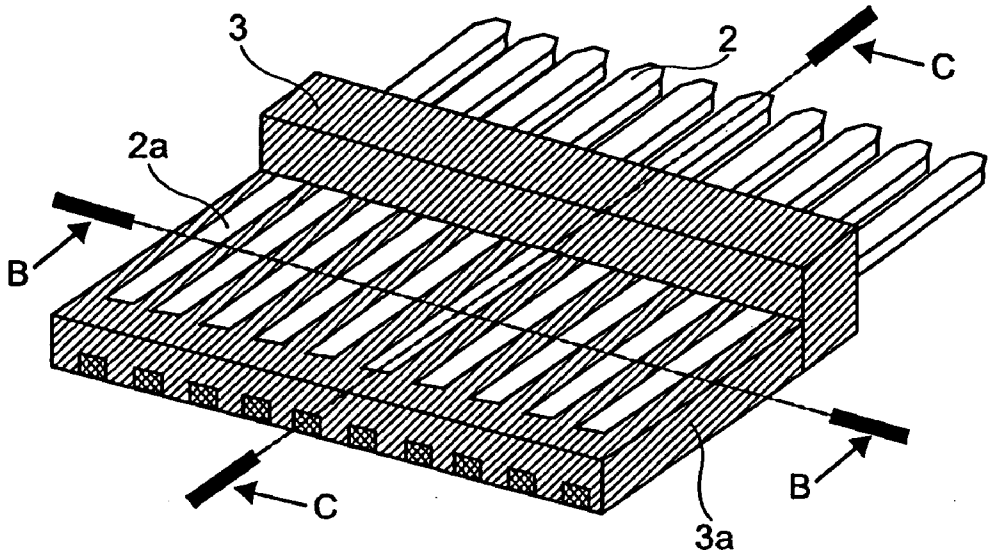


FIG. 6

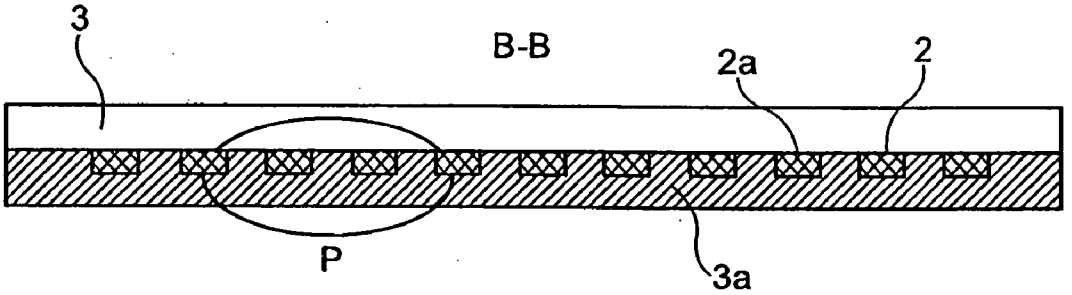


FIG. 7

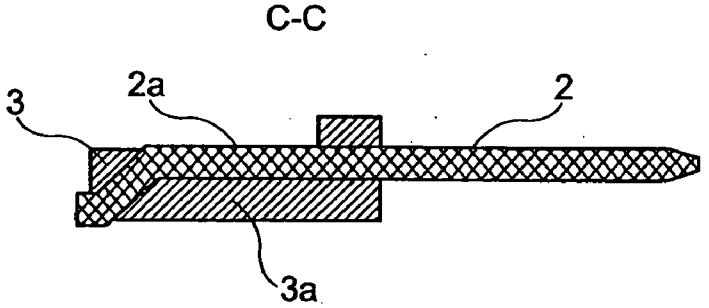


FIG. 8

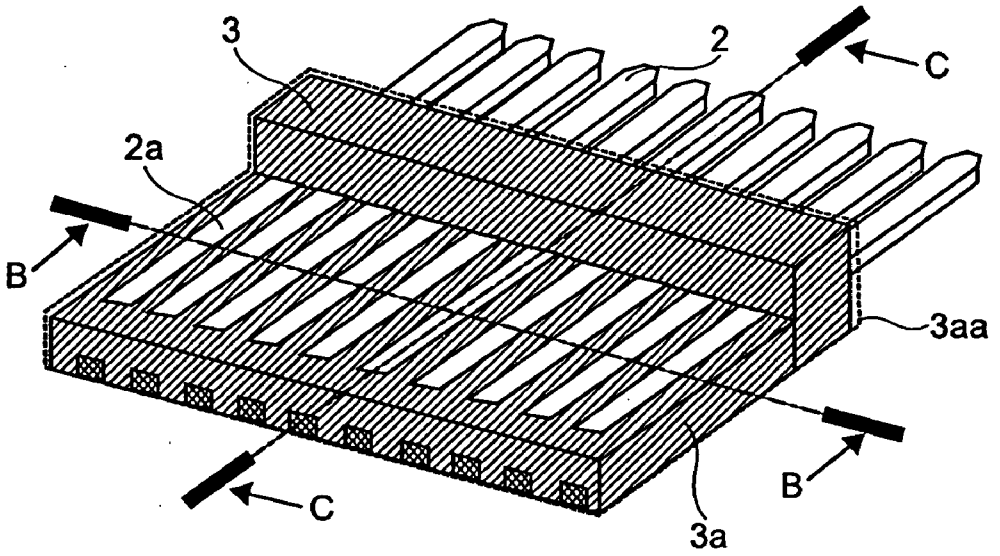


FIG. 9

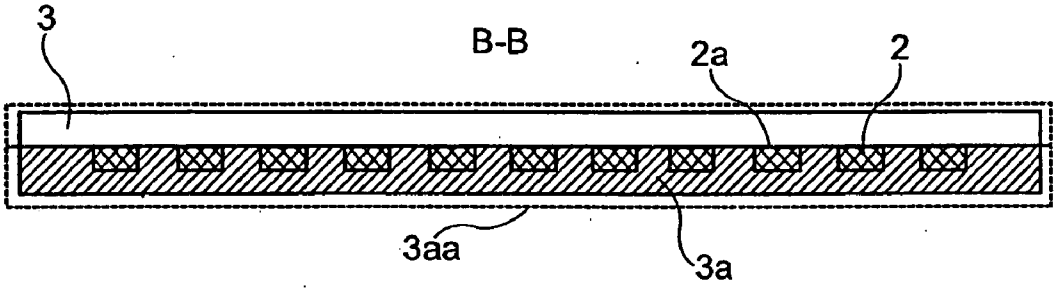


FIG. 10

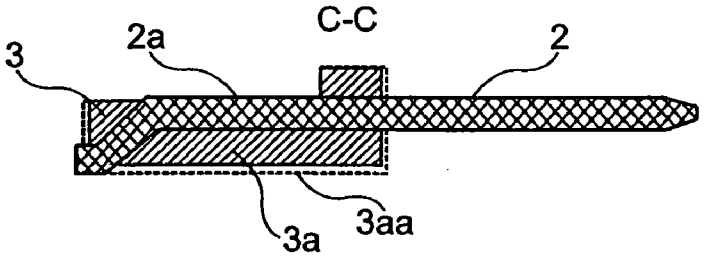


FIG. 11

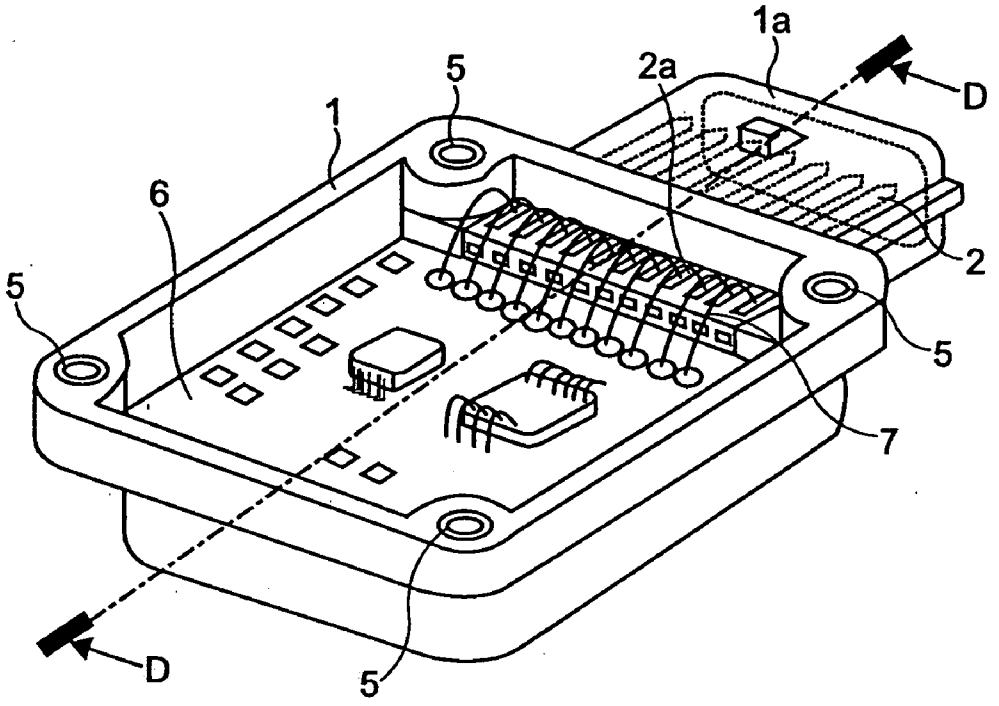


FIG. 12

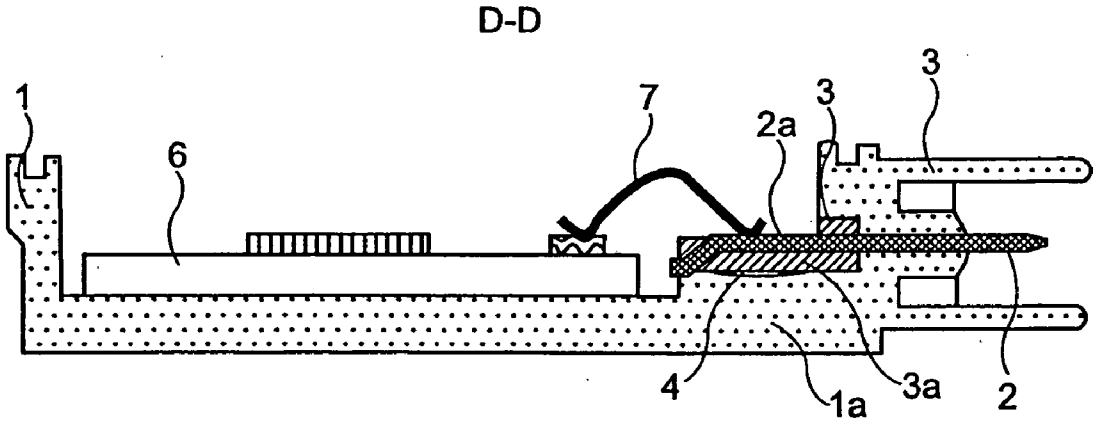


FIG. 13

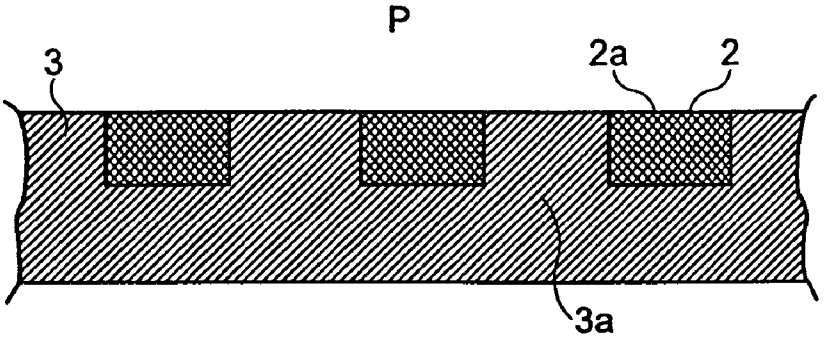


FIG. 14

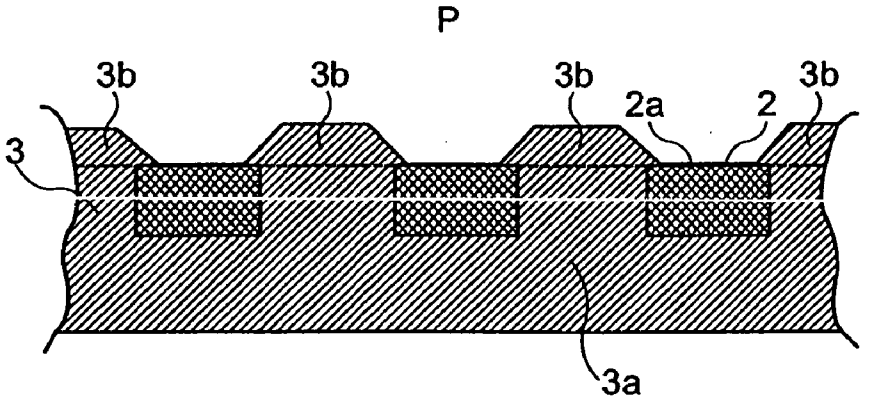


FIG. 15

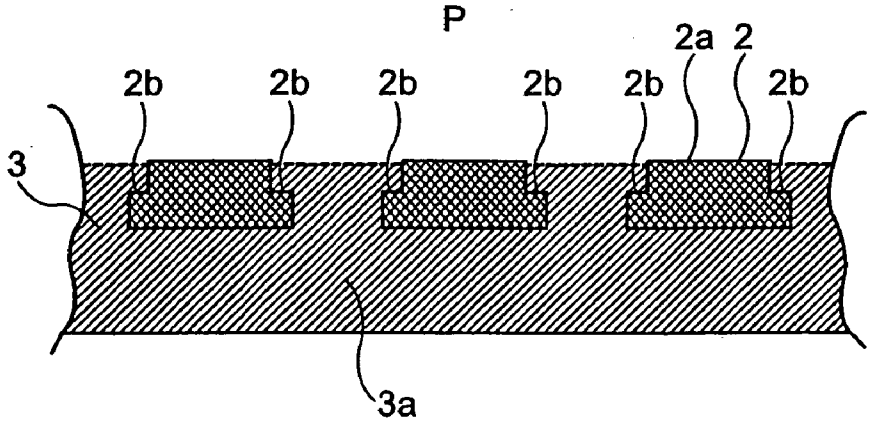


FIG. 16

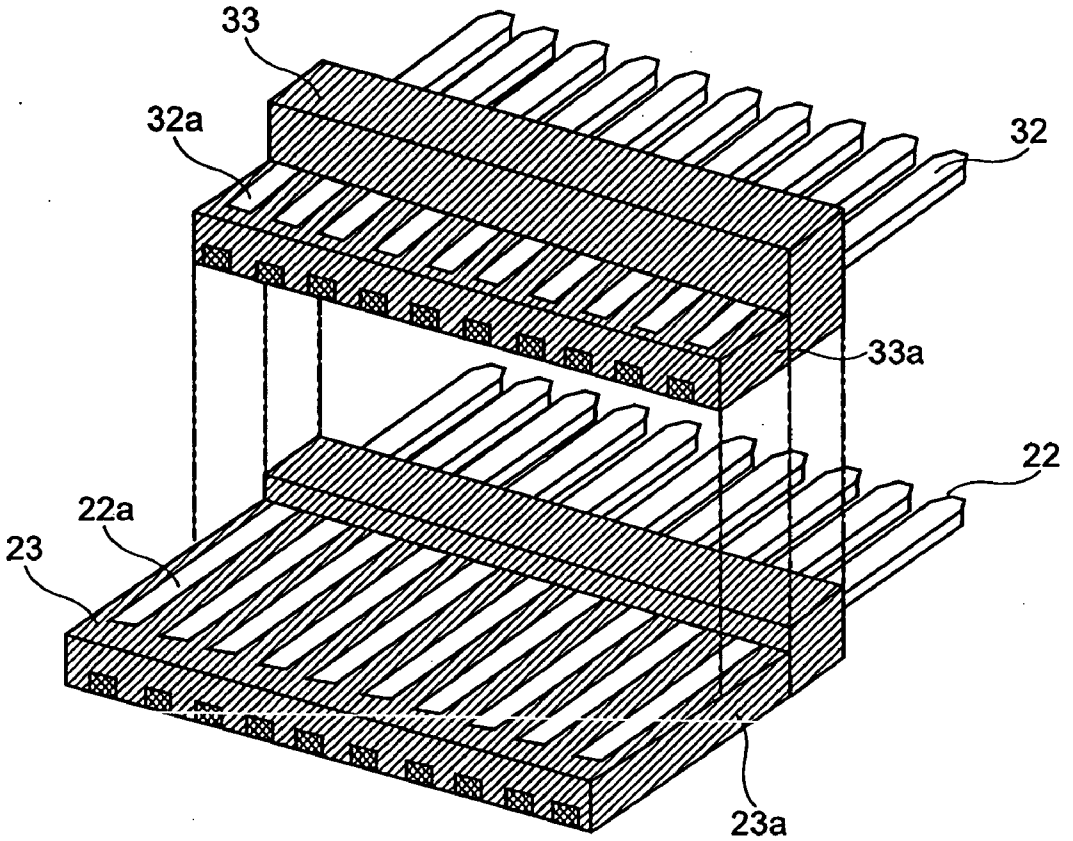


FIG. 17

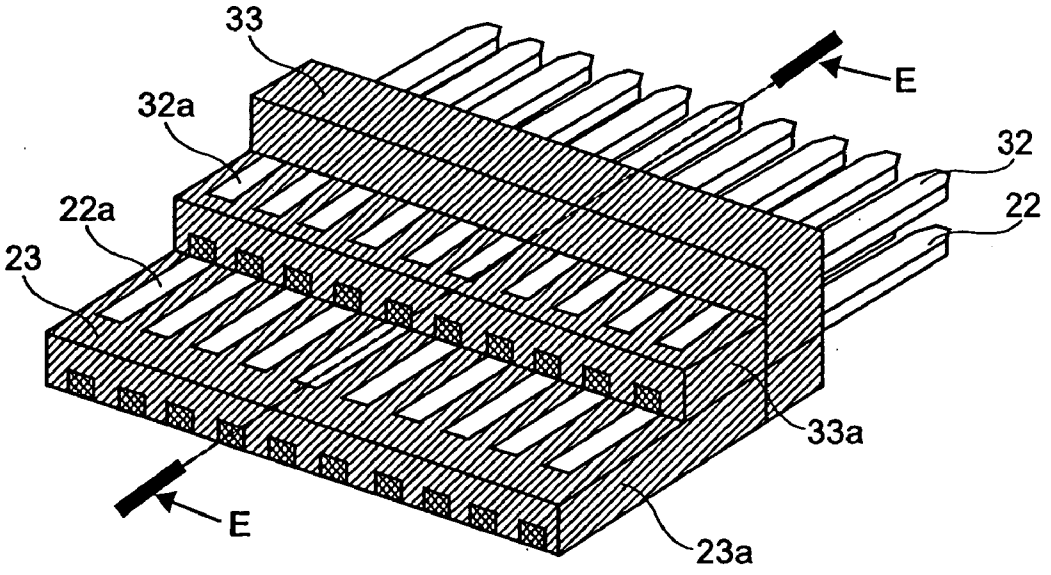


FIG. 18

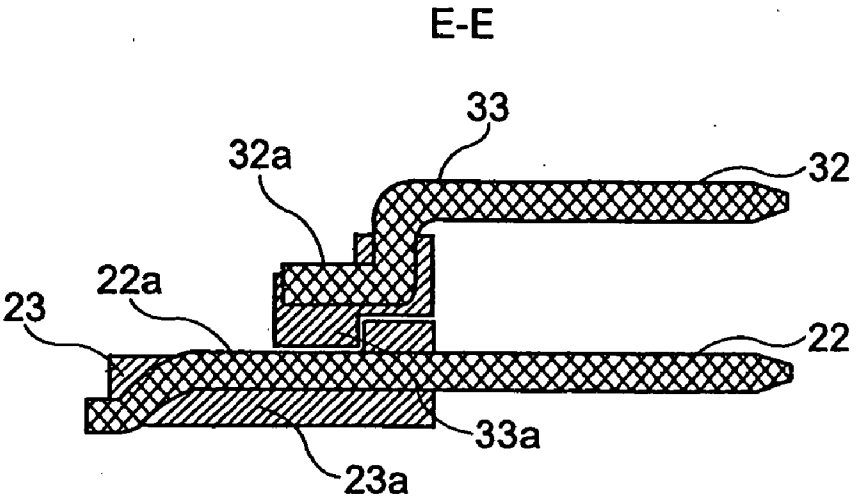

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FIG. 19

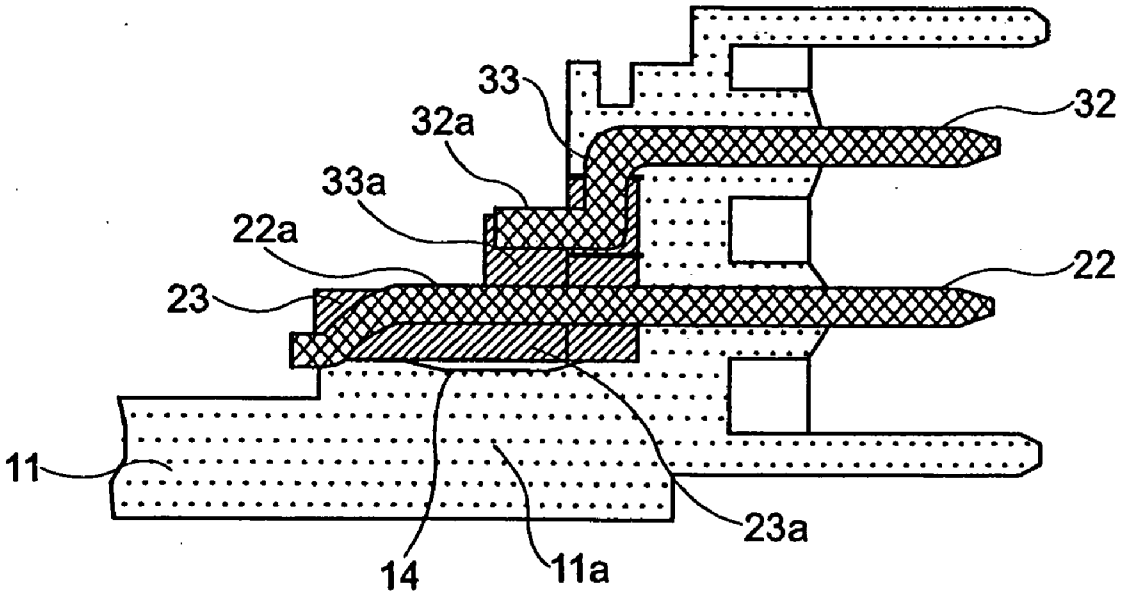

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FIG. 20

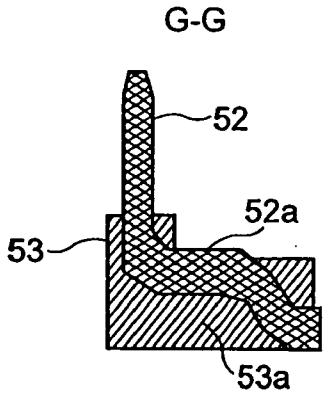


FIG. 21

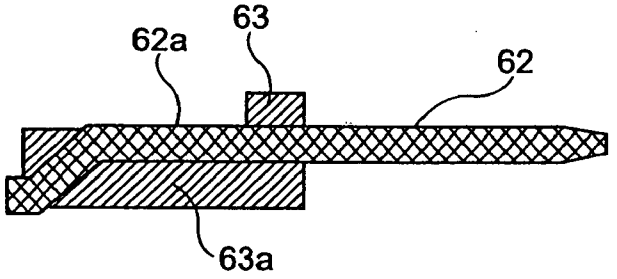


FIG. 22

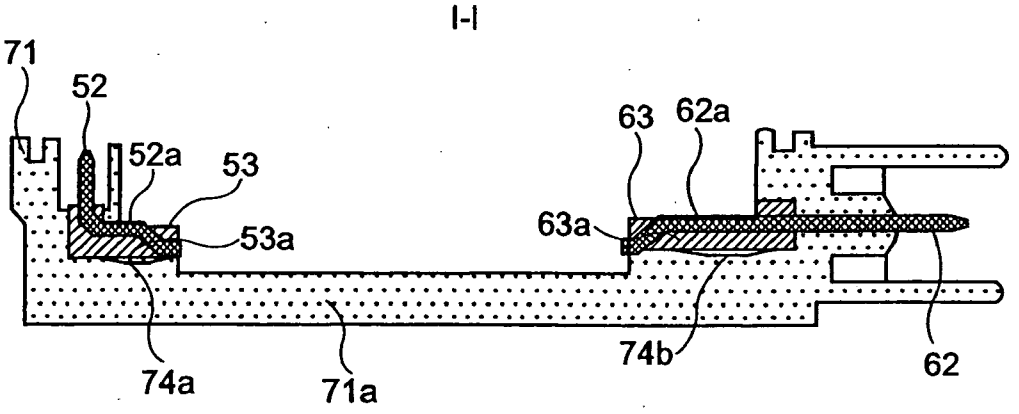


FIG. 23

