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(54) **SMART PACKAGING FOR BEVERAGE**

(57) The present invention is directed to a smart metal, glass, paper-based, wood-based, or plastic packaging (1, 2, 3, 4) for beverage comprising at least one sensory perceptible output, characterized in that a structural component of the packaging forms a component of the at least one sensory perceptible output.
in addition, the present invention is directed to a method

for manufacturing a smart packaging for a beverage is provided comprising the steps of manufacturing a packaging for a beverage and constituting at least one sensory perceptible output on or in the packaging, wherein a structural component of the packaging is taken for constituting a component of the at least one sensory perceptible output.

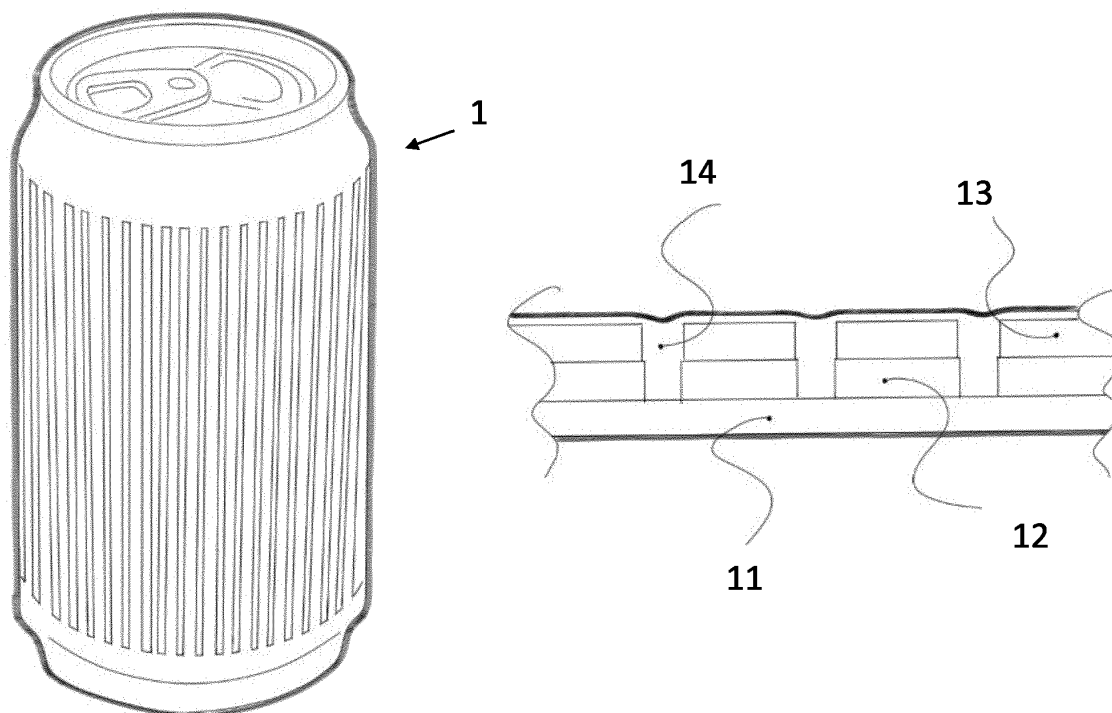


FIG 1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to smart packaging, in particular to integrated smart packaging for beverage, especially suitable for carbonated beverage, in particular beer-integrated smart packaging.

BACKGROUND OF THE INVENTION

[0002] In general, smart packaging incorporates features that indicate or communicate product status or changes, environmental status or changes, or other information. It is a dynamic and preferably active extension of the static and passive communication function of traditional packaging, and communicates information to the consumer based on its ability to sense, detect, or record external or internal changes in the product's environment.

