First, referring to FIG. 14, the wireless power receiver **1000** according to the fifth embodiment may include a magnetic substrate **100**, a coil unit **200** and a connecting unit **300**.

According to one embodiment, the wireless power receiver **1000** can wirelessly receive power from the transmission side using electromagnetic induction. In this case, the coil **230** of the coil unit **200** can wirelessly receive power through the electromagnetic induction with a coil of the transmission side.

According to one embodiment, the wireless power receiver **1000** can wirelessly receive power from the transmission side using resonance.

The magnetic substrate **100** may change the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can reduce the amount of the magnetic field leaked to the outside by changing the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can change the direction of the magnetic field received from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field received from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 16, the magnetic substrate **100** may include a magnet **110** and a support **120**.

The magnet **110** may include a particle or a ceramic. According to one embodiment, the magnet **110** may be one of a spinel type magnet, a hexa type magnet, a sendust type magnet and a permalloy type magnet.

The support **120** may include thermosetting resin or thermoplastic resin and support the magnetic substrate **100**.

The magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

Referring again to FIG. 14, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may formed as a conductive layer or a conductive pattern.

The coil unit **200** may be disposed inside the magnetic substrate **100**. In detail, the coil unit **200** may be buried inside the magnetic substrate **100**. In more detail, the magnetic substrate **100** may include a pattern groove and the coil unit **200** may be disposed in the pattern groove. The pattern groove may be formed as a conductive pattern or a conductive layer similar to the coil unit **200**.

The coil unit **200** has a thickness smaller than that of the magnetic substrate **100** and an upper portion of the coil unit **200** may be exposed out of the magnetic substrate **100**.

A process for manufacturing the wireless power receiver **1000** by disposing the coil unit **200** and the connecting unit **300** in the magnetic substrate **100** will be described later with reference to FIGS. 17 to 21.

The first connection terminal **210** of the coil unit **200** is located at one end of the coil **230** and the second connection terminal **220** of the coil unit **200** is located at the other end of the coil **230**.

The first and second connection terminals **210** and **220** of the coil unit **200** are necessary for connection with the connecting unit **300**.

The coil **230** may be formed as a coil pattern which is obtained by winding a conductive line several times. According to one embodiment, when viewed from the top, the coil pattern may have a spiral shape. However, the embodiment is not limited thereto, and various patterns may be formed.

The coil unit **200** may transfer the power wirelessly received from the transmission side to the connecting unit **300**. The coil unit **200** may transfer the power wirelessly received from the transmission side using the electromagnetic induction or resonance to the connecting unit **300**.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320** and a printed circuit board **330**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210 of** the coil unit **200** and the second connection terminal **320** of the

connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200**.

The printed circuit board **330** may include a wiring layer and the wiring layer may include a wireless power receiving circuit, which will be described later.

The connecting unit **300** connects the wireless power receiving circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the wireless power receiver circuit. The wireless power receiver circuit may include a rectifier circuit (not shown) for converting AC power into DC power and a smoothing circuit for transferring the DC power to the load after removing ripple components from the DC power.

FIGS. 15 and 16 show the detailed structure of the wireless power receiver **1000** according to the fifth embodiment when the coil unit **200** is connected to the connecting unit **300**.

FIG. 15 shows the coil unit **200** and the connecting unit **300** interconnected with each other.

The coil unit **200** can be connected to the connecting unit **300** by a solder.

Referring to FIG. 16, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a second solder **20**. In detail, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a via hole of the first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a via hole of the second solder **20**.

According to one embodiment, the via hole can be formed by using a laser. The laser may include a UV laser or a CO2 laser.

FIG. 16 is a sectional view of the wireless power receiver **1000** in which the magnetic substrate **100** and the coil unit **200** are connected to the connecting unit **300**.

That is, the first connection terminal **210**, the second connection terminal **220** and the coil **230** constituting the coil unit **200** may be disposed in a pattern groove **140** of the magnetic substrate **100**.

In addition, the magnetic substrate **100** and the coil unit **200** are connected to the connecting unit **300**.

The coil **230** may be designed to have a predetermined width **W** and a predetermined thickness **T** and the magnetic substrate **100** may be designed to have a predetermined thickness **T1**. According to one embodiment, the coil **230** has a thickness of 0.1mm and the magnetic substrate **100** has a thickness of 0.43 mm, but these numerical values are illustrative purposes only. According to one embodiment, the thickness **T** of the coil **230** may be smaller than the thickness **T1** of the magnetic substrate **100**.

In the wireless power receiver **1000** according to the fifth embodiment, the coil unit **200** is directly disposed in the pattern groove **140** of the magnetic substrate **100**, so the overall thickness of an electronic appliance equipped with the wireless power receiver **1000** can be reduced as much as the thickness of the coil unit **200**. Thus, if the wireless power receiver **1000** according to the fifth embodiment is applied to the electronic device, such as the portable terminal, the overall thickness of the portable terminal can be reduced suitably for the current trend of slimness

In addition, in the wireless power receiver **1000** according to the fifth embodiment, the coil unit **200** is disposed in the pattern groove **140** of the magnetic substrate **100**. Thus, different from the electronic appliance in which a coil pattern is formed on an FPCB, the overall size of the electronic device equipped with the wireless power receiver **1000** can be reduced.

FIGS. 17 to 21 are views for explaining a method of manufacturing the wireless power receiver **1000** according to the fifth embodiment.

Hereinafter, the method of manufacturing the wireless power receiver **1000** according to the fifth embodiment will be described with reference to FIGS. 17 to 21 as well as FIGS. 14 to 16.

First, referring to FIG. 17, the magnetic substrate **100** is prepared. According to one embodiment, the magnetic substrate **100** may be produced by coating metal powder of sendust alloys, such as Al, Fe and SiO2, on polyethylene rubber and then forming an oxide layer on a surface of the polyethylene rubber.

Then, referring to FIG. 18, heat and pressure are applied using a mold **1** to form the pattern groove in the magnetic substrate **100** for receiving the coil unit **200**. The mold **1** may

have the shape corresponding to the shape of the coil unit **200**. According to one embodiment, the mold **1** can be manufactured by using an aluminum alloy, a copper alloy or a cast iron.

The mold **1** may be provided with a protrusion at a region corresponding to the coil unit **200** for wirelessly receiving the power.

When the heat is applied by using the mold **1**, the heat having the specific temperature is applied by taking the property of the metal powder of the sendust alloy constituting the magnetic substrate **100** into consideration. According to one embodiment, if the magnetic substrate **100** is produced by coating the metal powder of sendust alloy on the polyethylene rubber, when the heat and pressure are applied by using the mold **1**, high-pressure is applied at the temperature in the range of 100°C to 180°C, and then the mold **100** is cooled to the temperature of 100°C or below. After that, the mold **1** is separated from the magnetic substrate **100**. If the mold **1** is separated just after the pressure has been applied to the magnetic substrate **100**, the desired pattern groove **140** may not be formed due to residual heat in the pattern groove **140**. For this reason, the mold **1** is separated from the magnetic substrate **100** after cooling the mold **100** to the temperature of 100°C or below.

If the magnetic substrate **100** is prepared by using the metal powder of sendust alloy, the heat temperature and pressure may vary depending on the distribution and concentration of the metal powder. That is, if the distribution of the metal powder is not uniform, the higher temperature and pressure may be applied. In contrast, if the distribution of the metal powder is uniform, the lower temperature and pressure may be applied. In addition, if the concentration of the metal powder is low, the lower temperature and pressure may be applied as compared with the case in which the concentration of the metal powder is high. Further, the heat temperature and pressure may vary depending on the composition of the metal powder, that is, depending on the alloy constituting the metal powder.

In this manner, the temperature applied to the mold **1** may vary depending on the distribution, concentration and composition of the powder.

According to one embodiment, laser may be irradiated, instead of applying heat and pressure using the mold **1**, to form the pattern groove in the magnetic substrate **100** to receive the coil unit **200**. In this case, the pattern groove can be formed by using an excimer laser that irradiates the laser beam having a wavelength band of ultraviolet ray. The excimer laser may

include a KrF excimer laser (central wavelength 248 nm) or an ArF excimer laser (central wavelength 193 nm).

Next, referring to FIG. 19, the mold **1** is separated from the magnetic substrate **100** so that the magnetic substrate **100** is formed with the pattern groove **140**.

Then, referring to FIG. 20, the coil unit **200** is inserted into the pattern groove **140** formed in the magnetic substrate **100**. As the coil unit **200** is inserted into the pattern groove **140**, a predetermined conductive pattern is formed in the pattern groove **140** of the magnetic substrate **100**.

According to one embodiment, a process for forming the coil unit **200** in the pattern groove **140** of the magnetic substrate **100** may include a plating process or a process for inserting a metal which has been etched to have the conductive pattern formed by the coil unit **200**.

In detail, according to the plating process, the metallic material is filled in the pattern groove **140** to form the coil unit **200**. At this time, the metallic material may include one selected from Cu, Ag, Sn, Au, Ni and Pd and the filling of the metallic metal can be performed through one of electroless plating, screen printing, sputtering, evaporation, ink-jetting and dispensing or a combination thereof.

Then, referring to FIG. 21, the soldering process is performed to connect the coil unit **200** with the connecting unit **300**.

That is, the first connection terminal **210** of the coil unit **200** is connected to the first connection terminal **310** of the connecting unit **300** through the solder **10** and the second connection terminal **220** of the coil unit **200** is connected to the second connection terminal **320** of the connecting unit **300** through the solder **20**.

As described above, according to the method of manufacturing the wireless power receiver **1000** of the fifth embodiment, the pattern groove is formed in the magnetic substrate **100** and the coil unit **200** is disposed in the pattern groove, so that the overall thickness of the wireless power receiver **1000** can be reduced. In addition, the wireless power receiver **1000** can be manufactured by simply forming the pattern groove and then inserting the coil unit into the pattern groove, so that the manufacturing process can be simplified.

FIG. 22 is a view for explaining variation of inductance, resistance and Q values of the coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed on a top

surface of the magnetic substrate according to the first embodiment, and FIG. 23 is a view for explaining variation of inductance, resistance and Q values of the coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate according to the fifth embodiment.

The inductance, resistance and Q values of the coil unit **200** can be expressed as following equation 1.

[Equation 1]

$$Q=W*L/R$$

In equation 1, w is a frequency used when transmitting power, L is inductance of the coil unit **200** and R is resistance of the coil unit **200**.

As can be understood from equation 1, the Q value becomes high as the inductance of the coil unit **200** is increased. If the Q value is increased, the power transmission efficiency can be improved. The resistance of the coil unit **200** is a numerical value of power loss occurring in the coil unit **200** and the Q value becomes high as the resistance value is decreased.

Referring to FIGS. 22 and 23, when comparing the fifth embodiment, in which the coil unit **200** is disposed in the pattern groove **140** of the magnetic substrate **100**, with the first embodiment, in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**, when the usable frequency is 150 kHz, the inductance of the coil unit **200** is increased by 352.42 um from about 9986.92 um to about 10339.34 um and the resistance of the coil unit **200** is reduced by 0.057 Ω from 0.910 Ω to 0.853 Ω. That is, the Q value is increased corresponding to the increment of the inductance and the reduction of the resistance.

Therefore, the wireless power receiver **1000** according to the fifth embodiment can increase the Q value by disposing the coil unit **200** in the pattern groove of the magnetic substrate **100**.

FIG. 24 is an H-field for illustrating a radiation pattern of a magnetic field when the coil unit is disposed on a top surface of the magnetic substrate according to the first embodiment, and FIG. 25 is an H-field for illustrating a radiation pattern of a magnetic field when the coil unit is disposed in the pattern groove formed in the magnetic substrate according to the fifth embodiment.

Referring to FIGS. 24 and 25, a greater amount of magnetic fields is radiated from the outer peripheral portion of the coil unit **200** when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate **100** as compared with the case in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**. This is because the magnetic field directed to the outside is changed in the lateral direction of the coil unit **200** due to the coil unit **200** buried in the magnetic substrate **100**.

In addition, a greater amount of magnetic fields is radiated at the inner portion of the coil unit **200** when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate **100** as compared with the case in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**. This is also because the magnetic field directed to the outside is changed in the lateral direction of the coil unit **200** due to the coil unit **200** buried in the magnetic substrate **100**.

Referring to FIGS. 24 and 25, the wireless power receiver **1000** may further include a short-range communication antenna **600**.

The short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. According to one embodiment, when the coil unit **200** is disposed at the center of the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Similar to the coil unit **200**, the short-range communication antenna **600** may be formed as a conductive pattern or a conductive layer.

Various short-range communication technologies can be applied to the short-range communication antenna **600** and the NFC technology is preferable.

Hereinafter, a wireless power receiver according to another embodiment will be described with reference to FIGS. 26 to ~~37~~36.

FIG. 26 is an exploded perspective view of the wireless power receiver **1000** according to still another embodiment, FIG. 27 is a perspective view of the wireless power receiver **1000** according to still another embodiment, and FIG. 28 is a sectional view of the wireless power receiver **1000** according to still another embodiment.

Meanwhile, FIG. 27 is a perspective view showing the assembled state of the elements of the wireless power receiver **1000** shown in FIG. 26, in which some elements are omitted.

The wireless power receiver **1000** according to still another embodiment may be disposed in an electronic device, such as a portable terminal.

Referring to FIGS. 26 to 28, the wireless power receiver **1000** may include a magnetic substrate **100**, a coil unit **200**, a connecting unit **300**, a short-range communication antenna **600**, an adhesive layer **700**, a first dual-side adhesive layer **710**, a second dual-side adhesive layer **720**, a protective film **800** and a release paper layer **730**.

Referring to FIG. 26, the magnetic substrate **100** can change the direction of the magnetic field transferred from the transmission side.

The magnetic substrate **100** changes the direction of the magnetic field transferred to the coil unit **200** from the transmission side to reduce the amount of the magnetic field leaked to the outside. Thus, the magnetic substrate **100** may have the electromagnetic wave shielding effect.

In detail, the magnetic substrate **100** changes the direction of the magnetic field transferred from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field transferred to the coil unit **200** from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 28, the magnetic substrate **100** may include a magnet **110** and a support **120**.

According to one embodiment, the magnet **110** may be one of a spinel type magnet, a hexa type magnet, a sendust type magnet and a permalloy type magnet.

The support **120** may include thermosetting resin or thermoplastic resin and support the magnetic substrate **100**.

Referring again to FIG. 26, the magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

A receiving space **130** is formed at a predetermined area of the magnet substrate **100**. The receiving space **130** has a structure the same as that of the connecting unit **300**. The connecting unit **300** is disposed in the receiving space **130** and connected to the coil unit **200**.

The coil unit **200** can receive the power from the transmission side using the electromagnetic induction or resonance. Similar to the coil unit **200** illustrated in FIG. 1, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may be formed as a conductive layer or a conductive pattern.

The connecting unit **300** connects a receiver circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the receiver circuit.

The connecting unit **300** may include a wiring layer and the wiring layer may include the wireless power receiving circuit. The wireless power receiving circuit may include a rectifier circuit for rectifying the power received from the coil unit **200**, a smoothing circuit for removing noise signals, and a main IC chip for performing the operation to wirelessly receive the power.

In addition, the receiver circuit can transfer the signal received from the short-range communication antenna **600** to a short-range communication signal processing unit (not shown).

The connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100** and connected to the coil unit **200**. FIG. 27 shows the connecting unit **300** disposed in the receiving space **130** of the magnetic substrate **100**.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320**, a third connection terminal **340** and a fourth connection terminal **350**. The first connection terminal **310** of the connecting unit **300** is connected to the first connection terminal **210** of the coil unit **200**, the second connection terminal **320** of the connecting unit **300** is connected to the second connection terminal **220** of the coil unit **200**, the third connection terminal **340** of the connecting unit **300** is connected to a first connection terminal **610** of the short-range communication antenna **600** and the fourth connection terminal **350** of the connecting unit **300** is connected to a second connection terminal **620** of the short-range communication antenna **600**.

The connecting unit **300** may have the shape corresponding to the shape of the receiving space **130** and may be disposed in the receiving space **130**. Since the connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100**, the thickness of the wireless power receiver **1000** can be remarkably reduced as much as the thickness of the connecting unit **300**. Thus, the thickness of the electronic device, such as a portable terminal, equipped with the wireless power receiver **1000** can be remarkably reduced.

According to one embodiment, the connecting unit **300** may include a flexible printed circuit board (FPCB), a tape substrate (TS) or a lead frame (LF). If the tape substrate is used as the connecting unit **300**, the thickness of the connecting unit **300** can be reduced, so that the overall size of the wireless power receiver **1000** can be reduced.

If the lead frame is used as the connecting unit **300**, the wiring layer included in the connecting unit **300** can be protected from the heat, external moisture or impact and the mass production can be realized.

Referring again to FIG. 26, the short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the NFC signal processing unit (not shown) can process the signal transferred to the short-range communication antenna **600** through the connecting unit **300**.

Various short-range communication technologies can be applied to the short-range communication antenna **600** and the NFC technology is preferable.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. Referring to FIG. 27, when the coil unit **200** is disposed at the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Referring again to FIG. 26, the adhesive layer (not shown) may be disposed under the protective film **800** to form the protective film **800** on the coil unit **200** and the short-range communication antenna **600**, which will be described later in detail.

The first dual-side adhesive layer **710** is interposed between the magnetic substrate **100** and the coil unit **200**/short-range communication antenna **600** to adhere the coil unit **200** to the magnetic substrate **100**, which will be described later in detail. Similar to the magnetic substrate **100**, a receiving space having the shape identical to the shape of the connecting unit **300** may be formed in the first dual-side adhesive layer **710**.

Referring again to FIG. 28, the second dual-side adhesive layer **720** adheres the protective film **800** to the release paper layer **730**, which will be described later in detail.

The coil unit **200** may be disposed on the magnetic substrate **100** and may have a spiral structure, but the embodiment is not limited thereto.

Hereinafter, the method of manufacturing the wireless power receiver **1000** according to still another embodiment will be described with reference to FIGS. 29 to ~~37~~36.

When the manufacturing process starts, as shown in FIG. 29, the conductor **201**, the adhesive layer **700** and the protective film **800** are prepared.

According to one embodiment, the conductor **201** may be formed by using an alloy including copper. The copper is in the form of roll annealed copper or electrodeposited copper. The conductor **201** may have various thicknesses depending on the specification of a product. According to one embodiment, the conductor **201** may have the thickness of 100μm, but the embodiment is not limited thereto.

The adhesive layer **700** is used to reinforce the adhesive strength between the conductor **201** and the protective film **800**. The adhesive layer **700** may include thermosetting resin, but the embodiment is not limited thereto. The adhesive layer may have the thickness of 17μm, but the embodiment is not limited thereto.

The protective film **800** protects the conductor **201** when a predetermined conductive pattern is formed in the conductor **201**. In detail, the protective film **800** supports the conductor **201** in the etching process, which will be described later, to protect the conductor **201** such that the predetermined conductive pattern can be formed in the conductor **201**.

According to one embodiment, the protective film **800** may include polyimide film (PI film), but the embodiment is not limited thereto.

Then, as shown in FIG. 30, the conductor **201** is formed on the protective film **800** by the adhesive layer **700**. The laminating process can be used to form the conductor **201** on the

protective film **800**. The laminating process refers to the process to bond heterogeneous materials with each other by applying predetermined heat and pressure.

Then, as shown in FIG. 31, a photoresist film **900** is attached onto the top surface of the conductor **201**. The photoresist film **900** is used for etching the conductor **201** to form a predetermined conductive pattern in the conductor **201**. A UV exposure type film or an LDI exposure type film may be used as the photoresist film **900**. According to another embodiment, a photoresist coating solution can be coated on the top surface of the conductor **201** without using the photoresist film **900**.

After that, as shown in FIG. 32, the photoresist film **900** is subject to the exposure and development processes to form a mask pattern **910**.

The mask pattern **910** may be formed on the top surface of the conductor **201** corresponding to the position of the conductive pattern.

The exposure process refers to the process for selectively irradiating light onto the photoresist film **900** corresponding to the conductive pattern. In detail, in the exposure process, the light is irradiated onto regions of the conductor **201** where the conductive pattern is not formed. The development process refers to the process for removing the regions to which the light is irradiated through the exposure process.

Due to the exposure and development processes, the mask pattern **910** may be formed in the regions corresponding to the coil unit **200** and the short-range communication antenna **600**. The conductor **201** exposed through the mask pattern **910** may be etched.

Then, as shown in FIG. 33, a predetermined portion of the conductor **201** where the mask pattern **910** is not formed may be removed through the etching process. The etching process refers to the process of removing the predetermined portion of the conductor **201** where the mask pattern **910** is not formed by using a chemical reacting with the predetermined portion of the conductor **201**. According to one embodiment, the conductor **201** may be patterned through the wet etching or dry etching.

After that, as shown in FIG. 34, the mask pattern **910** is removed so that the first and second connection terminals **210** and **220** of the coil unit **200**, the first and second connection terminals **610** and **620** of the short-range communication antenna **600**, the coil **230** having a

predetermined conductive pattern and the short-range communication antenna **600** having a predetermined conductive pattern may be formed.

Then, as shown in FIG. 35, the soldering process is performed to connect the coil unit **200** and the short-range communication antenna **600** to the connecting unit **300**. According to one embodiment, the soldering process includes the reflow process, but the embodiment is not limited thereto. The reflow process refers to the process for bonding the coil unit **230** and the short-range communication antenna **600** with the connecting unit **300** by melting solder cream using high-temperature heat to ensure the stable electrical connection between the connecting unit **300** and the coil unit **230**/NFC antenna **600**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210** of the coil unit **200** by a solder **30**, the second connection terminal **320** of the connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200** by the solder **30**, the third connection terminal **340** of the connecting unit **300** may be connected to the first connection terminal **610** of the short-range communication antenna **600** by the solder **30** and the fourth connection terminal **350** of the connecting unit **300** may be connected to the second connection terminal **620** of the short-range communication antenna **600**.

Then, as shown in FIG. 36, the magnetic substrate **100** is laminated on a predetermined portion of the conductive pattern where the connecting unit **300** is not present. In detail, the magnetic substrate **100** may be laminated on the top surfaces of the coil **230** and the short-range communication antenna **600**.

Prior to the above, the receiving space corresponding to the connecting unit **300** can be formed at the magnetic substrate **100**. The receiving space of the magnetic substrate **100** may have the shape identical to the shape of the connecting unit **300**.

As described above with reference to FIG. 26, since the connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100**, the thickness of the wireless power receiver **1000** can be remarkably reduced as much as the thickness of the connecting unit **300**. Thus, the thickness of the electronic device, such as a portable terminal, equipped with the wireless power receiver **1000** can be remarkably reduced.

The coil **230**/short-range communication antenna **600** and the magnetic substrate **100** may be adhered with each other by the first dual-side adhesive layer **710**. According to one

embodiment, the magnetic substrate **100** may have the thickness in the range of 100μm to 800μm, but the embodiment is not limited thereto. According to one embodiment, the first dual-side adhesive layer **710** may have the thickness in the range of 10μm to 50μm, but the embodiment is not limited thereto.

After that, ~~as shown in FIG. 37,~~ the release paper layer **730** is attached to one side of the protective film **800** by interposing the second dual-size adhesive layer **720** therebetween. The release paper layer **730** is a paper layer for protecting the second dual-size adhesive layer **720** and may be removed when the wireless power receiver is disposed in a case of an electronic device, such as a portable terminal.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

CLAIMS

What is claimed is:

1. A wireless power receiver comprising:

a magnetic substrate; and

a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

2. The wireless power receiver of claim 1, wherein the coil is formed as a conductive pattern on the magnetic substrate.

3. The wireless power receiver of claim 1, wherein the magnetic substrate has a receiving space of a predetermined shape formed therein corresponding to a shape of a connecting unit connected to a wireless power receiving circuit.

4. The wireless power receiver of claim 3, further comprising the connecting unit disposed in the receiving space and connected to the coil.

5. The wireless power receiver of claim 4, wherein the connecting unit comprises one of a flexible printed circuit board, a lead frame and a tape substrate.

6. The wireless power receiver of claim 1, further comprising a short-range communication antenna formed on the magnetic substrate to surround the coil.

7. The wireless power receiver of claim 6, wherein the short-range communication antenna comprises a near field communication (NFC) antenna.

8. The wireless power receiver of claim 6, wherein the magnetic substrate has a receiving space of a predetermined shape formed therein corresponding to a shape of a connecting unit connected to a wireless power receiving circuit.

9. The wireless power receiver of claim 8, further comprising the connecting unit disposed in the receiving space and connected to the coil and a near field communication signal process unit.

10. A wireless power receiver comprising:

a magnetic substrate; and

a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer at the magnetic substrate,

wherein a part of the coil is disposed inside the magnetic substrate.

11. The wireless power receiver of claim 10, wherein the coil is formed as a conductive pattern at the magnetic substrate.

12. The wireless power receiver of claim 10, wherein the magnetic substrate comprises a pattern groove for receiving a part of the coil and the part of the coil is disposed in the pattern groove.

13. The wireless power receiver of claim 10, wherein the coil has a thickness smaller than a thickness of the magnetic substrate and an upper portion of the coil is exposed out of the magnetic substrate.

14. A method of manufacturing a wireless power receiver for wirelessly receiving power, the method comprising:

forming a conductor on a protective film;

forming a conductive pattern by etching the conductor;

connecting a connecting unit to be connected to an external circuit to a connection terminal of the conductive pattern;

obtaining a magnetic substrate having a receiving space of a predetermined shape corresponding to the connecting unit; and

disposing the magnetic substrate on the conductive pattern while positioning the connecting unit in the receiving space.

