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OU et al.

(54) **HOUSING, ELECTRONIC DEVICE USING THE SAME, AND METHOD FOR MAKING THE SAME**

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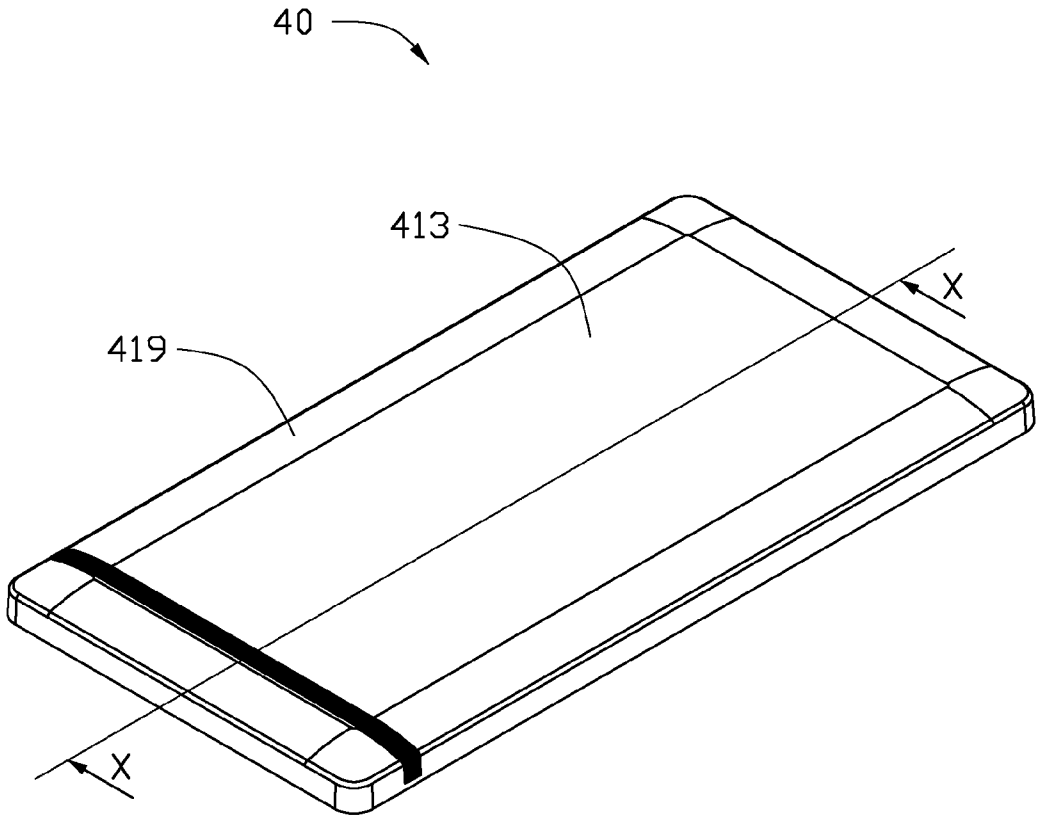
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H05K 5/04 (2006.01)

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CPC ***G06F 1/1698*** (2013.01); ***H05K 5/04*** (2013.01); ***H05K 5/0247*** (2013.01); ***G06F 1/1626*** (2013.01)

(57) **ABSTRACT**

A housing includes a metal base and a non-conductive member. The metal base has an internal surface and at least one gap. The non-conductive member covers at least a portion of the internal surface of the metal base, and the non-conductive member is formed on the bottom of the at least one gap.