[0003] State of the art smart packaging systems provide health and safety of the product for the consumer and also monitor the condition of packed beverages to give information about shelf life and regarding the quality of the beverage during transport and storage. In this technique indicators and sensors are used instead of time consuming, expensive quality measurements for improving the shelf life and providing beverage safety. In smart packaging system indicators give information about product quality by surrounding conditions and head space gases of packagings, also indicators can be attached to the packaging surface or integrate to packagings which are improved for determining metabolite residue formed during storage. Temperature, microbial spoilage, packaging integrity, physical shock, freshness of the packed product can be controlled.

[0004] An example thereof is US2015307245 directed to a wine capsule that is configured to be attached to a beverage container and to provide a user with information relating to the temperature history of the beverage. The data logger includes at least one energy storage component (e.g., one or more capacitors), an energy harvester, a temperature sensor, at least one processor, at least one first memory, and at least one wireless communicator. The energy harvester harvests ambient electromagnetic energy. The wireless communicator is configured to transmit the stored information to a personal computer, a smartphone or tablet, or a dedicated reader device which is configured to communicate with and receive information from the wireless communicator.

[0005] A obvious drawback of the system of US2015307245 is clearly that such wine capsule is not suitable for being combined with other types of beverage packaging than bottles. In addition, as soon as the wine capsule is removed from the bottle, the bottle itself becomes a normal "stupid" bottle.

[0006] A more important general drawback however is that, although the above system covers the basic needs

of beverage containment and quality control, it does not address the clear consumers' demand for packaging that is more advanced with respect to consumer interaction and creativity.

[0007] Thanks to the coming of inexpensive electronics and printing technology it recently became possible to create smart packaging that permit amongst others tracking of purchases, inventory control, automatic re-ordering, and assessment of tampering, packaging breeching etc. In addition, smart packaging containing lights, sound production, different types of sensors and corresponding sensory inputs, smart electronics, and interaction between humans, smart devices, vending machines, coupled with wireless communication, results in enhanced and personalized experience for the consumer. Also point of purchase personalized advertising, inducements, prizes, and a game-like environment can integrate at various psychological levels to positively reinforce brand loyalty and promote purchases.

[0008] In the above context, the smart packaging described in WO2015147995 contains electronics that can enable a user / purchaser to interact with the packaging and cause actions to happen either on the packaging itself or on a smart device like a smart phone or computer or a vending machine, or communicate or cause communication with a website where a data base might reside. For instance, a soda bottle or can or bag of chips can have the capability of being touched to a smart phone, having a code read, and the smart phone can take one or more actions based on the type of product within its proximity.

[0009] The smart packaging includes at least one battery and/or energy storage element and/or energy receiving element; an element configured to store information; an element configured to sense being touched; an element configured to display information and/or an element configured to generate light; an element configured to receive and/or transmit information; and circuitry electrically one or more elements of the packaging to one another.

[0010] An aspect that has been neglected in smart packaging as described in WO2015147995, is to integrate smart packaging technology within the existing reality of today including today's industrial packaging processing and their application, i.e. the aspect of integrating intelligent technologies up to the level of industrial processing of for example a beverage can, and the product specifications, and raw materials involved has been neglected. Smart packaging has always been described without efficient implementation of its manufacturing in industrial processing been taken in account.

[0011] In addition, WO2015147995 does not address the functionalities specifically associated and required with the content of said packaging, i.e. carbonated beverages, in particular beer. As an example, an underlying objective is to provide for a smart packaging which can communicate time and temperature history of the carbonated beverage such as beer to ensure optimum mat-

uration, proper aging, and to avoid misuse or mishandling. Another example of an underlying objective is to provide for a smart packaging which communicates the state of beverages within the packaging, either visually, either by illumination, either by sound, or haptic experiences, i.e. in case of carbonated beverages, such as beer, reaching ideal consumption temperature vs beverage type is communicated.

[0012] Further, smart packaging is a compelling proposition made increasingly relevant by the relentless and fast pace at which digital technologies integrate consumers' lives, and the proliferation of the Internet of Things (IoT). An extensive list of applications in this sense, enabled by the smart packaging in accordance with the present invention will be provided in below description.

[0013] Another very important objective of smart packaging according to the present invention is to reduce the production cost, even to the point where it will be cost-effective to put intelligent features and communication means on an inexpensive product, and in particular on disposable products.