15. The method of claim 14, wherein the forming of the conductive pattern comprises etching the conductor to form the conductive pattern corresponding to a coil for wirelessly receiving the power and a near field communication antenna for making communication with an outside.

16. The method of claim 15, which comprises positioning connection terminals of the coil and the near field communication antenna in the receiving space.

17. The method of claim 14, wherein the disposing of the magnetic substrate comprises forming the magnetic substrate on the conductive pattern using a dual-side adhesive layer.

18. The method of claim 14, further comprising forming a release paper layer on the protective film using a dual-side adhesive layer.

19. A terminal equipped therein with a wireless power receiver of claim 1.

20. A terminal equipped therein with a wireless power receiver of claim 10.

ABSTRACT

A wireless power receiver according to one embodiment includes a magnetic substrate and a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

DESCRIPTION

WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C §119 of Korean Patent Application Nos. 10-2012-0029987, filed March 23, 2012, and 10-2012-0079004, filed July 19, 2012, which are hereby incorporated by reference in their entirety.

BACKGROUND

The embodiment relates to a wireless power receiver and a method of manufacturing the same. In more particular, the embodiment relates to a wireless power receiver used for wireless power transmission or an antenna to reduce a thickness of the wireless power receiver and to simplify the manufacturing process thereof and a method of manufacturing the same.

A wireless power transmission or a wireless energy transfer refers to a technology of wirelessly transferring electric energy to desired devices. In the 1800's, an electric motor or a transformer employing the principle of electromagnetic induction has been extensively used and then a method of transmitting electrical energy by irradiating electromagnetic waves, such as radio waves or lasers, has been suggested. Actually, electrical toothbrushes or electrical razors, which are frequently used in daily life, are charged based on the principle of electromagnetic induction. The electromagnetic induction refers to the generation of an electric current through induction of a voltage when a magnetic field is changed around a conductor. The electromagnetic induction scheme has been successfully commercialized for electronic appliances having small sizes, but represents a problem in that the transmission distance of power is too short.

Besides the electromagnetic induction scheme, the long-distance transmission using the resonance and the short-wavelength radio frequency has been suggested as the wireless energy transfer scheme.

However, in general, a wireless power receiver disposed in a terminal has a thick thickness and the manufacturing process thereof is complicated.

BRIEF SUMMARY

An embodiment provides a method capable of remarkably reducing a thickness of a wireless power receiver by directly disposing a coil unit on a top surface of a magnetic substrate.

An embodiment provides a method capable of ensuring high power transmission efficiency and enabling communication with external devices by directly disposing a coil unit and a near field communication antenna on a top surface of a magnetic substrate.

An embodiment provides a method capable of simplifying the manufacturing process for a wireless power receiver by directly disposing a coil unit on a magnetic substrate.

An embodiment provides a method capable of remarkably reducing a thickness of a wireless power receiver by disposing a coil unit inside a magnetic substrate.

An embodiment provides a method capable of ensuring high power transmission efficiency and enabling communication with external devices by disposing a coil unit inside a magnetic substrate and a near field communication antenna on a magnetic substrate.

An embodiment provides a method capable of simplifying the manufacturing process for a wireless power receiver by disposing a coil unit inside a magnetic substrate.

A wireless power receiver according to one embodiment includes a magnetic substrate and a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

A wireless power receiver according to one embodiment includes a magnetic substrate and a coil a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer at the magnetic substrate, wherein a part of the coil is disposed inside the magnetic substrate.

A method of manufacturing a wireless power receiver for wirelessly receiving power according to one embodiment includes forming a conductor on a protective film, forming a conductive pattern by etching the conductor, connecting a connecting unit to be connected to an external circuit to a connection terminal of the conductive pattern, obtaining a magnetic substrate having a receiving space of a predetermined shape corresponding to the connecting unit and disposing the magnetic substrate on the conductive pattern while positioning the connecting unit in the receiving space.

According to one embodiment, the thickness of the wireless power receiver can be remarkably reduced by directly disposing the coil unit on a top surface of the magnetic substrate.

According to one embodiment, the high power transmission efficiency can be ensured and communication with external devices can be enabled by directly disposing the coil unit and the near field communication antenna on the top surface of the magnetic substrate.

According to one embodiment, the manufacturing process for the wireless power receiver can be simplified by directly disposing the coil unit on the magnetic substrate only through laminating and etching processes.

According to one embodiment, the thickness of the wireless power receiver can be remarkably reduced by forming the conductive pattern inside the magnetic substrate.

According to one embodiment, the high power transmission efficiency can be ensured by forming the conductive pattern inside the magnetic substrate and the communication with external devices can be enabled by using the near field communication antenna.

According to one embodiment, the connecting unit is disposed in the receiving space of the magnetic substrate so that the thickness of the wireless power receiver can be remarkably reduced as much as the thickness of the connecting unit.

According to one embodiment, a tape substrate is used as the connecting unit so that the overall size of the wireless power receiver can be reduced.

According to one embodiment, a lead frame is used as the connecting unit, so the wiring layer included in the connecting unit can be protected from the heat, external moisture or impact and the mass production can be realized.

According to one embodiment, the magnetic field directed to the outside can be changed into the coil unit due to the conductive pattern formed in the magnetic substrate, so the power transmission efficiency can be improved, at the same time, the amount of the magnetic field leaked to the outside can be reduced so that the bad influence of the magnetic field exerted to the human body can be diminished.

According to one embodiment, the wireless power receiver can be manufactured only through the processes of forming the pattern groove and inserting the coil unit, so that the manufacturing process can be simplified.

Other various effects of the embodiments will be disclosed directly or indirectly in the detailed description of the embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a wireless power receiver **1000** according to the first embodiment;

FIG. 2 is a plan view illustrating a wireless power receiver **1000** according to the first embodiment;

FIG. 3 is a sectional view taken along line A-A' of a connecting unit **300** of a wireless power receiver **1000** shown in FIG. 2;

FIGS. 4 to 8 are views for explaining a method of manufacturing a wireless power receiver **1000** according to one embodiment;

FIG. 9 is a sectional view taken along line A-A' of a connecting unit **300** of a wireless power receiver **1000** shown in FIG. 2 according to the second embodiment;

FIG. 10 is a plan view illustrating a wireless power receiver **1000** according to the third embodiment;

FIG. 11 is a perspective view illustrating a wireless power receiver **1000** according to the fourth embodiment;

FIG. 12 is a plan view illustrating a wireless power receiver **1000** according to the fourth embodiment;

FIG. 13 is a sectional view taken along line B-B' of a connecting unit **300** of a wireless power receiver **1000** shown in FIG. 12 according to the fourth embodiment;

FIG. 14 is a perspective view illustrating a wireless power receiver **1000** according to the fifth embodiment;

FIG. 15 is a plan view illustrating a wireless power receiver **1000** according to the fourth embodiment;

FIG. 16 is a sectional view taken along line C-C' of a wireless power receiver **1000** according to the fifth embodiment;

FIGS. 17 to 21 are views for explaining a method of manufacturing a wireless power receiver **1000** according to the fifth embodiment;

FIG. 22 is a view for explaining variation of inductance, resistance and **Q** values of a coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed on a top surface of a magnetic substrate according to the first embodiment;

FIG. 23 is a view for explaining variation of inductance, resistance and **Q** values of a coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed in a pattern groove formed in a magnetic substrate according to the fifth embodiment;

FIG. 24 is an H-field for illustrating a radiation pattern of a magnetic field when a coil unit is disposed on a top surface of a magnetic substrate according to the first embodiment;

FIG. 25 is an H-field for illustrating a radiation pattern of a magnetic field when a coil unit is disposed in a pattern groove formed in a magnetic substrate according to the fifth embodiment;

FIG. 26 is an exploded perspective view of a wireless power receiver **1000** according to still another embodiment;

FIG. 27 is a perspective view of a wireless power receiver **1000** according to still another embodiment;

FIG. 28 is a sectional view of a wireless power receiver **1000** according to still another embodiment; and

FIGS. 29 to 36 are views for explaining a method of manufacturing a wireless power receiver according to still another embodiment.

DETAILED DESCRIPTION

Hereinafter, exemplary embodiments will be described in detail with reference to accompanying drawings so that those skilled in the art can easily work with the embodiments.

Hereinafter, "conductive pattern" refers to the shape of a conductive layer and may be used to refer to a structure formed by a patterning process. "conductive layer" may be used interchangeably with "conductive pattern" and refers to a structure formed by methods including patterning, etching, deposing, selective plating, and the like.

FIG. 1 is a perspective view illustrating a wireless power receiver **1000** according to the first embodiment, FIG. 2 is a plan view illustrating the wireless power receiver **1000** according

to the first embodiment and FIG. 3 is a sectional view taken along line A-A' of a connecting unit **300** of the wireless power receiver **1000** shown in FIG. 2.

Referring to FIGS. 1 to 3, the wireless power receiver **1000** may include a magnetic substrate **100**, a coil unit **200** and a connecting unit **300**.

The wireless power receiver **1000** may wirelessly receive power from a transmission side. According to one embodiment, the wireless power receiver **1000** may wirelessly receive the power using electromagnetic induction. According to one embodiment, the wireless power receiver **1000** may wirelessly receive the power using resonance.

The electromagnetic induction and resonance may be used when transmitting the power using the magnetic field.

The magnetic substrate **100** may change the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can reduce the amount of the magnetic field to be leaked to the outside by changing the direction of the magnetic field received from the transmission side.

In detail, the magnetic substrate **100** changes the direction of the magnetic field transferred from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field received from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 3, the magnetic substrate **100** may include a magnet **110** and a support **120**.

The magnet **110** may include a particle or a ceramic.

The support **120** may include thermosetting resin or thermoplastic resin.

The magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

Referring again to FIG. 1, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may be formed as a conductive layer or a conductive pattern.

The first connection terminal **210** is located at one end of the coil **230** and the second connection terminal **220** is provided at the other end of the coil **230**.

The first and second connection terminals **210** and **220** are necessary for connection with the connecting unit **300**.

The coil **230** may be formed as a conductive pattern which is obtained by winding a conductive line several times. According to one embodiment, when viewed from the top, the coil pattern may have a spiral shape. However, the embodiment is not limited thereto, and various patterns may be formed.

The coil unit **200** can be directly disposed on the top surface of the magnetic substrate **100**. According to one embodiment, an adhesive layer (not shown) may be disposed between the coil unit **200** and the magnetic substrate **100**.

The coil unit **200** may include a conductor. The conductor may include a metal or an alloy. According to one embodiment, the metal may include silver or copper, but the embodiment is not limited thereto.

The coil unit **200** may transfer the power, which is wirelessly received from the transmission side, to the connecting unit **300**. The coil unit **200** can receive the power from the transmission side using the electromagnetic induction or resonance.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320** and a printed circuit board **330**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210** of the coil unit **200** and the second connection terminal **320** of the connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200**.

The printed circuit board **330** may include a wiring layer and a receiver circuit, which will be described later, may be disposed on the wiring layer.

The connecting unit **300** connects the wireless power receiving circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the wireless power receiving circuit. The wireless power receiving circuit may include a rectifier circuit for converting AC power into DC power and a smoothing circuit for transferring the DC power to the load after removing ripple components from the DC power.

FIGS. 2 and 3 are views for explaining the structure of the wireless power receiver **1000** according to the first embodiment in detail when the coil unit **200** is connected with the connecting unit **300**.

FIG. 2 is a plan view illustrating the wireless power receiver **1000** according to the first embodiment.

FIG. 2 shows the coil unit **200** connected with the connecting unit **300**.

According to one embodiment, the connection between the coil unit **200** and the connecting unit **300** may be achieved by a solder. In detail, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting **unit 300** through a second solder **20**. In more detail, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a via hole of the first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a via hole of the second solder **20**.

The wireless power receiver **1000** shown in FIG. 2 may be equipped in an electronic appliance, such as a terminal.

The terminal may include a typical mobile phone, such as a cellular phone, a PCS (personal communication service) phone, a GSM phone, a CDMA-2000 phone, or a WCDMA phone, a PMP (portable multimedia player), a PDA (personal digital assistant), a smart phone, or an MBS (mobile broadcast system) phone, but the embodiment is not limited thereto. Various devices can be used as the terminal if they can wirelessly receive the power.

A section taken along line A-A' of the connecting unit **300** shown in FIG. 2 will be explained with reference to FIG. 3.

FIG. 3 is a sectional view taken along line A-A' of the connecting unit **300** of the wireless power receiver **1000** shown in FIG. 2.

Referring to FIG. 3, the first connection terminal **210**, the second connection terminal **220** and the coil **230** constituting the coil unit **200** are disposed on the top surface of the magnetic substrate **100**.

In the wireless power receiver **1000** according to the first embodiment, the coil unit **200** is directly disposed on the top surface of the magnetic substrate **100**, so the overall thickness can be remarkably reduced when comparing with the case in which the coil pattern is formed on an FPCB.

Preferably, the magnetic substrate **100** has a thickness of 0.43 mm and the coil unit **200** has a thickness of 0.1 mm, so the overall thickness is 0.53 mm. However, this numerical value is illustrative purpose only.

That is, the thickness of the wireless power receiver **1000** can be reduced by preparing the coil unit **200** in the form of a conductor, a conductive pattern or a thin film. Since the current trend has tended toward the slimness, if the wireless power receiver **1000** is applied to the electronic device, such as the portable terminal, the overall thickness of the portable terminal can be reduced and the power can be effectively received from the transmission side.

The connecting unit **300** is directly disposed on the coil unit **200**. Since the connecting unit **300** is directly disposed on the coil unit **200**, the coil unit **200** can be readily connected with the connecting unit **300**.

The first connection terminal **210** of the coil unit **200** is connected to the first connection terminal **310** of the connecting unit **300** through the solder **10**.

The second connection terminal **220** of the coil unit **200** is connected to the second connection terminal **320** of the connecting unit **300** through the solder **20**.

The coil **230** may be designed to have a predetermined width **W** and a predetermined thickness **T**. In addition, the coil **230** can be designed to have a predetermined winding interval.

FIGS. 4 to 8 are views for explaining a method of manufacturing the wireless power receiver **1000** according to one embodiment.

The structure of the wireless power receiver **1000** may be essentially identical to the structure of the wireless power receiver **1000** described with reference to FIGS. 1 to 3.

First, referring to FIG. 4, the magnetic substrate **100** is prepared.

Then, referring to FIG. 5, a conductor **201** is directly laminated on the top surface of the magnetic substrate **100**. According to one embodiment, the conductor **201** may be laminated after the adhesive layer has been laminated on the top surface of the magnetic substrate **100**.

According to one embodiment, a laminating process can be used to form the conductor **201** on the top surface of the magnetic substrate **100**. According to the laminating process, the conductor **201** is heated at the predetermined temperature and then predetermined pressure is applied to the conductor **201**. The laminating process refers to a process of forming heterogeneous materials, such as a metal foil and a paper, by using heat and pressure.

Then, referring to FIG. 6, a mask **500** is laminated on the top surface of the conductor **201**. The mask **500** may be selectively formed on the top surface of the conductor **201** corresponding to positions of the first connection terminal **210**, the second connection terminal **220** and the coil **230** of the coil unit **200**.

After that, referring to FIG. 7, the structure shown in FIG. 6 is immersed in an etchant so that portions of the conductor **201** where the mask **500** is not positioned may be etched. Thus, the conductor **201** may have a predetermined conductive pattern.

Then, the coil unit **200** of the wireless power receiver **1000** is formed by removing the mask **500**.

Thereafter, referring to FIG. 8, the soldering work is performed to connect the coil unit **200** with the connecting unit **300**.

That is, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through the first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through the second solder **20**.

As described above, since the coil unit **200** is directly disposed on the top surface of the magnetic substrate **100**, the overall thickness of the wireless power receiver **1000** can be remarkably reduced. In addition, since the wireless power receiver **1000** can be manufactured only through the laminating and etching processes, the manufacturing process may be simplified.

FIG. 9 is a sectional view taken along line A-A' of the connecting unit **300** of the wireless power receiver **1000** shown in FIG. 2 according to the second embodiment.

Referring to FIG. 9, the wireless power receiver **1000** may include a magnetic substrate **100**, a coil unit **200,** a connecting unit **300** and an adhesive layer **700**.

The magnetic substrate **100**, the coil unit **200**, and the connecting unit **300** are identical to those described with reference to FIG. 1.

The adhesive layer **700** is interposed between the magnetic substrate **100** and the coil unit **200** to bond the magnetic substrate **100** to the coil unit **200**.

FIG. 10 is a plan view illustrating a wireless power receiver **1000** according to the third embodiment.

Referring to FIG. 10, the wireless power receiver **1000** may include a magnetic substrate **100,** a coil unit **200**, a connecting unit **300** and a short-range communication antenna **600**.

The magnetic substrate **100**, the coil unit **200** and the connecting unit **300** are identical to those described with reference to FIGS. 1 to 3.

The short-range communication antenna **600** includes a first connection terminal **610**, a second connection terminal **620** and an outer peripheral coil **630**.

The first connection terminal **610** and the second connection terminal **620** of the short-range communication antenna **600** are connected to the connecting unit **300**.

The short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. According to one embodiment, when the coil unit **200** is disposed at the center of the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Similar to the coil unit **200**, the short-range communication antenna **600** may be formed as a conductive pattern or a conductive layer.

Various short-range communication technologies can be applied to the short-range communication antenna **600**, and the NFC technology is preferable. The NFC technology has the band of 12.56 MHz and is used for wireless communication in a short distance.

The short-range communication antenna **600** can be directly disposed on the top surface of the magnetic substrate **100**.

The method of forming the short-range communication antenna **600** on the magnetic substrate **100** may be identical to the method described with reference to FIG. 4.

Hereinafter, a wireless power receiver **1000** according to the fourth embodiment will be described with reference to FIGS. 11 to 13.

FIG. 11 is a perspective view illustrating the wireless power receiver **1000** according to the fourth embodiment.

Referring to FIG. 11, the wireless power receiver **1000** includes a magnetic substrate **100**, a coil unit **200** and a connecting unit **300**.

The magnetic substrate **100** and the coil unit **200** are identical to those described with reference to FIG. 1. However, the magnetic substrate **100** is slightly different from the magnetic substrate **100** described with reference to FIG. 1, so the following description will be made while focusing the difference of the magnetic substrate **100**.

Referring to FIG. 11, the magnet substrate **100** is formed with a receiving space **130** having a structure the same as that of the connecting unit **300**. That is, referring to FIG. 1, the coil unit **200** is disposed on the top surface of the magnetic substrate **100** and the connecting unit **300** is disposed on the coil unit **200**. However, referring to FIG. 11, the receiving space **130** having the structure the same as that of the connecting unit **300** is formed in the magnetic substrate **100**, so that the connecting unit **300** may be disposed under the coil unit **200**.

FIG. 12 is a plan view illustrating a wireless power receiver **1000** according to the fourth embodiment.

FIG. 12 shows the state in which the coil unit **200** and the connecting unit **300** are interconnected with each other.

The connecting unit **300** has a thickness equal to or smaller than a thickness of the magnetic substrate **100**. The connecting unit **300** may be implemented as a flexible printed circuit board (FPCB).

The connecting unit **300** may be disposed in the receiving space **130** of the magnetic substrate **100**.

If the thickness of the connecting unit **300** is equal to or smaller than the thickness of the magnetic substrate **100**, different from the embodiment shown in FIG. 3, the overall thickness of the wireless power receiver **1000** can be reduced as much as the thickness of the connecting unit

300. In addition, since the usage of the magnet **110** and the support **120** can be reduced due to the receiving space **130**, it is advantageous in terms of cost effectiveness.

FIG. 13 is a sectional view taken along line B-B' of the connecting unit **300** of the wireless power receiver **1000** shown in FIG. 12 according to the fourth embodiment.

The following description will be made on the assumption that the connecting unit **300** has a thickness smaller than that of the magnetic substrate **100**.

Referring to FIG. 13, the first connection terminal **210**, the second connection terminal **220** and the coil **230** constituting the coil unit **200** are disposed on the top surface of the connecting unit **300**.

The connecting unit **300** is disposed under the coil unit **200**.

The first connection terminal **210** of the coil unit **200** is connected to the first connection terminal **310** of the connecting unit **300** by the solder **10**.

The second connection terminal **220** of the coil unit **200** is connected to the second connection terminal **320** of the connecting unit **300** by the solder **20**.

The coil **230** may be designed to have a predetermined width **W** and a predetermined thickness **T**. In addition, the coil **230** can be designed to have a predetermined winding interval.

Referring to FIG. 12, different from the embodiment shown in FIG. 3, the thickness of the connecting unit **300** is smaller than the thickness of the magnetic substrate **100**, so the overall thickness of the wireless power receiver **1000** can be reduced as much as the thickness of the connecting unit **300**. In addition, since the usage of the magnet **110** and the support **120** can be reduced due to the receiving space **130**, it is advantageous in terms of cost effectiveness.

Hereinafter, a wireless power receiver **1000** according to the fifth embodiment will be described in detail with reference to FIGS. 14 to 20.

FIG. 14 is a perspective view illustrating the wireless power receiver **1000** according to the fifth embodiment, FIG. 15 is a plan view illustrating the wireless power receiver **1000** according to the fourth embodiment, FIG. 16 is a sectional view taken along line C-C' of the wireless power receiver **1000** according to the fifth embodiment, and FIGS. 17 to 21 are views for explaining a method of manufacturing the wireless power receiver **1000** according to the fifth embodiment.

First, referring to FIG. 14, the wireless power receiver **1000** according to the fifth embodiment may include a magnetic substrate **100**, a coil unit **200** and a connecting unit **300**.

According to one embodiment, the wireless power receiver **1000** can wirelessly receive power from the transmission side using electromagnetic induction. In this case, the coil **230** of the coil unit **200** can wirelessly receive power through the electromagnetic induction with a coil of the transmission side.

According to one embodiment, the wireless power receiver **1000** can wirelessly receive power from the transmission side using resonance.

The magnetic substrate **100** may change the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can reduce the amount of the magnetic field leaked to the outside by changing the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can change the direction of the magnetic field received from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field received from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 16, the magnetic substrate **100** may include a magnet **110** and a support **120**.

The magnet **110** may include a particle or a ceramic. According to one embodiment, the magnet **110** may be one of a spinel type magnet, a hexa type magnet, a sendust type magnet and a permalloy type magnet.

The support **120** may include thermosetting resin or thermoplastic resin and support the magnetic substrate **100**.

The magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

Referring again to FIG. 14, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may formed as a conductive layer or a conductive pattern.

The coil unit **200** may be disposed inside the magnetic substrate **100**. In detail, the coil unit **200** may be buried inside the magnetic substrate **100**. In more detail, the magnetic substrate **100** may include a pattern groove and the coil unit **200** may be disposed in the pattern groove. The pattern groove may be formed as a conductive pattern or a conductive layer similar to the coil unit **200**.

The coil unit **200** has a thickness smaller than that of the magnetic substrate **100** and an upper portion of the coil unit **200** may be exposed out of the magnetic substrate **100**.

A process for manufacturing the wireless power receiver **1000** by disposing the coil unit **200** and the connecting unit **300** in the magnetic substrate **100** will be described later with reference to FIGS. 17 to 21.

The first connection terminal **210** of the coil unit **200** is located at one end of the coil **230** and the second connection terminal **220** of the coil unit **200** is located at the other end of the coil **230**.

The first and second connection terminals **210** and **220** of the coil unit **200** are necessary for connection with the connecting unit **300**.

The coil **230** may be formed as a coil pattern which is obtained by winding a conductive line several times. According to one embodiment, when viewed from the top, the coil pattern may have a spiral shape. However, the embodiment is not limited thereto, and various patterns may be formed.

The coil unit **200** may transfer the power wirelessly received from the transmission side to the connecting unit **300**. The coil unit **200** may transfer the power wirelessly received from the transmission side using the electromagnetic induction or resonance to the connecting unit **300**.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320** and a printed circuit board **330**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210 of** the coil unit **200** and the second connection terminal **320** of the

connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200**.

The printed circuit board **330** may include a wiring layer and the wiring layer may include a wireless power receiving circuit, which will be described later.

The connecting unit **300** connects the wireless power receiving circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the wireless power receiver circuit. The wireless power receiver circuit may include a rectifier circuit (not shown) for converting AC power into DC power and a smoothing circuit for transferring the DC power to the load after removing ripple components from the DC power.

FIGS. 15 and 16 show the detailed structure of the wireless power receiver **1000** according to the fifth embodiment when the coil unit **200** is connected to the connecting unit **300**.

FIG. 15 shows the coil unit **200** and the connecting unit **300** interconnected with each other.

The coil unit **200** can be connected to the connecting unit **300** by a solder.

Referring to FIG. 16, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a second solder **20**. In detail, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a via hole of the first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a via hole of the second solder **20**.

According to one embodiment, the via hole can be formed by using a laser. The laser may include a UV laser or a CO2 laser.

FIG. 16 is a sectional view of the wireless power receiver **1000** in which the magnetic substrate **100** and the coil unit **200** are connected to the connecting unit **300**.

That is, the first connection terminal **210**, the second connection terminal **220** and the coil **230** constituting the coil unit **200** may be disposed in a pattern groove **140** of the magnetic substrate **100**.

In addition, the magnetic substrate **100** and the coil unit **200** are connected to the connecting unit **300**.