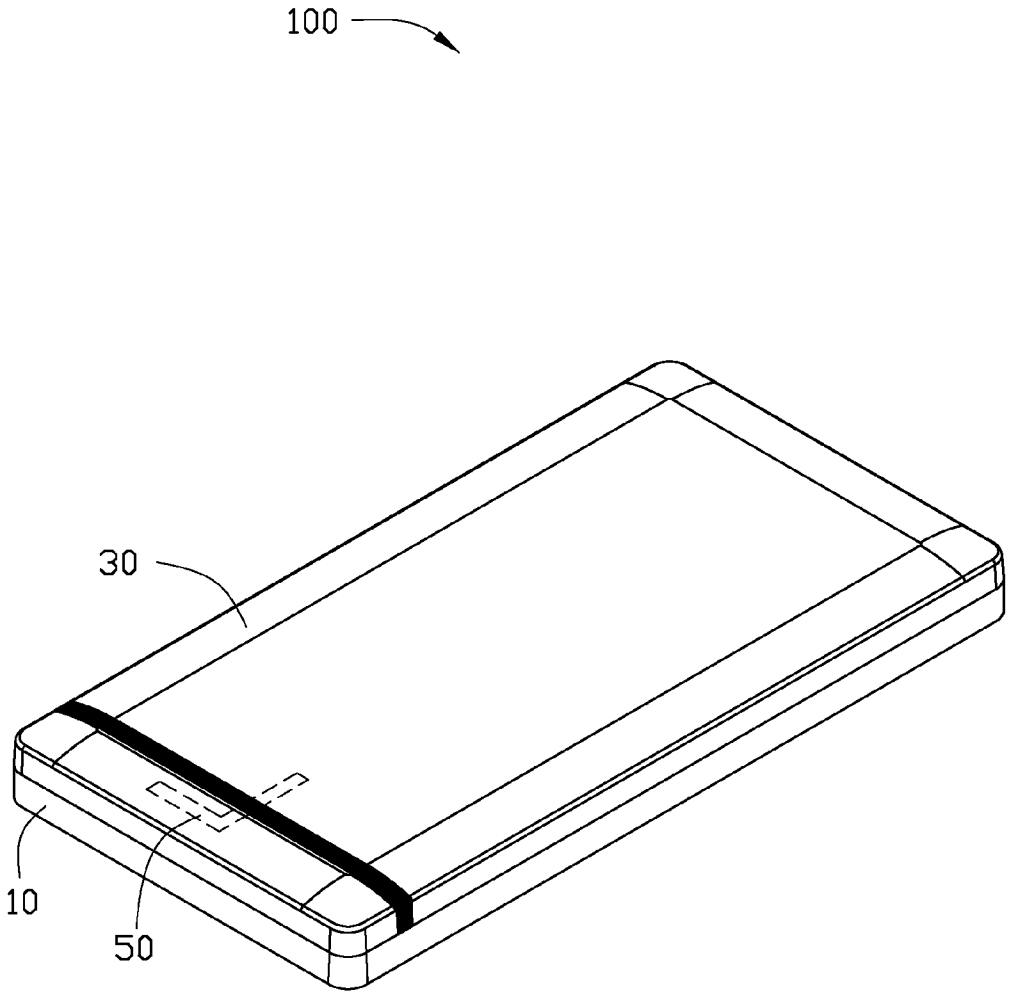


FIG. 1

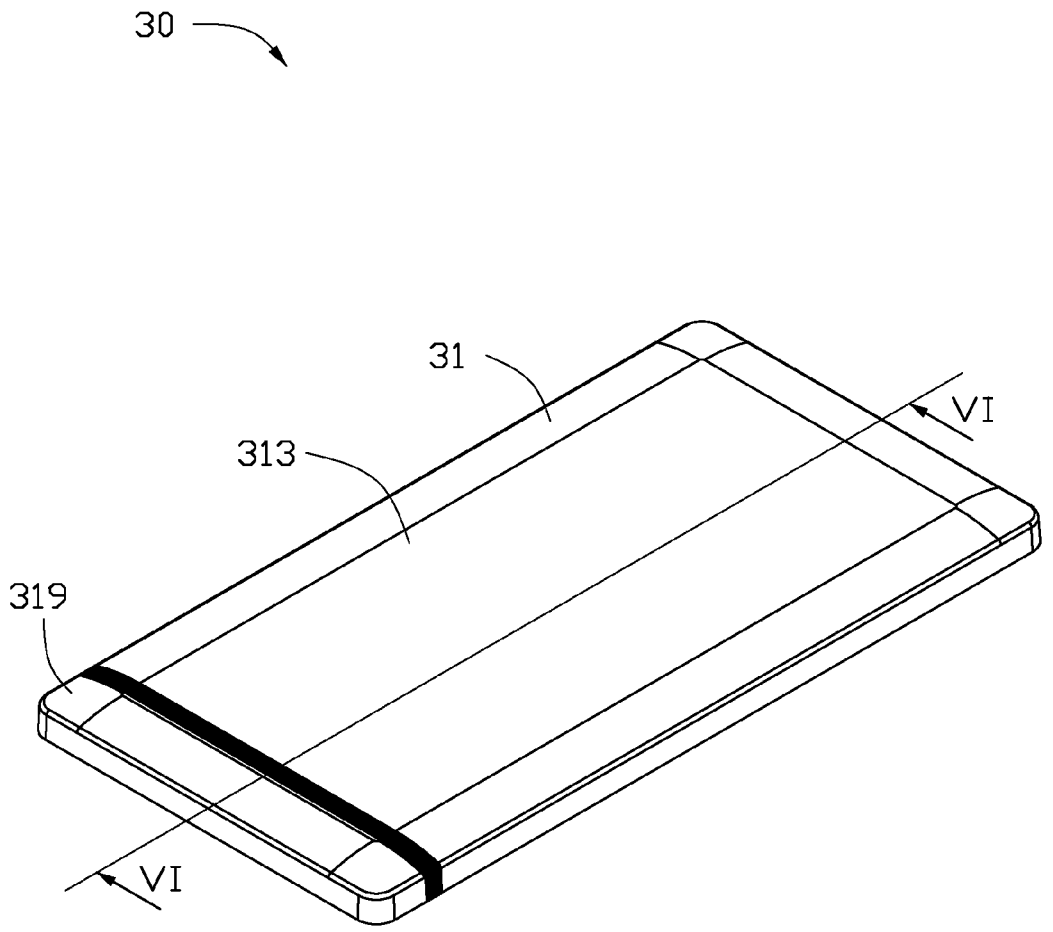


FIG. 2

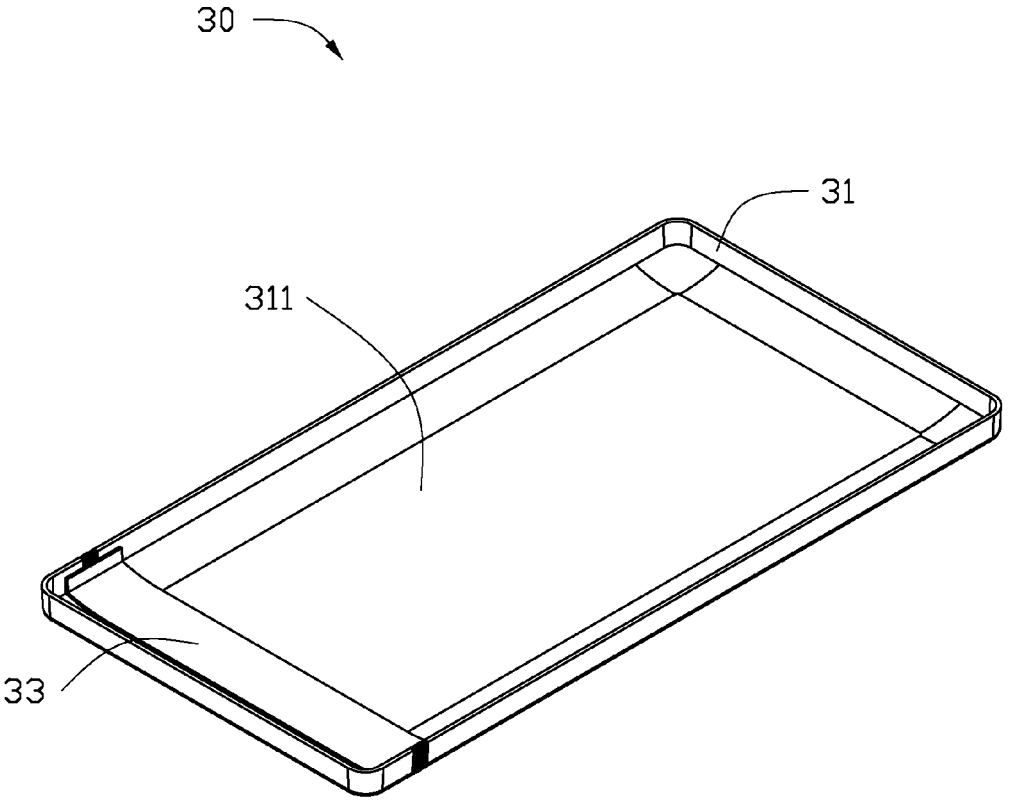


FIG. 3

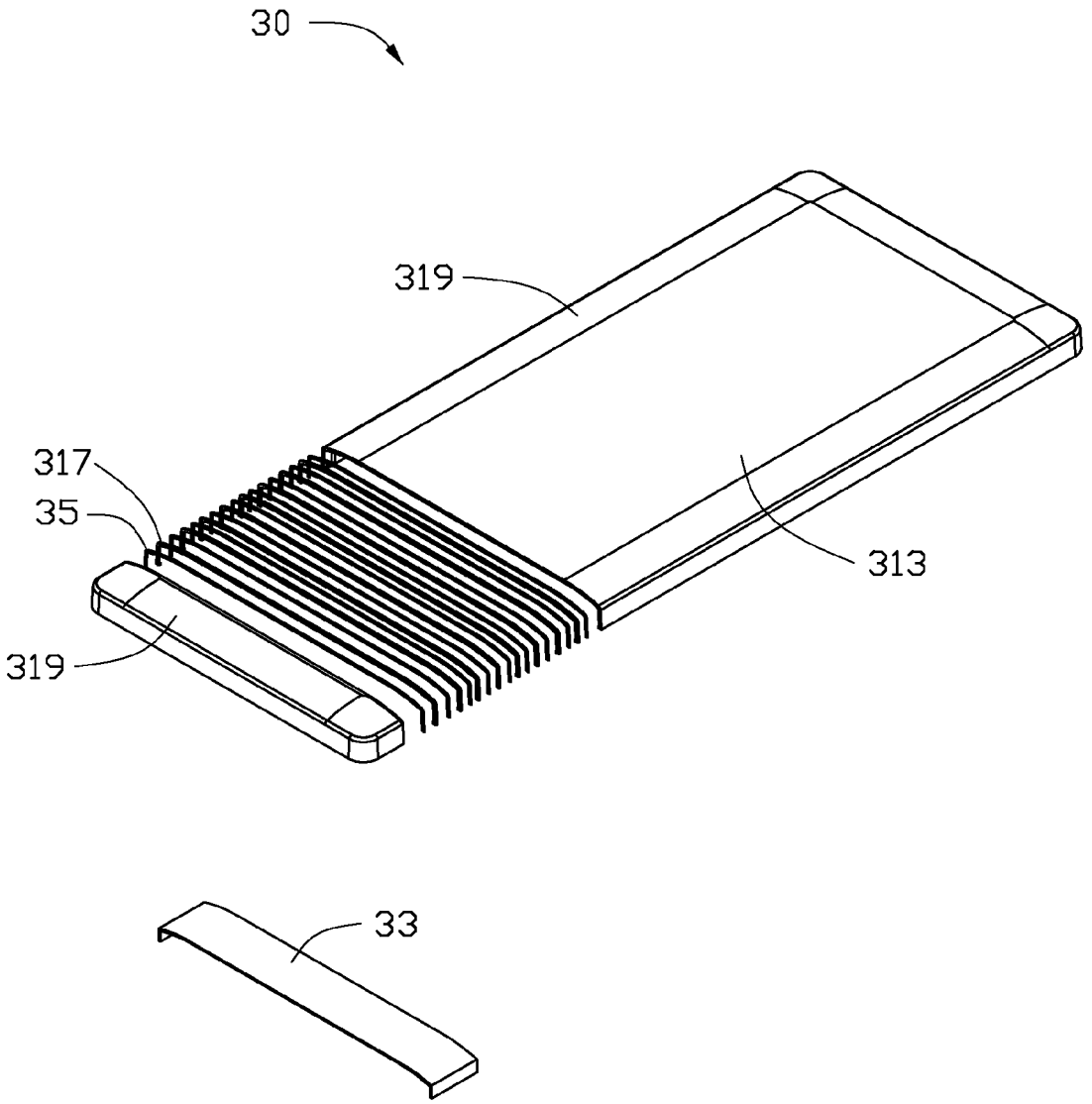


FIG. 4

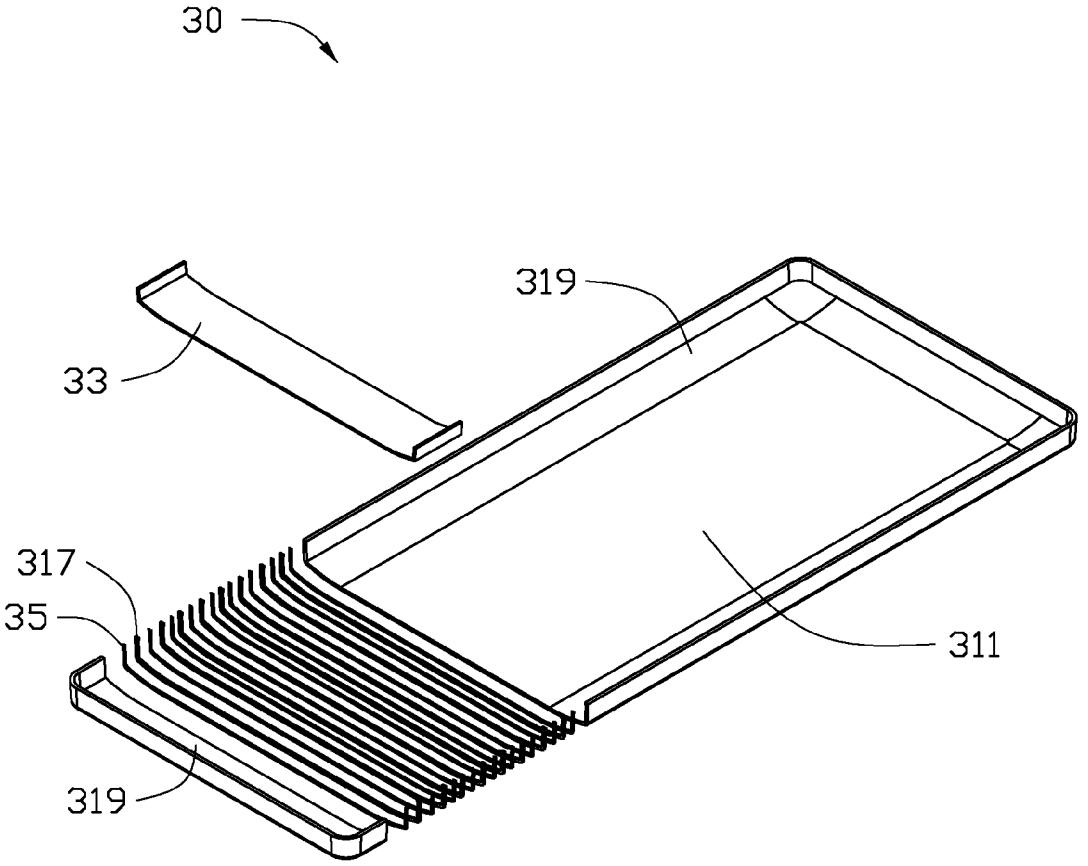


FIG. 5

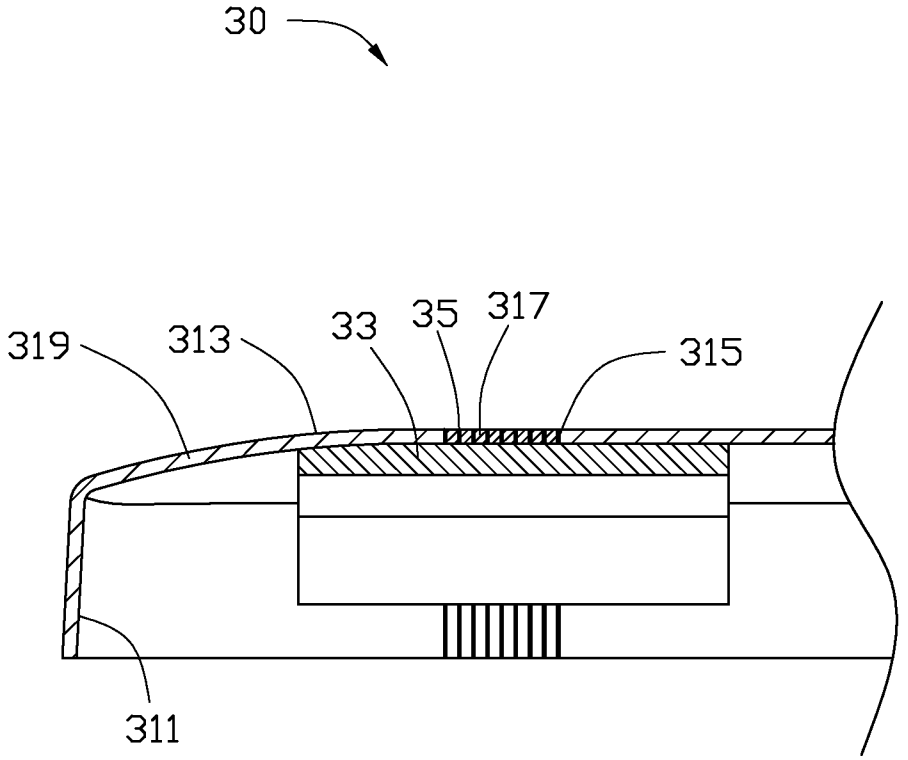


FIG. 6

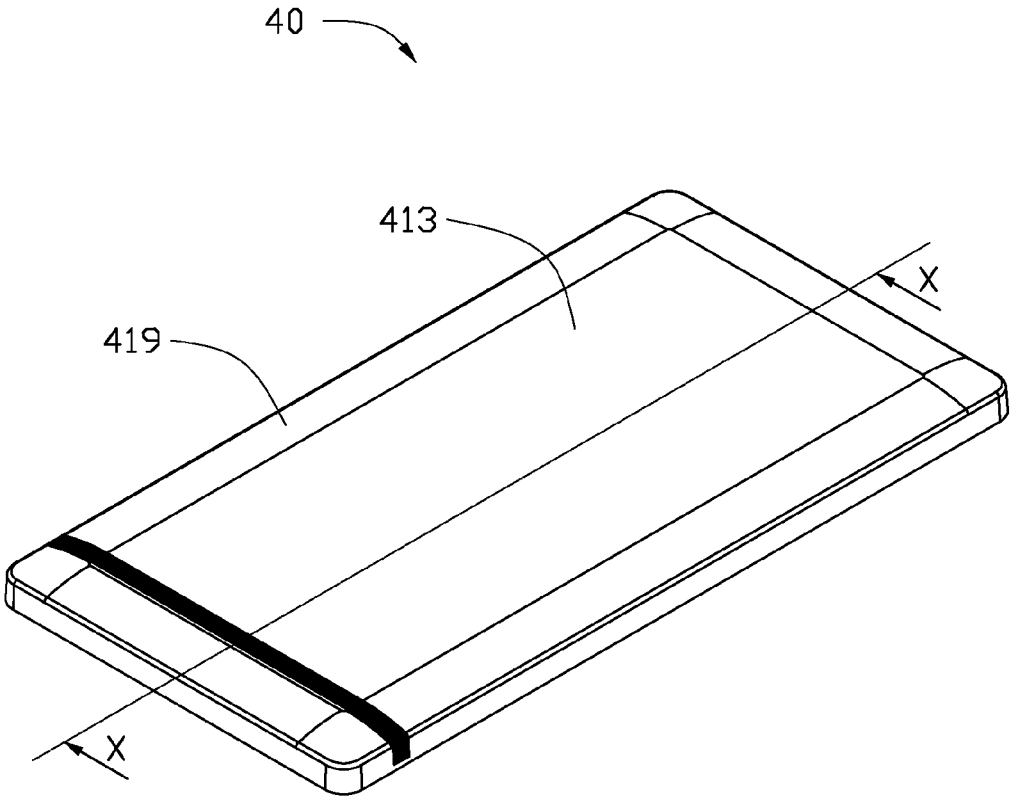


FIG. 7

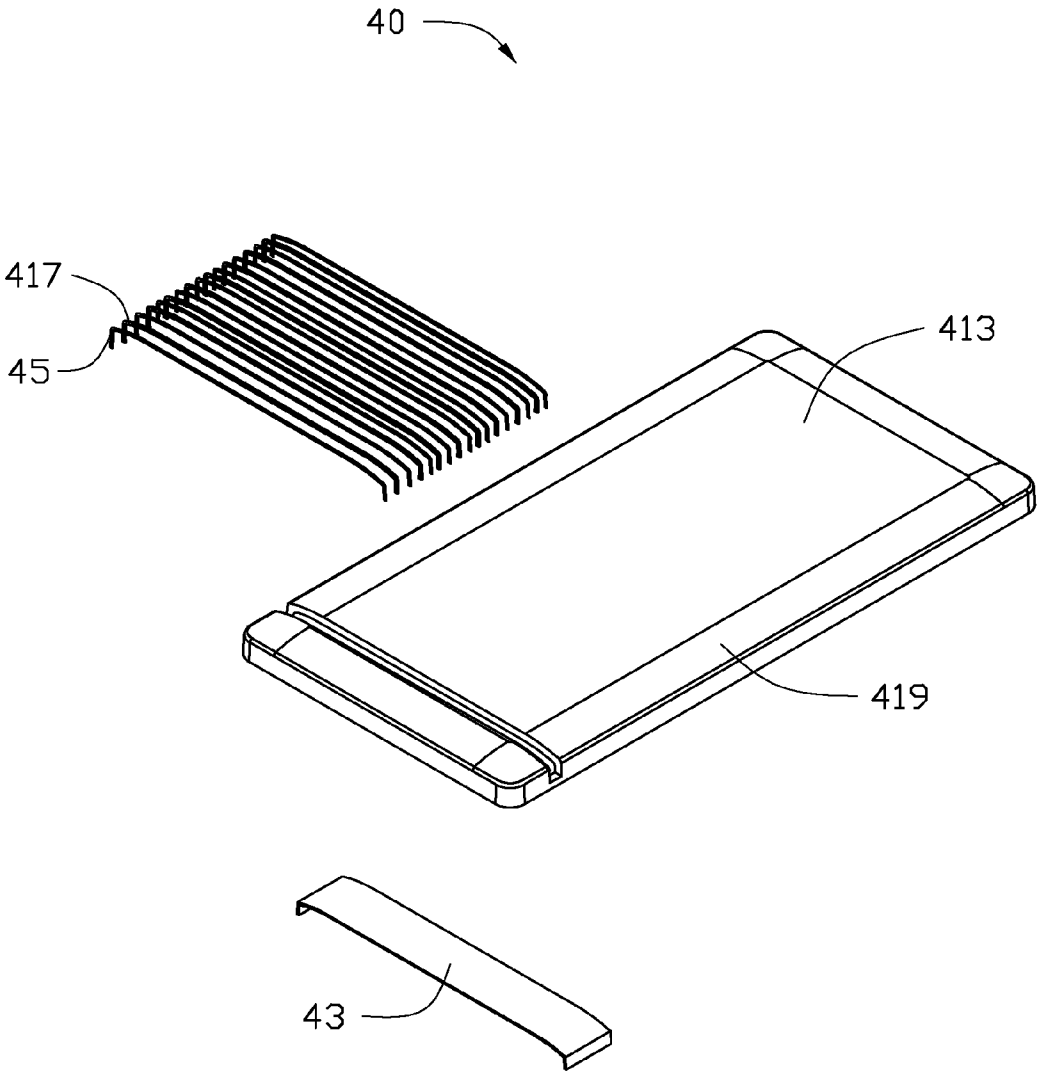


FIG. 8

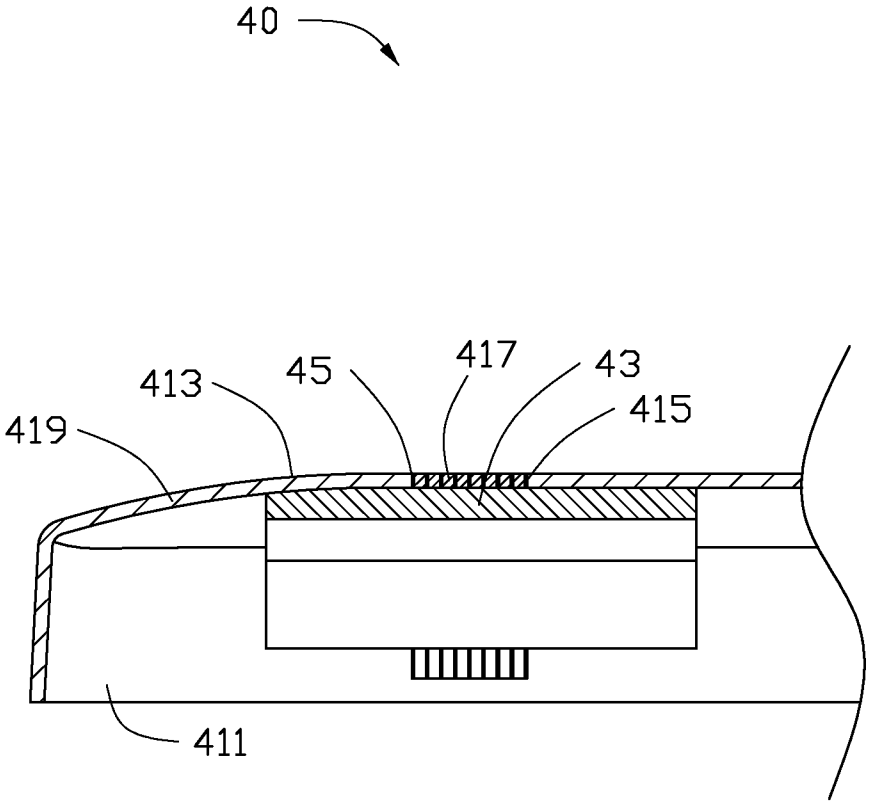


FIG. 9

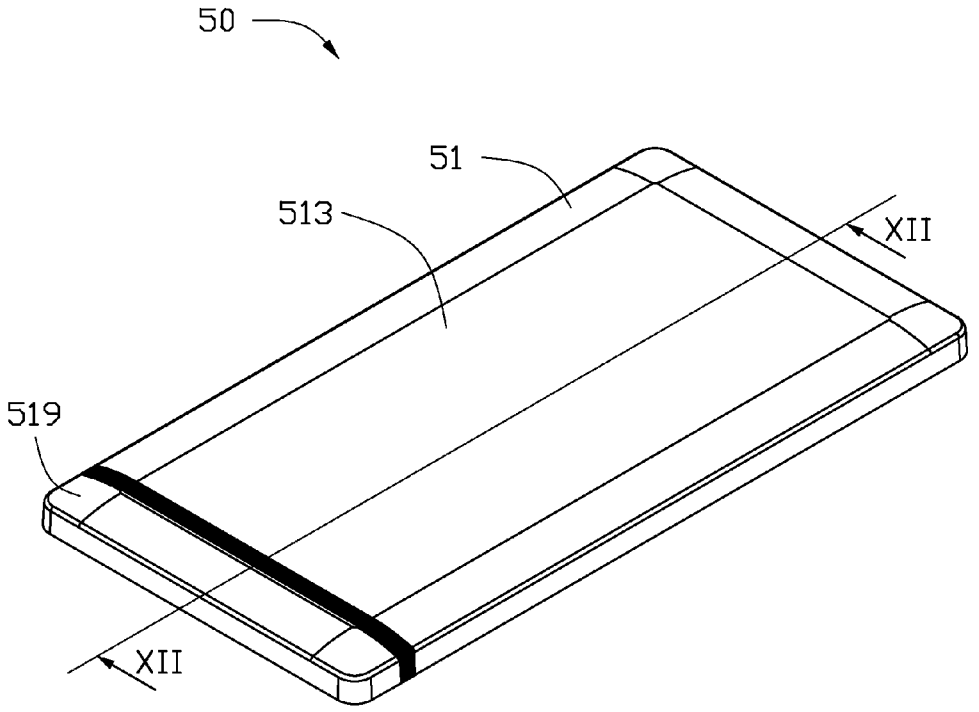


FIG. 10

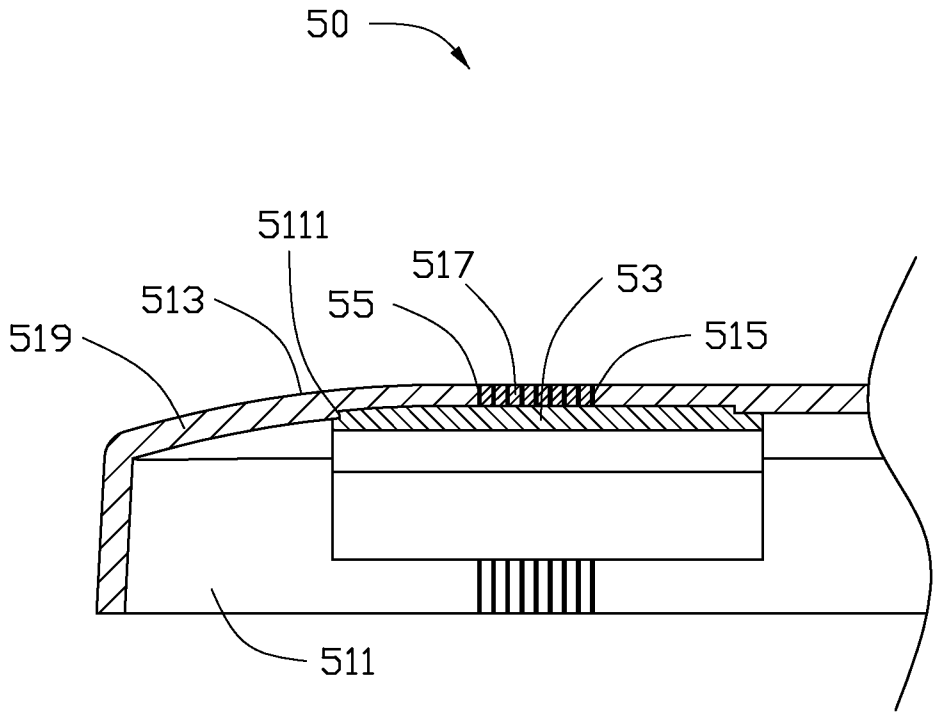


FIG. 11

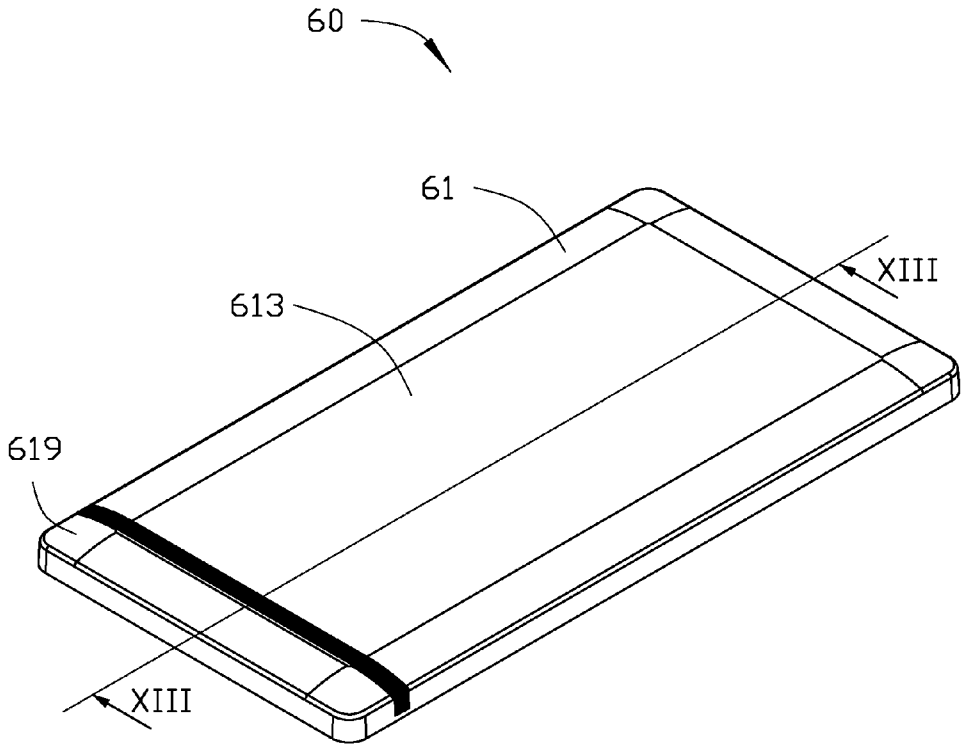


FIG. 12

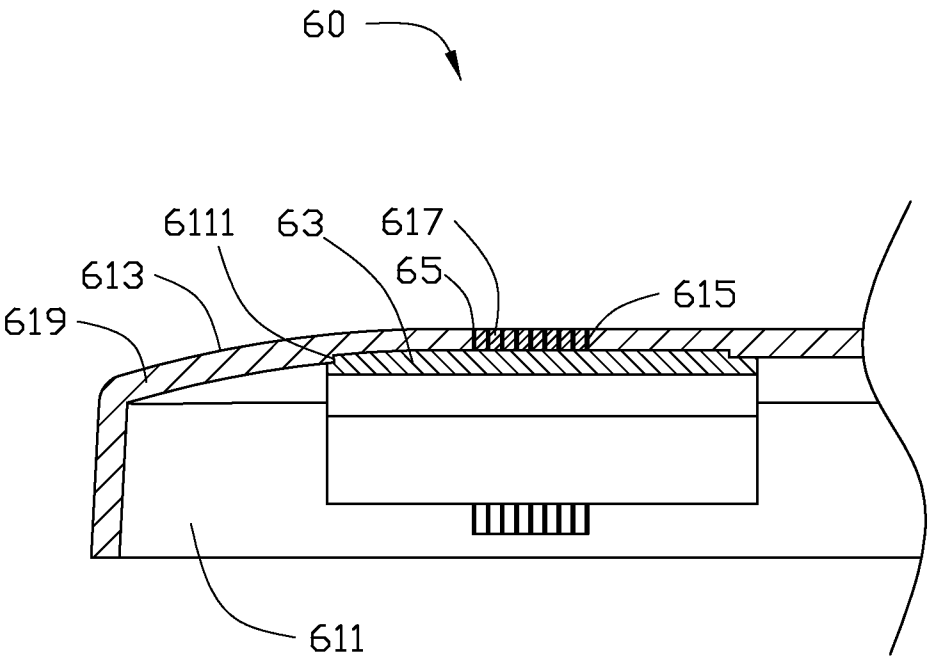


FIG. 13

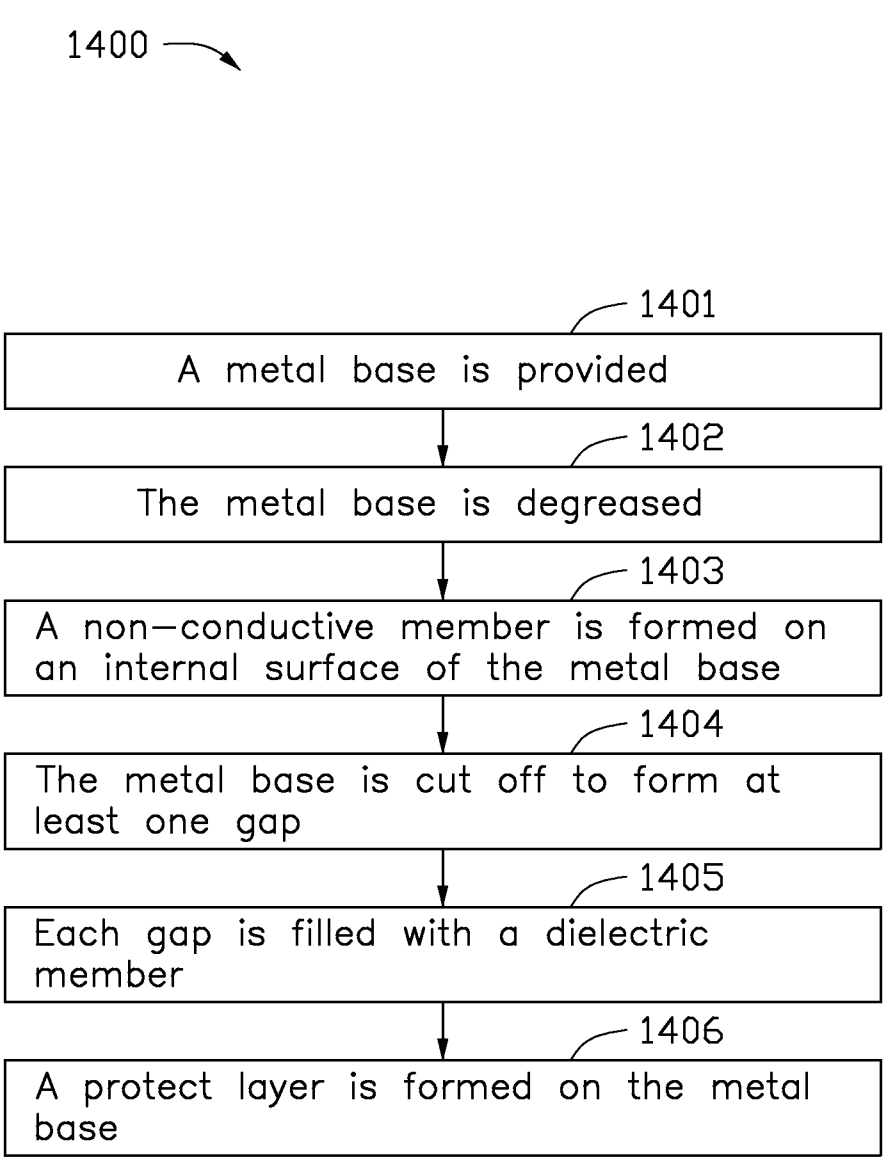

1400
1401
A metal base is provided
1402
The metal base is degreased
1403
A non-conductive member is formed on an internal surface of the metal base
1404
The metal base is cut off to form at least one gap
1405
Each gap is filled with a dielectric member
1406
A protect layer is formed on the metal base

FIG. 14

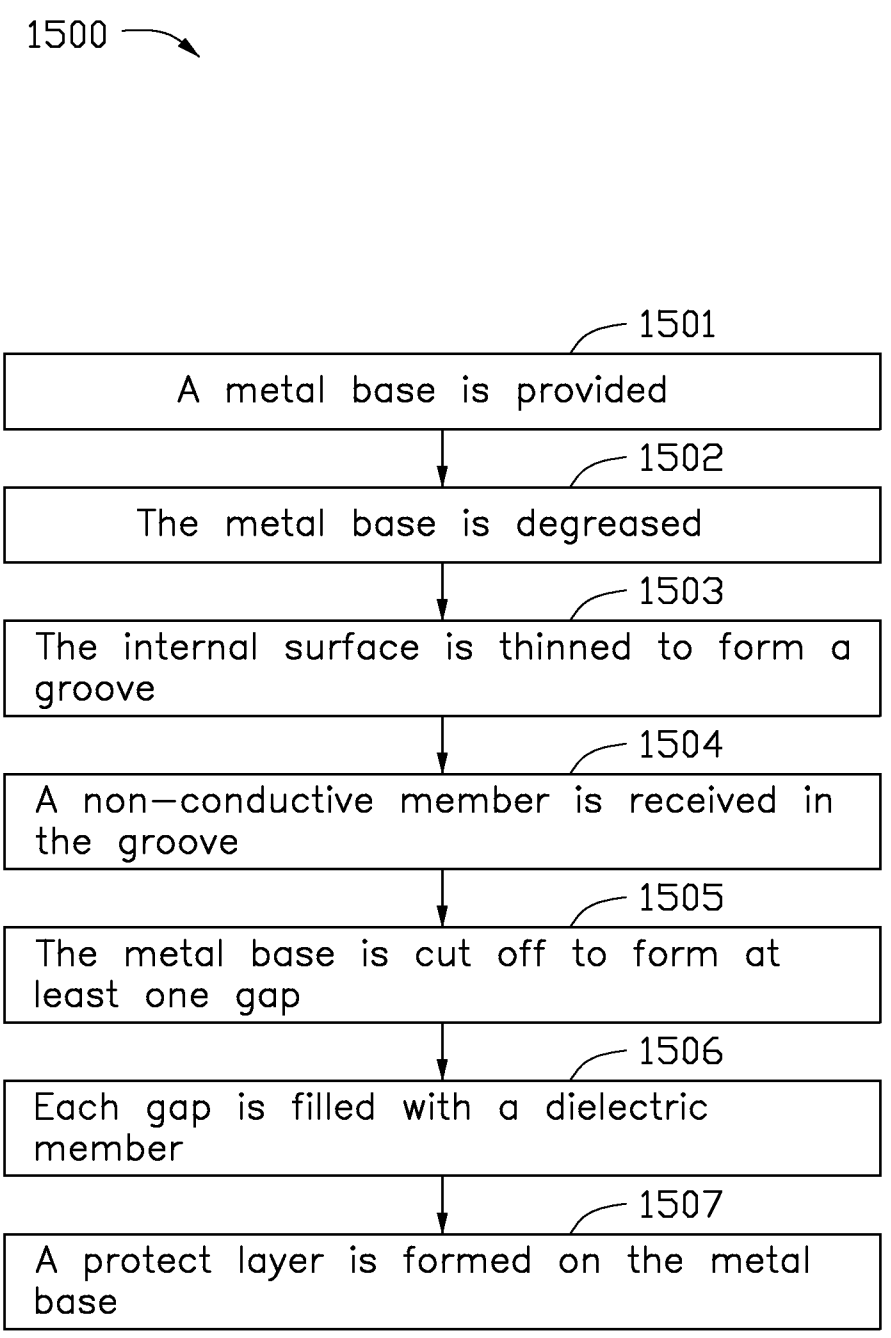