SUMMARY OF THE INVENTION

[0014] The present invention is directed to a smart metal, glass, paper-based, wood-based, or plastic packaging for beverage comprising at least one sensory perceptible output, characterized in that a structural component of the packaging forms a component of the at least one sensory perceptible output.

[0015] in addition, the present invention is directed to a method for manufacturing a smart packaging for a beverage is provided comprising the steps of manufacturing a packaging for a beverage and constituting at least one sensory perceptible output on or in the packaging, wherein a structural component of the packaging is taken for constituting a component of the at least one sensory perceptible output.

SHORT DESCRIPTION OF THE DRAWINGS:

[0016]

FIG 1 illustrates an embodiment of a smart metal beverage can including a visual output in accordance with the present invention. Details are outlined in example 1.

FIG 2 illustrated an embodiment of a smart glass or plastic bottle including a visual output in accordance with the present invention. Details are outlined in example 2.

FIG 3 illustrates an embodiment of a smart metal beverage can including a haptic output in accordance with the present invention. Details are outlined in example 3.

FIG 4 illustrates an embodiment of a fiberboard multipack including a visual output in accordance with the present invention. Details are outlined in example 4.

DETAILED DESCRIPTION OF THE INVENTION

[0017] As the world is moving increasingly into internet-of-things, smart packaging in accordance with the present invention offers an extensive range of intelligent functionalities in packaging for beverages, integrated up to the level of industrial processing, which can be used for consumer engagement and brand enhancement. It can amongst others also be used for proof of product authenticity and origin, tamper evidence and even further to source and delivery tracking and supply chain optimization.

[0018] In addition, smart packaging according to the present invention may drive down the cost of smart packaging to produce a smart and connected product to the point where it will be cost-effective to put intelligent features and communication means on an inexpensive product.

[0019] Therefore, in a first embodiment, the present invention provides a smart metal, glass, paper-based, wood-based, or plastic packaging for beverage comprising at least one sensory perceptible output, characterized in that a structural component of the packaging forms a component of the at least one sensory perceptible output.

[0020] The smart packaging may be primary of secondary.

[0021] A structural component of a smart primary packaging for beverage is understood as a material component which is necessary to the packaging for functioning as a beverage container, i.e. for enabling the packaging to contain a beverage or to be transported, more specifically for functioning as a carbonated beverage container, and in particular for functioning as a beer container.

[0022] A structural component of a smart secondary packaging for beverage is understood as a material component which is necessary to the packaging for holding primary packaging for beverage.

[0023] A component or material layer which does not offer any contribution to enable the packaging to contain a beverage or to be transported, and for example merely serves as a decorative layer or decorative layer system, such as ink or varnish, is not understood as a structural component.

[0024] Contradictory to a packaging with a printed display wherein the packaging is just a substrate for printing on and wherein the outer surface of the packaging as is with regards to constituting the display is only required to be suitable for printing the necessary layers upon, in the present invention a structural component of the packaging is an essential component of the actual sensory perceptible output and it must have the necessary material characteristics required for proper functioning of the sensory perceptible output. A component or material

layer which does not offer any contribution to the proper functioning of the output, and for example merely serves as a substrate for fixing or printing the output on, is not understood as an essential component of the output.

[0025] In other words, the structural component is a component which is essential for the proper functioning of the sensory perceptible output and which is inherently already present in the packaging as is before the output is fully constituted thereon. Consequently, it would not be possible to integrate at least partially the process of constituting the sensory perceptible output in the manufacturing of a packaging which misses that specific component (specific material layer) because it is necessary for the functioning of the sensory perceptible output. Both the smart packaging and the sensory perceptible output have a structural component in common, i.e. at least one necessary material layer included in the structure of the packaging, or in the structure of a part of the packaging, and not serving merely is a decorative layer serves as a necessary component of the sensory perceptible output.