The coil **230** may be designed to have a predetermined width **W** and a predetermined thickness **T** and the magnetic substrate **100** may be designed to have a predetermined thickness **T1**. According to one embodiment, the coil **230** has a thickness of 0.1mm and the magnetic substrate **100** has a thickness of 0.43 mm, but these numerical values are illustrative purposes only. According to one embodiment, the thickness **T** of the coil **230** may be smaller than the thickness **T1** of the magnetic substrate **100**.

In the wireless power receiver **1000** according to the fifth embodiment, the coil unit **200** is directly disposed in the pattern groove **140** of the magnetic substrate **100**, so the overall thickness of an electronic appliance equipped with the wireless power receiver **1000** can be reduced as much as the thickness of the coil unit **200**. Thus, if the wireless power receiver **1000** according to the fifth embodiment is applied to the electronic device, such as the portable terminal, the overall thickness of the portable terminal can be reduced suitably for the current trend of slimness

In addition, in the wireless power receiver **1000** according to the fifth embodiment, the coil unit **200** is disposed in the pattern groove **140** of the magnetic substrate **100**. Thus, different from the electronic appliance in which a coil pattern is formed on an FPCB, the overall size of the electronic device equipped with the wireless power receiver **1000** can be reduced.

FIGS. 17 to 21 are views for explaining a method of manufacturing the wireless power receiver **1000** according to the fifth embodiment.

Hereinafter, the method of manufacturing the wireless power receiver **1000** according to the fifth embodiment will be described with reference to FIGS. 17 to 21 as well as FIGS. 14 to 16.

First, referring to FIG. 17, the magnetic substrate **100** is prepared. According to one embodiment, the magnetic substrate **100** may be produced by coating metal powder of sendust alloys, such as Al, Fe and SiO2, on polyethylene rubber and then forming an oxide layer on a surface of the polyethylene rubber.

Then, referring to FIG. 18, heat and pressure are applied using a mold **1** to form the pattern groove in the magnetic substrate **100** for receiving the coil unit **200**. The mold **1** may

have the shape corresponding to the shape of the coil unit **200**. According to one embodiment, the mold **1** can be manufactured by using an aluminum alloy, a copper alloy or a cast iron.

The mold **1** may be provided with a protrusion at a region corresponding to the coil unit **200** for wirelessly receiving the power.

When the heat is applied by using the mold **1**, the heat having the specific temperature is applied by taking the property of the metal powder of the sendust alloy constituting the magnetic substrate **100** into consideration. According to one embodiment, if the magnetic substrate **100** is produced by coating the metal powder of sendust alloy on the polyethylene rubber, when the heat and pressure are applied by using the mold **1**, high-pressure is applied at the temperature in the range of 100°C to 180°C, and then the mold **100** is cooled to the temperature of 100°C or below. After that, the mold **1** is separated from the magnetic substrate **100**. If the mold **1** is separated just after the pressure has been applied to the magnetic substrate **100**, the desired pattern groove **140** may not be formed due to residual heat in the pattern groove **140**. For this reason, the mold **1** is separated from the magnetic substrate **100** after cooling the mold **100** to the temperature of 100°C or below.

If the magnetic substrate **100** is prepared by using the metal powder of sendust alloy, the heat temperature and pressure may vary depending on the distribution and concentration of the metal powder. That is, if the distribution of the metal powder is not uniform, the higher temperature and pressure may be applied. In contrast, if the distribution of the metal powder is uniform, the lower temperature and pressure may be applied. In addition, if the concentration of the metal powder is low, the lower temperature and pressure may be applied as compared with the case in which the concentration of the metal powder is high. Further, the heat temperature and pressure may vary depending on the composition of the metal powder, that is, depending on the alloy constituting the metal powder.

In this manner, the temperature applied to the mold **1** may vary depending on the distribution, concentration and composition of the powder.

According to one embodiment, laser may be irradiated, instead of applying heat and pressure using the mold **1**, to form the pattern groove in the magnetic substrate **100** to receive the coil unit **200**. In this case, the pattern groove can be formed by using an excimer laser that irradiates the laser beam having a wavelength band of ultraviolet ray. The excimer laser may

include a KrF excimer laser (central wavelength 248 nm) or an ArF excimer laser (central wavelength 193 nm).

Next, referring to FIG. 19, the mold **1** is separated from the magnetic substrate **100** so that the magnetic substrate **100** is formed with the pattern groove **140**.

Then, referring to FIG. 20, the coil unit **200** is inserted into the pattern groove **140** formed in the magnetic substrate **100**. As the coil unit **200** is inserted into the pattern groove **140**, a predetermined conductive pattern is formed in the pattern groove **140** of the magnetic substrate **100**.

According to one embodiment, a process for forming the coil unit **200** in the pattern groove **140** of the magnetic substrate **100** may include a plating process or a process for inserting a metal which has been etched to have the conductive pattern formed by the coil unit **200**.

In detail, according to the plating process, the metallic material is filled in the pattern groove **140** to form the coil unit **200**. At this time, the metallic material may include one selected from Cu, Ag, Sn, Au, Ni and Pd and the filling of the metallic metal can be performed through one of electroless plating, screen printing, sputtering, evaporation, ink-jetting and dispensing or a combination thereof.

Then, referring to FIG. 21, the soldering process is performed to connect the coil unit **200** with the connecting unit **300**.

That is, the first connection terminal **210** of the coil unit **200** is connected to the first connection terminal **310** of the connecting unit **300** through the solder **10** and the second connection terminal **220** of the coil unit **200** is connected to the second connection terminal **320** of the connecting unit **300** through the solder **20**.

As described above, according to the method of manufacturing the wireless power receiver **1000** of the fifth embodiment, the pattern groove is formed in the magnetic substrate **100** and the coil unit **200** is disposed in the pattern groove, so that the overall thickness of the wireless power receiver **1000** can be reduced. In addition, the wireless power receiver **1000** can be manufactured by simply forming the pattern groove and then inserting the coil unit into the pattern groove, so that the manufacturing process can be simplified.

FIG. 22 is a view for explaining variation of inductance, resistance and Q values of the coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed on a top

surface of the magnetic substrate according to the first embodiment, and FIG. 23 is a view for explaining variation of inductance, resistance and Q values of the coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate according to the fifth embodiment.

The inductance, resistance and Q values of the coil unit **200** can be expressed as following equation 1.

[Equation 1]

$$Q=W*L/R$$

In equation 1, w is a frequency used when transmitting power, L is inductance of the coil unit **200** and R is resistance of the coil unit **200**.

As can be understood from equation 1, the Q value becomes high as the inductance of the coil unit **200** is increased. If the Q value is increased, the power transmission efficiency can be improved. The resistance of the coil unit **200** is a numerical value of power loss occurring in the coil unit **200** and the Q value becomes high as the resistance value is decreased.

Referring to FIGS. 22 and 23, when comparing the fifth embodiment, in which the coil unit **200** is disposed in the pattern groove **140** of the magnetic substrate **100**, with the first embodiment, in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**, when the usable frequency is 150 kHz, the inductance of the coil unit **200** is increased by 352.42 um from about 9986.92 um to about 10339.34 um and the resistance of the coil unit **200** is reduced by 0.057 Ω from 0.910 Ω to 0.853 Ω. That is, the Q value is increased corresponding to the increment of the inductance and the reduction of the resistance.

Therefore, the wireless power receiver **1000** according to the fifth embodiment can increase the Q value by disposing the coil unit **200** in the pattern groove of the magnetic substrate **100**.

FIG. 24 is an H-field for illustrating a radiation pattern of a magnetic field when the coil unit is disposed on a top surface of the magnetic substrate according to the first embodiment, and FIG. 25 is an H-field for illustrating a radiation pattern of a magnetic field when the coil unit is disposed in the pattern groove formed in the magnetic substrate according to the fifth embodiment.

Referring to FIGS. 24 and 25, a greater amount of magnetic fields is radiated from the outer peripheral portion of the coil unit **200** when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate **100** as compared with the case in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**. This is because the magnetic field directed to the outside is changed in the lateral direction of the coil unit **200** due to the coil unit **200** buried in the magnetic substrate **100**.

In addition, a greater amount of magnetic fields is radiated at the inner portion of the coil unit **200** when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate **100** as compared with the case in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**. This is also because the magnetic field directed to the outside is changed in the lateral direction of the coil unit **200** due to the coil unit **200** buried in the magnetic substrate **100**.

Referring to FIGS. 24 and 25, the wireless power receiver **1000** may further include a short-range communication antenna **600**.

The short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. According to one embodiment, when the coil unit **200** is disposed at the center of the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Similar to the coil unit **200**, the short-range communication antenna **600** may be formed as a conductive pattern or a conductive layer.

Various short-range communication technologies can be applied to the short-range communication antenna **600** and the NFC technology is preferable.

Hereinafter, a wireless power receiver according to another embodiment will be described with reference to FIGS. 26 to 36.

FIG. 26 is an exploded perspective view of the wireless power receiver **1000** according to still another embodiment, FIG. 27 is a perspective view of the wireless power receiver **1000** according to still another embodiment, and FIG. 28 is a sectional view of the wireless power receiver **1000** according to still another embodiment.

Meanwhile, FIG. 27 is a perspective view showing the assembled state of the elements of the wireless power receiver **1000** shown in FIG. 26, in which some elements are omitted.

The wireless power receiver **1000** according to still another embodiment may be disposed in an electronic device, such as a portable terminal.

Referring to FIGS. 26 to 28, the wireless power receiver **1000** may include a magnetic substrate **100**, a coil unit **200**, a connecting unit **300**, a short-range communication antenna **600**, an adhesive layer **700**, a first dual-side adhesive layer **710**, a second dual-side adhesive layer **720**, a protective film **800** and a release paper layer **730**.

Referring to FIG. 26, the magnetic substrate **100** can change the direction of the magnetic field transferred from the transmission side.

The magnetic substrate **100** changes the direction of the magnetic field transferred to the coil unit **200** from the transmission side to reduce the amount of the magnetic field leaked to the outside. Thus, the magnetic substrate **100** may have the electromagnetic wave shielding effect.

In detail, the magnetic substrate **100** changes the direction of the magnetic field transferred from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field transferred to the coil unit **200** from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 28, the magnetic substrate **100** may include a magnet **110** and a support **120**.

According to one embodiment, the magnet **110** may be one of a spinel type magnet, a hexa type magnet, a sendust type magnet and a permalloy type magnet.

The support **120** may include thermosetting resin or thermoplastic resin and support the magnetic substrate **100**.

Referring again to FIG. 26, the magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

A receiving space **130** is formed at a predetermined area of the magnet substrate **100**. The receiving space **130** has a structure the same as that of the connecting unit **300**. The connecting unit **300** is disposed in the receiving space **130** and connected to the coil unit **200**.

The coil unit **200** can receive the power from the transmission side using the electromagnetic induction or resonance. Similar to the coil unit **200** illustrated in FIG. 1, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may be formed as a conductive layer or a conductive pattern.

The connecting unit **300** connects a receiver circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the receiver circuit.

The connecting unit **300** may include a wiring layer and the wiring layer may include the wireless power receiving circuit. The wireless power receiving circuit may include a rectifier circuit for rectifying the power received from the coil unit **200**, a smoothing circuit for removing noise signals, and a main IC chip for performing the operation to wirelessly receive the power.

In addition, the receiver circuit can transfer the signal received from the short-range communication antenna **600** to a short-range communication signal processing unit (not shown).

The connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100** and connected to the coil unit **200**. FIG. 27 shows the connecting unit **300** disposed in the receiving space **130** of the magnetic substrate **100**.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320**, a third connection terminal **340** and a fourth connection terminal **350**. The first connection terminal **310** of the connecting unit **300** is connected to the first connection terminal **210** of the coil unit **200**, the second connection terminal **320** of the connecting unit **300** is connected to the second connection terminal **220** of the coil unit **200**, the third connection terminal **340** of the connecting unit **300** is connected to a first connection terminal **610** of the short-range communication antenna **600** and the fourth connection terminal **350** of the connecting unit **300** is connected to a second connection terminal **620** of the short-range communication antenna **600**.

The connecting unit **300** may have the shape corresponding to the shape of the receiving space **130** and may be disposed in the receiving space **130**. Since the connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100**, the thickness of the wireless power receiver **1000** can be remarkably reduced as much as the thickness of the connecting unit **300**. Thus, the thickness of the electronic device, such as a portable terminal, equipped with the wireless power receiver **1000** can be remarkably reduced.

According to one embodiment, the connecting unit **300** may include a flexible printed circuit board (FPCB), a tape substrate (TS) or a lead frame (LF). If the tape substrate is used as the connecting unit **300**, the thickness of the connecting unit **300** can be reduced, so that the overall size of the wireless power receiver **1000** can be reduced.

If the lead frame is used as the connecting unit **300**, the wiring layer included in the connecting unit **300** can be protected from the heat, external moisture or impact and the mass production can be realized.

Referring again to FIG. 26, the short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the NFC signal processing unit (not shown) can process the signal transferred to the short-range communication antenna **600** through the connecting unit **300**.

Various short-range communication technologies can be applied to the short-range communication antenna **600** and the NFC technology is preferable.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. Referring to FIG. 27, when the coil unit **200** is disposed at the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Referring again to FIG. 26, the adhesive layer (not shown) may be disposed under the protective film **800** to form the protective film **800** on the coil unit **200** and the short-range communication antenna **600**, which will be described later in detail.

The first dual-side adhesive layer **710** is interposed between the magnetic substrate **100** and the coil unit **200**/short-range communication antenna **600** to adhere the coil unit **200** to the magnetic substrate **100**, which will be described later in detail. Similar to the magnetic substrate **100**, a receiving space having the shape identical to the shape of the connecting unit **300** may be formed in the first dual-side adhesive layer **710**.

Referring again to FIG. 28, the second dual-side adhesive layer **720** adheres the protective film **800** to the release paper layer **730**, which will be described later in detail.

The coil unit **200** may be disposed on the magnetic substrate **100** and may have a spiral structure, but the embodiment is not limited thereto.

Hereinafter, the method of manufacturing the wireless power receiver **1000** according to still another embodiment will be described with reference to FIGS. 29 to 36.

When the manufacturing process starts, as shown in FIG. 29, the conductor **201**, the adhesive layer **700** and the protective film **800** are prepared.

According to one embodiment, the conductor **201** may be formed by using an alloy including copper. The copper is in the form of roll annealed copper or electrodeposited copper. The conductor **201** may have various thicknesses depending on the specification of a product. According to one embodiment, the conductor **201** may have the thickness of 100μm, but the embodiment is not limited thereto.

The adhesive layer **700** is used to reinforce the adhesive strength between the conductor **201** and the protective film **800**. The adhesive layer **700** may include thermosetting resin, but the embodiment is not limited thereto. The adhesive layer may have the thickness of 17μm, but the embodiment is not limited thereto.

The protective film **800** protects the conductor **201** when a predetermined conductive pattern is formed in the conductor **201**. In detail, the protective film **800** supports the conductor **201** in the etching process, which will be described later, to protect the conductor **201** such that the predetermined conductive pattern can be formed in the conductor **201**.

According to one embodiment, the protective film **800** may include polyimide film (PI film), but the embodiment is not limited thereto.

Then, as shown in FIG. 30, the conductor **201** is formed on the protective film **800** by the adhesive layer **700**. The laminating process can be used to form the conductor **201** on the

protective film **800**. The laminating process refers to the process to bond heterogeneous materials with each other by applying predetermined heat and pressure.

Then, as shown in FIG. 31, a photoresist film **900** is attached onto the top surface of the conductor **201**. The photoresist film **900** is used for etching the conductor **201** to form a predetermined conductive pattern in the conductor **201**. A UV exposure type film or an LDI exposure type film may be used as the photoresist film **900**. According to another embodiment, a photoresist coating solution can be coated on the top surface of the conductor **201** without using the photoresist film **900**.

After that, as shown in FIG. 32, the photoresist film **900** is subject to the exposure and development processes to form a mask pattern **910**.

The mask pattern **910** may be formed on the top surface of the conductor **201** corresponding to the position of the conductive pattern.

The exposure process refers to the process for selectively irradiating light onto the photoresist film **900** corresponding to the conductive pattern. In detail, in the exposure process, the light is irradiated onto regions of the conductor **201** where the conductive pattern is not formed. The development process refers to the process for removing the regions to which the light is irradiated through the exposure process.

Due to the exposure and development processes, the mask pattern **910** may be formed in the regions corresponding to the coil unit **200** and the short-range communication antenna **600**. The conductor **201** exposed through the mask pattern **910** may be etched.

Then, as shown in FIG. 33, a predetermined portion of the conductor **201** where the mask pattern **910** is not formed may be removed through the etching process. The etching process refers to the process of removing the predetermined portion of the conductor **201** where the mask pattern **910** is not formed by using a chemical reacting with the predetermined portion of the conductor **201**. According to one embodiment, the conductor **201** may be patterned through the wet etching or dry etching.

After that, as shown in FIG. 34, the mask pattern **910** is removed so that the first and second connection terminals **210** and **220** of the coil unit **200**, the first and second connection terminals **610** and **620** of the short-range communication antenna **600**, the coil **230** having a

predetermined conductive pattern and the short-range communication antenna **600** having a predetermined conductive pattern may be formed.

Then, as shown in FIG. 35, the soldering process is performed to connect the coil unit **200** and the short-range communication antenna **600** to the connecting unit **300**. According to one embodiment, the soldering process includes the reflow process, but the embodiment is not limited thereto. The reflow process refers to the process for bonding the coil unit **230** and the short-range communication antenna **600** with the connecting unit **300** by melting solder cream using high-temperature heat to ensure the stable electrical connection between the connecting unit **300** and the coil unit **230**/NFC antenna **600**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210** of the coil unit **200** by a solder **30**, the second connection terminal **320** of the connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200** by the solder **30**, the third connection terminal **340** of the connecting unit **300** may be connected to the first connection terminal **610** of the short-range communication antenna **600** by the solder **30** and the fourth connection terminal **350** of the connecting unit **300** may be connected to the second connection terminal **620** of the short-range communication antenna **600**.

Then, as shown in FIG. 36, the magnetic substrate **100** is laminated on a predetermined portion of the conductive pattern where the connecting unit **300** is not present. In detail, the magnetic substrate **100** may be laminated on the top surfaces of the coil **230** and the short-range communication antenna **600**.

Prior to the above, the receiving space corresponding to the connecting unit **300** can be formed at the magnetic substrate **100**. The receiving space of the magnetic substrate **100** may have the shape identical to the shape of the connecting unit **300**.

As described above with reference to FIG. 26, since the connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100**, the thickness of the wireless power receiver **1000** can be remarkably reduced as much as the thickness of the connecting unit **300**. Thus, the thickness of the electronic device, such as a portable terminal, equipped with the wireless power receiver **1000** can be remarkably reduced.

The coil **230**/short-range communication antenna **600** and the magnetic substrate **100** may be adhered with each other by the first dual-side adhesive layer **710**. According to one

embodiment, the magnetic substrate **100** may have the thickness in the range of 100μm to 800μm, but the embodiment is not limited thereto. According to one embodiment, the first dual-side adhesive layer **710** may have the thickness in the range of 10μm to 50μm, but the embodiment is not limited thereto.

After that, the release paper layer **730** is attached to one side of the protective film **800** by interposing the second dual-size adhesive layer **720** therebetween. The release paper layer **730** is a paper layer for protecting the second dual-size adhesive layer **720** and may be removed when the wireless power receiver is disposed in a case of an electronic device, such as a portable terminal.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

CLAIMS

What is claimed is:

1. A wireless power receiver comprising:

a magnetic substrate; and

a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

2. The wireless power receiver of claim 1, wherein the coil is formed as a conductive pattern on the magnetic substrate.

3. The wireless power receiver of claim 1, wherein the magnetic substrate has a receiving space of a predetermined shape formed therein corresponding to a shape of a connecting unit connected to a wireless power receiving circuit.

4. The wireless power receiver of claim 3, further comprising the connecting unit disposed in the receiving space and connected to the coil.

5. The wireless power receiver of claim 4, wherein the connecting unit comprises one of a flexible printed circuit board, a lead frame and a tape substrate.

6. The wireless power receiver of claim 1, further comprising a short-range communication antenna formed on the magnetic substrate to surround the coil.

7. The wireless power receiver of claim 6, wherein the short-range communication antenna comprises a near field communication (NFC) antenna.

8. The wireless power receiver of claim 6, wherein the magnetic substrate has a receiving space of a predetermined shape formed therein corresponding to a shape of a connecting unit connected to a wireless power receiving circuit.

9. The wireless power receiver of claim 8, further comprising the connecting unit disposed in the receiving space and connected to the coil and a near field communication signal process unit.

10. A wireless power receiver comprising:

a magnetic substrate; and

a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer at the magnetic substrate,

wherein a part of the coil is disposed inside the magnetic substrate.

11. The wireless power receiver of claim 10, wherein the coil is formed as a conductive pattern at the magnetic substrate.

12. The wireless power receiver of claim 10, wherein the magnetic substrate comprises a pattern groove for receiving a part of the coil and the part of the coil is disposed in the pattern groove.

13. The wireless power receiver of claim 10, wherein the coil has a thickness smaller than a thickness of the magnetic substrate and an upper portion of the coil is exposed out of the magnetic substrate.

14. A method of manufacturing a wireless power receiver for wirelessly receiving power, the method comprising:

forming a conductor on a protective film;

forming a conductive pattern by etching the conductor;

connecting a connecting unit to be connected to an external circuit to a connection terminal of the conductive pattern;

obtaining a magnetic substrate having a receiving space of a predetermined shape corresponding to the connecting unit; and

disposing the magnetic substrate on the conductive pattern while positioning the connecting unit in the receiving space.

15. The method of claim 14, wherein the forming of the conductive pattern comprises etching the conductor to form the conductive pattern corresponding to a coil for wirelessly receiving the power and a near field communication antenna for making communication with an outside.

16. The method of claim 15, which comprises positioning connection terminals of the coil and the near field communication antenna in the receiving space.

17. The method of claim 14, wherein the disposing of the magnetic substrate comprises forming the magnetic substrate on the conductive pattern using a dual-side adhesive layer.

18. The method of claim 14, further comprising forming a release paper layer on the protective film using a dual-side adhesive layer.

19. A terminal equipped therein with a wireless power receiver of claim 1.

20. A terminal equipped therein with a wireless power receiver of claim 10.

ABSTRACT

A wireless power receiver according to one embodiment includes a magnetic substrate and a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

Electronic Acknowledgement Receipt	
EFS ID:	14758976
Application Number:	13663012
International Application Number:	
Confirmation Number:	3575
Title of Invention:	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME
First Named Inventor/Applicant Name:	Jeong Wook AN
Customer Number:	23557
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	Resp-Notice-Repl-Figs.pdf	115280 5ae3f62bac4db21f29c2ffface35948019cda1ca2	no	3
Warnings:					
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OC000000057674033

Date Mailed: 11/21/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Jeong Wook AN, Seoul, KOREA, REPUBLIC OF;
Jung Oh LEE, Seoul, KOREA, REPUBLIC OF;
Sung Hyun LEEM, Seoul, KOREA, REPUBLIC OF;
Yang Hyun KIM, Seoul, KOREA, REPUBLIC OF;

Applicant(s)

LG Innotek Co., LTD., Seoul, KOREA, REPUBLIC OF

Assignment For Published Patent Application

LG INNOTEK CO., LTD., Seoul, KOREA, REPUBLIC OF

Power of Attorney: The patent practitioners associated with Customer Number 23557

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
REPUBLIC OF KOREA 10-2012-0029987 03/23/2012
REPUBLIC OF KOREA 10-2012-0079004 07/19/2012

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to Retrieve Electronic Priority Application(s)** (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 11/16/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/663,012**

Projected Publication Date: To Be Determined - pending completion of Omitted Items

Non-Publication Request: No

Early Publication Request: No

Title

WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME

Preliminary Class

340

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage, facilitate, and accelerate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/663,012

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	390
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 62 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1260

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/663,012	10/29/2012	Jeong Wook AN	SUN.LGI.420

CONFIRMATION NO. 3575

23557
SALIWANCHIK, LLOYD & EISENSCHENK
A PROFESSIONAL ASSOCIATION
PO Box 142950
GAINESVILLE, FL 32614

FORMALITIES LETTER

OC000000057674034

Date Mailed: 11/21/2012

NOTICE OF OMITTED ITEM(S) IN A NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

A filing date has been accorded to the above-identified nonprovisional application papers; however, the following item(s) appear to have been omitted from the application:

- Figure(s) **37** described in the specification.

Applicant must reply to this notice within the time period set forth in this notice to avoid abandonment of this application. Applicant must select one of the three following options and the reply must comply with the requirements set forth in the selected option and any other requirements set forth in this notice. The reply should also indicate which option applicant has selected.

I. Petition for date of deposit: Should applicant contend that the above-noted omitted item(s) was in fact deposited in the U.S. Patent and Trademark Office (USPTO) with the nonprovisional application papers, a copy of this Notice and a petition (and $400.00 petition fee *(37 CFR 1.17(f))*) with evidence of such deposit **must** be filed within **TWO MONTHS** of the date of this Notice. The petition fee will be refunded if it is determined that the item(s) was received by the USPTO. **THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b).**

II. Petition for later filing date: Should applicant desire to supply the omitted item(s) and accept the date that such omitted item(s) was filed in the USPTO as the filing date of the above-identified application, a copy of this Notice, the omitted item(s) (with a supplemental oath or declaration in compliance with 37 CFR 1.63 and 1.64 referring to such items), and a petition under 37 CFR 1.182 (with the $400.00 petition fee *(37 CFR 1.17(f))* requesting the later filing date **must** be filed within **TWO MONTHS** of the date of this Notice. **THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b).**
Applicant is advised that generally the filing fee required for an application is the filing fee in effect on the filing date accorded the application and that payment of the requisite basic filing fee on a date later than the filing date of the application requires payment of a surcharge (37 CFR 1.16(f)). To avoid processing delays and payment of a surcharge, applicant should submit any balance due for the requisite filing fee based on the later filing date being requested when submitting the omitted item(s) and the petition (and petition fee) requesting the later filing date.

