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(54) **Title**: SURFACE INTEGRATED CIRCUIT FOR POWER TRANSMISSION AND METHOD OF MANUFACTURE

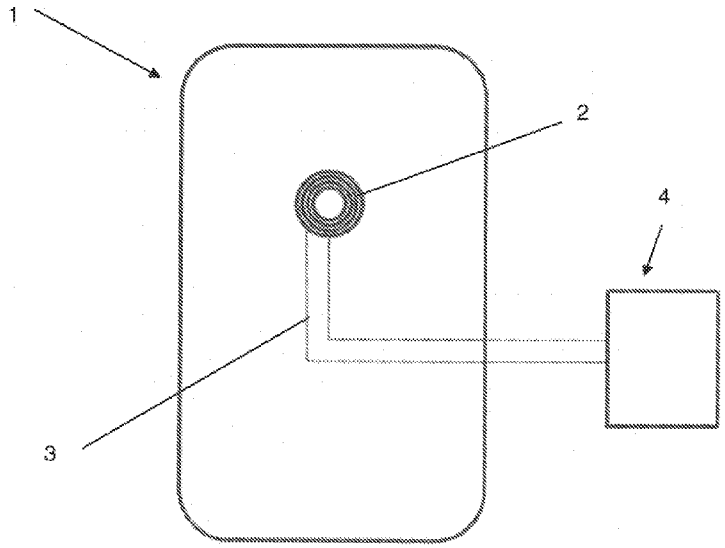

Figure 1

(57) **Abstract**: A trim component comprising a decorative layer and an electrical circuit path positioned on the B (i.e., back or hidden) surface of the decorative layer, the electrical circuit path comprising conductive ink/paint in a geometric configuration suitable for transmitting wireless power. The trim component can further comprise a protective layer positioned such that the electrical circuit path is at least partially enclosed between the decorative layer and the protective layer.

WO 2011/163544 A2

Surface Integrated Circuit for Power Transmission and Method of Manufacture

CLAIM OF PRIORITY

[001] This application claims priority to United States Application Serial Number 61/358,016 titled "WIRELESS POWER BY INTEGRATING THE TRANSMITTING CIRCUIT INTO THE SURFACE OF AN AUTOMOTIVE PART" filed June 24, 2010, the entire contents thereof are incorporated herein by reference.

Field of the Invention

[002] This invention relates to an electrical circuit integrated into a surface for power transmission, and more particularly to a circuit integrated into a trim component surface and methods of manufacturing the same.

Background of the Invention

[003] Many electronic devices such as mobile phones, navigation devices, mp3-players and other mobile audio devices, laptop computers, smart pads, and the like are used in automobiles and other transportation vehicles.

[004] Thus, there exists a need to electrically power these devices within a vehicle. Use of power cords can be inconvenient and charging multiple devices can require a dedicated outlet for each. Further, specific outlet configurations in vehicles require correspondingly configured vehicle chargers which add expense and consume space. Consequently, it can be advantageous to provide wireless power transmission capabilities within a vehicle. However, current wireless power transmission technology is inefficient and provision of wireless power in vehicles according to current technology can be expensive, and difficult to execute, amongst other drawbacks.

Summary

[005] It is therefore an objective of the present invention, to provide a trim component with an improved power transmission efficiency (i.e., for charging mobile electronics) by reducing the distance between the inductive coils providing power and the electronics receiving power.

[006] In some embodiments, the present invention provides a trim component of a vehicle comprising a decorative layer, a protective material layer, and an electrical circuit path positioned between the B (i.e., back or hidden) surface of the decorative layer and the A (i.e., front or show) surface of the protective layer. In some embodiments the electrical circuit path can comprise conductive ink/paint and the geometric configuration of the circuit path can be suitable for transmitting wireless power. Consequently, an electronic device can be powered directly during use and/or charged for later use.

[007] In some embodiments, the present invention provides a process for the manufacture of a vehicle interior trim component comprising the steps of: providing a decorative film layer; applying conductive material, for example in the form of ink, paint, or film, to the B surface of the decorative film layer to provide an electrical circuit path; and applying a protective layer over the conductive material.

Brief Description of the Drawings

[008] Fig. 1 illustrates a schematic view of a surface-integrated power transmission circuit according to some embodiments of the invention;

[009] Fig. 2 illustrates a schematic cross-sectional view of a surface-integrated circuit according to some embodiments of the invention;

[010] Fig. 3 illustrates a schematic cross-sectional view of a surface-integrated circuit according to other embodiments of the invention.