[0026] Consequently, the manufacturing of the sensory perceptible output may be at least partially integrated in the manufacturing of the smart packaging, resulting in reduced material cost, reduced production time, and in general reduced production cost, even to the point where it will be cost-effective to put intelligent features and communication means on an inexpensive product, and in particular on disposable products.

[0027] In general, the present invention enables intelligent technologies to be integrated up to the level of and into industrial mass production of beverage containers.

[0028] In the context of the present invention, a sensory perceptible output may be constituted essentially by an active layer which must be at least partially activated in order to generate a sensory perceptible output. Depending on the type of active layer, it may be activated and controlled by several types of activation triggers, such as a voltage difference over the active layer, or by voltage differences over parts of the active layer, by an electromagnetic field, or by a magnetic field. Further also (locally applied) temperature changes, (locally applied) pressure variation or (locally applied) strain variation may trigger activation.

[0029] In order to generate a voltage difference over the active layer, it may be covered by at least one adjacent electrically conductive layer (e.g. an electrode, or it may be positioned in between adjacent electrically conductive layers, namely an electrically conductive bottom layer (also called the bottom electrode) and an electrically conductive top layer (also called the top electrode).

[0030] In case of activation by a magnetic field, the active layer may be activated by one or more adjacent electrically conductive layers (in some cases separated from the active layer by insulators).. On top of an electrically conductive top layer, and encapsulation layer may be applied to protect the underlying layers. Further, additional components (i.e. layers) may be present such as a polarizer, a mirror, a polarized light emitter, etc. for ex-

ample in case of a liquid crystal display.

[0031] A temperature change may be applied using resistive conducting tracks acting a heating elements.

[0032] Besides an electric field, a magnetic, field, an electromagnetic field, a temperature variation, pressure variation, or strain variation being generated by means internal to the smart packaging, each type of activation trigger may also be generated by means partially, or completely external to the smart packaging, for example generation means provided at the point-of-sale such as an electromagnetic field generator in the shelf of a store or in the cash register.

[0033] The active layer may be also externally activated by another packaging. The latter may be of any type of (smart) primary or secondary packaging having appropriate means to activate an active layer of a sensory perceptible output constituted in or on another primary or secondary packaging. As an example, an electromagnetic field generated by a secondary packaging may activate an output on a corresponding primary packaging, or vice versa.

[0034] In the context of the present invention, a sensory perceptible output may be any type of device integrated in the packaging enabling a user or consumer to sense any sensory perceptible status change of the packaging or the beverage. Such output may be video output, an audio output, a haptic output, or any other output sensible by touch, taste, or smell.

[0035] More specifically, a visual output may be any device integrated in the packaging enabling an area of the container to emit light, or to change its absorption or transmission of specific wavelengths of light (e.g. colour change), under electrical, electromagnetic, or magnetic control, or triggered by pressure, strain, or temperature variation. Emitting, absorbing, or transmitting light may include showing any kind of colour signal, or presenting a graphic, a text, a logo, a video, including a brand, a label, an interactive label etc., or projecting a graphic, text, logo, etc. onto an object present in the environment.

[0036] A visual output may be for example any type of display such as amongst others Liquid Crystal Displays (LCD), Electronic Paper Displays (EPD), rigid or flexible organic light-emitting diode (OLED) displays, electrochromic displays, electroluminescent displays, electrophoretic displays, OLED light sources, LED light sources, or any combination thereof, or any type of projector or beamer with suitable size.

[0037] A haptic output may be any device integrated in the packaging enabling at least part of the packaging to apply forces, vibrations, or motions, under electrical control, in a way that is felt by a user holding or touching the container, or in a way that the forces, vibration or motions may be transferred to other objects, for example to other bottles in the packaging or on the shelf. Such device may use for example piezoelectric materials.

[0038] An audio output may by any device integrated in the packaging enabling an area of the packaging to vibrate for transmitting an audio signal into the air, or for

transducing an audio signal to other objects surrounding the packaging and allowing transmitting the audio signal in to the air. The frequency range of vibrations may include that of human hearing, as well as ultrasonic and sub-sonic frequencies. An example of an audio output may be electrostatic speakers or thin-film flexible speakers.