III. Acceptance of application as deposited: Applicant may accept the application as deposited in the USPTO by filing an appropriate amendment as set forth in either (A) or (B) below within **TWO MONTHS** of the date of this Notice. **THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b)** . The application will maintain a filing date as of the date of deposit of the application papers in the USPTO, and original application papers (i.e., the original disclosure of the invention) will include only those application papers present in the USPTO on the date of deposit. A petition is not required for this option.

(A) If applicant wants to accept the application as deposited without adding the subject matter that was in the omitted item (e.g., a missing page or figure), applicant is required to submit one or more of the following items without adding any new matter (see 35 U.S.C. 132(a)):

1. For a missing page of the specification,
   a) a substitute specification including claims that amends the specification to renumber the pages consecutively and cancels any incomplete sentences, and
   b) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125;
2. For a missing figure of the drawings,
   a) replacement drawing sheets in compliance with 37 CFR 1.121(d) to renumber the drawing figures consecutively (if necessary),
   b) a substitute specification excluding claims that amends the specification to cancel any references to any omitted drawing(s) and corrects the references in the specification to the drawing figures to correspond with any relabeled drawing figures, and
   c) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125;
3. For a missing page of the claim listing only, a replacement claim listing with the claims renumbered consecutively or, if amendment to the claims is also necessary, then a complete claim listing in compliance with 37 CFR 1.121(c);
4. For a missing or unreadable compact disc,
   a) a substitute specification (excluding the claims) deleting the reference to the compact disc and the files contained on the compact disc, and
   b) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125; and
5. For a missing or unreadable file submitted on a compact disc,
   a) a substitute specification (excluding the claims) deleting the reference to the missing or unreadable file, and a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125; and
   b) a replacement transmittal letter listing all of the files except the missing or unreadable file in compliance with 37 CFR 1.52(e)(3)(ii).

(B) Alternatively, if applicant wants to accept the application as deposited but wishes to add the subject matter in the omitted item (e.g., a missing page or figure) by relying on an incorporation by reference under 37 CFR 1.57 or other portions of the original disclosure, applicant is required to submit one or more of the following items without adding any new matter (see 35 U.S.C. 132(a)):

1. To add the subject matter in a missing page of specification,
   a) a substitute specification excluding claims and
   b) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125;
2. To add a missing figure of the drawings, new and replacement drawing sheets in compliance with 37 CFR 1.121(d);
3. To add the subject matter in a missing page of the claim listing, a complete claim listing in compliance with 37 CFR 1.121(c) (e.g., a claim in the missing page should be submitted as a new claim);
4. To add the subject matter in a missing or unreadable compact disc,
   a) a replacement compact disc and a duplicate copy of the compact disc, in compliance with 37 CFR 1.52(e); and
   b) a statement that the replacement compact disc contains no new matter in compliance with 37 CFR 1.52(e)(4); and,
5. To add the subject matter in a missing or unreadable file submitted on a compact disc,
   a) a replacement compact disc that contains all of the files listed in the specification including the missing or unreadable file and a duplicate copy of the compact disc, in compliance with 37 CFR 1.52(e); and

b) a statement that the replacement compact disc contains no new matter in compliance with 37 CFR 1.52(e)(4).

If applicant is relying on an incorporation by reference under 37 CFR 1.57 to add the omitted subject matter, then applicant must also comply with the requirements of 37 CFR 1.57.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/kung/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/663,012	10/29/2012	Jeong Wook AN	SUN.LGI.420

CONFIRMATION NO. 3575

POA ACCEPTANCE LETTER

23557
SALIWANCHIK, LLOYD & EISENSCHENK
A PROFESSIONAL ASSOCIATION
PO Box 142950
GAINESVILLE, FL 32614

OC00000057674065

Date Mailed: 11/21/2012

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/02/2012.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/hngo/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/AIA/82B(07-12)
Approved for use through 11/30/2014. OMB 0651-0035
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in the attached transmittal letter.

■ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

23557

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

Name	Registration Number	Name	Registration Number

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

■ The address associated with the above-mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant:

☐ Inventor or Joint Inventor

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (*e.g.*, a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature	Jeong Joong Kim	Date	October 5, 2012
Name	Jeong-Joong Kim	Telephone	+82-31-436-7690
Title and Company	Vice President, LG Innotek Co., Ltd.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below *.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..

Document Description: Power of Attorney

PTO/AIA/82A (07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number	13/663,012
Filing Date	October 29, 2012
First Named Inventor	Jeong Wook An
Title	Wireless Power Receiver and Method of Manufacturing the Same
Art Unit	
Examiner Name	
Attorney Docket Number	SUN.LGI.420

SIGNATURE of Applicant or Patent Practitioner

Signature		Date	November 2, 2012
Name	Jeff Lloyd	Telephone	352-375-8100
Registration Number	35,589		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	14137472
Application Number:	13663012
International Application Number:	
Confirmation Number:	3575
Title of Invention:	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME
First Named Inventor/Applicant Name:	Jeong Wook AN
Customer Number:	23557
Filer:	Jeff Lloyd/Wea Sto Domingo
Filer Authorized By:	Jeff Lloyd
Attorney Docket Number:	SUN.LGI.420
Receipt Date:	02-NOV-2012
Filing Date:	
Time Stamp:	15:17:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Comm-POA-Transmittal.pdf	210148 63518bbf07d0f15959533f328e7c0156392cf20b	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Power of Attorney	2	3
Warnings:			
Information:			
	Total Files Size (in bytes):	210148	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

I hereby certify that this correspondence is being electronically filed in the United States Patent and Trademark Office on November 2, 2012.

Patent Application
Docket No. SUN.LGI.420
Serial No. 13/663,012

Jeff Lloyd, Patent Attorney, Reg. No. 35,589

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	Jeong Wook An, Jung Oh Lee, Sung Hyun Leem, Yang Hyun Kim
Serial No.	:	13/663,012
Filed	:	October 29, 2012
Conf. No.	:	3575
For	:	Wireless Power Receiver and Method of Manufacturing the Same

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

COMMUNICATION

Sir:

Attached hereto, please find a Power of Attorney by Applicant (PTO/AIA/82B) executed by a representative of the assignee, LG Innotek Co., Ltd., and a Transmittal for Power of Attorney to One or More Registered Practitioners (PTO/AIA/82A) for the patent application referenced above.

Respectfully submitted,

Jeff Lloyd
Patent Attorney
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JL/whs
Attachments: Power of Attorney by Applicant (PTO/AIA/82B);
Transmittal for Power of Attorney to One or More Registered Practitioners (PTO/AIA/82A).

J:\SUN\LGI\420\PTO-misc\Comm-POA-Transmittal.doc/whs

DocCode – SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 13663012 Document Date: 10/29/2012

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Form Revision Date: February 8, 2006

2012/10/29 이정오
LG이노텍/x.x.x.1IZ 이정오

COMBINED DECLARATION (37 C.F.R. § 1.63) AND ASSIGNMENT

As a below-named inventor, I hereby declare that:

I believe I am the original inventor or an original joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled

Insert Title: **WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME**

the specification for which

☒ is attached hereto.
☐ was filed _____, Serial No. _____.

The above-identified application was made or authorized to be made by me.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

ASSIGNMENT

WHEREAS, the undersigned has invented certain new and useful improvements described in the application identified above.

WHEREAS,

Insert Assignee(s) Name/Address: **LG INNOTEK CO., LTD.,**

a corporation of the country of the Seoul Square, 541, Namdaemunno 5-ga, Jung-gu, Seoul, 100-714, Republic of Korea

(hereinafter ASSIGNEE), is desirous of acquiring the entire right, title, and interest in and to said invention and in and to any Letters Patent which may be granted therefor in the United States and in any and all foreign countries;

2012/10/29 이정오
LG이노텍/x...

NOW, THEREFORE, in view of valuable consideration, receipt of which is hereby acknowledged, I/we, the undersigned, have sold, assigned, and transferred, and by these presents do sell, assign, and transfer, unto said ASSIGNEE, its successors and assigns, the full and exclusive right to the said invention in the United States and its territorial possessions and in all foreign countries and the entire right, title, and interest in and to any and all Letters Patent which may be granted therefor in the United States and its territorial possessions and in any and all foreign countries and in and to any and all divisions, reissues, continuations, and extensions thereof.

I/we hereby authorize and request the Patent Office Officials in the United States and in any and all foreign countries to issue any and all of said Letters Patent, when granted, to ASSIGNEE, as the assignee of the entire right, title, and interest in and to the same, for the sole use and behoof of said ASSIGNEE, its successors and assigns.

FURTHER, I/we agree that we will communicate to said ASSIGNEE, or its representatives, any facts known to me respecting said invention; testify in any legal proceedings; sign all lawful papers; execute all divisional, continuation, substitution, renewal, and reissue applications; execute all necessary assignment papers to cause any and all of said Letters Patent to be issued to said ASSIGNEE; make all rightful oaths; and generally do everything possible to aid the said ASSIGNEE, its successors and assigns, to obtain and enforce proper protection for said invention in the United States and in any and all foreign countries.

In witness whereof, executed by the undersigned on the date opposite the undersigned name.

Legal Name of inventor	AN, Jeong Wook	Date:	29 / Oct / 2012
Inventor's Signature			

☒ Additional inventors are being named on the 1 supplemental sheet(s) attached hereto.

2012/10/29 이정오
LG이노텍/X.X.X.117 이정오

SUPPLEMENTAL SHEET FOR DECLARATION AND ASSIGNMENT

ADDITIONAL INVENTOR(S)
Supplemental Sheet Page 1 of 1

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor: LEE, Jung Oh

Date: 29 oct. 2012

Inventor's Signature: Jung

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor: LEEM, Sung Hyun

Date: 29. oct. 2012

Inventor's Signature: 임성현

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor: KIM, Yang Hyun

Date:

Inventor's Signature

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor

Date:

Inventor's Signature

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor

Date:

Inventor's Signature

2012/10/29 김양현
LG이노텍/x.x.x.197 김양현

SUPPLEMENTAL SHEET FOR DECLARATION AND ASSIGNMENT

ADDITIONAL INVENTOR(S)
Supplemental Sheet Page 1 of 1

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor: LEE, Jung Oh Date:

Inventor's Signature

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor: LEEM, Sung Hyun Date:

Inventor's Signature

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor: KIM, Yang Hyun Date: 2012.10.30

Inventor's Signature

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor Date:

Inventor's Signature

LEGAL NAME OF JOINT INVENTOR, IF ANY:

Legal Name of inventor Date:

Inventor's Signature

PTO/AIA/14 (08-12)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	SUN.LGI.420
	Application Number	
Title of Invention	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jeong Wook		AN	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Seoul	Country of Residence	KR

Mailing Address of Inventor:

Address 1	Seoul Square, 541, Namdaemunno 5-ga, Jung-gu		
Address 2			
City	Seoul	**State/Province**	
Postal Code	100-714	**Country**	KR

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jung Oh		LEE	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Seoul	Country of Residence	KR

Mailing Address of Inventor:

Address 1	Seoul Square, 541, Namdaemunno 5-ga, Jung-gu		
Address 2			
City	Seoul	**State/Province**	
Postal Code	100-714	**Country**	KR

Inventor 3 Remove

Legal Name

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	SUN.LGI.420
	Application Number	
Title of Invention	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Sung Hyun		LEEM	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Seoul	Country of Residence i	KR

Mailing Address of Inventor:

Address 1	Seoul Square, 541, Namdaemunno 5-ga, Jung-gu		
Address 2			
City	Seoul	State/Province	
Postal Code	100-714	Country i	KR

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Yang Hyun		KIM	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Seoul	Country of Residence i	KR

Mailing Address of Inventor:

Address 1	Seoul Square, 541, Namdaemunno 5-ga, Jung-gu		
Address 2			
City	Seoul	State/Province	
Postal Code	100-714	Country i	KR

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	23557		
Email Address	jl@slepatents.com	Add Email	Remove Email

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	SUN.LGI.420
	Application Number	
Title of Invention	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME	

Application Information:

Title of the Invention	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME		
Attorney Docket Number	SUN.LGI.420	**Small Entity Status Claimed** ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	36	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	23557		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	SUN.LGI.420
	Application Number	
Title of Invention	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME	

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country i	Filing Date (YYYY-MM-DD)	Priority Claimed
10-2012-0029987	KR	2012-03-23	(•) Yes ( ) No

Remove

Application Number	Country i	Filing Date (YYYY-MM-DD)	Priority Claimed
10-2012-0079004	KR	2012-07-19	(•) Yes ( ) No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	SUN.LGI.420
	Application Number	
Title of Invention	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME	

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Remove

(•) Assignee	( ) Legal Representative under 35 U.S.C. 117
( ) Person to whom the inventor is obligated to assign.	( ) Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Assignee is an Organization check here. [X]

Organization Name	LG INNOTEK CO., LTD.		
Mailing Address Information:			
Address 1	Seoul Square, 541, Namdaemunno 5-ga, Jung-gu		
Address 2			
City	Seoul	**State/Province**	
Country [i]	KR	Postal Code	100-714
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/JEFF LLOYD/			Date (YYYY-MM-DD)	2012-10-29
First Name	JEFF	Last Name	LLOYD	Registration Number	35589

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	SUN.LGI.420
	Application Number	
Title of Invention	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal	
Application Number:	
Filing Date:	
Title of Invention:	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME
First Named Inventor/Applicant Name:	Jeong Wook An
Filer:	Jeff Lloyd/MORGAN H LAMPP
Attorney Docket Number:	SUN.LGI.420
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	390	390
Utility Search Fee	1111	1	620	620
Utility Examination Fee	1311	1	250	250
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1260**

Electronic Acknowledgement Receipt	
EFS ID:	14097730
Application Number:	13663012
International Application Number:	
Confirmation Number:	3575
Title of Invention:	WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME
First Named Inventor/Applicant Name:	Jeong Wook An
Customer Number:	23557
Filer:	Jeff Lloyd/MORGAN H LAMPP
Filer Authorized By:	Jeff Lloyd
Attorney Docket Number:	SUN.LGI.420
Receipt Date:	29-OCT-2012
Filing Date:	
Time Stamp:	16:12:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1260
RAM confirmation Number	1957
Deposit Account	190065
Authorized User	LLOYD, JEFF
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees) Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees) Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		as-filed.pdf	773882 40f4f4471a6b1bcfc45d946ecb0254e68b8cab26	yes	53
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Specification		1	28	
	Claims		29	31	
	Abstract		32	32	
	Drawings-other than black and white line drawings		33	53	
Warnings:					
Information:					
2	Oath or Declaration filed	Dec-Assignment-AF.pdf	124776 9e09d875d5e7ff99b7d4e2c8b1e69b183f0bbddd	no	4
Warnings:					
Information:					
3	Application Data Sheet	ADS.pdf	1002295 00b1c1a30cbc71ba156ded5d9f497b6cb81328d0	no	7
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	33113 073d3b6545de9e5f52a0a706f89b19157d17c831	no	2
Warnings:					
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		Total Files Size (in bytes):	1934066		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

DESCRIPTION

WIRELESS POWER RECEIVER AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C §119 of Korean Patent Application Nos. 10-2012-0029987, filed March 23, 2012, and 10-2012-0079004, filed July 19, 2012, which are hereby incorporated by reference in their entirety.

BACKGROUND

The embodiment relates to a wireless power receiver and a method of manufacturing the same. In more particular, the embodiment relates to a wireless power receiver used for wireless power transmission or an antenna to reduce a thickness of the wireless power receiver and to simplify the manufacturing process thereof and a method of manufacturing the same.

A wireless power transmission or a wireless energy transfer refers to a technology of wirelessly transferring electric energy to desired devices. In the 1800's, an electric motor or a transformer employing the principle of electromagnetic induction has been extensively used and then a method of transmitting electrical energy by irradiating electromagnetic waves, such as radio waves or lasers, has been suggested. Actually, electrical toothbrushes or electrical razors, which are frequently used in daily life, are charged based on the principle of electromagnetic induction. The electromagnetic induction refers to the generation of an electric current through induction of a voltage when a magnetic field is changed around a conductor. The electromagnetic induction scheme has been successfully commercialized for electronic appliances having small sizes, but represents a problem in that the transmission distance of power is too short.

Besides the electromagnetic induction scheme, the long-distance transmission using the resonance and the short-wavelength radio frequency has been suggested as the wireless energy transfer scheme.

However, in general, a wireless power receiver disposed in a terminal has a thick thickness and the manufacturing process thereof is complicated.

BRIEF SUMMARY

An embodiment provides a method capable of remarkably reducing a thickness of a wireless power receiver by directly disposing a coil unit on a top surface of a magnetic substrate.

An embodiment provides a method capable of ensuring high power transmission efficiency and enabling communication with external devices by directly disposing a coil unit and a near field communication antenna on a top surface of a magnetic substrate.

An embodiment provides a method capable of simplifying the manufacturing process for a wireless power receiver by directly disposing a coil unit on a magnetic substrate.

An embodiment provides a method capable of remarkably reducing a thickness of a wireless power receiver by disposing a coil unit inside a magnetic substrate.

An embodiment provides a method capable of ensuring high power transmission efficiency and enabling communication with external devices by disposing a coil unit inside a magnetic substrate and a near field communication antenna on a magnetic substrate.

An embodiment provides a method capable of simplifying the manufacturing process for a wireless power receiver by disposing a coil unit inside a magnetic substrate.

A wireless power receiver according to one embodiment includes a magnetic substrate and a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

A wireless power receiver according to one embodiment includes a magnetic substrate and a coil a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer at the magnetic substrate, wherein a part of the coil is disposed inside the magnetic substrate.

A method of manufacturing a wireless power receiver for wirelessly receiving power according to one embodiment includes forming a conductor on a protective film, forming a conductive pattern by etching the conductor, connecting a connecting unit to be connected to an external circuit to a connection terminal of the conductive pattern, obtaining a magnetic substrate having a receiving space of a predetermined shape corresponding to the connecting unit and disposing the magnetic substrate on the conductive pattern while positioning the connecting unit in the receiving space.

According to one embodiment, the thickness of the wireless power receiver can be remarkably reduced by directly disposing the coil unit on a top surface of the magnetic substrate.

According to one embodiment, the high power transmission efficiency can be ensured and communication with external devices can be enabled by directly disposing the coil unit and the near field communication antenna on the top surface of the magnetic substrate.

According to one embodiment, the manufacturing process for the wireless power receiver can be simplified by directly disposing the coil unit on the magnetic substrate only through laminating and etching processes.

According to one embodiment, the thickness of the wireless power receiver can be remarkably reduced by forming the conductive pattern inside the magnetic substrate.

According to one embodiment, the high power transmission efficiency can be ensured by forming the conductive pattern inside the magnetic substrate and the communication with external devices can be enabled by using the near field communication antenna.

According to one embodiment, the connecting unit is disposed in the receiving space of the magnetic substrate so that the thickness of the wireless power receiver can be remarkably reduced as much as the thickness of the connecting unit.

According to one embodiment, a tape substrate is used as the connecting unit so that the overall size of the wireless power receiver can be reduced.

According to one embodiment, a lead frame is used as the connecting unit, so the wiring layer included in the connecting unit can be protected from the heat, external moisture or impact and the mass production can be realized.

According to one embodiment, the magnetic field directed to the outside can be changed into the coil unit due to the conductive pattern formed in the magnetic substrate, so the power transmission efficiency can be improved, at the same time, the amount of the magnetic field leaked to the outside can be reduced so that the bad influence of the magnetic field exerted to the human body can be diminished.

According to one embodiment, the wireless power receiver can be manufactured only through the processes of forming the pattern groove and inserting the coil unit, so that the manufacturing process can be simplified.

Other various effects of the embodiments will be disclosed directly or indirectly in the detailed description of the embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a wireless power receiver **1000** according to the first embodiment;

FIG. 2 is a plan view illustrating a wireless power receiver **1000** according to the first embodiment;

FIG. 3 is a sectional view taken along line A-A' of a connecting unit **300** of a wireless power receiver **1000** shown in FIG. 2;

FIGS. 4 to 8 are views for explaining a method of manufacturing a wireless power receiver **1000** according to one embodiment;

FIG. 9 is a sectional view taken along line A-A' of a connecting unit **300** of a wireless power receiver **1000** shown in FIG. 2 according to the second embodiment;

FIG. 10 is a plan view illustrating a wireless power receiver **1000** according to the third embodiment;

FIG. 11 is a perspective view illustrating a wireless power receiver **1000** according to the fourth embodiment;

FIG. 12 is a plan view illustrating a wireless power receiver **1000** according to the fourth embodiment;

FIG. 13 is a sectional view taken along line B-B' of a connecting unit **300** of a wireless power receiver **1000** shown in FIG. 12 according to the fourth embodiment;

FIG. 14 is a perspective view illustrating a wireless power receiver **1000** according to the fifth embodiment;

FIG. 15 is a plan view illustrating a wireless power receiver **1000** according to the fourth embodiment;

FIG. 16 is a sectional view taken along line C-C' of a wireless power receiver **1000** according to the fifth embodiment;

FIGS. 17 to 21 are views for explaining a method of manufacturing a wireless power receiver **1000** according to the fifth embodiment;

FIG. 22 is a view for explaining variation of inductance, resistance and **Q** values of a coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed on a top surface of a magnetic substrate according to the first embodiment;

FIG. 23 is a view for explaining variation of inductance, resistance and **Q** values of a coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed in a pattern groove formed in a magnetic substrate according to the fifth embodiment;

FIG. 24 is an H-field for illustrating a radiation pattern of a magnetic field when a coil unit is disposed on a top surface of a magnetic substrate according to the first embodiment;

FIG. 25 is an H-field for illustrating a radiation pattern of a magnetic field when a coil unit is disposed in a pattern groove formed in a magnetic substrate according to the fifth embodiment;

FIG. 26 is an exploded perspective view of a wireless power receiver **1000** according to still another embodiment;

FIG. 27 is a perspective view of a wireless power receiver **1000** according to still another embodiment;

FIG. 28 is a sectional view of a wireless power receiver **1000** according to still another embodiment; and

FIGS. 29 to 37 are views for explaining a method of manufacturing a wireless power receiver according to still another embodiment.

DETAILED DESCRIPTION

Hereinafter, exemplary embodiments will be described in detail with reference to accompanying drawings so that those skilled in the art can easily work with the embodiments.

Hereinafter, "conductive pattern" refers to the shape of a conductive layer and may be used to refer to a structure formed by a patterning process. "conductive layer" may be used interchangeably with "conductive pattern" and refers to a structure formed by methods including patterning, etching, deposing, selective plating, and the like.

FIG. 1 is a perspective view illustrating a wireless power receiver **1000** according to the first embodiment, FIG. 2 is a plan view illustrating the wireless power receiver **1000** according

to the first embodiment and FIG. 3 is a sectional view taken along line A-A' of a connecting unit **300** of the wireless power receiver **1000** shown in FIG. 2.

Referring to FIGS. 1 to 3, the wireless power receiver **1000** may include a magnetic substrate **100**, a coil unit **200** and a connecting unit **300**.

The wireless power receiver **1000** may wirelessly receive power from a transmission side. According to one embodiment, the wireless power receiver **1000** may wirelessly receive the power using electromagnetic induction. According to one embodiment, the wireless power receiver **1000** may wirelessly receive the power using resonance.

The electromagnetic induction and resonance may be used when transmitting the power using the magnetic field.

The magnetic substrate **100** may change the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can reduce the amount of the magnetic field to be leaked to the outside by changing the direction of the magnetic field received from the transmission side.

In detail, the magnetic substrate **100** changes the direction of the magnetic field transferred from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field received from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 3, the magnetic substrate **100** may include a magnet **110** and a support **120**.

The magnet **110** may include a particle or a ceramic.

The support **120** may include thermosetting resin or thermoplastic resin.

The magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

Referring again to FIG. 1, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may be formed as a conductive layer or a conductive pattern.

The first connection terminal **210** is located at one end of the coil **230** and the second connection terminal **220** is provided at the other end of the coil **230**.

The first and second connection terminals **210** and **220** are necessary for connection with the connecting unit **300**.

The coil **230** may be formed as a conductive pattern which is obtained by winding a conductive line several times. According to one embodiment, when viewed from the top, the coil pattern may have a spiral shape. However, the embodiment is not limited thereto, and various patterns may be formed.

The coil unit **200** can be directly disposed on the top surface of the magnetic substrate **100**. According to one embodiment, an adhesive layer (not shown) may be disposed between the coil unit **200** and the magnetic substrate **100**.

The coil unit **200** may include a conductor. The conductor may include a metal or an alloy. According to one embodiment, the metal may include silver or copper, but the embodiment is not limited thereto.

The coil unit **200** may transfer the power, which is wirelessly received from the transmission side, to the connecting unit **300**. The coil unit **200** can receive the power from the transmission side using the electromagnetic induction or resonance.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320** and a printed circuit board **330**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210** of the coil unit **200** and the second connection terminal **320** of the connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200**.