1500
1501
A metal base is provided
1502
The metal base is degreased
1503
The internal surface is thinned to form a groove
1504
A non-conductive member is received in the groove
1505
The metal base is cut off to form at least one gap
1506
Each gap is filled with a dielectric member
1507
A protect layer is formed on the metal base

FIG. 15

HOUSING, ELECTRONIC DEVICE USING THE SAME, AND METHOD FOR MAKING THE SAME

FIELD

[0001] The subject matter herein generally relates to a housing, an electronic device using the housing, and a method for making the housing.

BACKGROUND

[0002] Metal housings are widely used for electronic devices such as mobile phones or personal digital assistants (PDAs). Antennas are also important components in electronic devices. But the signal of the antenna located in the metal housing is often shield by the metal housing.

BRIEF DESCRIPTION OF THE FIGURES

[0003] Implementations of the present technology will now be described, by way of example only, with reference to the attached figures.

[0004] FIG. **1** is an isometric view of an electronic device, according to an exemplary embodiment.

[0005] FIG. **2** is an isometric view of a housing of the electronic device shown in FIG. **1** according to a first exemplary embodiment.

[0006] FIG. **3** is similar to FIG. **2**, but shown from another angle.

[0007] FIG. **4** is an exploded, isometric view of the housing shown in FIG. **2**, according to the first exemplary embodiment.

[0008] FIG. **5** is similar to FIG. **4**, but shown from another angle.

[0009] FIG. **6** is a cross-sectional view of the housing along line VI-VI of FIG. **2**.

[0010] FIG. **7** is an isometric view of a housing according to a second exemplary embodiment.

[0011] FIG. **8** is an exploded, isometric view of the housing shown in FIG. **7**.

[0012] FIG. **9** is a cross-sectional view of the housing along line X-X of FIG. **7**.

[0013] FIG. **10** is an isometric view of a housing according to a third exemplary embodiment.

[0014] FIG. **11** is a cross-sectional view of the housing along line XII-XII of FIG. **10**.

[0015] FIG. **12** is an isometric view of a housing according to a fourth exemplary embodiment.

[0016] FIG. **13** is a cross-sectional view of the housing along line XIII-XIII of FIG. **12**.

[0017] FIG. **14** is a flow chart of a method for making a housing in accordance with a first exemplary embodiment.

[0018] FIG. **15** is another flow chart of a method for making a housing in accordance with a second exemplary embodiment.

DETAILED DESCRIPTION

[0019] It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein can be practiced without these specific details. In other instances, methods, procedures and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

[0020] The term "comprising" when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the like. The term "coupled" when utilized, means "either a direct electrical connection between the things that are connected, or an indirect connection through one or more passive or active intermediary devices, but not necessarily limited to".