[0039] Other sensory perceptible outputs may be any type devices integrated in the packaging enabling a user or consumer to sense any change of surface state of the packaging (e.g. change of roughness, static electricity), to sense a smell which is released upon activation, to sense a taste which is released upon activation, etc.

[0040] In embodiment in accordance with the present invention, in order to generate a voltage difference, an electromagnetic field, or a magnetic field, or a temperature, pressure, or strain variation over the active layer, the smart packaging may comprise a power supply supplying power obtained from a source present on or in the smart packaging, or from a source external to the smart packaging via an energy harvesting element on or in the smart packaging. Types of power sources may be for example batteries, (super)capacitors. Types of energy harvesting elements may be antennas, kinetic or thermoelectric generators, photovoltaics (e.g. organic photovoltaics (OPV), etc.

[0041] In some embodiments, the active layer may be activated by activation triggers generated external to the smart packaging in which case the packaging does not require to have a power supply for powering the at least one sensory perceptible output.

[0042] In an embodiment in accordance with the present invention, a smart packaging may additionally comprise any type of supporting electronic systems, which may include digital logic, processing units, memory, gate arrays including programmable gate arrays, passive components, such as resistors, capacitors, inductors, analogue instrumentation, power control circuits, display driver circuits, or any combination thereof. These supporting electronic systems may be built from discrete components attached to the smart packaging substrate, connected by conductive tracks on the substrate, and/or components printed upon the substrate.

[0043] More specifically, a smart packaging a smart in accordance with the present invention may comprise a sensory perceptible output, wherein a structural component, or a plurality of structural compounds of the packaging forms a component or a plurality of components of the at least one sensory perceptible output, and additionally a combination of a variable number of components of the following functional areas:

- a sensor: in a smart packaging according to the present invention, any type of sensor suitable for being integrated in smart packaging may be used, being discrete sensor components, or printable sensors, and being able to measure or indicate amongst others light, color, force or strain, proximity, liquid

level, flow, gas presence, humidity, viscosity, temperature, pressure, chemical contamination, position and geo-location, acceleration, movement, touch, impact, biometric authentication, etc. They also may capture information from or around the human body (e.g. heart rate, breathing rate, physical activity, sleep pattern, etc.). Also a camera may be present in or on the smart packaging.

- a processing unit: in a smart packaging according to the present invention, any type of processing unit suitable for being integrated in smart packaging may be used. Mainstream chip developers, motivated by the growing IoT market, are launching ultra-small ultra-low powered chips with integrated memory. There are emerging technologies that allow processors to be printed on thin film materials, like flexible polyamide, polyester foils, etc. Other systems, such as communications and memory, can also be printed to create specific solutions, known as system on a chip (SoC).
- a communication unit: in a smart packaging according to the present invention, any type of communication unit may be implemented that is suitable for communicating via a connectivity protocol standard or via a custom protocol. A number different connectivity standards have been designed for different data throughputs and transmission ranges. For each embodiment of the present invention the most suitable standard may be determined. Numerous communication means standards exist today, the front runners in the smart phone dominated market are Bluetooth and NFC, for localised communication. However, as more devices are connected to the IoT, dedicated networks such as SigFox could play an important part in the future by connecting primary and secondary packaging to other connected devices and objects anywhere in the world. Bluetooth, Zigbee, Z-wave, 6LowPan, Thread, Wifi, Cellular, NFC, Sigfox, Neul, LoRaWAN, Li-Fi.
- a power source: any type of power source suitable for powering an output and being integrated in a smart packaging may be used such as for example discrete batteries, flexible batteries, printed batteries, microbatteries, (super)capacitors, energy harvesting elements such as be antennas, piezoelectric, electrodynamic, or thermoelectric generators, photovoltaics (e.g. organic photovoltaics (OPV), electromagnetic field energy harvesting, etc.