The printed circuit board **330** may include a wiring layer and a receiver circuit, which will be described later, may be disposed on the wiring layer.

The connecting unit **300** connects the wireless power receiving circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the wireless power receiving circuit. The wireless power receiving circuit may include a rectifier circuit for converting AC power into DC power and a smoothing circuit for transferring the DC power to the load after removing ripple components from the DC power.

FIGS. 2 and 3 are views for explaining the structure of the wireless power receiver **1000** according to the first embodiment in detail when the coil unit **200** is connected with the connecting unit **300**.

FIG. 2 is a plan view illustrating the wireless power receiver **1000** according to the first embodiment.

FIG. 2 shows the coil unit **200** connected with the connecting unit **300**.

According to one embodiment, the connection between the coil unit **200** and the connecting unit **300** may be achieved by a solder. In detail, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting **unit 300** through a second solder **20**. In more detail, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a via hole of the first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a via hole of the second solder **20**.

The wireless power receiver **1000** shown in FIG. 2 may be equipped in an electronic appliance, such as a terminal.

The terminal may include a typical mobile phone, such as a cellular phone, a PCS (personal communication service) phone, a GSM phone, a CDMA-2000 phone, or a WCDMA phone, a PMP (portable multimedia player), a PDA (personal digital assistant), a smart phone, or an MBS (mobile broadcast system) phone, but the embodiment is not limited thereto. Various devices can be used as the terminal if they can wirelessly receive the power.

A section taken along line A-A' of the connecting unit **300** shown in FIG. 2 will be explained with reference to FIG. 3.

FIG. 3 is a sectional view taken along line A-A' of the connecting unit **300** of the wireless power receiver **1000** shown in FIG. 2.

Referring to FIG. 3, the first connection terminal **210**, the second connection terminal **220** and the coil **230** constituting the coil unit **200** are disposed on the top surface of the magnetic substrate **100**.

In the wireless power receiver **1000** according to the first embodiment, the coil unit **200** is directly disposed on the top surface of the magnetic substrate **100**, so the overall thickness can be remarkably reduced when comparing with the case in which the coil pattern is formed on an FPCB.

Preferably, the magnetic substrate **100** has a thickness of 0.43 mm and the coil unit **200** has a thickness of 0.1 mm, so the overall thickness is 0.53 mm. However, this numerical value is illustrative purpose only.

That is, the thickness of the wireless power receiver **1000** can be reduced by preparing the coil unit **200** in the form of a conductor, a conductive pattern or a thin film. Since the current trend has tended toward the slimness, if the wireless power receiver **1000** is applied to the electronic device, such as the portable terminal, the overall thickness of the portable terminal can be reduced and the power can be effectively received from the transmission side.

The connecting unit **300** is directly disposed on the coil unit **200**. Since the connecting unit **300** is directly disposed on the coil unit **200**, the coil unit **200** can be readily connected with the connecting unit **300**.

The first connection terminal **210** of the coil unit **200** is connected to the first connection terminal **310** of the connecting unit **300** through the solder **10**.

The second connection terminal **220** of the coil unit **200** is connected to the second connection terminal **320** of the connecting unit **300** through the solder **20**.

The coil **230** may be designed to have a predetermined width **W** and a predetermined thickness **T**. In addition, the coil **230** can be designed to have a predetermined winding interval.

FIGS. 4 to 8 are views for explaining a method of manufacturing the wireless power receiver **1000** according to one embodiment.

The structure of the wireless power receiver **1000** may be essentially identical to the structure of the wireless power receiver **1000** described with reference to FIGS. 1 to 3.

First, referring to FIG. 4, the magnetic substrate **100** is prepared.

Then, referring to FIG. 5, a conductor **201** is directly laminated on the top surface of the magnetic substrate **100**. According to one embodiment, the conductor **201** may be laminated after the adhesive layer has been laminated on the top surface of the magnetic substrate **100**.

According to one embodiment, a laminating process can be used to form the conductor **201** on the top surface of the magnetic substrate **100**. According to the laminating process, the conductor **201** is heated at the predetermined temperature and then predetermined pressure is applied to the conductor **201**. The laminating process refers to a process of forming heterogeneous materials, such as a metal foil and a paper, by using heat and pressure.

Then, referring to FIG. 6, a mask **500** is laminated on the top surface of the conductor **201**. The mask **500** may be selectively formed on the top surface of the conductor **201** corresponding to positions of the first connection terminal **210**, the second connection terminal **220** and the coil **230** of the coil unit **200**.

After that, referring to FIG. 7, the structure shown in FIG. 6 is immersed in an etchant so that portions of the conductor **201** where the mask **500** is not positioned may be etched. Thus, the conductor **201** may have a predetermined conductive pattern.

Then, the coil unit **200** of the wireless power receiver **1000** is formed by removing the mask **500**.

Thereafter, referring to FIG. 8, the soldering work is performed to connect the coil unit **200** with the connecting unit **300**.

That is, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through the first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through the second solder **20**.

As described above, since the coil unit **200** is directly disposed on the top surface of the magnetic substrate **100**, the overall thickness of the wireless power receiver **1000** can be remarkably reduced. In addition, since the wireless power receiver **1000** can be manufactured only through the laminating and etching processes, the manufacturing process may be simplified.

FIG. 9 is a sectional view taken along line A-A' of the connecting unit **300** of the wireless power receiver **1000** shown in FIG. 2 according to the second embodiment.

Referring to FIG. 9, the wireless power receiver **1000** may include a magnetic substrate **100**, a coil unit **200,** a connecting unit **300** and an adhesive layer **700**.

The magnetic substrate **100**, the coil unit **200**, and the connecting unit **300** are identical to those described with reference to FIG. 1.

The adhesive layer **700** is interposed between the magnetic substrate **100** and the coil unit **200** to bond the magnetic substrate **100** to the coil unit **200**.

FIG. 10 is a plan view illustrating a wireless power receiver **1000** according to the third embodiment.

Referring to FIG. 10, the wireless power receiver **1000** may include a magnetic substrate **100,** a coil unit **200**, a connecting unit **300** and a short-range communication antenna **600**.

The magnetic substrate **100**, the coil unit **200** and the connecting unit **300** are identical to those described with reference to FIGS. 1 to 3.

The short-range communication antenna **600** includes a first connection terminal **610**, a second connection terminal **620** and an outer peripheral coil **630**.

The first connection terminal **610** and the second connection terminal **620** of the short-range communication antenna **600** are connected to the connecting unit **300**.

The short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. According to one embodiment, when the coil unit **200** is disposed at the center of the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Similar to the coil unit **200**, the short-range communication antenna **600** may be formed as a conductive pattern or a conductive layer.

Various short-range communication technologies can be applied to the short-range communication antenna **600**, and the NFC technology is preferable. The NFC technology has the band of 12.56 MHz and is used for wireless communication in a short distance.

The short-range communication antenna **600** can be directly disposed on the top surface of the magnetic substrate **100**.

The method of forming the short-range communication antenna **600** on the magnetic substrate **100** may be identical to the method described with reference to FIG. 4.

Hereinafter, a wireless power receiver **1000** according to the fourth embodiment will be described with reference to FIGS. 11 to 13.

FIG. 11 is a perspective view illustrating the wireless power receiver **1000** according to the fourth embodiment.

Referring to FIG. 11, the wireless power receiver **1000** includes a magnetic substrate **100**, a coil unit **200** and a connecting unit **300**.

The magnetic substrate **100** and the coil unit **200** are identical to those described with reference to FIG. 1. However, the magnetic substrate **100** is slightly different from the magnetic substrate **100** described with reference to FIG. 1, so the following description will be made while focusing the difference of the magnetic substrate **100**.

Referring to FIG. 11, the magnet substrate **100** is formed with a receiving space **130** having a structure the same as that of the connecting unit **300**. That is, referring to FIG. 1, the coil unit **200** is disposed on the top surface of the magnetic substrate **100** and the connecting unit **300** is disposed on the coil unit **200**. However, referring to FIG. 11, the receiving space **130** having the structure the same as that of the connecting unit **300** is formed in the magnetic substrate **100**, so that the connecting unit **300** may be disposed under the coil unit **200**.

FIG. 12 is a plan view illustrating a wireless power receiver **1000** according to the fourth embodiment.

FIG. 12 shows the state in which the coil unit **200** and the connecting unit **300** are interconnected with each other.

The connecting unit **300** has a thickness equal to or smaller than a thickness of the magnetic substrate **100**. The connecting unit **300** may be implemented as a flexible printed circuit board (FPCB).

The connecting unit **300** may be disposed in the receiving space **130** of the magnetic substrate **100**.

If the thickness of the connecting unit **300** is equal to or smaller than the thickness of the magnetic substrate **100**, different from the embodiment shown in FIG. 3, the overall thickness of the wireless power receiver **1000** can be reduced as much as the thickness of the connecting unit

300. In addition, since the usage of the magnet **110** and the support **120** can be reduced due to the receiving space **130**, it is advantageous in terms of cost effectiveness.

FIG. 13 is a sectional view taken along line B-B' of the connecting unit **300** of the wireless power receiver **1000** shown in FIG. 12 according to the fourth embodiment.

The following description will be made on the assumption that the connecting unit **300** has a thickness smaller than that of the magnetic substrate **100**.

Referring to FIG. 13, the first connection terminal **210**, the second connection terminal **220** and the coil **230** constituting the coil unit **200** are disposed on the top surface of the connecting unit **300**.

The connecting unit **300** is disposed under the coil unit **200**.

The first connection terminal **210** of the coil unit **200** is connected to the first connection terminal **310** of the connecting unit **300** by the solder **10**.

The second connection terminal **220** of the coil unit **200** is connected to the second connection terminal **320** of the connecting unit **300** by the solder **20**.

The coil **230** may be designed to have a predetermined width **W** and a predetermined thickness **T**. In addition, the coil **230** can be designed to have a predetermined winding interval.

Referring to FIG. 12, different from the embodiment shown in FIG. 3, the thickness of the connecting unit **300** is smaller than the thickness of the magnetic substrate **100**, so the overall thickness of the wireless power receiver **1000** can be reduced as much as the thickness of the connecting unit **300**. In addition, since the usage of the magnet **110** and the support **120** can be reduced due to the receiving space **130**, it is advantageous in terms of cost effectiveness.

Hereinafter, a wireless power receiver **1000** according to the fifth embodiment will be described in detail with reference to FIGS. 14 to 20.

FIG. 14 is a perspective view illustrating the wireless power receiver **1000** according to the fifth embodiment, FIG. 15 is a plan view illustrating the wireless power receiver **1000** according to the fourth embodiment, FIG. 16 is a sectional view taken along line C-C' of the wireless power receiver **1000** according to the fifth embodiment, and FIGS. 17 to 21 are views for explaining a method of manufacturing the wireless power receiver **1000** according to the fifth embodiment.

First, referring to FIG. 14, the wireless power receiver **1000** according to the fifth embodiment may include a magnetic substrate **100**, a coil unit **200** and a connecting unit **300**.

According to one embodiment, the wireless power receiver **1000** can wirelessly receive power from the transmission side using electromagnetic induction. In this case, the coil **230** of the coil unit **200** can wirelessly receive power through the electromagnetic induction with a coil of the transmission side.

According to one embodiment, the wireless power receiver **1000** can wirelessly receive power from the transmission side using resonance.

The magnetic substrate **100** may change the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can reduce the amount of the magnetic field leaked to the outside by changing the direction of the magnetic field received from the transmission side.

The magnetic substrate **100** can change the direction of the magnetic field received from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field received from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 16, the magnetic substrate **100** may include a magnet **110** and a support **120**.

The magnet **110** may include a particle or a ceramic. According to one embodiment, the magnet **110** may be one of a spinel type magnet, a hexa type magnet, a sendust type magnet and a permalloy type magnet.

The support **120** may include thermosetting resin or thermoplastic resin and support the magnetic substrate **100**.

The magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

Referring again to FIG. 14, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may formed as a conductive layer or a conductive pattern.

The coil unit **200** may be disposed inside the magnetic substrate **100**. In detail, the coil unit **200** may be buried inside the magnetic substrate **100**. In more detail, the magnetic substrate **100** may include a pattern groove and the coil unit **200** may be disposed in the pattern groove. The pattern groove may be formed as a conductive pattern or a conductive layer similar to the coil unit **200**.

The coil unit **200** has a thickness smaller than that of the magnetic substrate **100** and an upper portion of the coil unit **200** may be exposed out of the magnetic substrate **100**.

A process for manufacturing the wireless power receiver **1000** by disposing the coil unit **200** and the connecting unit **300** in the magnetic substrate **100** will be described later with reference to FIGS. 17 to 21.

The first connection terminal **210** of the coil unit **200** is located at one end of the coil **230** and the second connection terminal **220** of the coil unit **200** is located at the other end of the coil **230**.

The first and second connection terminals **210** and **220** of the coil unit **200** are necessary for connection with the connecting unit **300**.

The coil **230** may be formed as a coil pattern which is obtained by winding a conductive line several times. According to one embodiment, when viewed from the top, the coil pattern may have a spiral shape. However, the embodiment is not limited thereto, and various patterns may be formed.

The coil unit **200** may transfer the power wirelessly received from the transmission side to the connecting unit **300**. The coil unit **200** may transfer the power wirelessly received from the transmission side using the electromagnetic induction or resonance to the connecting unit **300**.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320** and a printed circuit board **330**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210 of** the coil unit **200** and the second connection terminal **320** of the

connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200**.

The printed circuit board **330** may include a wiring layer and the wiring layer may include a wireless power receiving circuit, which will be described later.

The connecting unit **300** connects the wireless power receiving circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the wireless power receiver circuit. The wireless power receiver circuit may include a rectifier circuit (not shown) for converting AC power into DC power and a smoothing circuit for transferring the DC power to the load after removing ripple components from the DC power.

FIGS. 15 and 16 show the detailed structure of the wireless power receiver **1000** according to the fifth embodiment when the coil unit **200** is connected to the connecting unit **300**.

FIG. 15 shows the coil unit **200** and the connecting unit **300** interconnected with each other.

The coil unit **200** can be connected to the connecting unit **300** by a solder.

Referring to FIG. 16, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a second solder **20**. In detail, the first connection terminal **210** of the coil unit **200** may be connected to the first connection terminal **310** of the connecting unit **300** through a via hole of the first solder **10** and the second connection terminal **220** of the coil unit **200** may be connected to the second connection terminal **320** of the connecting unit **300** through a via hole of the second solder **20**.

According to one embodiment, the via hole can be formed by using a laser. The laser may include a UV laser or a CO2 laser.

FIG. 16 is a sectional view of the wireless power receiver **1000** in which the magnetic substrate **100** and the coil unit **200** are connected to the connecting unit **300**.

That is, the first connection terminal **210**, the second connection terminal **220** and the coil **230** constituting the coil unit **200** may be disposed in a pattern groove **140** of the magnetic substrate **100**.

In addition, the magnetic substrate **100** and the coil unit **200** are connected to the connecting unit **300**.

The coil **230** may be designed to have a predetermined width **W** and a predetermined thickness **T** and the magnetic substrate **100** may be designed to have a predetermined thickness **T1**. According to one embodiment, the coil **230** has a thickness of 0.1mm and the magnetic substrate **100** has a thickness of 0.43 mm, but these numerical values are illustrative purposes only. According to one embodiment, the thickness **T** of the coil **230** may be smaller than the thickness **T1** of the magnetic substrate **100**.

In the wireless power receiver **1000** according to the fifth embodiment, the coil unit **200** is directly disposed in the pattern groove **140** of the magnetic substrate **100**, so the overall thickness of an electronic appliance equipped with the wireless power receiver **1000** can be reduced as much as the thickness of the coil unit **200**. Thus, if the wireless power receiver **1000** according to the fifth embodiment is applied to the electronic device, such as the portable terminal, the overall thickness of the portable terminal can be reduced suitably for the current trend of slimness

In addition, in the wireless power receiver **1000** according to the fifth embodiment, the coil unit **200** is disposed in the pattern groove **140** of the magnetic substrate **100**. Thus, different from the electronic appliance in which a coil pattern is formed on an FPCB, the overall size of the electronic device equipped with the wireless power receiver **1000** can be reduced.

FIGS. 17 to 21 are views for explaining a method of manufacturing the wireless power receiver **1000** according to the fifth embodiment.

Hereinafter, the method of manufacturing the wireless power receiver **1000** according to the fifth embodiment will be described with reference to FIGS. 17 to 21 as well as FIGS. 14 to 16.

First, referring to FIG. 17, the magnetic substrate **100** is prepared. According to one embodiment, the magnetic substrate **100** may be produced by coating metal powder of sendust alloys, such as Al, Fe and SiO2, on polyethylene rubber and then forming an oxide layer on a surface of the polyethylene rubber.

Then, referring to FIG. 18, heat and pressure are applied using a mold **1** to form the pattern groove in the magnetic substrate **100** for receiving the coil unit **200**. The mold **1** may

have the shape corresponding to the shape of the coil unit **200**. According to one embodiment, the mold **1** can be manufactured by using an aluminum alloy, a copper alloy or a cast iron.

The mold **1** may be provided with a protrusion at a region corresponding to the coil unit **200** for wirelessly receiving the power.

When the heat is applied by using the mold **1**, the heat having the specific temperature is applied by taking the property of the metal powder of the sendust alloy constituting the magnetic substrate **100** into consideration. According to one embodiment, if the magnetic substrate **100** is produced by coating the metal powder of sendust alloy on the polyethylene rubber, when the heat and pressure are applied by using the mold **1**, high-pressure is applied at the temperature in the range of 100°C to 180°C, and then the mold **100** is cooled to the temperature of 100°C or below. After that, the mold **1** is separated from the magnetic substrate **100**. If the mold **1** is separated just after the pressure has been applied to the magnetic substrate **100**, the desired pattern groove **140** may not be formed due to residual heat in the pattern groove **140**. For this reason, the mold **1** is separated from the magnetic substrate **100** after cooling the mold **100** to the temperature of 100°C or below.

If the magnetic substrate **100** is prepared by using the metal powder of sendust alloy, the heat temperature and pressure may vary depending on the distribution and concentration of the metal powder. That is, if the distribution of the metal powder is not uniform, the higher temperature and pressure may be applied. In contrast, if the distribution of the metal powder is uniform, the lower temperature and pressure may be applied. In addition, if the concentration of the metal powder is low, the lower temperature and pressure may be applied as compared with the case in which the concentration of the metal powder is high. Further, the heat temperature and pressure may vary depending on the composition of the metal powder, that is, depending on the alloy constituting the metal powder.

In this manner, the temperature applied to the mold **1** may vary depending on the distribution, concentration and composition of the powder.

According to one embodiment, laser may be irradiated, instead of applying heat and pressure using the mold **1**, to form the pattern groove in the magnetic substrate **100** to receive the coil unit **200**. In this case, the pattern groove can be formed by using an excimer laser that irradiates the laser beam having a wavelength band of ultraviolet ray. The excimer laser may

include a KrF excimer laser (central wavelength 248 nm) or an ArF excimer laser (central wavelength 193 nm).

Next, referring to FIG. 19, the mold **1** is separated from the magnetic substrate **100** so that the magnetic substrate **100** is formed with the pattern groove **140**.

Then, referring to FIG. 20, the coil unit **200** is inserted into the pattern groove **140** formed in the magnetic substrate **100**. As the coil unit **200** is inserted into the pattern groove **140**, a predetermined conductive pattern is formed in the pattern groove **140** of the magnetic substrate **100**.

According to one embodiment, a process for forming the coil unit **200** in the pattern groove **140** of the magnetic substrate **100** may include a plating process or a process for inserting a metal which has been etched to have the conductive pattern formed by the coil unit **200**.

In detail, according to the plating process, the metallic material is filled in the pattern groove **140** to form the coil unit **200**. At this time, the metallic material may include one selected from Cu, Ag, Sn, Au, Ni and Pd and the filling of the metallic metal can be performed through one of electroless plating, screen printing, sputtering, evaporation, ink-jetting and dispensing or a combination thereof.

Then, referring to FIG. 21, the soldering process is performed to connect the coil unit **200** with the connecting unit **300**.

That is, the first connection terminal **210** of the coil unit **200** is connected to the first connection terminal **310** of the connecting unit **300** through the solder **10** and the second connection terminal **220** of the coil unit **200** is connected to the second connection terminal **320** of the connecting unit **300** through the solder **20**.

As described above, according to the method of manufacturing the wireless power receiver **1000** of the fifth embodiment, the pattern groove is formed in the magnetic substrate **100** and the coil unit **200** is disposed in the pattern groove, so that the overall thickness of the wireless power receiver **1000** can be reduced. In addition, the wireless power receiver **1000** can be manufactured by simply forming the pattern groove and then inserting the coil unit into the pattern groove, so that the manufacturing process can be simplified.

FIG. 22 is a view for explaining variation of inductance, resistance and Q values of the coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed on a top

surface of the magnetic substrate according to the first embodiment, and FIG. 23 is a view for explaining variation of inductance, resistance and Q values of the coil unit **200** as a function of a usable frequency when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate according to the fifth embodiment.

The inductance, resistance and Q values of the coil unit **200** can be expressed as following equation 1.

[Equation 1]

$$Q=W*L/R$$

In equation 1, w is a frequency used when transmitting power, L is inductance of the coil unit **200** and R is resistance of the coil unit **200**.

As can be understood from equation 1, the Q value becomes high as the inductance of the coil unit **200** is increased. If the Q value is increased, the power transmission efficiency can be improved. The resistance of the coil unit **200** is a numerical value of power loss occurring in the coil unit **200** and the Q value becomes high as the resistance value is decreased.

Referring to FIGS. 22 and 23, when comparing the fifth embodiment, in which the coil unit **200** is disposed in the pattern groove **140** of the magnetic substrate **100**, with the first embodiment, in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**, when the usable frequency is 150 kHz, the inductance of the coil unit **200** is increased by 352.42 um from about 9986.92 um to about 10339.34 um and the resistance of the coil unit **200** is reduced by 0.057 Ω from 0.910 Ω to 0.853 Ω. That is, the Q value is increased corresponding to the increment of the inductance and the reduction of the resistance.

Therefore, the wireless power receiver **1000** according to the fifth embodiment can increase the Q value by disposing the coil unit **200** in the pattern groove of the magnetic substrate **100**.

FIG. 24 is an H-field for illustrating a radiation pattern of a magnetic field when the coil unit is disposed on a top surface of the magnetic substrate according to the first embodiment, and FIG. 25 is an H-field for illustrating a radiation pattern of a magnetic field when the coil unit is disposed in the pattern groove formed in the magnetic substrate according to the fifth embodiment.

Referring to FIGS. 24 and 25, a greater amount of magnetic fields is radiated from the outer peripheral portion of the coil unit **200** when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate **100** as compared with the case in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**. This is because the magnetic field directed to the outside is changed in the lateral direction of the coil unit **200** due to the coil unit **200** buried in the magnetic substrate **100**.

In addition, a greater amount of magnetic fields is radiated at the inner portion of the coil unit **200** when the coil unit **200** is disposed in the pattern groove formed in the magnetic substrate **100** as compared with the case in which the coil unit **200** is disposed on the top surface of the magnetic substrate **100**. This is also because the magnetic field directed to the outside is changed in the lateral direction of the coil unit **200** due to the coil unit **200** buried in the magnetic substrate **100**.

Referring to FIGS. 24 and 25, the wireless power receiver **1000** may further include a short-range communication antenna **600**.

The short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. According to one embodiment, when the coil unit **200** is disposed at the center of the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Similar to the coil unit **200**, the short-range communication antenna **600** may be formed as a conductive pattern or a conductive layer.

Various short-range communication technologies can be applied to the short-range communication antenna **600** and the NFC technology is preferable.

Hereinafter, a wireless power receiver according to another embodiment will be described with reference to FIGS. 26 to 37.

FIG. 26 is an exploded perspective view of the wireless power receiver **1000** according to still another embodiment, FIG. 27 is a perspective view of the wireless power receiver **1000** according to still another embodiment, and FIG. 28 is a sectional view of the wireless power receiver **1000** according to still another embodiment.

Meanwhile, FIG. 27 is a perspective view showing the assembled state of the elements of the wireless power receiver **1000** shown in FIG. 26, in which some elements are omitted.

The wireless power receiver **1000** according to still another embodiment may be disposed in an electronic device, such as a portable terminal.

Referring to FIGS. 26 to 28, the wireless power receiver **1000** may include a magnetic substrate **100**, a coil unit **200**, a connecting unit **300**, a short-range communication antenna **600**, an adhesive layer **700**, a first dual-side adhesive layer **710**, a second dual-side adhesive layer **720**, a protective film **800** and a release paper layer **730**.

Referring to FIG. 26, the magnetic substrate **100** can change the direction of the magnetic field transferred from the transmission side.

The magnetic substrate **100** changes the direction of the magnetic field transferred to the coil unit **200** from the transmission side to reduce the amount of the magnetic field leaked to the outside. Thus, the magnetic substrate **100** may have the electromagnetic wave shielding effect.

In detail, the magnetic substrate **100** changes the direction of the magnetic field transferred from the transmission side in the lateral direction such that the magnetic field can be more concentrated onto the coil unit **200**.

The magnetic substrate **100** can absorb some of the magnetic field transferred to the coil unit **200** from the transmission side and leaked to the outside to dissipate the magnetic field as heat. If the amount of the magnetic field leaked to the outside is reduced, the bad influence of the magnetic field exerted on the human body can be reduced.

Referring to FIG. 28, the magnetic substrate **100** may include a magnet **110** and a support **120**.