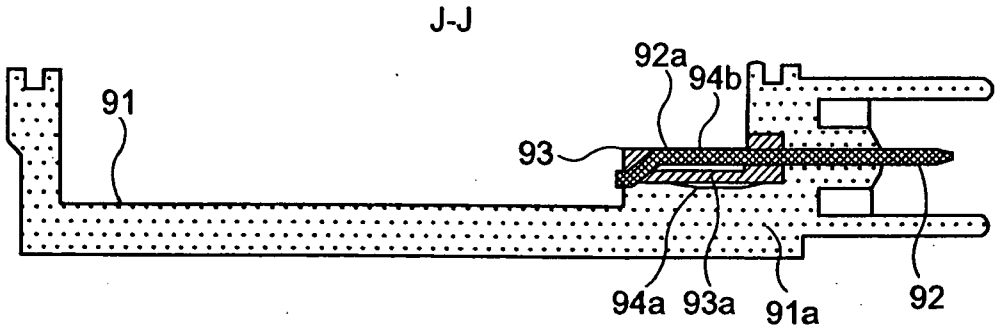


FIG. 24

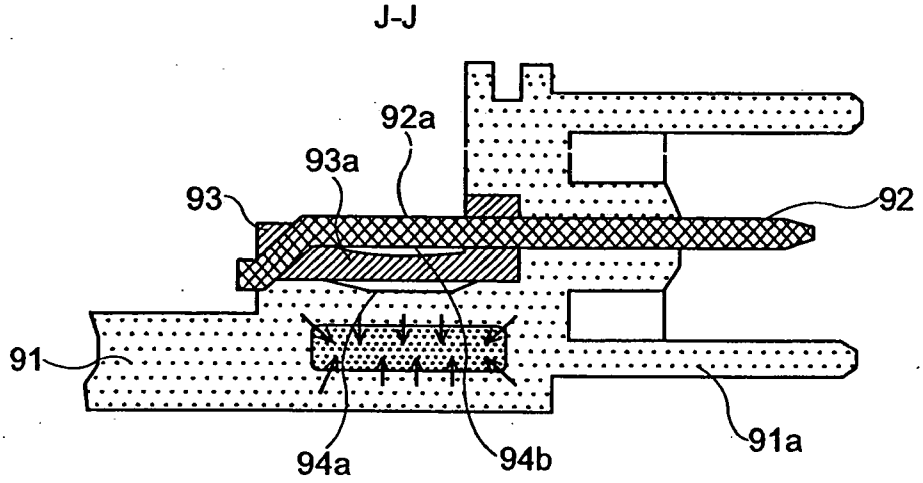


FIG. 25

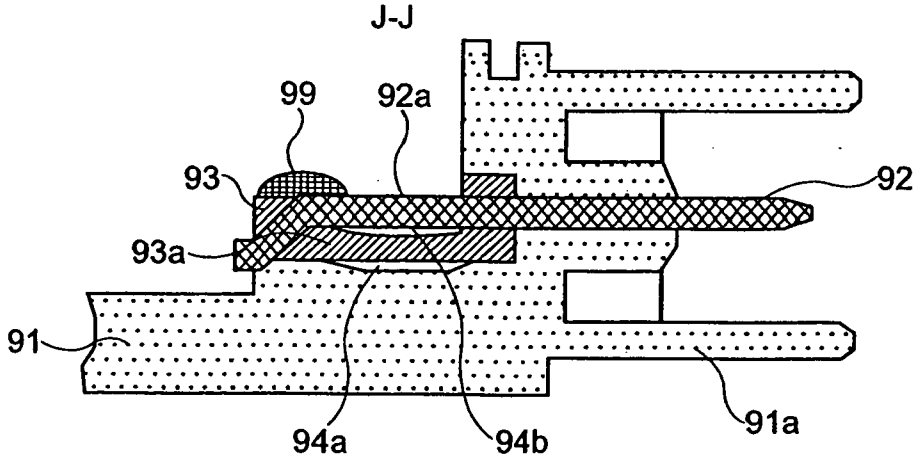


FIG. 26

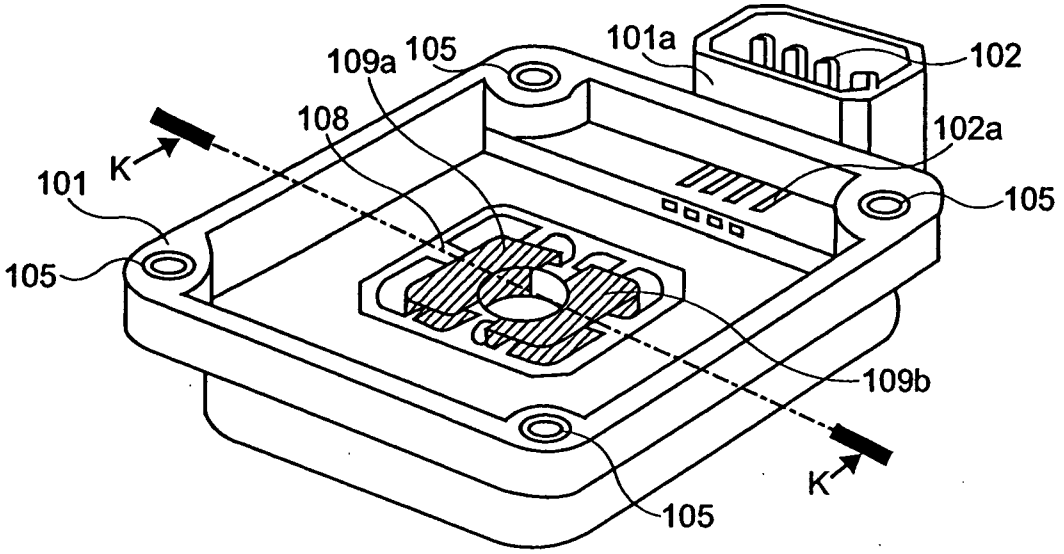


FIG. 27

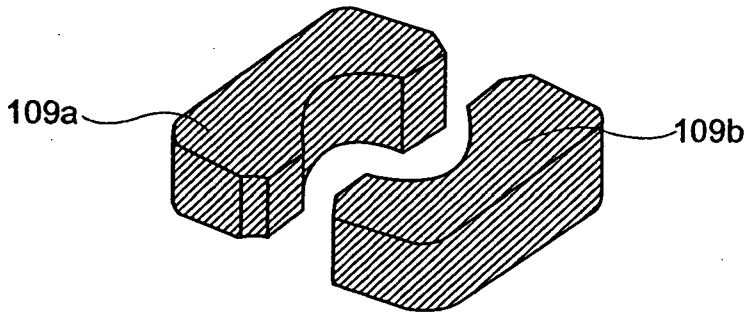


FIG. 28

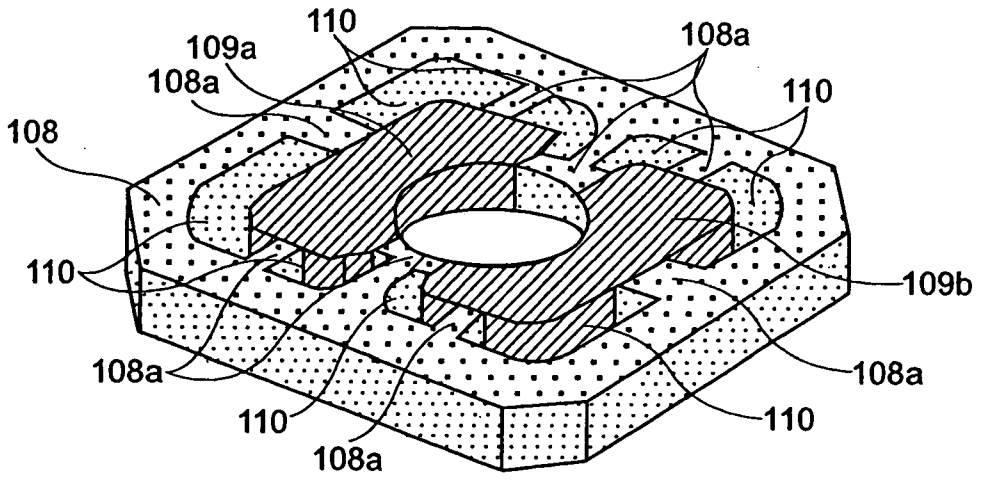


FIG. 29

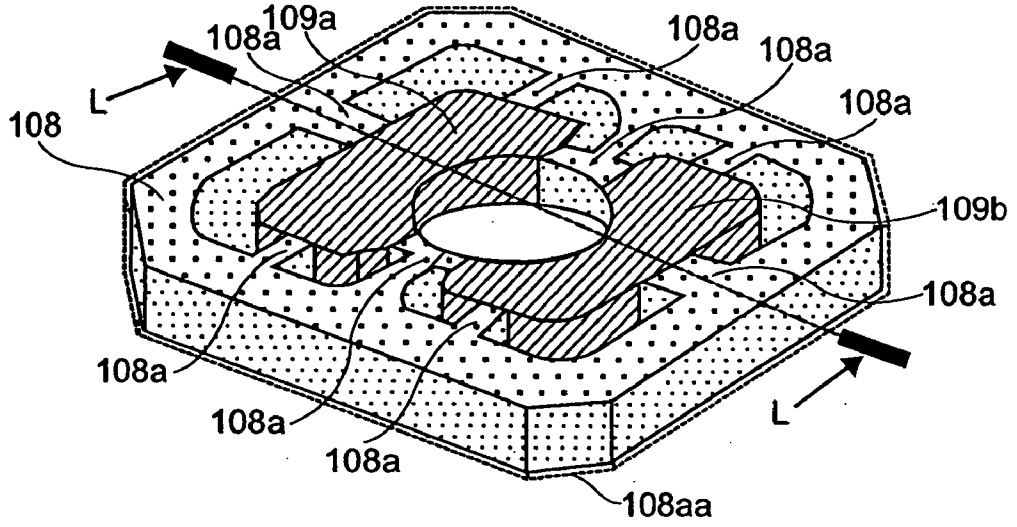


FIG. 30

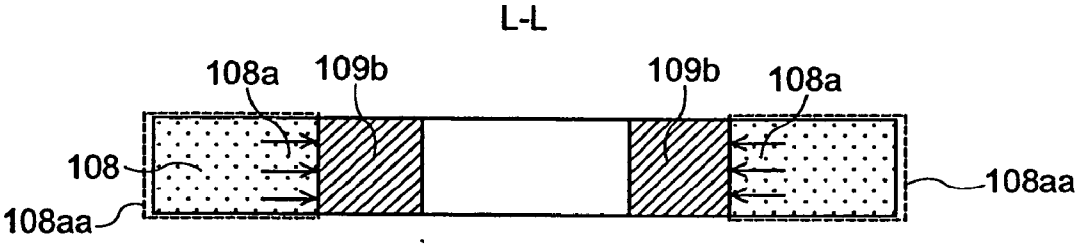


FIG. 31

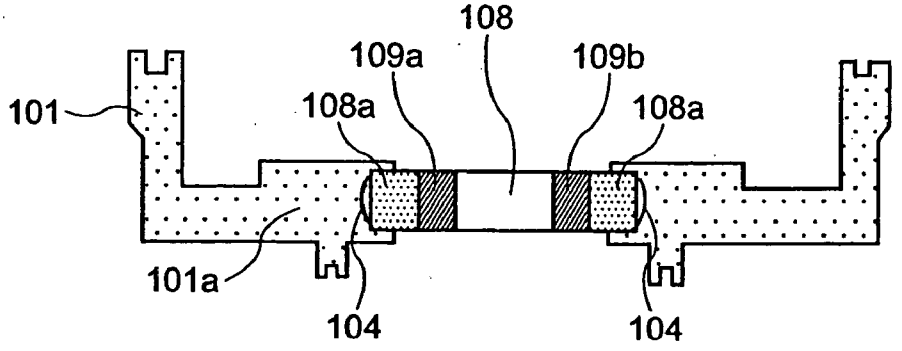


FIG. 32

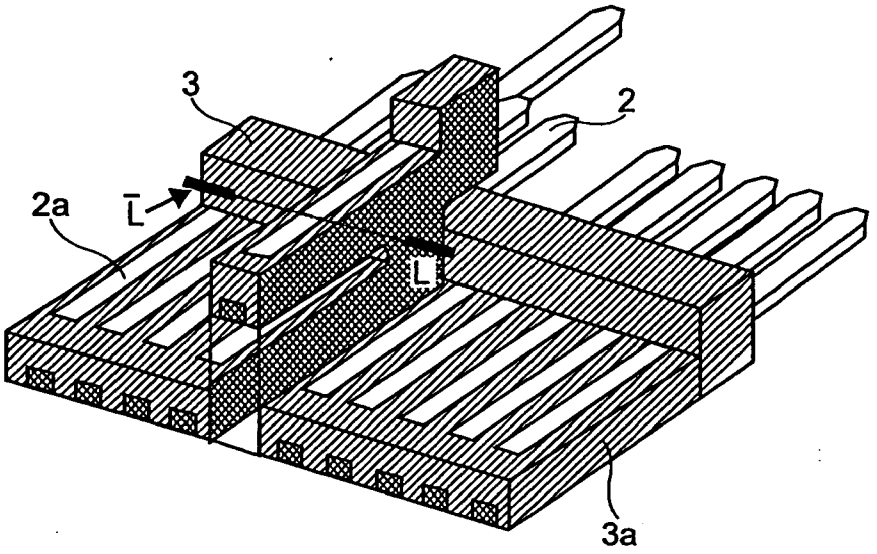


FIG. 33

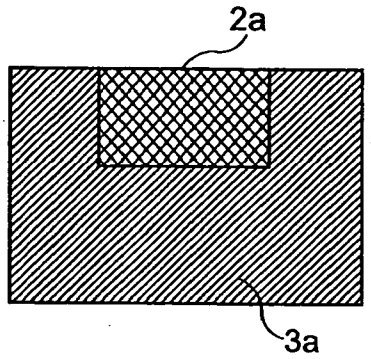


FIG. 34

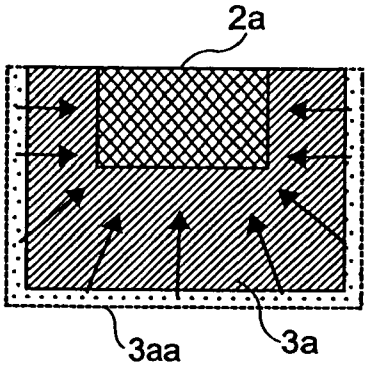
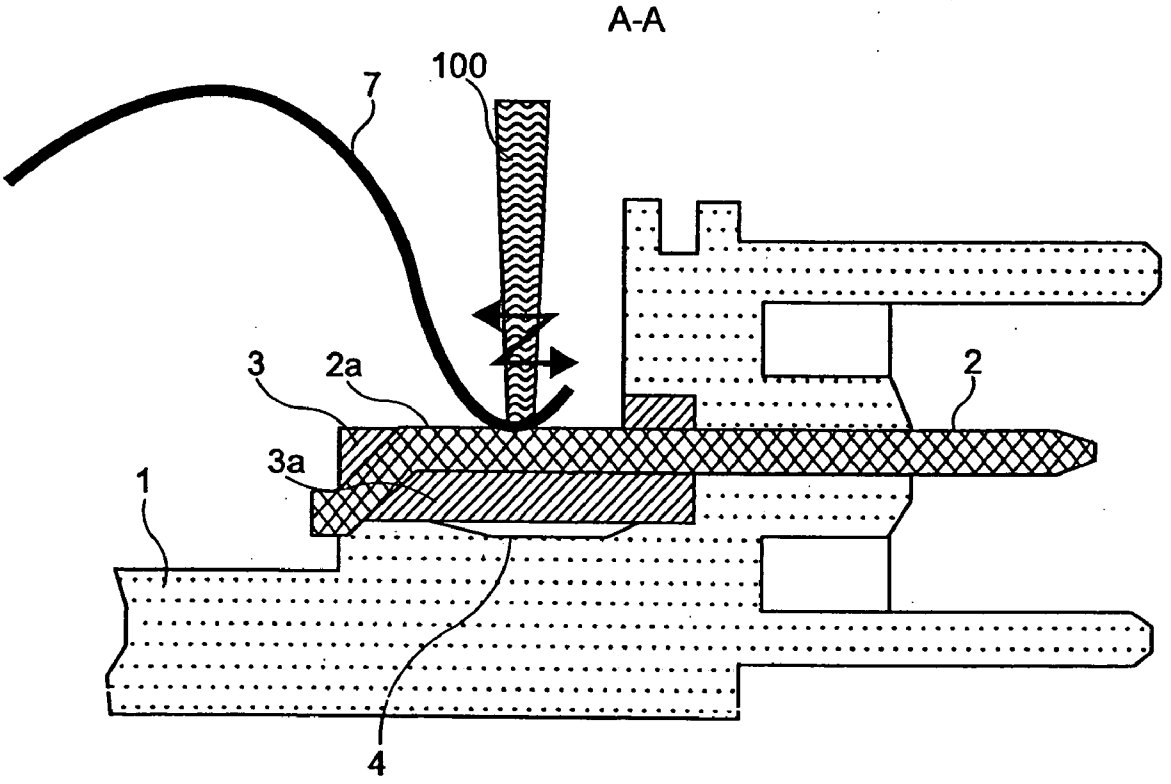


FIG. 35



STRUCTURE OF PARTS MADE FROM PLURAL COMPOSITE PIECES AND METHOD OF BUILDING THOSE PARTS

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a mold part having an insert part inserted therein, specifically to a structure of molded part integrated with plural metallic terminals by way of insert molding and its production method.