[0044] Embodiments in accordance with the present invention may be directed to primary packaging for beverages, such as a bottle made of glass, or metal (eg. aluminum) or plastic, or a metal can, or metal keg, or wooden bottle or barrel. Such primary packaging may in particular be suitable for carbonated beverages and pref-

erably beer.

[0045] Other embodiments in accordance with the present invention may be directed to secondary packaging such as a carton, a multipack, a tray, a HiCone, plastic ring carriers, plastic yokes, paperboard baskets, paperboard overwraps and cartons, corrugated fiberboard boxes, HDPE plastic handles, six pack rings, and shrink packs.

[0046] The structural component of the packaging forming a component of the at least one sensory perceptible output may be amongst others: the glass of glass beverage container, hot-end-coating layers (e.g. tin oxide, or other oxide, or other equivalent material applied e.g. by chemical vapour deposition, applied e.g. to increase adherence of the cold end coating), cold-end-coating layers (e.g. polyethylene wax, or other equivalent material, applied e.g. by spray coating, in order to e.g. make the surfaces more slippery as bottles pass down the line), the plastic of a plastic beverage container, the plastic of a plastic cap or lid, the metal of a metal beverage can including its body, lid, ring pull, or rivet, the metal of a keg including its valve and stem, metal of a metal cap or crown, the inner polymer coating of a metal beverage container, spray coat epoxy (e.g. applied to the raw metal of a metal can or bottle), the metal oxide layer (e.g. implemented by anodising of metal drinks can or bottle substrate), metallic layers (e.g. deposited by plating onto the metal substrate of a drinks can or bottle), polymer layer (e.g. moulded into inside of crown or screw bottle top to form both seal and corrosion protection), the fiberboard or corrugated board of secondary packaging, or plastic parts of secondary packaging (e.g. rings to hold bottles together, or handles), the wood of wooden barrel, etc.

[0047] In an embodiment, the present invention provides a smart metal, glass, paper-based, wood-based, or plastic packaging for beverage comprising at least one sensory perceptible output, wherein a metal structural component of the smart packaging may form an electrically conductive layer of the at least one sensory perceptible output, in particular the bottom or top electrode.

[0048] The metal structural component forming an electrically conductive layer may be a metal layer of a beverage bottle, can or keg, or the aluminum of a beverage bottle, can or keg, in particular the aluminum of the lid, the tab, the body of a beverage can, or a combination thereof.

[0049] The metal structural component forming an electrically conductive layer may also be the metal layer of a beverage keg, typically stainless steel, or of any other type of metal container.

[0050] The metal structural component forming an electrically conductive layer may also be a component of a paper-based, wood-based or plastic-based smart packaging. A plastic bottle may comprise for example a metal ring structure in the body or the neck, or a corrugated board tray may comprise a rigidity enhancing metal layer, or a carton packaging may have an integrated metallic (cfr. Tetrapak).

[0051] The metal structural component forming an electrically conductive layer may be the metal layer of a closure of a beverage bottle, such as for example the tin plate of a glass bottle crown or the metal of the crown itself, or the aluminum layer of a Roll On Pilfer Proof cap (ROPP).

[0052] In an embodiment of the present invention, an electrically conducting structural component of the smart packaging may form the ground plane of the at least one sensory perceptible output.

[0053] In addition, a metal structural component of the smart packaging may form a mirror layer in case the visual output is a display type requiring a mirror layer.

[0054] Further, a metal structural component of the smart packaging may form a mechanically resonant component of an audio or haptic output. In order to mechanically activate the mechanically resonant component, piezo electric vibrating elements or electrostatic elements which deflect upon applying an electric field, magnetic elements such as magnetic loud speaker components, vibration motors, etc may be used. Mechanical vibration may also be further transmitted to or via adjacent objects external to the packaging itself, such as a table. Mechanical vibration may also be transmitted into the beverage contained in order to create an optical effect within the beverage (e.g. local bubbles)

[0055] In a particular embodiment of the present invention, a metallic structural component of the packaging may form an overlap with another metallic component or layer or structural component. Such overlapping metallic layers could be used to form two electrically conducting layers of a sensory perceptible output between which an active layer could be placed. Given the non-transparency of the metal conducting layers, the output created may be preferably an audio, or haptic output.