Detailed Description of the Drawings

[011] The description that follows presents various exemplary embodiments of the present invention. Although many aspects/features of this invention are described in the context of a vehicle interior, and in particular an interior trim component, it should be understood that other configurations/implementations are possible and can provide the same or similar advantages. Further, although the disclosed methods are described as a series of steps, the order and inclusion of all steps is not limited to those described. Accordingly, it should be understood that changes and modifications can be made to the disclosed embodiments without departing from the spirit of the invention.

[012] In some embodiments, the present invention relates to a vehicle interior trim component. This trim component can be located anywhere in the interior of a vehicle (i.e., automobile, boat, bus, train, etc.). The trim component can be, for example, part of a console, dash-board, door panel, instrument panel, or a compartment therein. In another embodiment, the surface-integrated circuit could be incorporated into the consumer electronic device.

[013] This trim component can include a decorative film layer made from a plastic or similar material, which can have a varying degree of flexibility depending on the requirements of the particular construction. Alternatively, the decorative film layer can comprise a layer of ink on a carrier film. In some embodiments, the carrier film can be removed after the trim component is formed. This decorative film layer can comprise an A (visible or show) surface, which is oriented towards the interior of the vehicle. On the opposite side, the B (back or unseen) surface of the decorative film layer, an electrical circuit path can be provided. This electrical circuit path can be connected to the decorative film layer by material engagement; i.e. the electrical circuit path can be in direct contact with the decorative film layer and chemically and/or physically bound to the decorative layer. Depending on the particular embodiment, the circuit can be applied with/without glue or other adhesive between the electrical circuit path and the decorative film layer.

[014] According to the present invention, the electrical circuit path can comprise a conductive material in various forms, for example ink, paint, and/or film. The conductive material can comprise an electrically conducting component, for example silver, copper and/or PEDOT, preferably a binder and/or a solvent, which can be an organic solvent and/or a water-based solvent. The conductive material can be in the form of ink, paint, etched copper, foil, and/or metalized film, among others. In some embodiments, the circuit material comprises adjacent layers of conductive and isolating materials. In some embodiments, the specific electrical resistance of the electrical circuit path can be $< 10^{-1}$ ohms/cm. The thickness of the electrical circuit layer can be < 50 μm, or < 30 μm. In some embodiments, the electrical circuit material (ink, paint, and/or film, or layers thereof) can be thermally stable such that a protective layer can be molded to the back surface of the decorative film layer without interfering with the electrically conductive/inductive characteristics of the circuit material.

[015] In some embodiments, the conductive material, especially if comprising ink or paint, can be printed, sprayed, molded, and/or screen-printed on the decorative film layer. The conductive material can alternatively be deposited in a powder form (e.g. copper, silver, or other powder) by vapor deposition or other means. Alternatively, the electrically conductive material can be adhered by glue or an adhesive to the surface of a decorative film or ink on carrier film/material. When the conductive material has dried/cured, a material engagement exists between the conductive material and the back surface of the decorative layer. Various electrical components which comprise part of the circuitry can similarly be applied to the back side of the decorative film/ink layer by one of these or other methods known in the art. In some embodiments, the remainder of the component can be adhered to or formed (e.g., molded) adjacent to the B side of the film comprising the electrical circuit.

[016] In some embodiments, the electrical circuit can be suitable for transmitting wireless signals which can power or charge an electronic device. The electrical circuit can be especially suitable for providing inductive power.

Inductive power uses an electromagnetic field to transfer electrical energy from the electrical circuit to the electronic device to be powered and/or charged. The electrical energy can be stored in the electronic device (e.g., in one or more batteries) and/or used to power the device directly. In some embodiments, the electrical circuit comprises an inductive coil to create an alternating electromagnetic field. A second induction coil, provided in the electronic device, receives the power signal from the electromagnetic field and converts it back into electrical current to charge the battery of the electronic device and/or to power the device directly.

[017] In some embodiments, the trim component comprises a protective layer, which can be attached to the back surface of the decorative layer. This protective layer can be attached to the decorative layer, after the electrical circuit has been applied. The protective layer can be applied to protect the electrical circuit and in some embodiments the protective layer maintains the decorative layer in a certain shape and/or gives the decorative layer material strength. In some embodiments, the protective layer comprises a substantial portion of the mass and/or volume of the trim component. In other embodiments, the protective layer comprises a layer of material which physically/chemically separates at least a portion of the circuit on the B side of the decorative layer from a base trim material which comprises a substantial portion of the mass and/or volume of the trim component.