[0002] It is required to make the thickness of the resin as uniform as possible for making the mold parts in order to prevent the degradation in fluidity and surface property of the resin. However, in case that the mold part has a part having an increased thickness, as this increased thickness part has a larger amount of contraction due to the molding process in comparison with the other part in the mold part, it may cause unfavorable void generation inside such an increased thickness part as has a thickness larger than a designated limitation value. In case of molded parts having an insert part inserted therein, there is such a problem that the contraction of the increased thickness part and the voids generated inside it may make larger the gap developed in the interface between the insert part and the mold part.

[0003] In general, there is a method for molding the resin used for the increased thickness part in two-layer structure in order to solve the above described problem. In this method, sub parts having a required size are formed in a preliminary molding process, and then, those pre-mold parts are inserted as insert parts, and finally, those parts are integrated with over-mold parts by way of multiple molding.

[0004] In the mold part formed by inserting the insert parts, in the progress of mass production of a wide variety of goods, downsizing and sophisticated configuration of insert part due to higher function ality of parts, there is a limit for increasing the productivity only with a single molding process. In order to solve this problem in the similar manner to the method described above, sub parts are formed in a preliminary molding process, and then, those pre-mold parts are inserted as insert parts, and finally, those parts are integrated with over mold parts by way of multiple molding so that the productivity and the yield rate of the product may be increased. In addition, in terms of higher productivity and low-cost in the molding process, thermoplastic resin is often used as the mold material and an injection molding method is used widely for the molding method in general.