[0056] Examples of metallic overlaps may be:

- The folded seam at the top of a beverage can overlaps 6 layers of the two substrates.
- Seams in a 3- piece can may provide overlap for multiple metal substrate layers. A functional active layer could be added in between
- Overlap of a ring pull with the top of a can could form two electrodes, with an active layer between the ring pull and can top. The rivet may form electrical connection.
- Overlap of aluminum bottle with screw top or crown top
- Overlap of a conductive foil over the top of a metal crown cap, or metal bottle

[0057] In an embodiment, the present invention provides a smart metal, glass, paper-based, wooden, or plastic packaging for beverage comprising at least one sensory perceptible output, wherein a glass, paper-based, wooden, or plastic structural component of the smart packaging may form an electrically non-conductive layer of the at least one sensory perceptible output.

[0058] A glass or plastic structural component of the smart packaging may be for example the glass body or neck of glass bottles, or the plastic body or neck of plastic bottles, or plastic lids, or the paper/cardboard of secondary packaging, or the wood of a spirits or wine barrel.

[0059] In an embodiment of the present invention, a glass, paper-based, wooden, or plastic structural component of the smart packaging may form an electrically insulating component, or a protective encapsulating layer.

[0060] Further, a glass or plastic structural component of the smart packaging may form a mechanically resonant component of an audio or haptic output. Piezo electric vibrating elements or electrostatic elements which deflect upon applying an electric field, magnetic elements such as magnetic loud speaker components, vibration motors, etc may be used in order to mechanically activate the mechanically resonant component.

[0061] In addition, a glass or plastic structural component of the smart packaging may form an optically transparent component of a visual output.

[0062] In a particular embodiment, the glass or plastic of a beverage container is illuminated by a light source in the container and acts as a light guide, eg. a back light for a visual output, such as for example a liquid crystal display. The glass or plastic may also be patterned to act as a refractive or diffractive optical component to project or distribute light inwards or outwards.

[0063] Furthermore, electrically non-conductive structural components of the packaging may also form overlapping structures which may be functionalized as explained further in the text, for functioning as two conductive layers, or as active layer.

[0064] Examples of such non-conductive overlapping structures may be:

- Overlap between polymer or glass bottle, and respectively screw or crown lid
- Folds and seams in paper cartons
- Polymer sealing layer currently present inside of a metallic bottle tops (both crown and screw top)
- Overlap between polymer layers in "bottle in bottle" beverage containers

[0065] In accordance with the present invention, structural components other than metal, glass, paper-based, wooden, or plastic components may be structural coatings. For example, a hot end coating of a glass bottle contains metal oxides may serve as semi-conducting layer.

[0066] In an embodiment, the present invention provides a smart metal, glass, paper-based, wooden, or plastic packaging for beverage comprising at least one sensory perceptible output, wherein a structural component of the smart packaging may be functionalized to form an active layer of the at least one sensory perceptible output.

[0067] In an embodiment in accordance with the

present invention, one or more of the structural components of the smart packaging may comprise additives functionalizing the structural component(s) for being used as a component of at least one sensory perceptible output.

[0068] Additives may comprise electro-optical materials, such as electroluminescent materials, organic light emitting materials (e.g. OLED), electrochromic materials, electrophoretic materials, or liquid crystal materials, functionalizing a structural component for being used as an active layer of a visual output.

[0069] As a visual output, also metal, glass, plastic or paper-based, wood-based materials having additives such as fluorescent materials or thermochroic materials may be used.

[0070] Additives may also comprise electro-mechanical materials such as piezo-electric materials, electrostatic materials, or magnetic materials, for functionalizing an structural component for being used as an active layer of an audio output, or haptic output.

[0071] In an embodiment in accordance with the present invention, one or more of the structural components of the smart packaging may comprise additives functionalizing an electrically non-conductive structural component for being used as an electrically conductive layer of at least one sensory perceptible output.