[018] The protective layer can be attached to the back surface of the decorative film layer by any method known to a person skilled in the art. In some embodiments, the protective layer can be molded behind the decorative film layer on its B side. In some embodiments, the decorative layer, provided with the electrical circuit, can be placed in a mold and the substrate material can be filled, for example (in liquid form) injected, into the mould cavity on the back surface of the decorative film layer. In other embodiments, a solid material can be heat and/or chemically treated to a moldable state and then manipulated and cooled in a desired shape adjacent the decorative layer to set the trim component in the desired form.

[019] In some embodiments, prior to applying a protective layer, the decorative layer can be pre-formed in a desired shape after the conductive ink/paint has been applied.

[020] In some embodiments of the present invention, the protective layer only partially covers the B surface of the decorative layer. For example, a projection of the decorative layer can be left uncovered. This uncovered projection can be used to connect the trim component to the vehicle electronics (i.e., a power source).

[021] In some embodiments, the trim component can comprise a shielding layer, for example in the decorative layer, to prevent RF/EMC-emissions.

[022] Another aspect of the present invention provides a process for the manufacture of an interior trim component, comprising the steps of: providing a decorative layer; applying conductive material to the back surface of the decorative film layer to form an electrical circuit path; and applying a protective layer on the back surface of the decorative film layer.

[023] Another embodiment of the process involves the same steps above except that the carrier film layer can be released or removed and the decorative and conductive inks can be transferred to or retained by the trim (protective) layer of the component.

[024] In another embodiment, the conductive material can be printed or deposited (e.g., ink-jet, vapor deposition, etc.) onto a protective layer before or after it is formed into the desired shape. Alternatively, the conductive material can be printed or deposited onto a protective layer which is then adhered to a trim component base material. The conductive and decorative material can be printed or deposited simultaneously, or consecutively.

[025] As noted above, in some embodiments, the electrical circuit layer can be comprised of successive layers of conductive and insulating material to increase the strength of the electromagnetic field created for the inductive transfer of power.

[026] Figure 1 shows a trim component 1 according to the present invention. This trim component comprises a coil 2, preferably a printed coil 2, which is connected via leads 3, preferably printed leads 3, with a power transmit circuit 4. An electronic device with a receiving coil (not depicted) can be, for example, placed on the trim component 1 and charged wirelessly.

[027] Figure 2 shows details of the trim component 1 according to figure 1. The trim component 1 comprises a carrier layer 5, a decorative layer 6, preferably a printed decorative layer 6, and a protective layer 7, preferably a molded layer 7. Preferably on the decorative layer 6, at least one, preferably a multitude of conductive coil layers is applied by, for example, printing and/or plating. Two conductive layers are preferably separated by an insulating layer, respectively, which is preferably also printed or plated. The successive coil- and insulating layers are marked with reference sign 8. The stack of layers is embedded in the protective layer 7, which is molded onto the decorative layer 6 after the coil- or insulating layers have been applied to the decorative layer.

[028] Figure 3 shows essentially the embodiment according to figure 2, whereas, in the present case, the carrier layer has been omitted and/or the stack of layers 2, 8 is embedded in the decorative layer 6.

List of reference signs:

1 trim component
2 coil, printed coil
3 coil leads, printed coil leads
4 power transmit circuit
5 carrier film, clear carrier film
6 decorative layer, printed decorative layer
7 protective layer, molded protective layer
8 successive layers of conductive and insulating coils, successive layers of conductive and insulating, printed or plated coils

Claims:

1. A trim component comprising:
a decorative layer having front and back surfaces; and
an electrical circuit positioned on the back surface of the decorative layer, the circuit being configured for wireless energy transfer.

2. The trim component according to claim 1, wherein the wireless energy transfer is accomplished through electromagnetic induction.

3. The trim component according to claim 1 or 2, further comprising a protective layer adjacent the back surface of the decorative layer such that the electrical circuit is positioned between the decorative and protective layers.

4. The trim component according to claim 3, wherein the protective layer provides a structural base of the trim component.

5. The trim component according to claim 1-3, wherein the decorative layer comprises one of ink, pigment, and paint on a carrier layer.

6. The trim component according to claim 2, wherein the electrical circuit comprises successive layers of conductive and insulative materials.

7. The trim component according to claim 3, wherein a portion of the electrical circuit is exposed through the protective layer.

8. The trim component according to any of the proceeding claims, wherein the electrical circuit comprises one of conductive ink, pigment, film, paint, powder, and/or foil.