[0021] FIG. **1** illustrates an electronic device **100** according to an exemplary embodiment. The electronic device **100** can be, but not limited to, a mobile phone, a personal digital assistant or a tablet computer. The electronic device **100** includes a body **10**, a housing **30** assembled to the body **10**, and an antenna **50** located inside the housing **30**.

[0022] The body **10** can have a printed circuit board (PCB, not shown) and a battery (not shown) electronically connected with the PCB. The battery can charge the electronic device **100**.

[0023] Referring to FIGS. **2-5**, in one exemplary embodiment, the housing **30** is a back cover of the electronic device **100**. The housing **30** can include a metal base **31** and a non-conductive member **33**, a dielectric member **35** received in the metal base **31**, and a protective layer (not shown) formed on the metal base **31**.

[0024] In at least one embodiment, the metal base **31** can be coupled with the antenna **50**, such that the metal base **31** is used as a part of an antenna assembly of the electronic device **100**. In alternative embodiments, the metal base **31** is not coupled with the antenna **50**, such that the metal base **31** is not used as a part of the antenna assembly of the electronic device **100**.

[0025] The metal base **31** includes an internal surface **311** and an outer surface **313** opposite to the internal surface **311**. In at least one exemplary embodiment, a thickness of the metal base **31** is less than 0.5 mm, preferably, the thickness of the metal base is about 0.3 mm to about 0.5 mm. The non-conductive member **33** can directly cover at least a portion of the internal surface **311**.

[0026] It is to be understood, the location, shape and dimension of the portion of the internal surface **311** covered with the non-conductive member **33** can be designed according to that of the housing **30**.

[0027] The metal base **31** can be made of metal which can be selected from a group consisting of aluminium, aluminium alloy, magnesium, magnesium alloy, titanium, titanium alloy, copper and copper alloy.

[0028] Referring to FIG. **6**, sections of a portion of the metal base **31** are cut off to form at least one gap **315**. The dielectric member **35** can be received in the gap **315**. The non-conductive member **33** can be located at a bottom of the at least one gap **315**. The antenna **50** corresponds to the at least one gap **315**, the dielectric member **35** and the non-conductive member **33**, such that signal of the antenna **50** can pass through the gap **315** to have a high radiation efficiency.

[0029] In at least one exemplary embodiment, the at least one gap **315** includes a plurality of gaps **315**, and the metal

base **31** is spaced by the gaps **315**, forming a plurality of metal sheets **317** and at least one main body **319**. The location of the metal sheets **317** and the at least one main body **319** does not move, because the metal sheets **317** and the at least one main body **319** are bonded with the non-conductive member **33**, such that the housing **30** has high dimensional accuracy. Each metal sheet **317** has a width of about 0.15 mm to about 1.0 mm along a direction from an adjacent dielectric member **35** located at one side of the metal sheet **317** to another adjacent dielectric member **35** located at the opposite side of the metal sheet **317**. Each gap **315** and each dielectric member **35** have a width of about 0.02 mm to about 0.7 mm along a direction from an adjacent dielectric member **35** located at one side of the metal sheet **317** to another adjacent dielectric member **35** located at the opposite side of the metal sheet **317**.

[0030] Referring to FIGS. **4-6**, in at least one exemplary embodiment, the metal base **31** is spaced by the gaps **315**, forming a plurality of metal sheets **317** and two main bodies **319**. Each gap **315** can run through the two opposite ends of the metal base **31** along a direction of the metal sheets **319** parallel to the main body **319**.

[0031] The non-conductive member **33** can be made of a thermoplastic, a thermosetting plastic, a ceramic, or other non-conductive materials.

[0032] The thermoplastic can be selected from a group consisting of polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyethylene terephthalate (PET), polyether ether ketone (PEEK), polycarbonate (PC) and polyvinyl chloride polymer (PVC). The thermosetting plastic can be selected from a group consisting of a polyurethane resin, an epoxy, and a polyurea resin.

[0033] The dielectric member **35** can be bonded with the non-conductive member **33**, and received in the at least one gap **315** to bond the metal sheets **317** with the at least one main body **319**. The signal of the antenna **50** can pass through the dielectric member **35**, such that the antenna **50** has a high radiation efficiency.

[0034] The dielectric member **35** can be made of dielectric material, such as resin, rubber, ceramic, and so on.

[0035] The resin can be made of a thermoplastic or a thermosetting plastic. The thermoplastic can be selected from a group consisting of polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyethylene terephthalate (PET), polyether ether ketone (PEEK), polycarbonate (PC) and polyvinyl chloride polymer (PVC). The thermosetting plastic can be selected from a group consisting of an epoxy, and a polyurea resin, and a UV-curing adhesive. The UV-curing adhesive can be acrylic resin or polyurethane.

[0036] The protective layer (not shown) can be formed by an anodic oxidation coloring process, a spraying process or an electrophoresis process. The protective layer can have a thickness of about 10 μm to about 15 μm and cover the internal surface **311** and the outer surface **311** of the metal base **31**.

[0037] FIGS. **7-9** illustrate a housing **40** according to a second exemplary embodiment. The difference between the housing **40** of the second exemplary embodiment and the housing **30** of the first exemplary embodiment is that the metal base **41** is spaced by the gaps **415**, forming a plurality of metal sheets **417** and one main body **419**. The gaps **415** are positioned within the metal base **41**. And the gaps **415** cannot run through at least one end of the metal base **41** along a direction of the metal sheets **419** parallel to the main body **419**.

[0038] FIGS. **10-11** illustrate a housing **50** according to a third exemplary embodiment. The difference between the housing **50** of the third exemplary embodiment and the housing **30** of the first exemplary embodiment is that a thickness of the metal base **51** is more than 0.5 mm. Preferably, the thickness of the metal base **51** is about 0.8 mm to about 1.0 mm. Sections of a portion of an internal surface **511** of the metal base **51** can be thinned to form a groove **5111** by a thinning process. A non-conductive member **53** can be received in the groove **5111**. The thickness of the metal base **51** corresponding to the groove **5111** can be about 0.3 mm to about 0.5 mm. The thinning process can be carried out by a computer number control technology (CNC). It is to be understood that the non-conductive member **53** can also cover a periphery of groove **5111** to enhance the bonding strength between the non-conductive member **53** and the metal base **51**.

[0039] FIGS. **12-13** illustrate a housing **60** according to a fourth exemplary embodiment. The difference between the housing **60** of the fourth exemplary embodiment and the housing **40** of the second exemplary embodiment is that a thickness of the metal base **61** is more than 0.5 mm. Preferably, the thickness of the metal base **61** is about 0.8 mm to about 1.0 mm. Sections of a portion of an internal surface **611** can be thinned to form a groove **6111** by a thinning process. Non-conductive member **63** can be received in the groove **6111**. A thickness of the metal base **61** corresponding to the groove **6111** can be about 0.3 mm to about 0.5 mm. The thinning process can be carried out by a CNC technology. It is to be understood that the non-conductive member **63** can also cover a periphery of groove **6111** to enhance the bonding strength between the non-conductive member **63** and the metal base **61**.

[0040] Referring to FIG. **14**, a flowchart is presented in accordance with an example embodiment. The method **1400** is provided by way of example, as there are a variety of ways to carry out the method. The method **1400** described below can be carried out using the configurations illustrated in FIGS. **1-6**, for example, and various elements of these figures are referenced in explaining method **1400**. Each block shown in FIG. **14** represents one or more processes, methods or subroutines, carried out in the method **1400**. Furthermore, the order of blocks is illustrative only and the order of the blocks can change according to the present disclosure. Additional blocks may be added or fewer blocks may be utilized, without departing from this disclosure. The method **1400** for making the housing **30** can begin at block **1401**.

[0041] At block **1401**, a metal base **31** is provided. The metal base **31** has an internal surface **311** and an outer surface **313** opposite to the internal surface **311**. In at least one exemplary embodiment, a thickness of the metal base is less than 0.5 mm. Preferably, the thickness of the metal base is about 0.3 mm to about 0.5 mm.

[0042] The metal base **31** can be made by casting, punching, or CNC. The metal base **31** having a desired three dimensional shape is provided. The metal base **31** can be made of metal which can be selected from a group consisting of aluminium, aluminium alloy, magnesium, magnesium alloy, titanium, titanium alloy, copper and copper alloy.

[0043] At block **1402**, the metal base **31** is degreased. The degreasing process may include ultrasonic cleaning the metal base **31** in absolute ethanol for about 25 minutes to about 35 minutes to remove oil stain coated on the metal base **31**.

[0044] At block **1403**, the metal base **31** is put into a mold (not shown) to form a non-conductive member **33** on an

internal surface of the metal base **31**. The injection temperature is about 290° C. to about 320° C., and the injection pressure is about 2 MPa to about 4 MPa. Liquid resin can be filled into the mold and cover at least a portion of the internal surface **311** of the metal base **31**, forming the non-conductive member **31**.

[0045] It is to be understood that the non-conductive member **33** can be formed by a conventional injection process, and also can be formed by a nano mold technology (NMT).

[0046] NMT can be carried out by surface treating the metal base **31** to form a plurality of nano-pores (not shown) having a diameter of about 10 nm to about 300 nm on the internal surface **311**, such that the internal surface **311** can have a surface roughness of about 0.1 μm to about 1 μm. The surface treatment can be an electrochemical etching process, a dipping process, an anodic oxidation treatment or a chemical etching process. Then, the metal base **31** having nano-pores is put into a mold (not shown), and liquid resin is filled into the mold and cover at least a portion of the internal surface **311** of the metal base **31**, forming the non-conductive member **31**.