According to one embodiment, the magnet **110** may be one of a spinel type magnet, a hexa type magnet, a sendust type magnet and a permalloy type magnet.

The support **120** may include thermosetting resin or thermoplastic resin and support the magnetic substrate **100**.

Referring again to FIG. 26, the magnetic substrate **100** may be prepared in the form of a sheet and may have a flexible property.

A receiving space **130** is formed at a predetermined area of the magnet substrate **100**. The receiving space **130** has a structure the same as that of the connecting unit **300**. The connecting unit **300** is disposed in the receiving space **130** and connected to the coil unit **200**.

The coil unit **200** can receive the power from the transmission side using the electromagnetic induction or resonance. Similar to the coil unit **200** illustrated in FIG. 1, the coil unit **200** may include a first connection terminal **210**, a second connection terminal **220** and a coil **230**. The coil **230** may be formed as a conductive layer or a conductive pattern.

The connecting unit **300** connects a receiver circuit (not shown) with the coil unit **200** to transfer the power received from the coil unit **200** to a load (not shown) through the receiver circuit.

The connecting unit **300** may include a wiring layer and the wiring layer may include the wireless power receiving circuit. The wireless power receiving circuit may include a rectifier circuit for rectifying the power received from the coil unit **200**, a smoothing circuit for removing noise signals, and a main IC chip for performing the operation to wirelessly receive the power.

In addition, the receiver circuit can transfer the signal received from the short-range communication antenna **600** to a short-range communication signal processing unit (not shown).

The connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100** and connected to the coil unit **200**. FIG. 27 shows the connecting unit **300** disposed in the receiving space **130** of the magnetic substrate **100**.

The connecting unit **300** may include a first connection terminal **310**, a second connection terminal **320**, a third connection terminal **340** and a fourth connection terminal **350**. The first connection terminal **310** of the connecting unit **300** is connected to the first connection terminal **210** of the coil unit **200**, the second connection terminal **320** of the connecting unit **300** is connected to the second connection terminal **220** of the coil unit **200**, the third connection terminal **340** of the connecting unit **300** is connected to a first connection terminal **610** of the short-range communication antenna **600** and the fourth connection terminal **350** of the connecting unit **300** is connected to a second connection terminal **620** of the short-range communication antenna **600**.

The connecting unit **300** may have the shape corresponding to the shape of the receiving space **130** and may be disposed in the receiving space **130**. Since the connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100**, the thickness of the wireless power receiver **1000** can be remarkably reduced as much as the thickness of the connecting unit **300**. Thus, the thickness of the electronic device, such as a portable terminal, equipped with the wireless power receiver **1000** can be remarkably reduced.

According to one embodiment, the connecting unit **300** may include a flexible printed circuit board (FPCB), a tape substrate (TS) or a lead frame (LF). If the tape substrate is used as the connecting unit **300**, the thickness of the connecting unit **300** can be reduced, so that the overall size of the wireless power receiver **1000** can be reduced.

If the lead frame is used as the connecting unit **300**, the wiring layer included in the connecting unit **300** can be protected from the heat, external moisture or impact and the mass production can be realized.

Referring again to FIG. 26, the short-range communication antenna **600** can make near field communication with a reader. The short-range communication antenna **600** may serve as an antenna that transceives information in cooperation with the reader.

According to one embodiment, the NFC signal processing unit (not shown) can process the signal transferred to the short-range communication antenna **600** through the connecting unit **300**.

Various short-range communication technologies can be applied to the short-range communication antenna **600** and the NFC technology is preferable.

According to one embodiment, the short-range communication antenna **600** may be arranged at an outer peripheral portion of the coil unit **200**. Referring to FIG. 27, when the coil unit **200** is disposed at the magnetic substrate **100**, the short-range communication antenna **600** may be arranged along the outer peripheral portion of the magnetic substrate **100** to surround the coil unit **200**. The short-range communication antenna **600** may have a rectangular configuration by winding one conductive line several times, but the embodiment is not limited thereto.

Referring again to FIG. 26, the adhesive layer (not shown) may be disposed under the protective film **800** to form the protective film **800** on the coil unit **200** and the short-range communication antenna **600**, which will be described later in detail.

The first dual-side adhesive layer **710** is interposed between the magnetic substrate **100** and the coil unit **200**/short-range communication antenna **600** to adhere the coil unit **200** to the magnetic substrate **100**, which will be described later in detail. Similar to the magnetic substrate **100**, a receiving space having the shape identical to the shape of the connecting unit **300** may be formed in the first dual-side adhesive layer **710**.

Referring again to FIG. 28, the second dual-side adhesive layer **720** adheres the protective film **800** to the release paper layer **730**, which will be described later in detail.

The coil unit **200** may be disposed on the magnetic substrate **100** and may have a spiral structure, but the embodiment is not limited thereto.

Hereinafter, the method of manufacturing the wireless power receiver **1000** according to still another embodiment will be described with reference to FIGS. 29 to 37.

When the manufacturing process starts, as shown in FIG. 29, the conductor **201**, the adhesive layer **700** and the protective film **800** are prepared.

According to one embodiment, the conductor **201** may be formed by using an alloy including copper. The copper is in the form of roll annealed copper or electrodeposited copper. The conductor **201** may have various thicknesses depending on the specification of a product. According to one embodiment, the conductor **201** may have the thickness of 100μm, but the embodiment is not limited thereto.

The adhesive layer **700** is used to reinforce the adhesive strength between the conductor **201** and the protective film **800**. The adhesive layer **700** may include thermosetting resin, but the embodiment is not limited thereto. The adhesive layer may have the thickness of 17μm, but the embodiment is not limited thereto.

The protective film **800** protects the conductor **201** when a predetermined conductive pattern is formed in the conductor **201**. In detail, the protective film **800** supports the conductor **201** in the etching process, which will be described later, to protect the conductor **201** such that the predetermined conductive pattern can be formed in the conductor **201**.

According to one embodiment, the protective film **800** may include polyimide film (PI film), but the embodiment is not limited thereto.

Then, as shown in FIG. 30, the conductor **201** is formed on the protective film **800** by the adhesive layer **700**. The laminating process can be used to form the conductor **201** on the

protective film **800**. The laminating process refers to the process to bond heterogeneous materials with each other by applying predetermined heat and pressure.

Then, as shown in FIG. 31, a photoresist film **900** is attached onto the top surface of the conductor **201**. The photoresist film **900** is used for etching the conductor **201** to form a predetermined conductive pattern in the conductor **201**. A UV exposure type film or an LDI exposure type film may be used as the photoresist film **900**. According to another embodiment, a photoresist coating solution can be coated on the top surface of the conductor **201** without using the photoresist film **900**.

After that, as shown in FIG. 32, the photoresist film **900** is subject to the exposure and development processes to form a mask pattern **910**.

The mask pattern **910** may be formed on the top surface of the conductor **201** corresponding to the position of the conductive pattern.

The exposure process refers to the process for selectively irradiating light onto the photoresist film **900** corresponding to the conductive pattern. In detail, in the exposure process, the light is irradiated onto regions of the conductor **201** where the conductive pattern is not formed. The development process refers to the process for removing the regions to which the light is irradiated through the exposure process.

Due to the exposure and development processes, the mask pattern **910** may be formed in the regions corresponding to the coil unit **200** and the short-range communication antenna **600**. The conductor **201** exposed through the mask pattern **910** may be etched.

Then, as shown in FIG. 33, a predetermined portion of the conductor **201** where the mask pattern **910** is not formed may be removed through the etching process. The etching process refers to the process of removing the predetermined portion of the conductor **201** where the mask pattern **910** is not formed by using a chemical reacting with the predetermined portion of the conductor **201**. According to one embodiment, the conductor **201** may be patterned through the wet etching or dry etching.

After that, as shown in FIG. 34, the mask pattern **910** is removed so that the first and second connection terminals **210** and **220** of the coil unit **200**, the first and second connection terminals **610** and **620** of the short-range communication antenna **600**, the coil **230** having a

predetermined conductive pattern and the short-range communication antenna **600** having a predetermined conductive pattern may be formed.

Then, as shown in FIG. 35, the soldering process is performed to connect the coil unit **200** and the short-range communication antenna **600** to the connecting unit **300**. According to one embodiment, the soldering process includes the reflow process, but the embodiment is not limited thereto. The reflow process refers to the process for bonding the coil unit **230** and the short-range communication antenna **600** with the connecting unit **300** by melting solder cream using high-temperature heat to ensure the stable electrical connection between the connecting unit **300** and the coil unit **230**/NFC antenna **600**.

The first connection terminal **310** of the connecting unit **300** may be connected to the first connection terminal **210** of the coil unit **200** by a solder **30**, the second connection terminal **320** of the connecting unit **300** may be connected to the second connection terminal **220** of the coil unit **200** by the solder **30**, the third connection terminal **340** of the connecting unit **300** may be connected to the first connection terminal **610** of the short-range communication antenna **600** by the solder **30** and the fourth connection terminal **350** of the connecting unit **300** may be connected to the second connection terminal **620** of the short-range communication antenna **600**.

Then, as shown in FIG. 36, the magnetic substrate **100** is laminated on a predetermined portion of the conductive pattern where the connecting unit **300** is not present. In detail, the magnetic substrate **100** may be laminated on the top surfaces of the coil **230** and the short-range communication antenna **600**.

Prior to the above, the receiving space corresponding to the connecting unit **300** can be formed at the magnetic substrate **100**. The receiving space of the magnetic substrate **100** may have the shape identical to the shape of the connecting unit **300**.

As described above with reference to FIG. 26, since the connecting unit **300** is disposed in the receiving space **130** of the magnetic substrate **100**, the thickness of the wireless power receiver **1000** can be remarkably reduced as much as the thickness of the connecting unit **300**. Thus, the thickness of the electronic device, such as a portable terminal, equipped with the wireless power receiver **1000** can be remarkably reduced.

The coil **230**/short-range communication antenna **600** and the magnetic substrate **100** may be adhered with each other by the first dual-side adhesive layer **710**. According to one

embodiment, the magnetic substrate **100** may have the thickness in the range of 100μm to 800μm, but the embodiment is not limited thereto. According to one embodiment, the first dual-side adhesive layer **710** may have the thickness in the range of 10μm to 50μm, but the embodiment is not limited thereto.

After that, as shown in FIG. 37, the release paper layer **730** is attached to one side of the protective film **800** by interposing the second dual-size adhesive layer **720** therebetween. The release paper layer **730** is a paper layer for protecting the second dual-size adhesive layer **720** and may be removed when the wireless power receiver is disposed in a case of an electronic device, such as a portable terminal.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

CLAIMS

What is claimed is:

1. A wireless power receiver comprising:

a magnetic substrate; and

a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

2. The wireless power receiver of claim 1, wherein the coil is formed as a conductive pattern on the magnetic substrate.

3. The wireless power receiver of claim 1, wherein the magnetic substrate has a receiving space of a predetermined shape formed therein corresponding to a shape of a connecting unit connected to a wireless power receiving circuit.

4. The wireless power receiver of claim 3, further comprising the connecting unit disposed in the receiving space and connected to the coil.

5. The wireless power receiver of claim 4, wherein the connecting unit comprises one of a flexible printed circuit board, a lead frame and a tape substrate.

6. The wireless power receiver of claim 1, further comprising a short-range communication antenna formed on the magnetic substrate to surround the coil.

7. The wireless power receiver of claim 6, wherein the short-range communication antenna comprises a near field communication (NFC) antenna.

8. The wireless power receiver of claim 6, wherein the magnetic substrate has a receiving space of a predetermined shape formed therein corresponding to a shape of a connecting unit connected to a wireless power receiving circuit.

9. The wireless power receiver of claim 8, further comprising the connecting unit disposed in the receiving space and connected to the coil and a near field communication signal process unit.

10. A wireless power receiver comprising:

a magnetic substrate; and

a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer at the magnetic substrate,

wherein a part of the coil is disposed inside the magnetic substrate.

11. The wireless power receiver of claim 10, wherein the coil is formed as a conductive pattern at the magnetic substrate.

12. The wireless power receiver of claim 10, wherein the magnetic substrate comprises a pattern groove for receiving a part of the coil and the part of the coil is disposed in the pattern groove.

13. The wireless power receiver of claim 10, wherein the coil has a thickness smaller than a thickness of the magnetic substrate and an upper portion of the coil is exposed out of the magnetic substrate.

14. A method of manufacturing a wireless power receiver for wirelessly receiving power, the method comprising:

forming a conductor on a protective film;

forming a conductive pattern by etching the conductor;

connecting a connecting unit to be connected to an external circuit to a connection terminal of the conductive pattern;

obtaining a magnetic substrate having a receiving space of a predetermined shape corresponding to the connecting unit; and

disposing the magnetic substrate on the conductive pattern while positioning the connecting unit in the receiving space.

15. The method of claim 14, wherein the forming of the conductive pattern comprises etching the conductor to form the conductive pattern corresponding to a coil for wirelessly receiving the power and a near field communication antenna for making communication with an outside.

16. The method of claim 15, which comprises positioning connection terminals of the coil and the near field communication antenna in the receiving space.

17. The method of claim 14, wherein the disposing of the magnetic substrate comprises forming the magnetic substrate on the conductive pattern using a dual-side adhesive layer.

18. The method of claim 14, further comprising forming a release paper layer on the protective film using a dual-side adhesive layer.

19. A terminal equipped therein with a wireless power receiver of claim 1.

20. A terminal equipped therein with a wireless power receiver of claim 10.

ABSTRACT

A wireless power receiver according to one embodiment includes a magnetic substrate and a coil configured to wirelessly receive power, wherein the coil is formed as a conductive layer on the magnetic substrate.

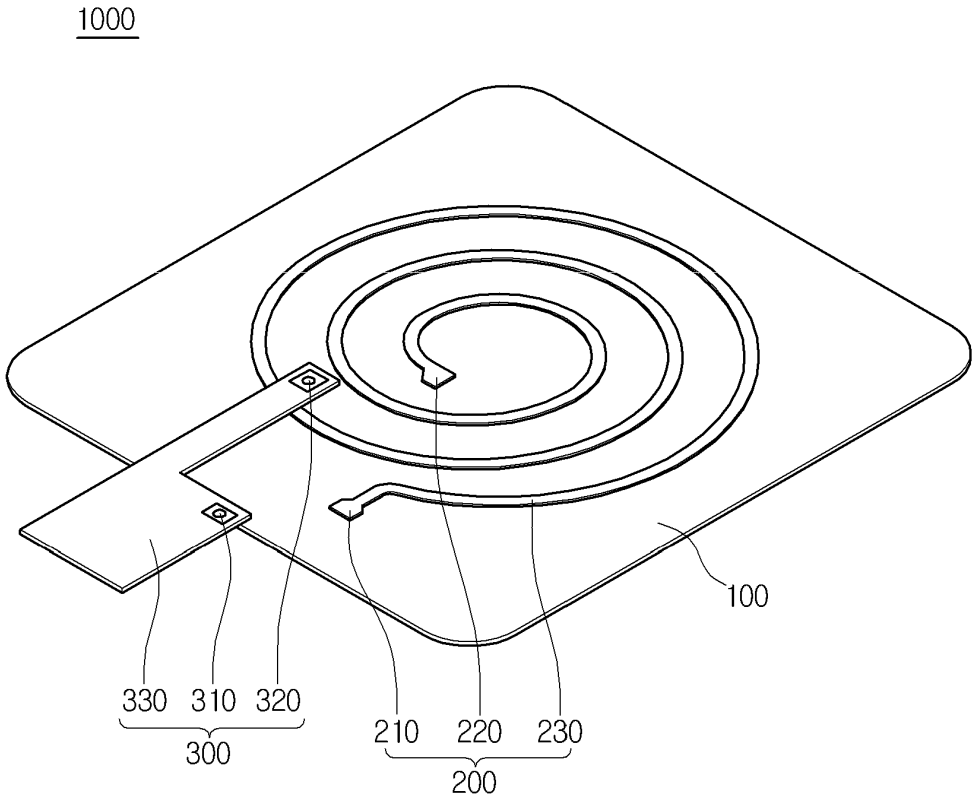

FIG. 1

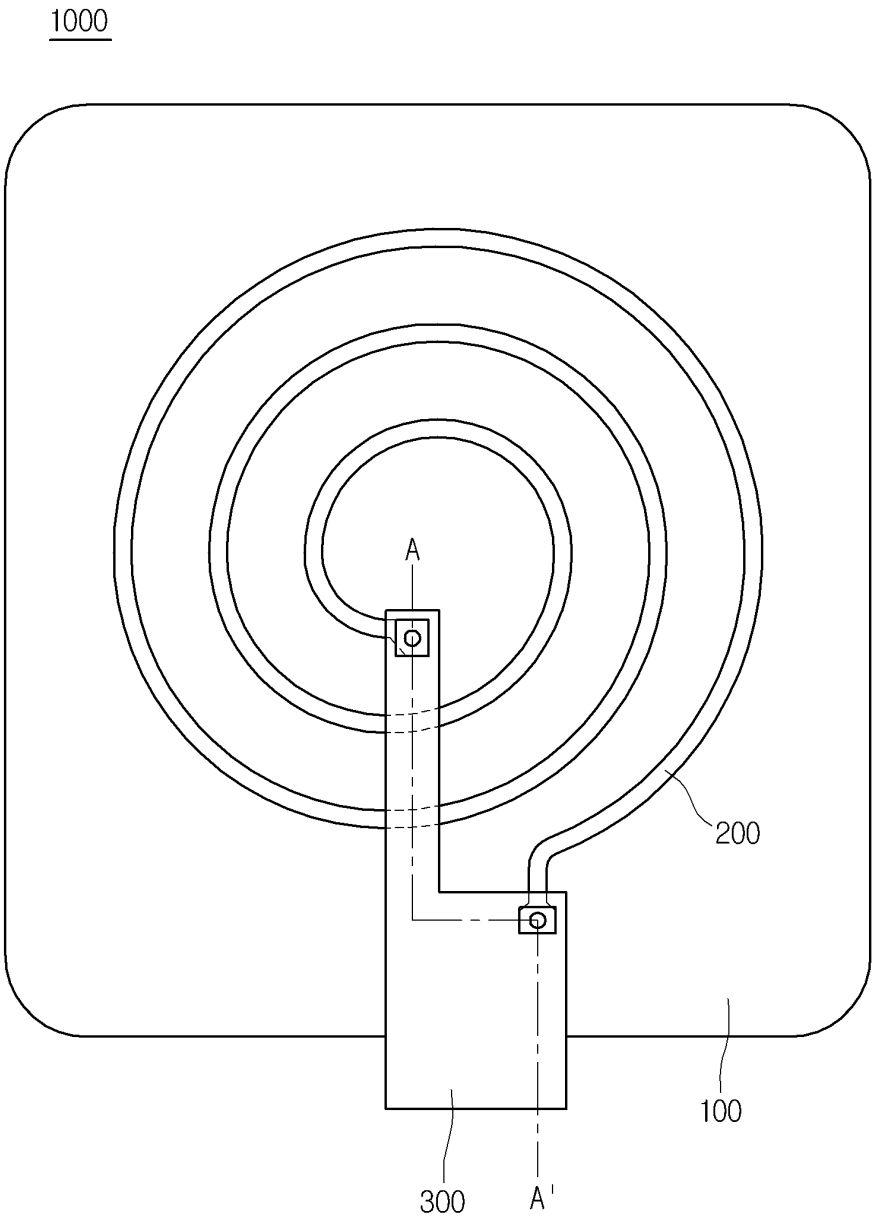

FIG. 2

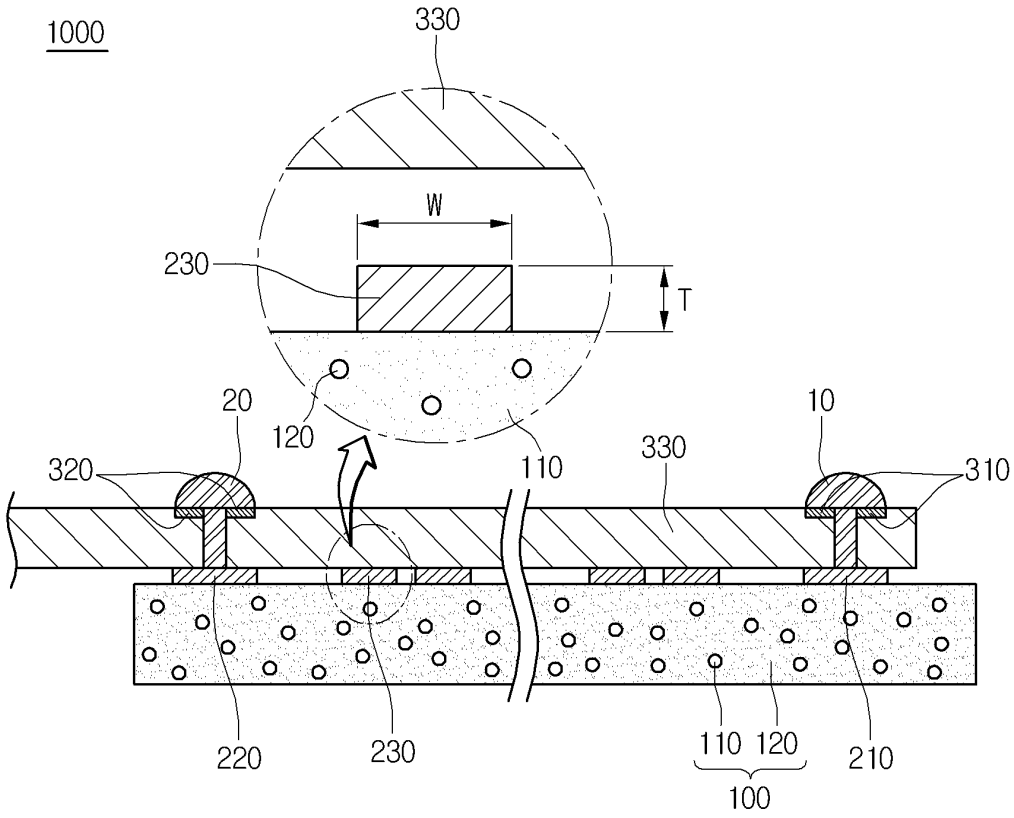
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FIG. 3

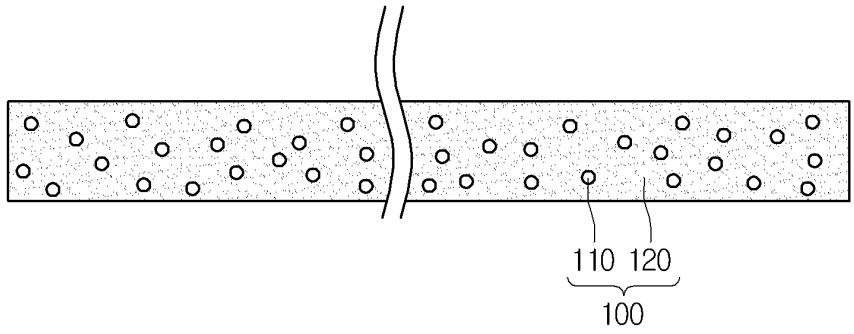
110 120
100

FIG. 4

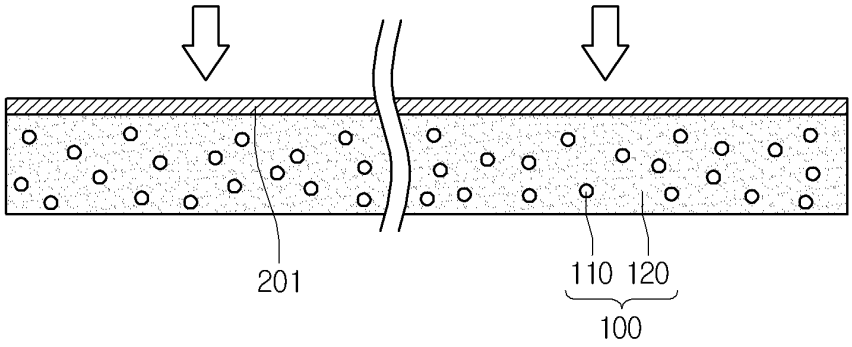

FIG. 5

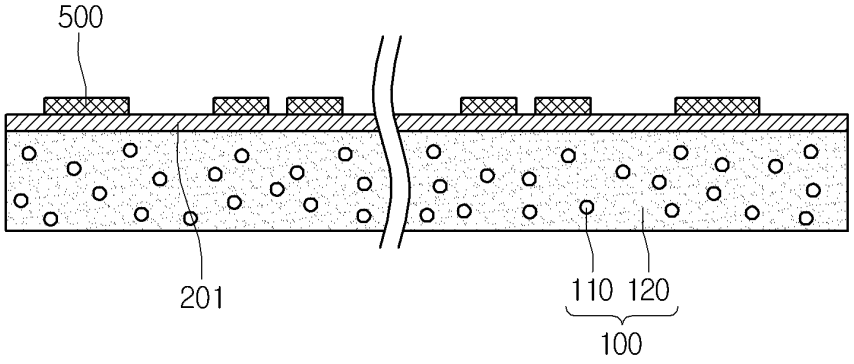

FIG. 6

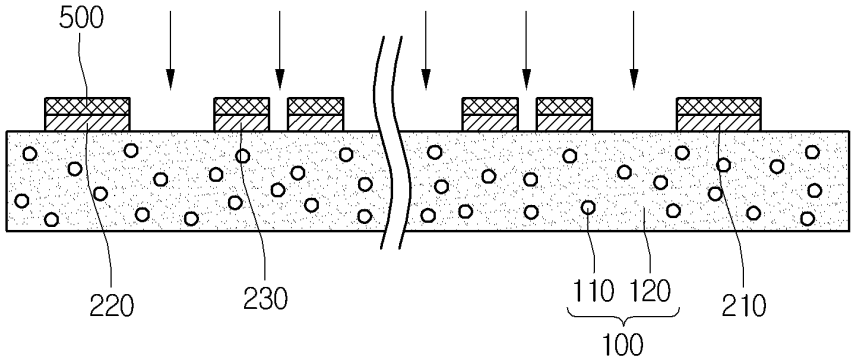

FIG. 7

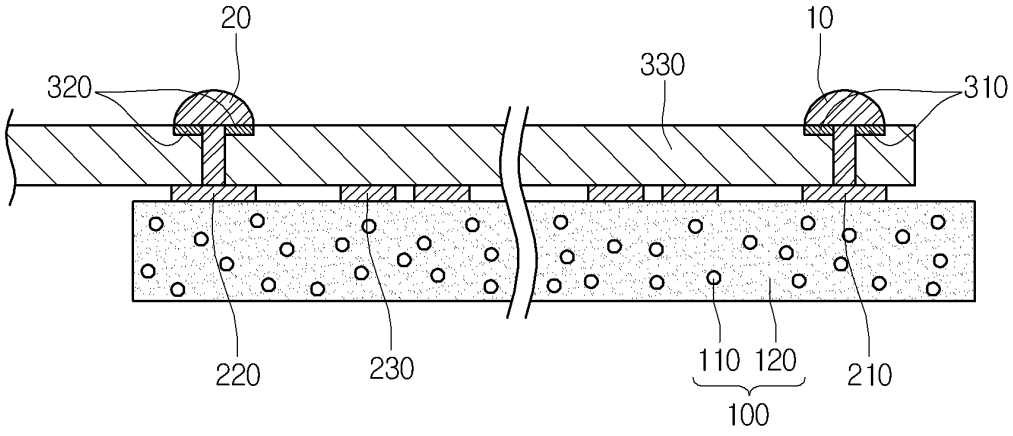
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FIG. 8