[0005] In case of a multiple molding process, a stress due to resin contraction at the over-molding process is applied to the pre-mold part inserted as an insert part, which results in an internal distortion inside the pre-mold part. In addition, heating process for integrating and molding at the over-molding process may give rise to resin contraction of the pre-mold part. This resin contraction mechanism is different from the contraction of the single body of the pre-mold part and depends on the type and shape of the over-mold part, which may result in such a problem as making larger the gap developed in the interface between the insert part and the pre-mold part.

[0006] In order to solve the above described problem, there is such a method that an adhesive material such as epoxy resin is coated and harden on the exposed surface of the insert part after the over-molding process in order to seal the interface between the insert part and the pre-mold part, and further fix firmly the insert part and the pre-mold part.

[0007] In Japanese Patent Laid-Open No. 7-142817 (1995), there exposed such a method that epoxy resin composed of an adhesive material having a heat hardening property is coated on the insert part for the cover film, and the heat treatment is applied after insert molding process in order to bond the insert part and the insert molding resin.

[0008] This pre-mold process is applied to the insert molding of plural metallic terminals as the insert part used for electrical connection.

[0009] However, in the same reason as described above, in case of multiple molding process, a stress due to resin contraction at the over-molding process is applied to the pre-mold part inserted as an insert part, which results in an internal distortion inside the pre-mold part. In addition, heating process for integrating and molding at the over-molding process may give rise to resin contraction of the pre-mold part.

[0010] This resin contraction mechanism is different from the contraction of the single body of the pre-mold part and depends on the type and shape of the over-mold part. In case of applying the insert molding of plural metallic terminals as the insert part used for electrical connection, this resin contraction may result in such a problem as making larger the gap developed in the interface between the metallic terminal and the pre-mold part.

[0011] In the wire-bonding process in the assembly process of the product, as such internal distortion and gap so developed in the molding process disperse and absorb the vibration associated with the bonding process, there may be the possibility leading to the bonding failure.

[0012] In order to solve the above described problem, there is such a method that an adhesive material such as epoxy resin is coated and harden on the region of bonding part of the metallic terminal after the over-molding process in order to fix firmly the metallic terminal and the pre-mold part.

[0013] As for another solution, the metallic terminal is inserted and pre-molded by using heat-hardening resin, which provides small amount of post-contraction and is less subject to heat history in the over-molding process, for the pre-mold part.

SUMMARY OF THE INVENTION

[0014] In order to solve the problems due to the increased thickness resin of the mold part inserted as an insert part or to improve the productivity of molding process, there is such a method as sub parts having a required size are formed in a preliminary molding process, and then, those pre-mold parts are inserted as insert parts, and finally, those parts are integrated with over-mold parts by way of multiple molding.

[0015] In case of the pre-mold part inserted as a insert part, a stress due to resin contraction at the over-molding process is applied to the pre-mold part inserted as an insert part, which results in an internal distortion inside the pre-mold part. In addition, heating process for integrating and molding at the over-molding process may give rise to resin contraction of the pre-mold part. This resin contraction mechanism is different from the contraction of the single body of the

pre-mold part and depends on the type and shape of the over-mold part, which may result in such a problem as making larger the gap developed in the interface between the insert part and the pre-mold part.

[0016] In order to solve the above described problem, there is such a method that an adhesive material such as epoxy resin is coated and harden on the exposed surface of the insert part after the over-molding process in order to seal the interface between the insert part and the pre-mold part, and further fix firmly the insert part and the pre-mold part. However, in this method, the coating process of the epoxy resin is required, and the hardening process for hardening and bonding the epoxy resin after the coating process requires the hardening time of 30 to 60 minutes. In addition, it is required to prepare the coating apparatus and the hardening oven, which may lead to lower productivity and higher cost.

[0017] As the viscosity of the epoxy resin decreases extremely before hardening and the epoxy resin takes in liquid form, the hardening shape varies widely due to the epoxy resin flowing in an uncured state, which may result in the low reliability in fixing the insert part and the pre-mold part.

[0018] As for another method, the metallic terminal is inserted and pre-molded by using heat-hardening resin, which provides small amount of post-contraction and is less subject to heat history in the over-molding process, for the pre-mold part. However, in this method, the material cost for the heat-hardening resin is higher than the thermo setting material, and the reliability of the heat-hardening resin is lower than the reliability of the thermo setting material due to the occurrence of resin flash associated with the heat-hardening resin.

[0019] In order to the above described problems, an object of the present invention is to provide a composite mold part by means that low-cost thermo setting resin is used, an insert molding process using an injection molding method advantageously having a higher efficiency in molding process is applied, and the interface between the insert part and the region around the insert part is firmly fixed without forming a gap at the interface between those parts.

[0020] Another object of the present invention is to provide an electronic apparatus for increasing the stability in bonding by means of preventing the generation of the gap which disperses and absorbs the vibration for the product (part) formed by wire bonding in the assembly process after molding process.

[0021] In order to solve the above problems, the present invention is characterized by a composite mold part formed by forming a pre-mold part by pre-molding an insert part composed of a composite material composed of metal, ceramic, resin or a combination of those materials or one or more metallic terminals used for electrical contact, which is not limited to this example, as the insert part with a pre-mold part composed of thermo plastic resin having crystallinity, and by inserting said pre-mold part into an over-mold part composed of thermo plastic resin and surrounding said pre-mod part with an over-mold part, wherein an insert molding process is applied to an pre-mold part surrounding said pre-mold part to be inserted after applying heat treatment with a temperature lower than a crystalline melting point of said pre-mold part.

[0022] It will be appreciated that the composite mold part using the pre-mold part of the present invention can be formed by the insert molding process by using the thermo setting resin and by using the injection mol ding method which is advantageous for the efficient molding process, and that the low-cost production method can provide the composite mold part having a high-reliable insert part which can prevent the occurrence of the gap at the interface between the insert part and the resin surrounding the insert part and the contact between the insert part and the resin surrounding the insert part can be kept.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] **FIG. 1** is an isometric view illustrating the composite mold part as Embodiment 1 of the mold part having the insert part according to the present invention.

[0024] **FIG. 2** is a cross-section view in the composite mold part in Embodiment 1 according to the present invention.

[0025] **FIG. 3** is a partial cross-section view of the region of the insert part in the composite mold part as Embodiment 1 of the mold part according to the present invention.

[0026] **FIG. 4** is an isometric view illustrating the insert part of the pre-mold part according to embodiment 1 of the present invention.

[0027] **FIG. 5** is an isometric view of the pre-mold part according to embodiment 1 of the present invention.

[0028] **FIG. 6** is a horizontal cross-section view of the pre-mold part according to embodiment 1 of the present invention.

[0029] **FIG. 7** is a vertical cross-section view of the pre-mold part according to embodiment 1 of the present invention.

[0030] **FIG. 8** is an isometric view of the pre-mold part when the resin contraction occurs according to embodiment 1 of the present invention.

[0031] **FIG. 9** is a horizontal cross-section view of the pre-mold part when the resin contraction occurs according to embodiment 1 of the present invention.

[0032] **FIG. 10** is a vertical cross-section view of the pre-mold part when the resin contraction occurs according to embodiment 1 of the present invention.

[0033] **FIG. 11** is an isometric view of the composite mold part when the electronic part is mounted according to embodiment 1 of the present invention.

[0034] **FIG. 12** is a cross-section isometric view of the composite mold part when the electronic part is mounted according to embodiment 1 of the pre sent invention.

[0035] **FIG. 13** is a partial cross-section view of the pre-mold part according to embodiment 1 of the present invention.

[0036] **FIG. 14** is a partial cross-section view of the pre-mold part according to embodiment 1 of the present invention.

[0037] **FIG. 15** is a partial cross-section view of the pre-mold part according to embodiment 1 of the present invention.

[0038] **FIG. 16** is an isometric view of the pre-mold part before engaging parts according to embodiment 3 of the present invention.

[0039] **FIG. 17** is an isometric view of the pre-mold part after engaging parts according to embodiment 3 of the present invention.

[0040] **FIG. 18** is a cross-section view of the pre-mold part after engaging parts according to embodiment 3 of the present invention.

[0041] **FIG. 19** is a cross-section view of the area of the insert part of the composite mold part according to embodiment 3 of the present invention.

[0042] **FIG. 20** is a cross-section view of the pre-mold part according to embodiment 2 of the present invention.

[0043] **FIG. 21** is a cross-section view of the pre-mold part according to embodiment 2 of the present invention.

[0044] **FIG. 22** is a cross-section view of the composite mold part according to embodiment 2 of the present invention.

[0045] **FIG. 23** is a cross-section view illustrating the composite mold part as the mold part having the insert part.

[0046] **FIG. 24** is a partial cross-section view of the area of the insert part of the composite mold part as the mold part having the insert part.

[0047] **FIG. 25** is a partial cross-section view of the area of the insert part of the composite mold part as the mold part having the insert part composed of an epoxy material.

[0048] **FIG. 26** is a partial cross-section view of the composite mold part according to embodiment 7 of the present invention.

[0049] **FIG. 27** is an isometric view of the insert part of the pre-mold part according to embodiment 7 of the present invention.

[0050] **FIG. 28** is an isometric view of the pre-mold part according to embodiment 7 of the present invention.

[0051] **FIG. 29** is an isometric view of the pre-mold part when the resin contraction occurs according to embodiment 7 of the present invention.

[0052] **FIG. 30** is a cross-section view of the pre-mold part when the resin contraction occurs according to embodiment 7 of the present invention.

[0053] **FIG. 31** is a cross-section view of the composite mold part according to embodiment 7 of the present invention.

[0054] **FIG. 32** is an isometric view of the pre-mold part according to embodiment 1 of the present invention.

[0055] **FIG. 33** is a partial cross-section view of the pre-mold part according to embodiment 1 of the present invention.

[0056] **FIG. 34** is a partial cross-section view of the pre-mold part when the resin contraction occurs according to embodiment 1 of the present invention.

[0057] **FIG. 35** is a cross-section view of the composite mold part when the wire bonding process according to embodiment 1 of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0058] Now, the problems to be solved by the present invention will be described in detail.

[0059] It is required to make the thickness of the resin as uniform as possible for making the mold parts in order to prevent the degradation in fluidity and surface property of the resin. However, in case that the mold part has a part having an increased thickness, as this increased thickness part has a larger amount of contraction due to the molding process in comparison with the other part in the mold part, it may cause unfavorable void generation inside such an increased thickness part as has a thickness larger than a designated limitation value. In case of molded parts having an insert part inserted therein, the contraction of the increased thickness part and the voids generated inside it may result in contributing to make larger the gap developed in the interface between the insert part and the mold part.

[0060] In general, there is a method for molding the resin used for the increased thickness part in two-layer structure in order to solve the above described problem, in which sub parts having a required size are formed in a preliminary molding process, and then, those pre-mold parts are inserted as insert parts, and finally, those parts are integrated with over-mold parts by way of multiple molding.