[0047] The resin for making the non-conductive member **33** can be a thermoplastic or a thermosetting plastic. The thermoplastic can be selected from a group consisting of polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyethylene terephthalate (PET), polyether ether ketone (PEEK), polycarbonate (PC) and polyvinyl chloride polymer (PVC). The thermosetting plastic can be selected from a group consisting of a polyurethane resin, an epoxy, and a polyurea resin.

[0048] It is to be understood that the non-conductive member **33** can also be made of ceramic, or other non-conductive materials

[0049] At block **1404**, sections of a portion of the metal base **31** corresponding to the non-conductive member **33** are cut off from the outer surface **313** to form at least one gap **315**, and the metal base **31** can be spaced by at least one gap **315**, forming at least one metal sheet **317** and at least one main body **319**. The non-conductive member **33** is located at the bottom of the gap **315**. The metal base **31** can be cut off by a laser cutting process or a CNC process.

[0050] In at least one exemplary embodiment, the metal base **31** is spaced by the at least one gap **315**, forming a plurality of metal sheets **317** and two main bodies **319**. The gaps **315** can run through the two opposite ends of the metal base **31**.

[0051] At block **1405**, each gap **315** is filled with a dielectric member **35**. The dielectric member **35** can be made of a dielectric material, such as a resin, a rubber, a ceramic, and so on. The resin can be made of a thermoplastic or a thermosetting plastic. The thermoplastic can be selected from a group consisting of polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyethylene terephthalate (PET), polyether ether ketone (PEEK), polycarbonate (PC) and polyvinyl chloride polymer (PVC). The thermosetting plastic can be selected from a group consisting of an epoxy, and a polyurea resin, and a UV-curing adhesive.

[0052] The dielectric member **35** can be formed by any of the following three methods:

[0053] In a first method, after filling a UV-curing adhesive into the gaps **315**, the UV-curing adhesive is cured by a UV irradiation process to form the dielectric members **35** located in the gaps **315**. The UV-curing adhesive can be an acrylic resin or a polyurethane resin.

[0054] In a second method, the metal base **31** is put into a mold (not shown). The injection temperature can be about 290° C. to about 320° C., and the injection pressure can be about 2 MPa to about 4 MPa. Liquid resin can be filled into the gaps **315**, forming the dielectric members **35**.

[0055] In a third method, the dielectric members **35** are formed by NMT.

[0056] The NMT is carried out by surface treating the metal base **31**, the metal sheets **317** and the main bodies **319** to form a plurality of nano-pores (not shown) having a diameter of about 10 nm to about 300 nm on the metal base **31**, metal sheets **317** and the main bodies **319**. The surface treating method can be an electrochemical etching process, a dipping process, an anodic oxidation treatment or a chemical etching process. Then, the metal base **31**, the metal sheets **317** and the main bodies **319** having nano-pores are put into a mold (not shown), and liquid resin is filled into the gaps **315** between each two adjacent metal sheets **317**, the main bodies **319** and the metal sheets **317** adjacent the main bodies **319**, forming the dielectric member **35**

[0057] The gaps **315** and the dielectric member **35** both have a width of about 0.02 mm to about 0.7 mm along a direction from an adjacent dielectric member **35** located at one side of the metal sheet **317** to another adjacent dielectric member **35** located at the opposite side of the metal sheet **317**. Each metal sheet **317** has a width of about 0.15 mm to about 1.0 mm along a direction from an adjacent dielectric member **35** located at one side of the metal sheet **317** to another adjacent dielectric member **35** located at the opposite side of the metal sheet **317**.

[0058] At block **1406**, a protective layer (not shown) having a thickness of about 10 μm to about 15 μm is formed on the surface of the metal base **31**. The protective layer can be formed by any of the following three methods:

[0059] In a first method, the protective layer is formed by an anodic oxidation coloring process. The anodic oxidation coloring process is carried out in a sulphuric acid solution having a concentration of about 160 g/L to about 220 g/L, with the metal base **31** being an anode, and a stainless steel board or a lead plate being a cathode. The voltage between the anode and the cathode is about 10 V to about 15 V. The temperature of the sulphuric acid is about 16° C. to about 18° C. The anodic oxidation coloring process may last for about 30 minutes to about 45 minutes to form the protective layer having a thickness of about 10 μm to about 15 μm. The protective layer has a plurality of pores (not shown). Then, the metal base **31** is dipped into a dyeing solution containing coloring agent at a temperature of about 30° C. to about 50° C. The coloring agent has a concentration of about 3 g/L to about 10 g/L. The dipping time may be about 1 minute to about 2 minutes. The coloring agent is absorbed into the pores of the protective layer, such that the protective layer can have color. The coloring agent is a dark organic coloring agent or a dark inorganic coloring agent. The protective layer containing coloring agent should be sealed to fix the coloring agent in the pores. The sealing treatment can be a boiling water sealing process, a steam sealing process, a nickel acetate sealing process, a potassium dichromate sealing process, a nickel sulfate sealing process, stearic acid sealing process, or a cold sealing process.

[0060] In a second method, the protective layer is formed by an electrophoresis process. The electrophoresis process is carried out in an electrophoresis solution at a temperature of about 30° C. to about 35° C., with the metal base **31** being an

anode, and a stainless steel board or a lead plate being a cathode. The voltage between the anode and the cathode is about 70 V to about 90 V. The electrophoresis process may last for about 20 seconds to about 44 seconds to form the protective layer having a thickness of about 10 μm to about 15 μm. The electrophoresis solution includes electrophoresis paint and water with a volume ratio of about 3-5:4-6. The electrophoresis paint can be an epoxy electrophoresis paint. The main chain of the epoxy electrophoresis paint can have polyether and dual alcohol, polyether and dual amine, or polyester and dual alcohol.

[0061] It is to be understood that the protective layer formed by the electrophoresis process or the anodic oxidation coloring process can cover an area of the metal base **31**. As the width of the dielectric member **35** is very small, it is hard to find out the dielectric member **35** located in the metal base **31**, such that the housing **30** can have an entire metallic appearance.

[0062] In a third method, the protective layer is formed by spraying paint onto the surface of the metal base **31** by a spraying gun (not shown). Then, the metal base **31** is put in a dryer to be backed, such that the protective layer having a thickness of about 10 μm to about 15 μm is formed on the entail surface of the metal base **31**. As the paint can cover the entire surface of the metal base **31** and the dielectric member **35**, the metal base **31** can have an entire metallic appearance.

[0063] FIGS. **7-9** illustrate a housing **40** according to a second exemplary embodiment. The difference between the method of the second exemplary embodiment and the method of the first exemplary embodiment is that the metal base **41** is spaced by gaps **415**, forming a plurality of metal sheets **417** and one main body **419**. The gaps **415** can be positioned within the metal base **41**. And the gaps **415** cannot run through at least one end of the metal base **41** along a direction of the metal sheets **419** parallel to the main body **419**.

[0064] Referring to FIG. **15**, a flowchart is presented according to another exemplary embodiment. The method **1500** is provided by way of example, as there are a variety of ways to carry out the method. The method **1500** described below can be carried out using the configurations illustrated in FIGS. **10-11**, for example, and various elements of these figures are referenced in explaining method **1500**. Each block shown in FIG. **15** represents one or more processes, methods or subroutines, carried out in the method **1500**. Furthermore, the order of blocks is illustrative only and the order of the blocks can change according to the present disclosure. Additional blocks may be added or fewer blocks may be utilized, without departing from this disclosure. The method **1500** for making the housing **50** can begin at block **1501**.

[0065] At block **1501**, a metal base **51** is provided. The metal base **51** has an internal surface **511** and an outer surface **513** opposite to the internal surface **511**. In at least one exemplary embodiment, a thickness of the metal base **51** is less than 0.5 mm. Preferably, the thickness of the metal base **51** is about 0.3 mm to about 0.5 mm. A thickness of the metal base **51** is more than 0.5 mm. Preferably, the thickness of the metal base **51** is about 0.8 mm to about 1.0 mm.

[0066] The metal base **51** can be made by casting, punching, or CNC. The metal base **51** having a desired three dimensional shape is provided. The metal base **51** can be made of a metal which can be selected from a group consisting of aluminium, aluminium alloy, magnesium, magnesium alloy, titanium, titanium alloy, copper and copper alloy.

[0067] At block **1502**, the metal base **51** is degreased. The degreasing process may include ultrasonic cleaning the metal base **51** in absolute ethanol for about 25 minutes to about 35 minutes to remove oil stain coated on the metal base **51**.

[0068] At block **1503**, a groove **5111** is formed on the metal base **51** by a thinning process. The thickness of the metal base **51** corresponding to the groove **5111** can be about 0.3 mm to about 0.5 mm. The thinning process can be carried out by a CNC technology.

[0069] At block **1504**, the metal base **51** is put into a mold (not shown) to form a non-conductive member **53** on an internal surface of the metal base **51**, the non-conductive member **53** can be received in the groove **5111**. The injection temperature is about 290° C. to about 320° C., and the injection pressure is about 2 MPa to about 4 MPa. Liquid resin can be filled into the mold and cover at least a portion of the internal surface **511** of the metal base **51**, forming the non-conductive member **51**.

[0070] It is to be understood, the non-conductive member **53** can also cover a periphery of groove **5111** to enhance the bonding strength between the non-conductive member **53** and the metal base **51**.

[0071] It is to be understood that the non-conductive member **53** can be formed by a conventional injection process, and also can be formed by a nano mold technology (NMT) as illustrated in block **1403**.

[0072] At block **1505**, sections of a portion of the metal base **51** corresponding to the non-conductive member **53** are cut off from the outer surface **513** to form at least one gap **515**, and the metal base **51** can be spaced by at least one gap **515**, forming at least one metal sheet **517** and at least one main body **519**. The non-conductive member **53** is located at the bottom of the gap **515**. The metal base **51** can be cut off by a laser cutting process or a CNC process.

[0073] In at least one exemplary embodiment, the metal base **51** is spaced by the at least one gap **515**, forming a plurality of metal sheets **517** and two main bodies **519**. The gaps **515** can run through the two opposite ends of the metal base **51**.