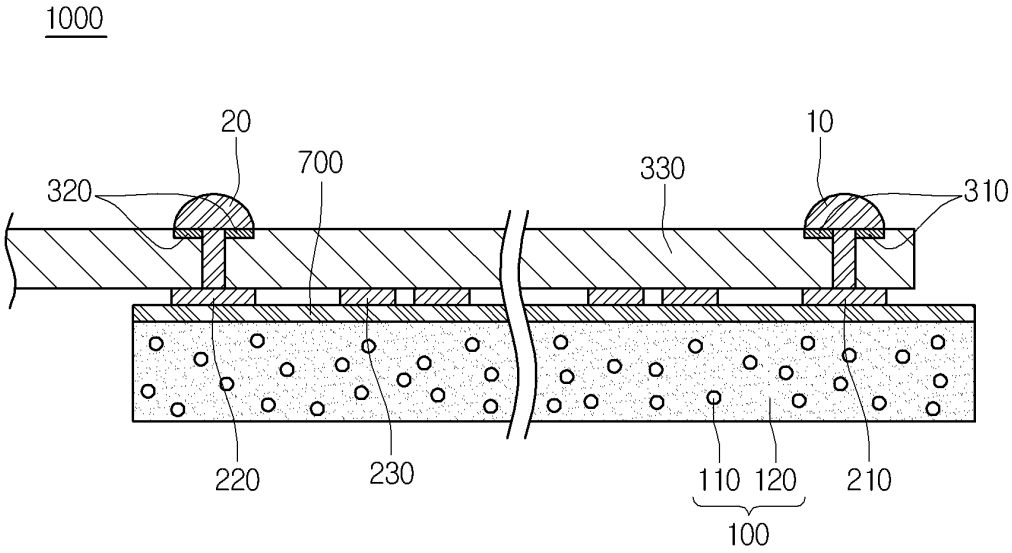
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FIG. 9

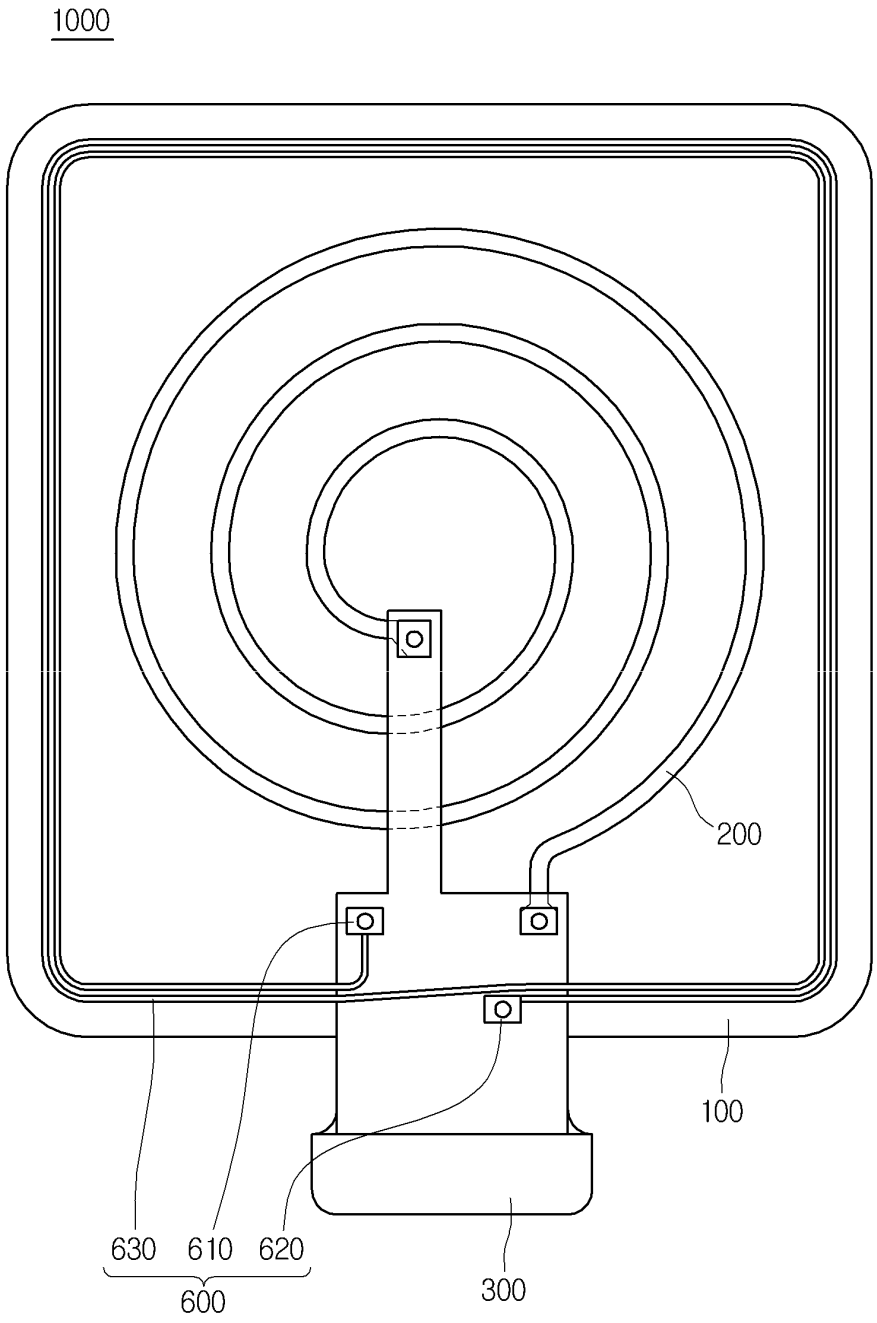


FIG. 10

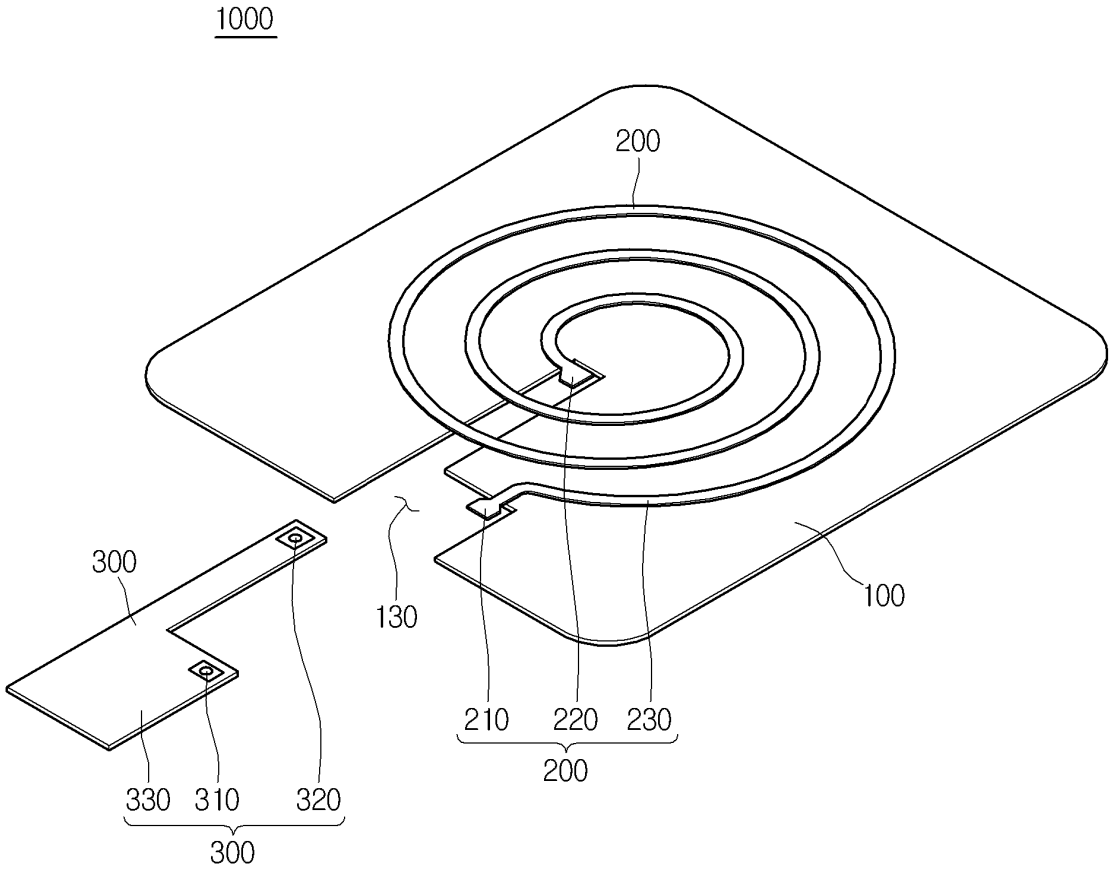


FIG. 11

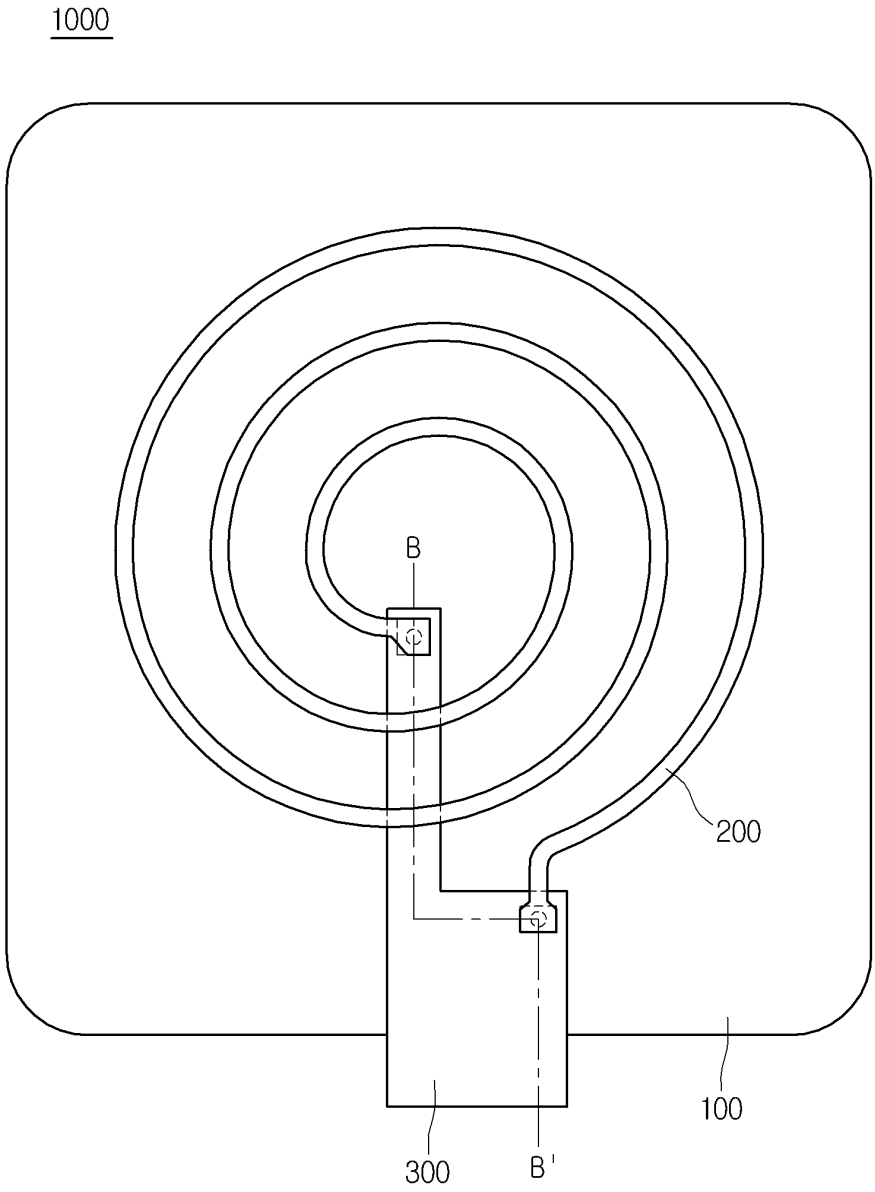
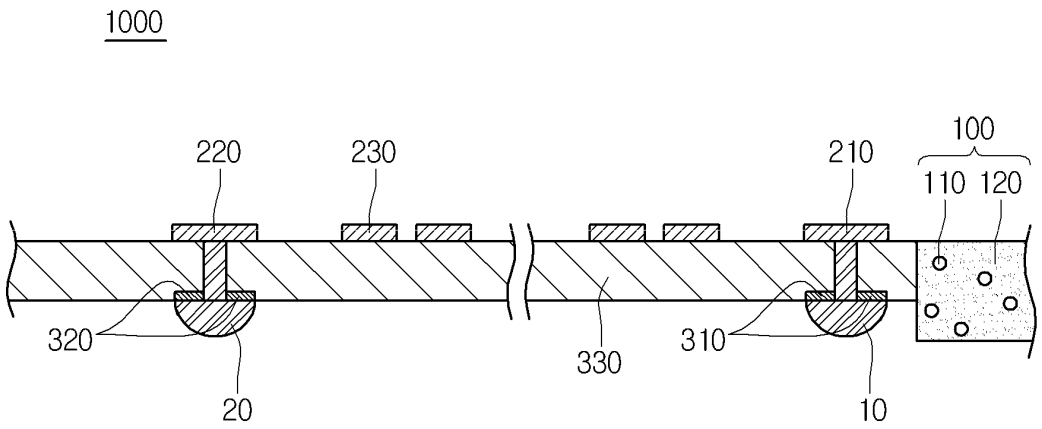


FIG. 12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10

FIG. 13

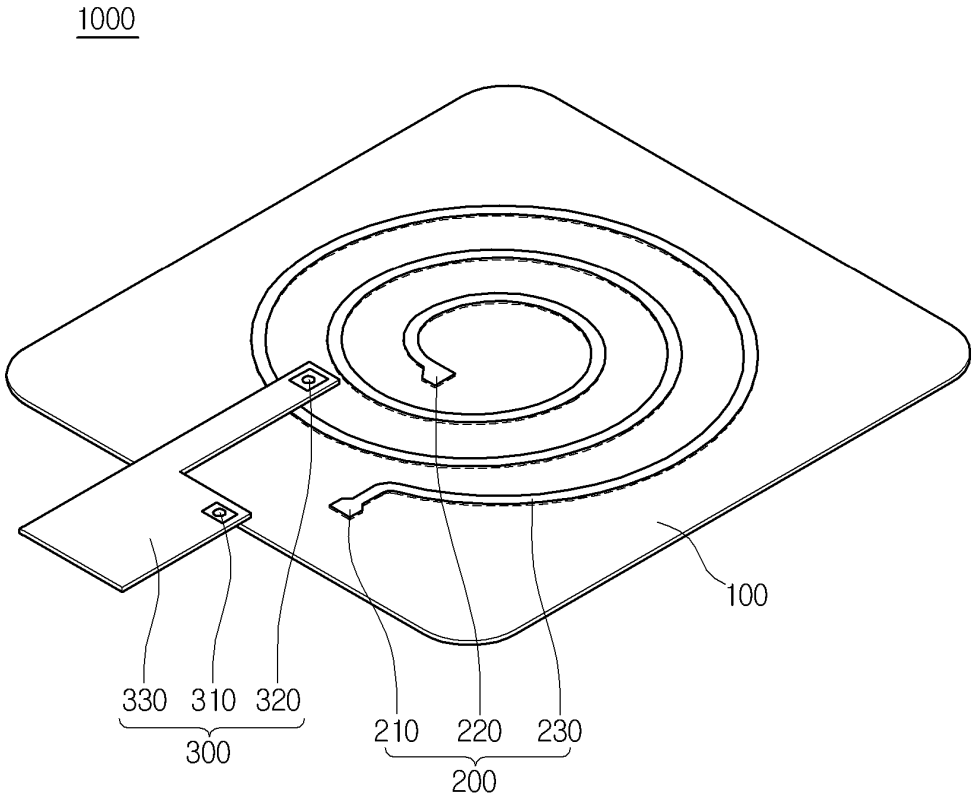
1000
100
330
310
320
300
210
220
230
200

FIG. 14

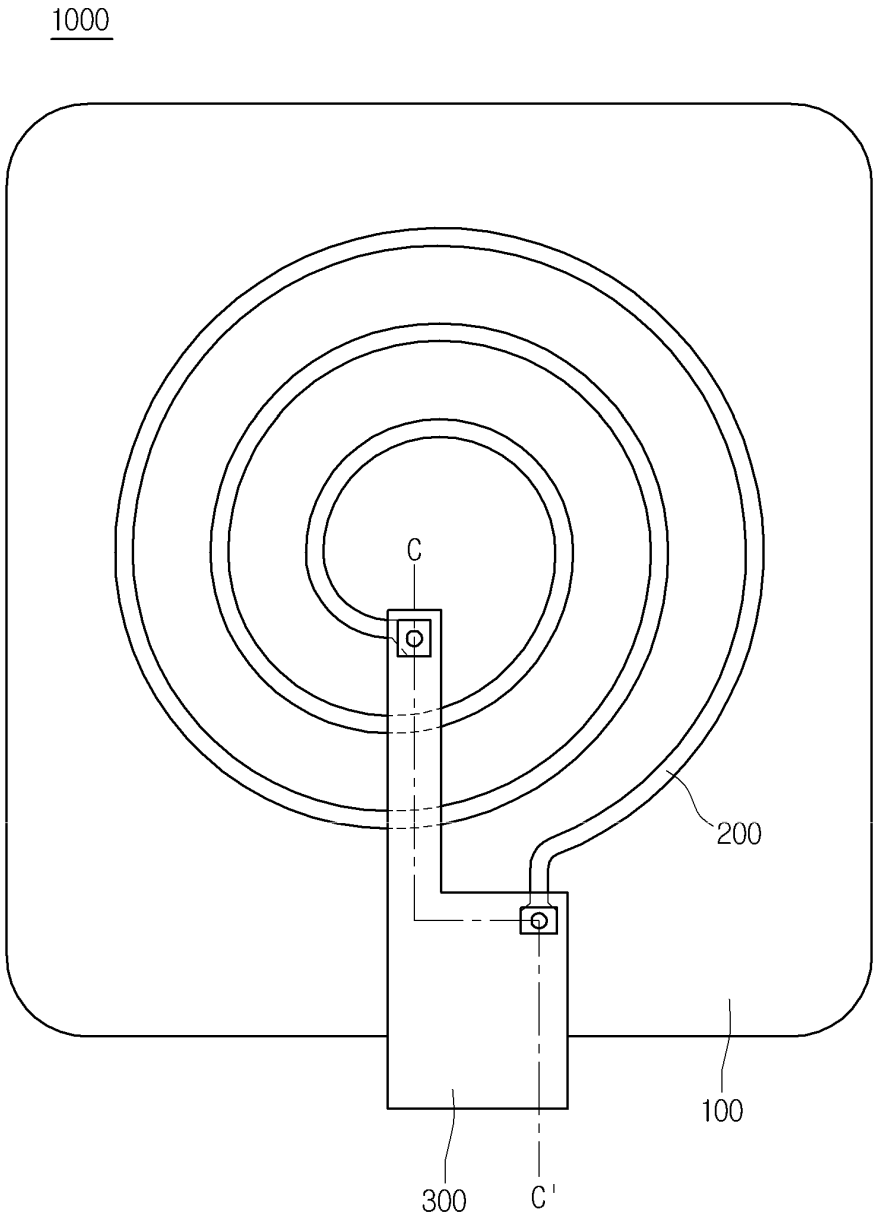

FIG. 15

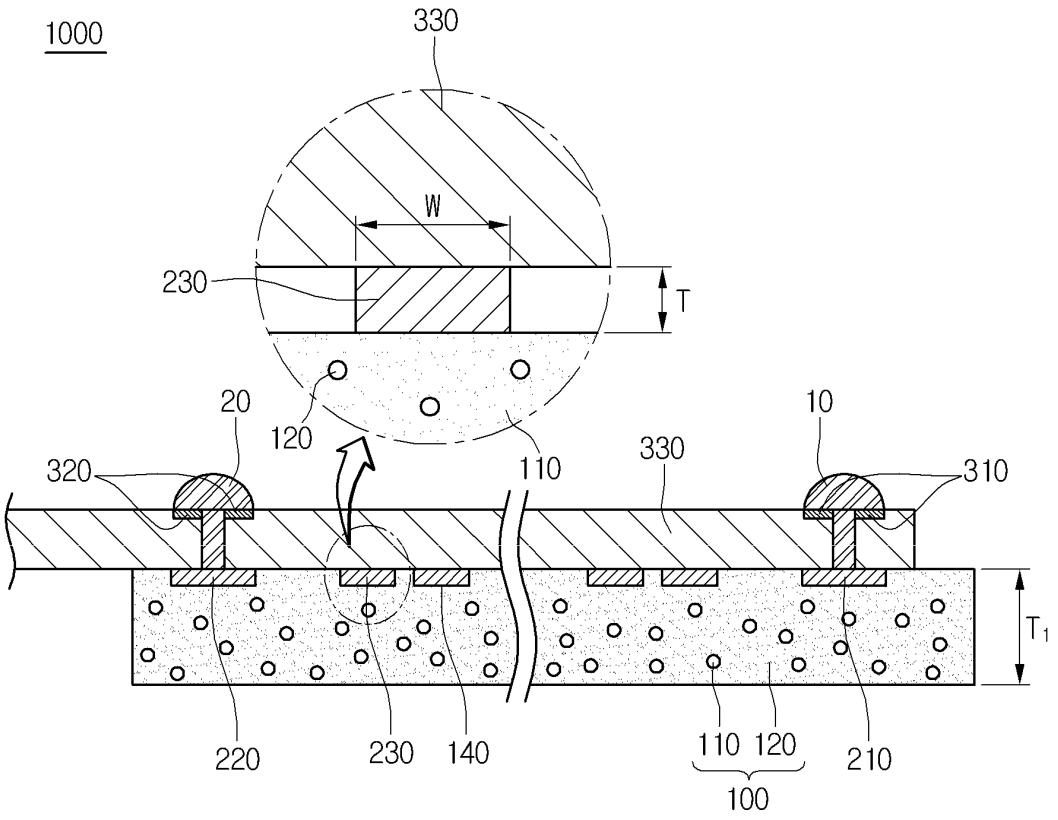
1000
330
W
230
T
20
120
10
320
110
330
310
T1
220
230
140
110 120
210
100