[0061] In the mold part formed by inserting the insert parts, in the progress of mass production of a wide variety of goods, downsizing and sophisticated configuration of insert part due to higher functionality of parts, there is a limit for increasing the productivity only with a single molding process, and thus, in order to solve this problem in the similar manner to the method described above, sub parts are formed in a preliminary molding process, and then, those pre-mold parts are inserted as insert parts, and finally, those parts are integrated with over mold parts by way of multiple molding so that the productivity and the yield rate of the product may be increased. In addition, in terms of higher productivity and low-cost in the molding process, thermoplastic resin is often used as the mold material and an injection molding method is used widely for the molding method in general.

[0062] A general structure of the mold part having an insert part formed by way of multiple molding process is shown in **FIG. 23** and **FIG. 24**. **FIG. 23** shows the cross-section view of the composite mold part **91** composed of the pre-mold part **93** formed by way of insert molding process with plural metallic terminals **92** and the pre-mold part **93***a* made of resin, and the over-mold part **91***a* with the pre-mold part **93** inserted therein, and **FIG. 24** shows the magnified view of those parts.

[0063] In this multiple molding process, the stress due to the resin contraction of the over-mold part **91** is applied to the pre-mold part **93***a* inserted as the insert part, and the internal distortion occurs inside the pre-mold part **93***a*. In addition, the heat treatment for integration molding with the over-mold part causes the resin contraction of the pre-mold part **93***a*, and this resin contraction mechanism is different from the contraction of the single body of the pre-mold part **93** and depends on the type and shape of the over-mold part, which may result in such a problem as making larger the gap **94***b* developed in the interface between the metallic terminal

92 and the pre-mold part **93***a*. And furthermore, the gap **94***a* occurs similarly at the interface between the pre-mold part **93***a* and the over-mold part **91***a*.

[**0064**] In order to solve the above described problem, as shown in **FIG. 25**, there is such a method that an adhesive material such as epoxy resin **99** is coated and harden at the electrical bonding part **92***a* of the metallic terminal **92** after the over-molding process in order to seal the interface between those parts, and further fix firmly the electrical bonding part **92***a* and the pre-mold part **93***a*.

[**0065**] However, in this method, the coating process of the epoxy material **99** such as epoxy resin is required, and the hardening process for hardening and bonding the epoxy material **99** such as epoxy resin after the coating process requires the hardening time of 30 to 60 minutes. In addition, it is required to prepare the coating apparatus and the hardening oven, which may lead to lower productivity and higher cost. And furthermore, as the viscosity of the epoxy material **99** decreases extremely before hardening and the epoxy resin takes in liquid form, the hardening shape varies widely due to the epoxy resin flowing in an uncured state, which may result in the low reliability in fixing the electrical bonding part **92***a* and the pre-mold part **93***a*.

[**0066**] As for another method, the metallic terminal is inserted and pre-molded by using heat-hardening resin, which provides small amount of post-contraction and is less subject to heat history in the over-molding process, for the pre-mold part. However, in this method, there are such problems that the material cost for the heat-hardening resin is higher than the thermo setting material, and that the reliability of the heat-hardening resin is lower than the reliability of the thermo setting material due to the occurrence of resin flash associated with the heat-hardening resin.

[**0067**] In order to solve the above problems, this embodiment is characterized by a composite mold part formed by forming a pre-mold part by pre-molding an insert part composed of a composite material composed of metal, ceramic, resin or a combination of those materials or one or more metallic terminals used for electrical contact, which is not limited to this example, as the insert part with a pre-mold part composed of thermo plastic resin having crystallinity, and by inserting said pre-mold part into an over-mold part composed of thermo plastic resin and surrounding said pre-mod part with an over-mold part, wherein an insert molding process is applied to an pre-mold part surrounding said pre-mold part to be inserted after applying heat treatment with a temperature lower than a crystalline melting point of said pre-mold part.

[**0068**] One embodiment of the present invention is characterized by that said plural pre-mold parts are inserted simultaneously, and molded together with using the over-mold part.

[**0069**] Another embodiment of the present invention is characterized by that said pre-mold parts are superposed and then inserted simultaneously, and molded together with using the over-mold part.

[**0070**] Yet another embodiment of the present invention is characterized by that said pre-mold part and the over-mold part composed of thermo setting resin having crystallinity are composed of the resin having the common base material and filled with the filler.

[**0071**] Another embodiment of the present invention is characterized by that said pre-mold part and the over-mold part composed of thermo setting resin having crystallinity are composed of the resin having the common base material and filled with the filler, and that the pre-mold part is composed of the resin having the filler filling factor higher than that of the resin used for the over-mold part.

[**0072**] Another embodiment of the present invention is characterized by that said pre-mold part and the over-mold part composed of thermo setting resin having crystallinity are composed of the resin having the common base material and filled with the filler, and that the pre-mold part is composed of the resin having the crystalline melting point higher than that of the resin used for the over-mold part.

[**0073**] Another embodiment of the present invention is characterized by that said pre-mold part and the over-mold part composed of thermo setting resin having crystallinity are composed of the resin having the common base material and filled with the filler, and that the pre-mold part is composed of the resin having the crystalline melting point equivalent to or higher than that of the resin used for the over-mold part, and having the fusibility with the over-mold part.

[**0074**] And furthermore, another embodiment of the present invention is characterized that an electron ic apparatus having an electronic part arranged inside the composite mold part with plural terminals inserted therein used for connecting electrically to outside, in which the composite mold part is composed of the above described configuration.

[**0075**] Embodiments of the present invention will be described in detail by referring to the attached figures. Note that the present invention is not limited to the following embodiments.

Embodiment 1

[**0076**] **FIG. 1** shows an isometric view of the composite mold part **1** as the mold part having the insert part used for the electronic apparatus in this embodiment. The composite mold part **1** is such a composite mold part as formed by inserting the pre-mold part **3** as the insert part into the over-mold part **1***a* and molding together with the over-mold part **1***a*, composed of the thermo setting resin, surrounding the pre-mold part **3**. As for another insert part, a bush **5** to be used for mounting at the main body is also molded together with the over-mold part **1***a*.

[**0077**] The pre-mold part **3** is formed as the metallic terminal **2** configured as plural Cu-based metallic plates with the thickness of 0.6 to 1.00 mm and with the width of 2 to 3 mm on the surface of which metallic deposit is formed with nickel, tin or gold used for electrical connection in order to develop the electrical conjunction and contact property and the corrosion protection property, and those metallic terminals are inserted as the insert part into the pre-mod part **3***a* composed of the thermo setting resin having crystallinity. In the pre-mold part **3** formed by applying the pre-mold process to the metallic terminal **2** used for electrical connection with the pre-mold part **3***a*, this embodiment has such a characteristic that heat treatment is applied in advance to the pre-mold part **3***a* with the temperature lower than the crystalline melting point of the pre-mold part **3***a*.

[0078] As for the material used for the pre-mold part **3***a*, polyester resin such as polybutylene terphthalate resin (PBT resin), and thermoplastic resin having crystallinity such as polyphenylene sulfide resin (PPS resin), polyamide resin (PA resin), polyacetal resin (POM resin) and polyethylene resin (PE resin) and compound resin formed by filling glass fiber as inorganic material, carbon fiber as organic material, or metallic material into those resin materials can be used.

[0079] As for the material used for the over-mold part **1***a*, in addition to resin materials enable to be used for the pre-mold part, thermoplastic resin having amorphous property such as polycarbonate resin (PC resin), polystyrene resin (PS resin) and ABS resin, thermo setting resin such as epoxy resin and phenol resin, and compound resin formed by filling glass fiber as inorganic material, carbon fiber as organic material, or metallic material into those resin materials can be used.

[0080] In the following example, such a material as formed with polybutylene terphthalate resin filled with glass fiber by 40% is used for the material used for both of the pre-mold part **3***a* and the over-mold part **1***a*.

[0081] So far, the basic structure of the composite mold part **1** is described above, and then the production method in the embodiment shown by **FIG. 1** is now described below. At first, the pre-mold part **3** is formed by means that, plural metallic terminals **2** shown in **FIG. 4** are inserted into a designated position of the die assembly, not explicitly shown in the figure, with it temperature increased in 40 to 100° C., and the metallic terminals **2** are fixed by the moving die assembly, the fixed die assembly and the clamp using slide pieces. By means of injection molding method, the molding resin fused in the heater temperature, 220° C. to 270° C., of the molding machine is made flow through the spool, the runner and the gate inside the die assembly and filled into the spatial cavity in order to form the pre-mold part **3**. Concurrently with this filling operation, the pre-mold part **3***a* formed as fused resin material is cooled and solidified immediately inside the die assembly, and then the finished pre-mold part **3** can be obtained by being released from the die assembly and pushed out from the die assembly with the knockout pin. The horizontal cross-section view of the pre-mold part is shown in **FIG. 6**, and the vertical cross-section view of the pre-mold part is shown in **FIG. 7**. In this embodiment, after molding the pre-mold part **3***a*, heat treatment is particularly applied to the pre-mold part **3***a* in the high temperature reservoir at 150° C. lower than the crystalline melting point of the pre-mold part **3***a* from 220° C. to 270° C. in about 1 hour. The pre-mold part **3** with heat treatment applied is inserted as the insert part, and then, the over-mold processing is applied for filling the over-mold part **1***a* into the spatial cavity in order to mold the composite mold part **1** as the over-mold part inside the die assembly with the fused molding resin heated in the heater temperature, 220° C. to 270° C., of the molding machine by means of injection molding method similar to the pre-mold processing. and then, after the composite mold part **1** as the over-mold part is cooled and solidified, the finished composite mold part **1** as the over-mold part can be obtained by being pushed out from the die assembly with the knockout pin.

[0082] The pre-mold part **3***a* surrounds continuously the metallic terminals **2** which are formed as plural metallic terminals **2** adjacent to one another, and the electrical connection part **2***a* of the individual metallic terminal **2** is exposed onto the surface of the pre-mold part **3***a* made of resin material. As shown in **FIG. 32** and **FIG. 33**, as a single body of the individual metallic terminal **2**, at the entire perimeter of the electrical connection part **2***a*, the pre-mold parts **3***a* formed with the resin material having the thickness 2 to 3 mm on the opposite surface of the electrical connection surface are arranged without intervals, and the pre-mold part **3***a* made with the same resin material surrounds the electrical connection part **2***a* without intervals also on the vertical surfaces to the electrical connection surface. In this embodiment, after molding the pre-mold part **3***a*, heat treatment is particularly applied to the pre-mold part **3***a* in the high temperature reservoir at 150° C. lower than the crystalline melting point of the pre-mold part **3***a* from 220° C. to 270° C. in about 1 hour. Owing to this heat treatment, the internal distortion caused during the molding process in the pre-mold part **3***aa* before heat treatment can be released as well as the crystallization of the pre-mold part **3***aa* can be accelerated, which leads to the contraction of the pre-mold part **3***a* in the direction so as to fasten the metallic terminals **2** as shown in **FIG. 34**. As this contraction behavior is developed throughout the pre-mold part **3** as well as the above described part locally, the pre-mold part **3** is contracted due to heat treatment. This contraction behavior is shown in **FIG. 8** to **FIG. 10**. The interface between the metallic terminal **2** and the pre-mold part **3***a* is contacted firmly to each other part without intervals in comparison with the structure before heat treatment, and as the molecular structure in the pre-mold part **3***a* is stabilized due to the development of crystallization, the rigidity of the pre-mold part **3***a* against the time-dependent variability and the deformation due to the thermal external force applied by the over-mold part **1***a* can be increased more significantly than the structure before heat treatment.