[0074] At block **1506**, each gap **515** is filled with a dielectric member **55**. The dielectric member **55** can be made of a dielectric material, such as a resin, a rubber, a ceramic, and so on. The resin can be made of a thermoplastic or a thermosetting plastic. The thermoplastic can be selected from a group consisting of polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyethylene terephthalate (PET), polyether ether ketone (PEEK), polycarbonate (PC) and polyvinyl chloride polymer (PVC). The thermosetting plastic can be selected from a group consisting of an epoxy, and a polyurea resin, and a UV-curing adhesive.

[0075] The dielectric member **55** can be formed by any of the following three methods:

[0076] In a first method, after filling a UV-curing adhesive into the gaps **515**, the UV-curing adhesive is cured by a UV irradiation process to form the dielectric members **55** located in the gaps **515**. The UV-curing adhesive can be an acrylic resin or a polyurethane resin.

[0077] In a second method, the metal base **51** is put into a mold (not shown). The injection temperature can be about 290° C. to about 320° C., and the injection pressure can be about 2 MPa to about 4 MPa. Liquid resin can be filled into the gaps **515**, forming the dielectric members **55**.

[0078] In a third method, the dielectric members **55** are formed by NMT.

[0079] The NMT is carried out by surface treating the metal base **51**, the metal sheets **517** and the main bodies **519** to form a plurality of nano-pores (not shown) having a diameter of about 10 nm to about 300 nm on the metal base **51**, metal sheets **517** and the main bodies **519**. The surface treating method can be an electrochemical etching process, a dipping process, an anodic oxidation treatment or a chemical etching process. Then, the metal base **51**, the metal sheets **517** and the main bodies **519** having nano-pores are put into a mold (not shown), and liquid resin is filled into the gaps **515** between each two adjacent metal sheets **517**, the main bodies **519** and the metal sheets **517** adjacent the main bodies **519**, forming the dielectric member **55**

[0080] The gaps **515** and the dielectric member **55** both have a width of about 0.02 mm to about 0.7 mm along a direction from an adjacent dielectric member **55** located at one side of the metal sheet **517** to another adjacent dielectric member **55** located at the opposite side of the metal sheet **517**. Each metal sheet **517** has a width of about 0.15 mm to about 1.0 mm along a direction from an adjacent dielectric member **55** located at one side of the metal sheet **517** to another adjacent dielectric member **55** located at the opposite side of the metal sheet **517**.

[0081] At block **1507**, a protective layer (not shown) having a thickness of about 10 μm to about 15 μm is formed on the surface of the metal base **51**. The protective layer can be formed by any of the following three methods:

[0082] In a first method, the protective layer is formed by an anodic oxidation coloring process. The anodic oxidation coloring process is carried out in a sulphuric acid solution having a concentration of about 160 g/L to about 220 g/L, with the metal base **51** being an anode, and a stainless steel board or a lead plate being a cathode. The voltage between the anode and the cathode is about 10 V to about 15 V. The temperature of the sulphuric acid is about 16° C. to about 18° C. The anodic oxidation coloring process may last for about 30 minutes to about 45 minutes to form the protective layer having a thickness of about 10 μm to about 15 μm. The protective layer has a plurality of pores (not shown). Then, the metal base **51** is dipped into a dyeing solution containing coloring agent at a temperature of about 30° C. to about 50° C. The coloring agent has a concentration of about 3 g/L to about 10 g/L. The dipping time may be about 1 minute to about 2 minutes. The coloring agent is absorbed into the pores of the protective layer, such that the protective layer can have color. The coloring agent is a dark organic coloring agent or a dark inorganic coloring agent. The protective layer containing coloring agent should be sealed to fix the coloring agent in the pores. The sealing treatment can be a boiling water sealing process, a steam sealing process, a nickel acetate sealing process, a potassium dichromate sealing process, a nickel sulfate sealing process, stearic acid sealing process, or a cold sealing process.

[0083] In a second method, the protective layer is formed by an electrophoresis process. The electrophoresis process is carried out in an electrophoresis solution at a temperature of about 30° C. to about 35° C., with the metal base **51** being an anode, and a stainless steel board or a lead plate being a cathode. The voltage between the anode and the cathode is about 70 V to about 90 V. The electrophoresis process may last for about 20 seconds to about 44 seconds to form the protective layer having a thickness of about 10 μm to about 15 μm. The electrophoresis solution includes electrophoresis paint and water with a volume ratio of about 3-5:4-6. The electrophoresis paint can be an epoxy electrophoresis paint. The main chain of the epoxy electrophoresis paint can have polyether and dual alcohol, polyether and dual amine, or polyester and dual alcohol.

[0084] It is to be understood that the protective layer formed by the electrophoresis process or the anodic oxidation coloring process can cover an area of the metal base **51**. As the width of the dielectric member **55** is very small, it is hard to find out the dielectric member **55** located in the metal base **51**, such that the housing **50** can have an entire metallic appearance.

[0085] In a third method, the protective layer is formed by spraying paint onto the surface of the metal base **51** by a spraying gun (not shown). Then, the metal base **51** is put in a dryer to be backed, such that the protective layer having a thickness of about 10 μm to about 15 μm is formed on the entail surface of the metal base **51**. As the paint can cover the entire surface of the metal base **51** and the dielectric member **55**, the metal base **51** can have an entire metallic appearance.

[0086] FIGS. **12-13** illustrate a housing **60** according to a fourth exemplary embodiment. The difference between the method of the fourth exemplary embodiment and the method of the second exemplary embodiment can be that a thickness of the metal base **61** is more than 0.5 mm. Preferably, the thickness of the metal base **31** is about 0.8 mm to about 1.0 mm, and sections of a portion of an internal surface **611** can be thinned to form a groove **6111** by a thinning process. A non-conductive member **63** can be received in the groove **3111**. The thickness of the metal base **61** corresponding to the groove **6111** is about 0.3 mm to about 0.5 mm. The thinning process can be carried out by a CNC technology. It is to be understood, the non-conductive member **63** can also cover a periphery of groove **6111** to enhance the bonding strength between the non-conductive member **63** and the metal base **61**.

[0087] It is to be understood, however, that even through numerous characteristics and advantages of the present disclosure have been set forth in the foregoing description, together with details of assembly and function, the disclosure is illustrative only, and changes may be made in detail, including in the matters of shape, size, and arrangement of parts within the principles of the disclosure to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A housing comprising:

a metal base defining an internal surface and at least one gap; and

a non-conductive member covering at least a portion of the internal surface of the metal base, and the non-conductive member being formed on a bottom of the at least one gap.

2. The housing as claimed in claim **1**, wherein the at least one gap includes a plurality of gaps, the metal base is spaced by the gaps to form a plurality of metal sheets and at least one main body, the metal sheets and the at least one main body are all bonded with the non-conductive member.

3. The housing as claimed in claim **1**, wherein each gap receives one dielectric member, the dielectric member is connected with the non-conductive member.

4. The housing as claimed in claim **1**, wherein each gap has a width of about 0.02 mm to about 0.7 mm along a direction from an adjacent non-conductive member located at one side

of a metal sheet to another adjacent non-conductive member located at an opposite side of the metal sheet.

5. The housing as claimed in claim **3**, wherein each dielectric member has a width of about 0.02 mm to about 0.7 mm along a direction from an adjacent non-conductive member located at one side of a metal sheet to another adjacent non-conductive member located at an opposite side of the metal sheet.

6. The housing as claimed in claim **3**, wherein each metal sheet has a width of about 0.15 mm to about 1.0 mm along a direction from an adjacent non-conductive member located at one side of a metal sheet to another adjacent non-conductive member located at an opposite side of the metal sheet.

7. The housing as claimed in claim **3**, wherein the internal surface of the metal base has a groove, the non-conductive member is received in the groove.

8. The housing as claimed in claim **7**, wherein a thickness of the metal base corresponding to the groove is about 0.3 mm to about 0.5 mm.

9. The housing as claimed in claim **3**, wherein the dielectric member is made of a resin, a rubber, or a ceramic.

10. The housing as claimed in claim **1**, wherein the metal base is made of the material selected from a group consisting of aluminium, aluminium alloy, magnesium, magnesium alloy, titanium, titanium alloy, copper and copper alloy.

11. The housing as claimed in claim **1**, wherein the non-conductive member is selected from a group consisting of polybutylene terephthalate, polyphenylene sulfide, polyethylene terephthalate, polyether ether ketone, polycarbonate, polyvinyl chloride polymer, polyurethane resin, epoxy, and polyurea resin.

12. A method of making a housing comprising:

providing a metal base, the metal base having an internal surface;

placing the metal base into a mold, liquid non-conductive material covering at least a portion of the internal surface of the metal base to form a non-conductive member at the at least a portion of the metal base;

cutting the metal base corresponding to the at least a portion of the metal base to form at least one gap, the non-conductive member being formed on a bottom of the gap; and

placing one dielectric member in one corresponding gap.

13. The method as claimed in claim **12**, wherein the method of making the housing further includes a step of thinning the thickness of at least a portion of the metal base by a thinning process before the forming of the non-conductive member to form a groove at the internal surface of the metal base, the non-conductive member is received in the groove.

14. The method as claimed in claim **12**, wherein the method of making the housing further includes a step of forming a protective layer on the metal base by a surface treating process after the forming the dielectric member, the dielectric layer has a thickness of about 10 μm to about 15 μm.

15. An electronic device, comprising:

a body;

a housing assembled on the body, the housing including a metal base and a non-conductive member, the metal base defining an internal surface and at least one gap, the non-conductive member covering at least a portion of the internal surface of the metal base, and the non-conductive member being formed on a bottom of the at least one gap; and

an antenna located inside the housing, the antenna corresponding to the at least one gap.

16. The electronic device as claimed in claim **15**, wherein the metal base is a part of the antenna and couples with the antenna.

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