FIG. 16

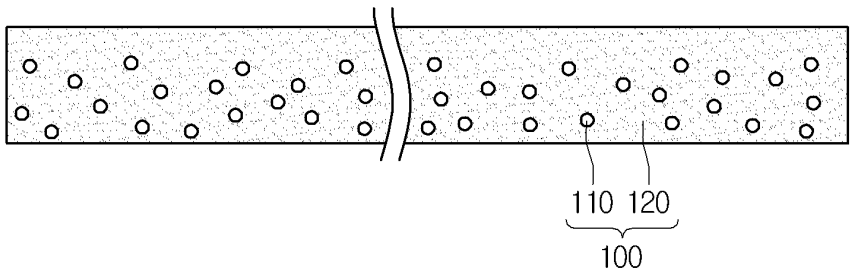
110 120
100

FIG. 17

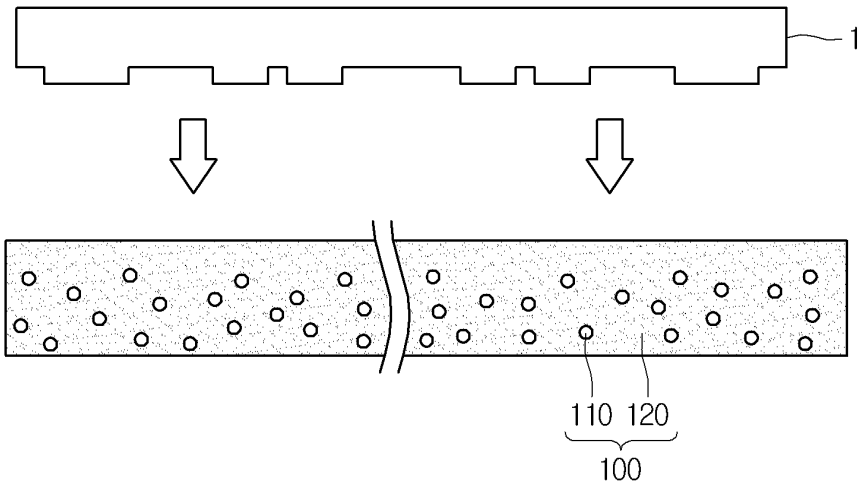

FIG. 18

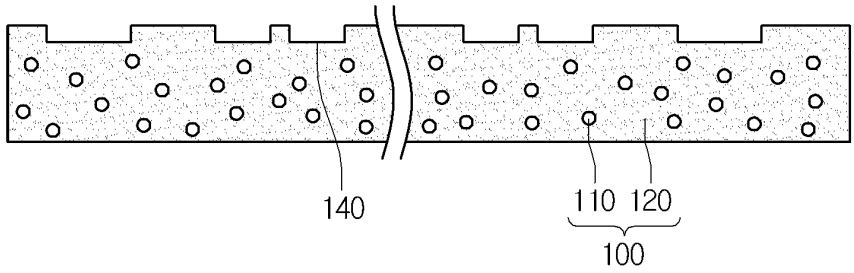

FIG. 19

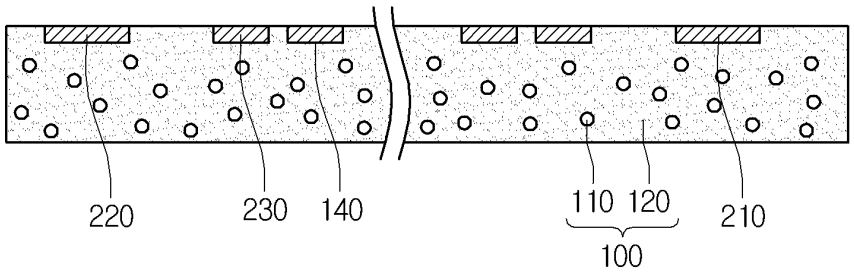
220
230
140
110
120
210
100

FIG. 20

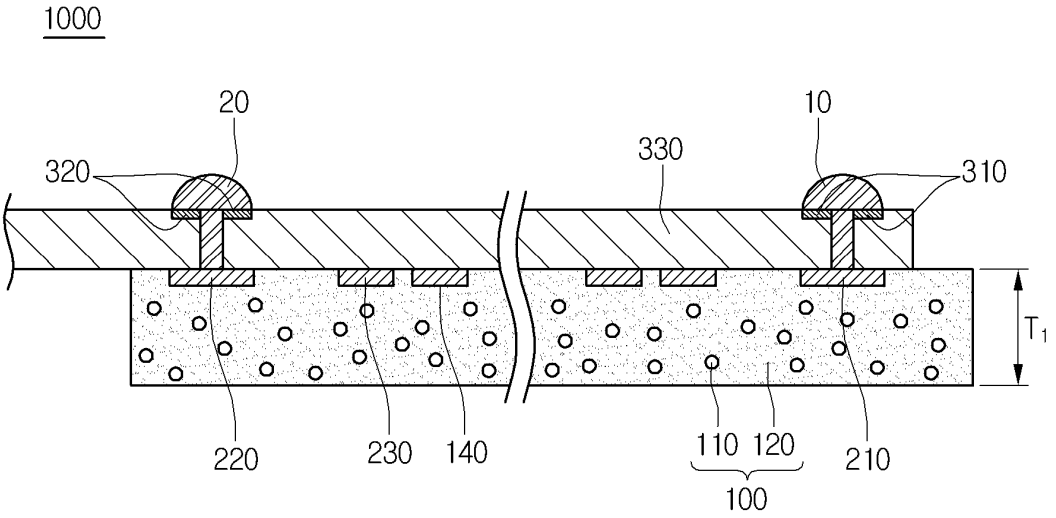
1000
20
10
320
330
310
T1
220
230
140
110
120
210
100

FIG. 21

Freq[kHz]	Inductance Setup1 : Sweep	Resistance Setup1 : Sweep	Q Setup1 : Sweep
130.000000	10023.448082	0.809633	10.012480
131.000000	10021.543951	0.814464	10.028048
132.000000	10019.649417	0.819320	10.043115
133.000000	10017.764376	0.824199	10.057691
134.000000	10015.888496	0.829101	10.071784
135.000000	10014.021426	0.834027	10.085405
136.000000	10012.163025	0.838976	10.098561
137.000000	10010.312867	0.843948	10.111262
138.000000	10008.470902	0.848942	10.123517
139.000000	10006.636764	0.853960	10.135333
140.000000	10004.810399	0.859000	10.146721
141.000000	10002.991358	0.864062	10.157687
142.000000	10001.179585	0.869147	10.168241
143.000000	9999.374809	0.874254	10.178391
144.000000	9997.577015	0.879383	10.188142
145.000000	9995.785687	0.884534	10.197506
146.000000	9994.000944	0.889706	10.206488
147.000000	9992.222542	0.894900	10.215097
148.000000	9990.450319	0.900116	10.223339
149.000000	9988.684063	0.905352	10.231223
150.000000	9986.923648	0.910610	10.238756
151.000000	9985.169040	0.915889	10.245944
152.000000	9983.419964	0.921189	10.252794
153.000000	9981.676290	0.926509	10.259313
154.000000	9979.937950	0.931850	10.265510
155.000000	9978.204783	0.937212	10.271388
156.000000	9976.476722	0.942594	10.276956
157.000000	9974.753596	0.947996	10.282220
158.000000	9973.035485	0.953418	10.287185
159.000000	9971.321833	0.958860	10.291859
160.000000	9969.613051	0.964321	10.296247

FIG. 22

Freq[kHz]	Inductance Setup1 : Sweep	Resistance Setup1 : Sweep	Q Setup1 : Sweep
130.000000	10375.469101	0.760491	11.053420
131.000000	10373.611592	0.764922	11.072242
132.000000	10371.760893	0.769376	11.090493
133.000000	10369.916781	0.773853	11.108182
134.000000	10368.078898	0.778351	11.125322
135.000000	10366.247102	0.782872	11.141920
136.000000	10364.421100	0.787415	11.157989
137.000000	10362.600644	0.791979	11.173537
138.000000	10360.785303	0.796565	11.188574
139.000000	10358.975165	0.801173	11.203109
140.000000	10357.169752	0.805802	11.217153
141.000000	10355.369156	0.810452	11.230713
142.000000	10353.572957	0.815124	11.243801
143.000000	10351.780892	0.819816	11.256422
144.000000	10349.993078	0.824529	11.268591
145.000000	10348.209063	0.829263	11.280309
146.000000	10346.428853	0.834018	11.291589
147.000000	10344.652133	0.838792	11.302441
148.000000	10342.878918	0.843587	11.312871
149.000000	10341.108850	0.848402	11.322886
150.000000	10339.342085	0.853237	11.332499
151.000000	10337.578231	0.858092	11.341712
152.000000	10335.817245	0.862967	11.350536
153.000000	10334.058946	0.867867	11.358980
154.000000	10332.303299	0.872774	11.367050
155.000000	10330.550019	0.877706	11.374754
156.000000	10328.799305	0.882658	11.382099
157.000000	10327.050748	0.887629	11.389091
158.000000	10325.304351	0.892618	11.395741
159.000000	10323.560143	0.897626	11.402053
160.000000	10321.817935	0.902653	11.408035

FIG. 23

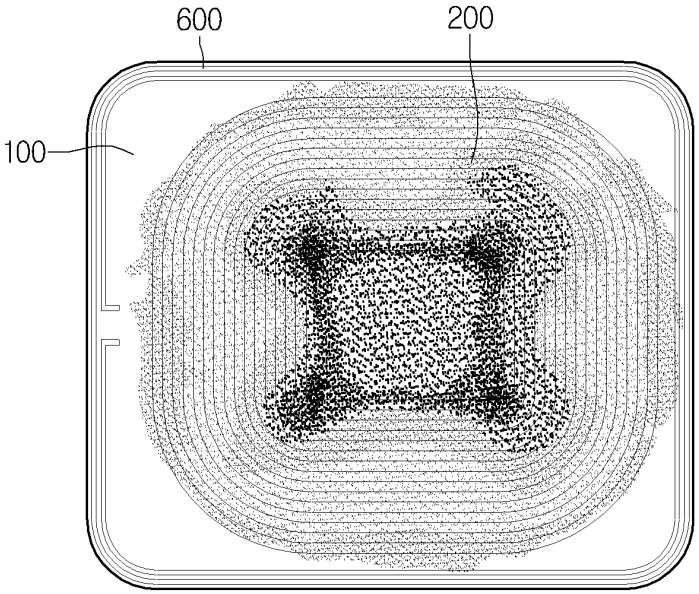

FIG. 24

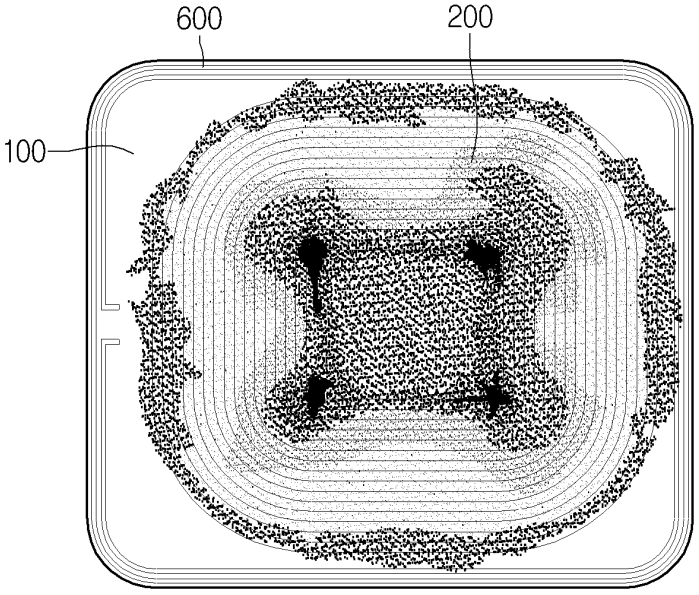

FIG. 25

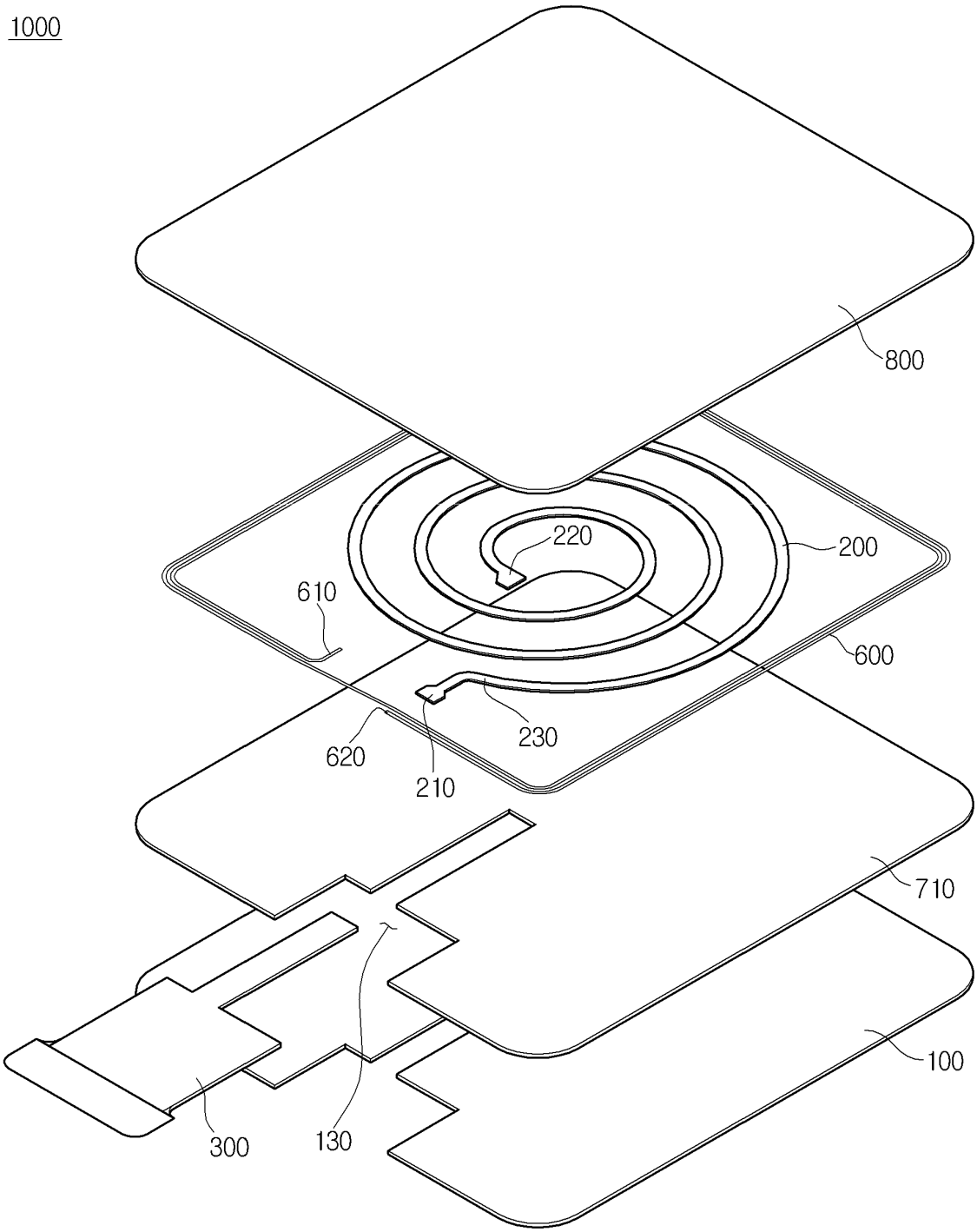

FIG. 26

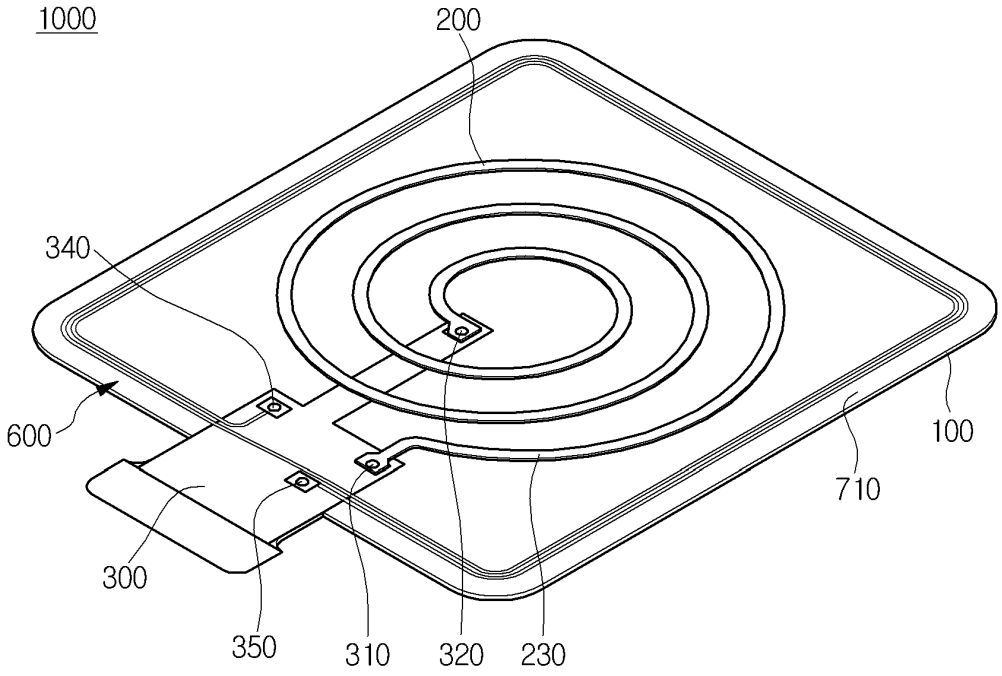
1000
200
340
600
100
710
300
350
310
320
230

FIG. 27

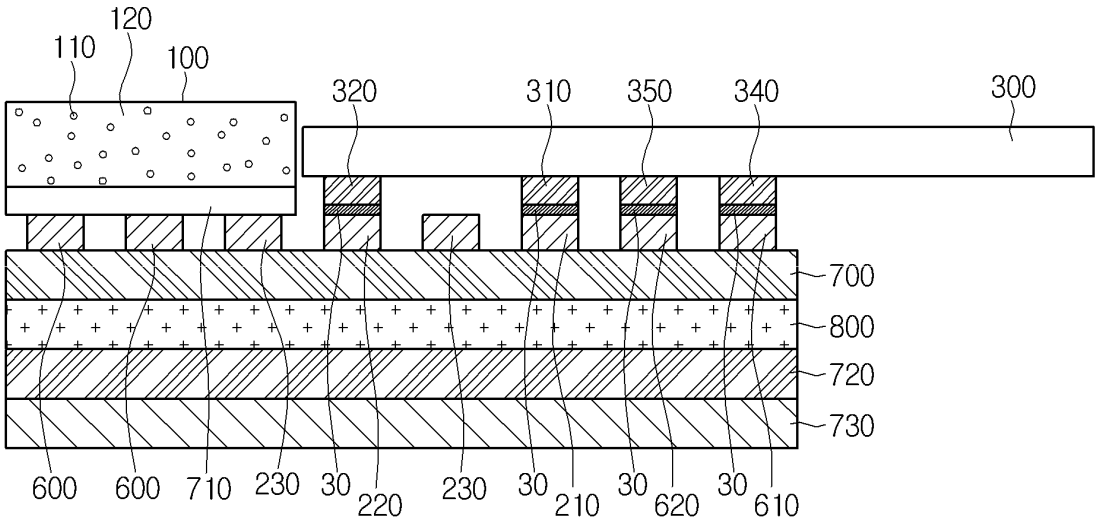
120
110
100
320
310
350
340
300
700
800
720
730
600
600
710
230
30
220
230
30
210
30
620
30
610

FIG. 28

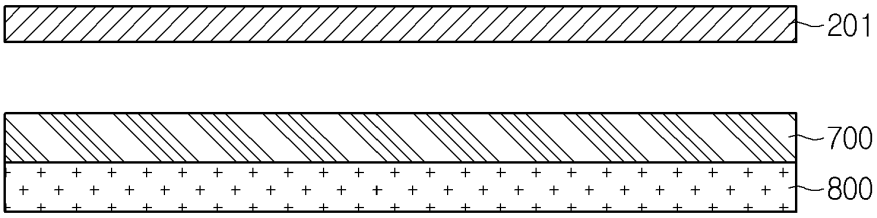

FIG. 29

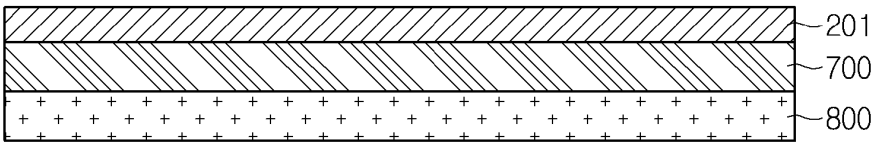

FIG. 30

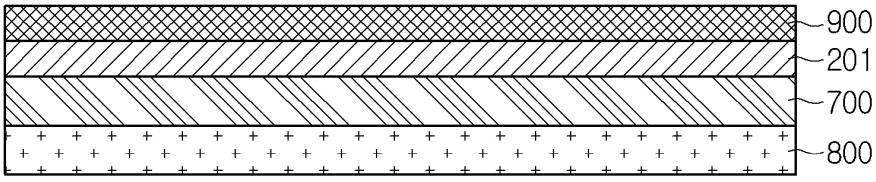

FIG. 31

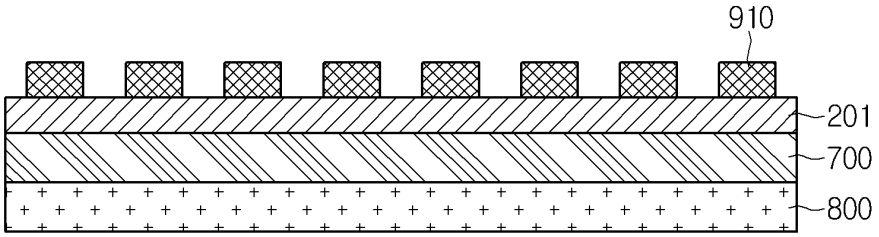

FIG. 32

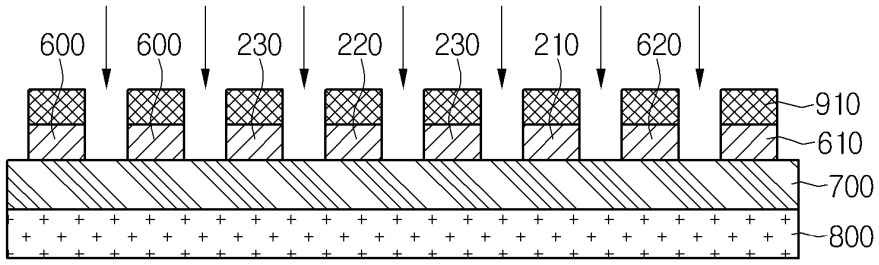

FIG. 33

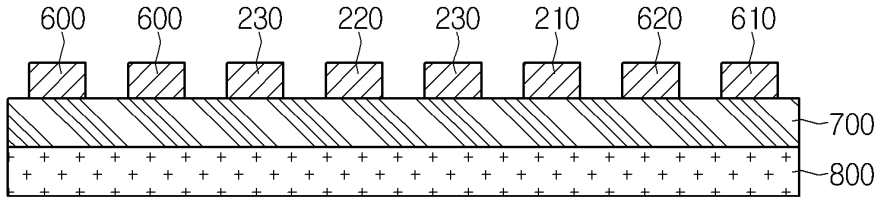

FIG. 34

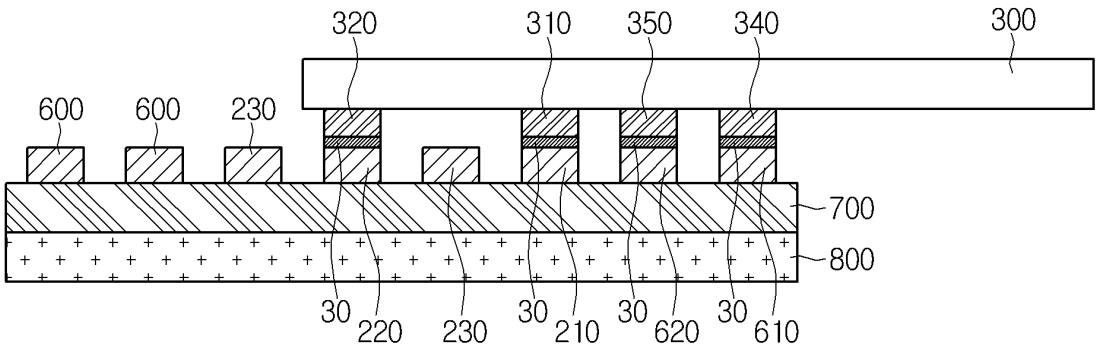
320
310
350
340
300
600
600
230
700
800
30
220
230
30
210
30
620
30
610

FIG. 35

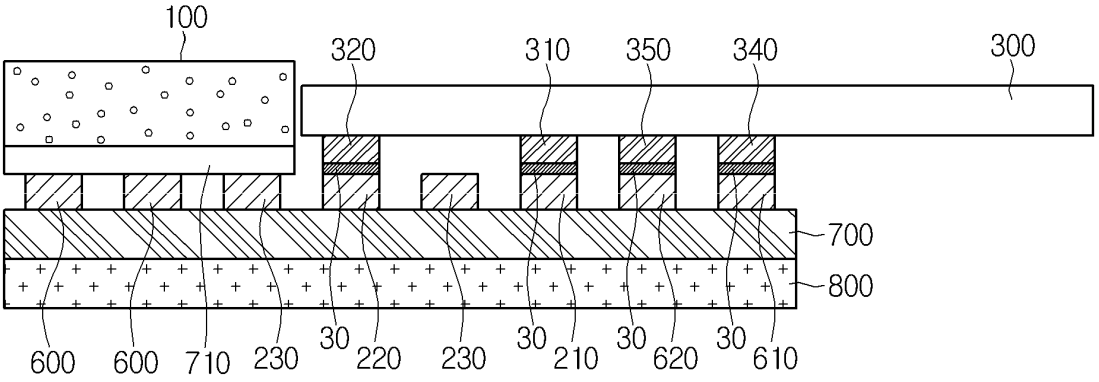
100
320
310
350
340
300
700
800
600
600
710
230
30
220
230
30
210
30
620
30
610

FIG. 36