[0083] The condition for heat treatment described above is not limited to this embodiment, but another condition such as the treatment temperature from 130 to 170° C. and the heating time for 1 to 4 hours can contribute to the same and satisfactory performance.

[0084] In addition, as for the thickness of the pre-mold part **3***a* made of resin arranged on the opposite surface of the electrical connection surface, 2 to 3 mm thickness for PBS resin as used in this embodiment provides the best performance, and in contrast, smaller thickness reduces the throughout rigidity of the pre-mold part **3**, which results in the distortion and deformation intolerable to the material filling pressure and the resin contraction. On the other hand, larger thickness causes voids generated inside the pre-mold part **3***a* made of resin, and as this void generation accelerates remarkably the resin expansion and contraction, which leads to making larger the gap in the interface between the metallic terminal **2** and the pre-mold part **3***a* made of resin.

[0085] In the composite mold part **1** formed by inserting the pre-mold part **3** with heat treatment applied and by over-molding process, it will be appreciated that the gap **4** may be developed between the pre-mold part **3***a* and the over-mold part **21***a* but there is no gap generated between the metallic terminal **2** and the pre-mold part **3***a* even when the resin contraction in the over-mold part **1***a* is developed.

[0086] The isometric view of the configuration in which the electronic part **6** is arranged at the designated position

inside the composite mold part **1** and the electrical connection part **2***a* of the metallic terminal **2** and the electronic part **6** are bonded by the aluminum wire **7** is shown in **FIG. 11** and its cross-section view is shown in **FIG. 12**. As shown in **FIG. 35**, the aluminum wire **7** is overlapped onto the electrical contact part surface **2***a*, and then, the bonding apparatus **100** presses down the aluminum wire **7** onto the surface of the electrical connection part **2***a*, and the aluminum wire **7** and the electrical connection part **2***a* are bonded to each other by the friction heat induced by the ultrasonic vibration generated by the bonding apparatus **100**. In this process, if there exists a gap in the interface between the lower part of the electrical connection part **2***a* and the pre-mold part **3***a*, the ultrasonic vibration energy used for bonding process is dispersed and the friction heat required for bonding process can not be generated, which results in the defect of bonding. However, in the composite mold part **1** of this embodiment, as the metallic terminal **2** and the pre-mold part **3***a* can be contacted more firmly to each other without gap generated between the metallic terminal **2** and the pre-mold part **3***a* than before heat treatment at the pre-mold part **3** alone, which can leads to the establishment of stable bonding performance without ultrasonic vibration energy dispersion at the bonding process.

[**0087**] The shapes of the electrical connection part **2***a* of the metallic terminal **2** and the pre-mold part **3***a* so formed as to accelerate the crystallization of the pre-mold part **3***a* by applying the above described heat treatment to the pre-mold part **3***a* and contacting firmly the interface between the metallic terminal **2** and the pre-mold part **3***a* is not limited to the shape shown by the cross-section view illustrated in **FIG. 13**, but it will be appreciated that the same effect can be obtained also by forming the protruding surface of the resin material **3***b* at the both end parts of the surface of the electrical connection part **2***a* adjacent to the pre-mold part **3***a* as shown in **FIG. 14**. It may be allowed also that the protruding part **2***b* of the metallic terminal is formed at the both end parts of the electrical connection part **2***a* below the surface of the electrical connection part **2***a* of the metallic terminal **2**.

Embodiment 2

[**0088**] **FIG. 22** shows a cross-section view of the composite mold part **71** as the mold part having the insert part used for the electro nic apparatus in this embodiment, the composite mold part **71** being formed by inserting simultaneously a couple of pre-mold parts **53** and **63** shown in **FIG. 20** and **FIG. 21**, respectively, and molding with the over-mold part **71***a*. This composite mold part **71** is composed as in the following manner, and based on the same principle as the embodiment 1. The metallic terminals **52** and **62** are configured as plural Cu-based metallic plates with the thickness of 0.6 to 1.00 mm and with the width of 2 to 3 mm on the surface of which metallic deposit is formed with nickel, tin or gold used for electrical connection in order to develop the electrical conjunction and contact property and the corrosion protection property, and those metallic terminals are inserted as the insert part into the pre-mod parts **53***a* and **63***a* composed of the thermo setting resin having crystallinity, and then the pre-mold parts **53** and **63** are formed by applying the pre-mold process to the metallic terminals **52** and **62** with the pre-mold parts **53***a* and **63***a*. The heat treatment is applied to the individual pre-mold parts **53***a* and **63***a* in the high temperature reservoir at 150° C. lower than the crystalline melting point of the pre-mold parts **53***a* and **63***a* in about 1 hour, and next, the pre-mold parts **53** and **63** are inserted as insert parts to the over-mold part **71***a*, and finally the composite mold part **71** is obtained by molding the pre-mold parts **53** and **63** with the over-mold part **71***a* composed of PBT resin composed of thermo setting material.

[**0089**] Owing to this heat treatment, the internal distortion in the individual pre-mold parts **53** and **63** can be released as well as the crystallization can be accelerated, which leads to the contraction of the pre-mold parts **53** and **63** in the direction so as to fasten the metallic terminals **52** and **62**. Therefore, also in the composite mold part **71** formed by over-molding, even if the gaps **74***a* and **74***b* might be developed between the pre-mold parts **53***a* and **63***a* and the over-mold part **71***a*, it will be appreciated that there is no gap generated between the metallic terminals **52** and **62** and the pre-mold parts **53***a* and **63***a*, which can leads to the establishment of stable bonding performance at the bonding.

Embodiment 3

[**0090**] **FIG. 19** shows a partial cross-section view of the composite mold part **11** as a mold part having the insert part used for the electronic apparatus in this embodiment, the composite mold part **11** being formed by superposing and inserting simultaneously a couple of pre-mold parts **23** and **33** shown in **FIG. 16**, **FIG. 17** and **FIG. 18**, respectively, and molding with the over-mold part **1***a*. This composite mold part **11** is composed as in the following manner, and based on the same principle as the above described embodiments.

[**0091**] The metallic terminals **22** and **32** are configured as plural Cu-based metallic plates with the thickness of 0.6 to 1.0 mm and with the width of 2 to 3 mm on the surface of which metallic deposit is formed with nickel, tin or gold used for electrical connection in order to develop the electrical conjunction and contact property and the corrosion protection property, and those metallic terminals are inserted as the insert part into the pre-mod parts **23***a* and **23***a* composed of the thermo setting resin having crystallinity, and then the pre-mold parts **53** and **63** are formed by applying the pre-mold process to the metallic terminals **22** and **32** with the pre-mold parts **23***a* and **33***a*. The heat treatment is applied to the individual pre-mold parts **23***a* and **33***a* in the high temperature reservoir at 150° C. lower than the crystalline melting point of the pre-mold parts **23***a* and **33***a* in about 1 hour, and next, the pre-mold part **33** is overlapped above the pre-mold part **23** as shown in **FIG. 12** and **FIG. 17**, and the overlapped pre-mold parts **23** and **33** are inserted as insert parts, and finally the composite mold part **11** is obtained by molding the over-mold part **11***a* with PBT resin composed of thermo setting material surrounding the pre-mold parts **23** and **33**.

[**0092**] In this embodiment, by means of decomposing the pre-mold parts for the metallic terminals **22** and **32** formed as the multi stage and for the pre-mold part having larger thickness, it will be appreciated that the pre-mold parts **23***a* and **33***a* can be contracted in the direction so as to fasten the metallic terminals **22** and **32**, respectively, and the void generation inside the pre-mold part can be prevented.

[**0093**] Owing to this heat treatment, the internal distortion caused during the molding process in the pre-mold parts **23**

and **33** can be relaxed as well as the crystallization of the pre-mold part **3***aa* can be accelerated, and the molecular structure can be stabilized, which leads to the improvement of the rigidity of the pre-mold parts **23***a* and **33***a* against the deformation stress after the heat treatment.

[**0094**] Therefore, also in the composite mold part **11** formed by over-molding, even if the gap **14** might be developed between the pre-mold part **23***a* the over-mold part **11***a*, it will be appreciated that there is no gap generated between the metallic terminals **52** and **62** and the pre-mold parts **23***a* and **33***a*, which can leads to the establishment of stable bonding performance at the bonding.

Embodiment 4

[**0095**] Though not shown explicitly, the materials used for the pre-mold part and the over-mold part are not limited to those used in this embodiment but can be selected from any combination of resin materials. In the embodiment 1, such a common material as PBT resin composed of heat setting material filled with glass fiber by 40% is used for both of the pre-mold part and the over-mold part. In contrast, in the embodiment 4, glass fiber is filled by 50% in the pre-mold part and glass fiber is filled by 40% in the over-mold part, which provides such resin combination as the filler fraction in the pre-mold part is higher than the filler fraction in the over-mold part.

[**0096**] In the similar manner to the embodiment 1, the metallic terminal is inserted as insert part and molded with the pre-mold part filled with the above described glass fiber by 50%, and then, the heat treatment is applied to the pre-mod part in the high temperature reservoir at 150° C. lower than the crystalline melting point of the pre-mold part, and finally, the pre-mold part completed with the heat treatment is inserted as the insert part, and molded with the over-mold part composed of glass fiber by 40%.

[**0097**] As glass fiber is filled into the resin material for the purpose of increasing the rigidity of resin material, the rigidity of the pre-mold part can be increased by means of making the fraction of glass fiber in the pre-mold higher than the fraction of glass fiber in the over-mold part, and this configuration is effective against the deformation stress by establishing the rigidity and in view of resin contraction behavior of the over-mold part. Thus, higher rigidity in the area of the connection part at the bonding can be established which can leads to stable bonding performance.

Embodiment 5

[**0098**] In the previous embodiments, such a common material as PBT resin composed of heat setting material is used for both of the pre-mold part and the over-mold part. In contrast, in the embodiment 5, the material used at the pre-mold part is different from the material used at the over-mold part, but those resin materials are filled with filler, and the pre-mold part and the over-mold part are so configured that PPS resin composed of thermo setting resin, having a crystalline melting point higher than the over-mold part, filled with glass fiber by 60% is used for the material of the pre-mod part, and that PBT resin composed of thermo setting resin filled with glass giver by 40% is used for the material of the over-mold part.

[**0099**] In the similar manner to the embodiment 1, the metallic terminal is inserted as insert part and molded with the pre-mold part composed of PPS resin filled with the above described glass fiber by 60%, and then, the heat treatment is applied to the pre-mod part in the high temperature reservoir at 170° C. lower than the crystalline melting point of the pre-mold part, and finally, the pre-mold part completed with the heat treatment is inserted as the insert part, and molded with the over-mold part composed of PBT resin filled with the above described glass fiber by 40%.