9. A method for manufacturing a trim component, comprising the steps of:

providing one of a decorative layer having a back surface and a protective layer having a front surface;

applying a conductive material to one of the back surface of the decorative layer and the front surface of the protective layer in order to provide an electrical circuit path thereon; and

applying the other of a decorative layer and a protective layer to at least partially enclose the electrical circuit path.

10. The method according to claim 9, wherein the conductive material is applied by printing, spraying, and/or vapor deposition.

11. The method according to claim 9 or 10, wherein the electrical circuit path comprises one of conductive ink, pigment, film, paint, powder, and/or foil.

12. The method according to claim 9-11, wherein the electrical circuit path comprises successive layers of conductive and insulative material.

13. The method according to claim 9-12, wherein the protective layer is applied by molding behind the decorative layer.

14. The method according to claim 9-13, wherein the decorative layer is pre-formed into a desired shape, after the conductive ink/paint has been applied.

15. The method according to claim 9-13, wherein the decorative layer comprises one of ink, pigment, and paint deposited on a carrier layer by printing and/or spraying.

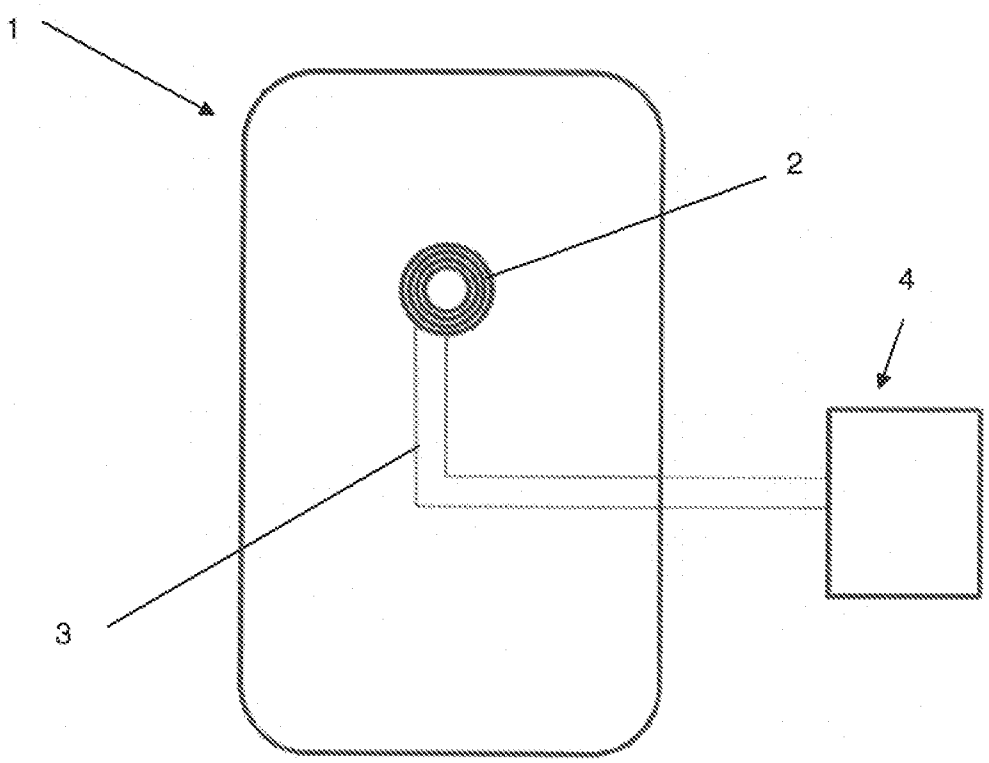

Figure 1

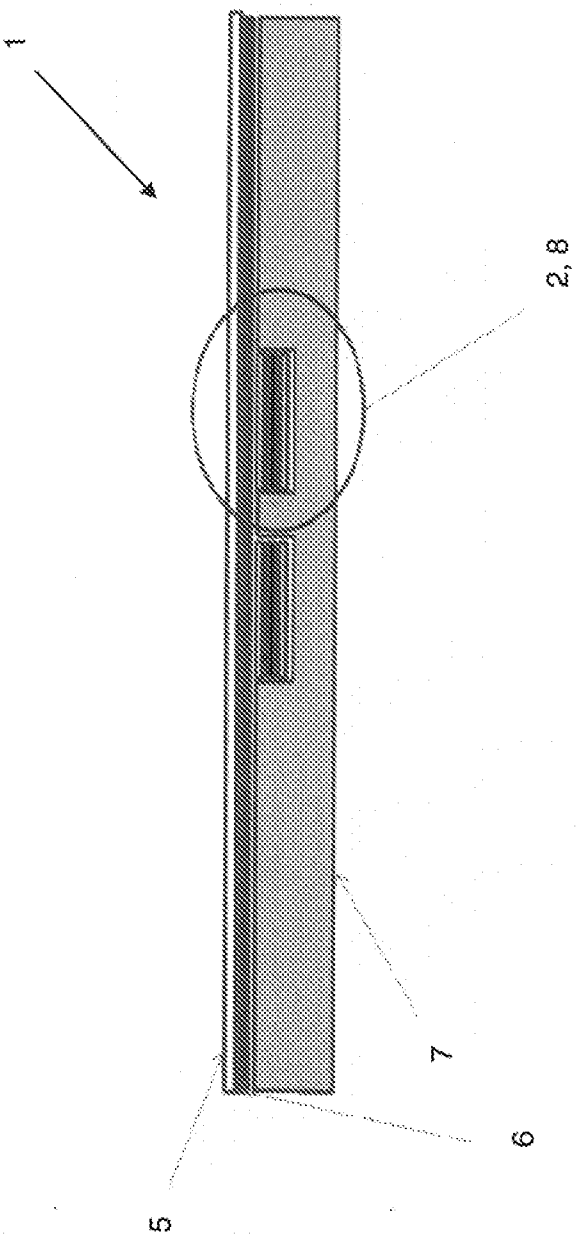

Figure 2

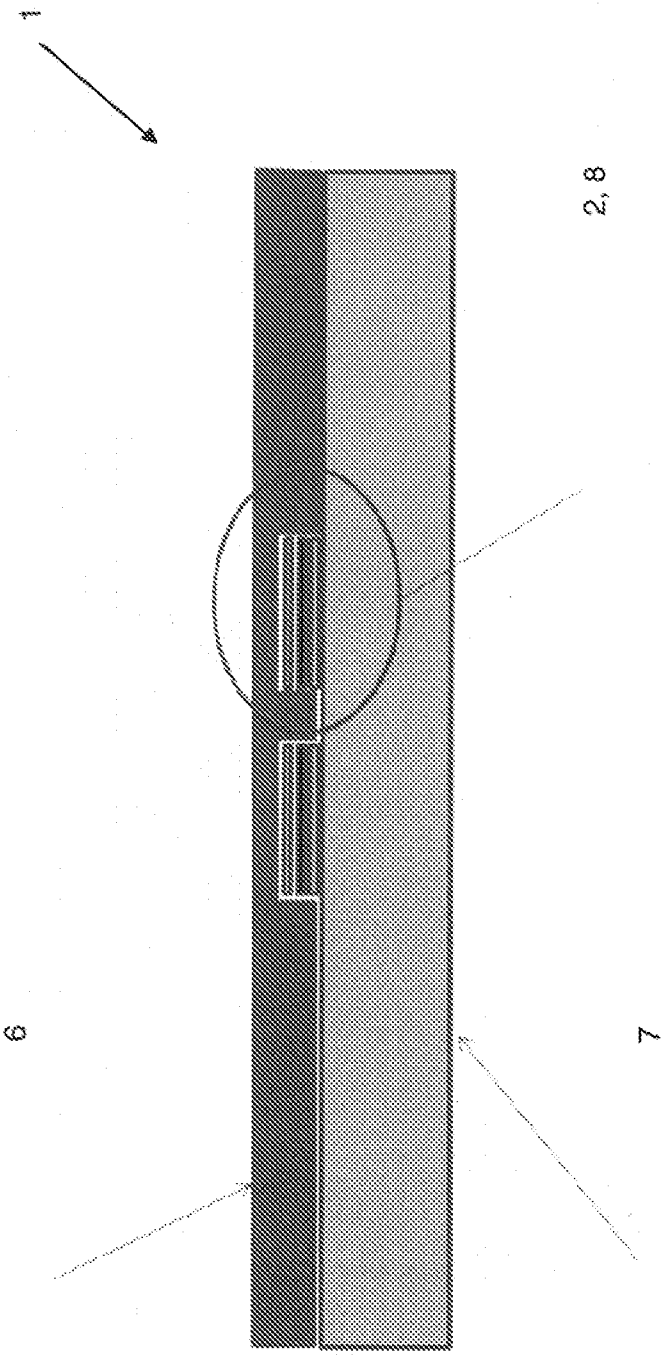

Figure 3