[**0100**] As described in the embodiment 4, as the filler fraction of glass fiber in the pre-mold part is higher, it will be appreciated that the rigidity of the pre-mold part is sufficient enough and the resin contraction behavior of the over-mold part is well established and stable bonding performance can be provided, and in addition, as the crystalline melting point of the pre-mold part is higher than the over-mold part, it will be appreciated that the heat effect against the pre-mold part can be reduced when heating and molding the over-mold part.

Embodiment 6

[**0101**] In the embodiment 6, such a common material as PBT resin composed of heat setting material is used for both of the pre-mold part and the over-mold part, and the pre-mold part and the over-mold part are so configured that resin filled with glass fiber by 50% is used for the pre-mold part and resin filled with glass fiber by 30% is used for the pre-mold part, which provides such resin combination as the filler fraction in the pre-mold part is higher than the filler fraction in the over-mold part, and that the pre-mod part has a crystalline melting point lower than the over-mold part.

[**0102**] In the similar manner to the embodiment 1, the metallic terminal is inserted as insert part and molded with the pre-mold part filled with the above described glass fiber by 50%, and then, the heat treatment is applied to the pre-mod part in the high temperature reservoir at 150° C. lower than the crystalline melting point of the pre-mold part, and finally, the pre-mold part completed with the heat treatment is inserted as the insert part, and molded with the over-mold part composed of glass fiber by 30%.

[**0103**] As the crystalline melting point of the pre-mold part is lower than the over-mold part,

[**0104**] The surface of the pre-mold part due to heating when molding the over-mold part is melted with the micron order thickness, and this melted part is fused with a part of the over-mold part and cooled and solidified. Thus, it will be appreciated that such a composite mold part as there is no gap generated at the interface between the pre-mold part and the over-mold part can be provided. The above described method is effective for the composite mold part which requires the firm contact between the pre-mold part and the over-mold part.

[**0105**] As described also in the embodiment 4, as the filler fraction of glass fiber in the pre-mold part is higher, it will be appreciated that the rigidity of the pre-mold part is sufficient enough and the resin contraction behavior of the over-mold part is well established and stable bonding performance can be provided.

Embodiment 7

[**0106**] Though the metallic terminal is used as the insert part in the embodiments 1 to 6, the insert part is not limited

to this example but any combination of materials is allowed. In the embodiment 7, in order to configure the magnetic circuit by using composite mold parts, the pre-mold part **108** shown in **FIG. 28** obtained by inserting the magnetic parts **109** and **1-9** shown in **FIG. 27** as the insert part, and the pre-mod part **108** is inserted as the insert part as well as the metallic terminals for electrical contact **102** and the bush **105** to be used for mounting at the main body, and composite mold part **101** finished by molding with the over-mold part **101***a* is shown in **FIG. 26**. In this embodiment, the magnetic parts **109***a* and **109***b* are described specifically in the following explanation.

[**0107**] The pre-mold part **108** is obtained by inserting a couple of magnetic material parts **109***a* and **109***b* into a designated position of the die assembly, and by pre-molding those insert parts with pre-mold part **108***a* composed of PBT resin by means of injection molding method. In addition, in the similar method to that of the embodiment, after molding, heat treatment is applied to the pre-mold part **108** in the high temperature reservoir at 150° C. lower than the crystalline melting point of the pre-mold part **108***a* in about 1 hour. The pre-mold part **108** with heat treatment applied is inserted as the insert part, and then, the over-mold processing is applied to the insert part with the over-mold part **101***a* composed of the same material as the pre-mold part **108**, and finally the composite mold part **101** can be obtained as the over-mold part.

[**0108**] Owing to this heat treatment, the internal distortion caused during the molding process in the pre-mold part **108***aa* before heat treatment can be released as well as the crystallization of the pre-mold part **108***aa* can be accelerated, which leads to the contraction of the pre-mold part **3***a* in the direction so as to fasten the magnetic material parts **109***a* and **109***b* as shown in **FIG. 29** and **FIG. 30**. Therefore, also in the composite mold part **101** formed by over-molding as shown in **FIG. 31**, even if the gap **104** might be developed between the pre-mold parts **108***a* and the over-mold part **101***a*, it will be appreciated that there is no gap generated between the magnetic material parts **109***a* and **109***b* and the pre-mold part **108***a*, which can leads to the establishment of precise support performance of the pre-mold part **108***a* for the magnetic material parts **109***a* and **109***b*. In this configuration of the pre-mold part **108**, there are several gaps **110** between the magnetic material parts **109***a* and **109***b* and the over-mold part **101***a*, and this gap **110** contributes to the relaxation of the distortional deviation in the resin volume due to the temperature change.

[**0109**] The above described embodiments can be applied to the apparatus forming the rotating body such as motors, and to the sensors for sensing the angles, positions and displacement by using the rotating body and for supplying the electric signal, and further applicable to the actuator and drive apparatus having those sensors. For example, those sensors include throttle valves for adjusting the intake air volume and the throttle position sensors mounted onto the throttle valve, the accelerator pedal position sensor for detecting the accelerator opening, and other sensors for forming those sensors and their control structure in the automobile industry. The above embodiment is not limited to the products mentioned above, but can be applied to those products which can resolve the problems to be solved by the present invention.

[**0110**] As the mold part in the above embodiment is configured as described above, it will be appreciate that there is no gap generated at the interface between the insert part and the resin surrounding the insert part and their firm contact can be established, and thus, the following effects can be obtained.

[**0111**] As the internal distortion in the pre-mold part due to the heat treatment can be relaxed as well as the crystallization of the pre-mold part can be accelerated, the dimension of the mold par after heat treatment can be stabilized and the deformation can be reduced, it will be appreciated that the quality and productivity in automation can be increased for the insert part which requires a high precision positioning process.

[**0112**] As for the wire bonding performance extremely subject to the gap between the insert part and the pre-mold part, it will be appreciated that the both parts can be firmly contacted to each other without gap, and hence stable bonding performance can be established without ultrasonic vibration energy dispersion at the bonding process.

[**0113**] As the between the insert part and the resin part can be established in comparison with the conventional insert parts, it will be appreciate that the application to sensors and on-board circuit parts used in the critical environment in which the conventional parts can not be applied can be established.

[**0114**] As the pre-mold part can be obtained by insert molding process using injection molding method which provides advantage in molding efficiency by using the thermo setting resin having crystallinity, it will be appreciate that higher productivity and lower production cost can be established.

[**0115**] As the pre-mold part can be defined in advance by the mold die assembly, it will be appreciated that the resin parts having an effective shape in order to increase the contact between the insert-part and the resin part surrounding the insert part can be arranged with a high degree of accuracy, and that the pre-mold part can be designed relatively freely without constraint applied to the quality, shape, arrangement and numbers of the insert parts to be inserted into the die assembly.

[**0116**] According to the present invention, it will be appreciated that the electronic parts are arranged on the mold or inside the mold, and the mold part for the electronic apparatus can be realized by providing the electric signal exchange with outside.

[**0117**] The above described embodiments can be applied to the apparatus forming the rotating body such as motors, and to the sensors for sensing the angles, positions and displacement by using the rotating body and for supplying the electric signal, and further applicable to the actuator and drive apparatus having those sensors.

[**0118**] Although the present invention has been illustrated and described with respect to exemplary embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omission and additions may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set out above but to

include all possible embodiments which can be embodied within a scope encompassed and equivalent thereof with respect to the feature set out in the appended claims.

1. A composite mold part formed by forming a pre-mold part by pre-molding an insert part composed of a composite material composed of metal, ceramic, resin or a combination of those materials with a pre-mold part composed of thermo plastic resin having crystallinity, and by inserting said pre-mold part into an over-mold part composed of thermo plastic resin and surrounding said pre-mod part with an over-mold part, wherein

an insert molding process is applied to an pre-mold part surrounding said pre-mold part to be inserted after applying heat treatment with a temperature lower than a crystalline melting point of said pre-mold part.

2. A composite mold part of claim 1, wherein

said composite material is one or more metallic terminal to be used for electrical connection.

3. A composite mold part of claim 1, comprising plural pre-mold parts, wherein

said insert part is inserted into said plural pre-mold parts, and molded together with an over-mold part.

4. A composite mold part of claim 1, comprising

plural pre-mold parts, wherein

said plural pre-mold part are overlapped and inserted, and molded together with an over-mold part.

5. A composite mold part of claim 1, wherein

said pre-mold part and said over-mold part are composed of a base resin material filled with an identical type of filler.

6. A composite mold part of claim 5, wherein

an amount of filler filled in said pr e-mold part is equal to an amount of filler filled in said over-mold part.

7. A composite mold part of claim 1, wherein

said pre-mold part and said over-mold part are composed of an identical base material and resin filled with filler, and said pre-mold part is composed of a resin with a filler fraction higher than that of said over-mold part.

8. A composite mold part of claim 1, wherein

said pre-mold part and said over-mold part are composed of a different base material and resin filled with filler, and said pre-mold part is composed of a resin with a crystalline melting point higher than that of said over-mold part.

9. A composite mold part of claim 1, wherein

said pre-mold part and said over-mold part are composed of an identical base material and resin filled with filler, said pre-mold part is composed of a resin with a crystalline melting point lower than that of said over-mold part, and said resin having a melting point equivalent to or higher than that of said over-mold part so as to have a good fusion characteristic with said over-mold part.

10. An electronic part wherein

a pre-mold part is formed with insert-molding so as to make a contact between said pre-mold part and said insert part by applying a heat treatment with a temperature lower than a crystalline melting point to an insert part including metal in a pre-mold part composed of thermo plastic resin, and

said pre-mold part is inserted into an over-mold part composed of thermo plastic resin.

11. An electronic part of claim 10, wherein

a gap generated at an interface between said insert part and said pre-mold part in said pre-mold part is narrower than a gap generated at an interface between said pre-mold part and said over-mold part.

12. A production method of composite molding part comprising:

a step for arranging an insert part at a designate position of a mold die assembly heated at a designated temperature;

a step for molding a pre-mold part by filling a molding resin into said pre-mold die assembly;

a step for applying heat treatment with a temperature lower than crystalline melting point of said molding resin to said pre-mold part; and

a step for arranging said pre-mold part with heat treatment applied at a designated position of a over-mold die assembly heated at a designated temperature, and inserting said pre-mold part with heat treatment applied as an insert part into an over-mold part by filling a mold resin into said over-mold die assembly in order to form a composite mold part.

13. A production method of composite molding part of claim 12, wherein

a designated temperature of said pre-mold die assembly or said over-mold die assembly is between 40° C. and 100° C.;

a heater temperature of molding apparatus for filling said mold resin is between 220° C. and 270° C. and selected to be lower than a crystalline melting point from 220° C. to 270° C. of said molding resin before the heat treatment step.

14. A production method of composite molding part of claim 12, wherein

after a step for molding a pre-mold part by filling a mold resin into said pre-mold die assembly, said mold resin is cooled and solidified, and after a step for forming said composite mold part by filling a mold resin into said over-mold die assembly, said mold resin is cooled and solidified.

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