[0072] In an embodiment in accordance with the present invention, one or more of the structural components of the smart packaging may be geometrically functionalized for being used as a component of at least one sensory perceptible output. The structural component may be pushed, stamped, or folded, and/or may overlap other structural components for gaining mechanically resonant properties, or create resonant systems or electrically connective structures.

[0073] In an embodiment in accordance with the present invention, a method for manufacturing a smart packaging for a beverage is provided comprising the steps of manufacturing a packaging for a beverage and constituting at least one sensory perceptible output on or in the packaging, wherein a structural component of the packaging is taken for constituting a component of the at least one sensory perceptible output.

[0074] In method of the present invention, the component constituted from a structural component of the packaging may be any component of the at least one sensory perceptible output, such as active layer, an electrically conductive layer (e.g. an electrode), an insulating layer, and encapsulating layer, etc.

[0075] The remaining parts of the at least one sensory perceptible output, i.e. parts other than the component constituted from the structural component of the packaging or part of it, may be added to the smart packaging by any available technique. Any printing, deposition, or shaping technique may be used including amongst others screen printing, flexography, gravure printing, offset printing, ink jet printing, xerography, lithography, evaporation, sputtering etching, coating, chemical vapour dep-

osition, embossing, stamping, laser patterning, mould patterning, electroplating, anodizing, dip coating, spin coating, gluing, blow moulding of polymers inside beverage containers, etc.

[0076] The remaining parts of the at least one sensory perceptible output, may also be constituted from a component of the packaging other than a structural component, such as decoration layers, varnishes, lacquers, etc. In such case, besides the fact that the manufacturing of the packaging and constituting the at least one sensory perceptible output use a common structural component, additional process steps may be shared for constituting the remaining parts, for example printing a decoration layer which is also an electrically conductive layer of an output, or spraying a coating which is also an electrically insulating layer of an output.

[0077] In an embodiment in accordance with the present invention, a method may be provided comprising the step of functionalizing the structural component for being used as a component of at least one sensory perceptible output. Such step of functionalizing the structural component of the packaging may be performed in the process of constituting the at least one sensory perceptible output after providing the packaging, or may be performed in the process of manufacturing the packaging.

[0078] In an embodiment in accordance with the present invention, the step of functionalizing the structural component for being used as a component of at least one sensory perceptible output comprises adding additives altering the chemical and/or physical properties of the structural component.

[0079] The additives may be added to the raw materials during the raw material production process, for example the additives may be added to glass, plastic or metal before solidifying, or to paper-based pulp. Such additives may be micro-encapsulated for enhancing its functionality.

[0080] Additives may also be embedded in the raw materials by rolling or embossing, or bound to the surface by chemical reaction.

[0081] In an embodiment in accordance with the present invention, metal, glass, plastic, or paper-based structural components of a packaging for beverage may comprise additives functionalizing the structural component for being used as an active layer of at least one sensory perceptible output.

[0082] In still another embodiment in accordance with the present invention, a method may be provided comprising the step of geometrically functionalizing the structural component for being used as a component of at least one sensory perceptible output by exposing the structural component to a shaping step, such as punching, stamping, folding etc. during manufacturing of the packaging. Such process step may give a structural component mechanically resonant properties, or create resonant systems or electrically connective structures.

[0083] In still another embodiment in accordance with the present invention, a method may be provided com-

prising the step of functionalizing the structural component for being used as a component of at least one sensory perceptible output by exposing the structural component to heat, such as for example baking or curing, or to annealing, laser irradiation, etc. In addition, the structural component may be directly applied at higher temperature than conventionally done (particularly in the case of glass or metal containers) in order to functionalize it.

[0084] Further, if required, a method may comprise the step of providing a power sources or energy harvesting elements for powering the at least one sensory perceptible output. These power sources or energy harvesting elements may be discrete electronic elements mounted in/on the smart packaging, or preferably they may be at least partially printable.

[0085] A sensor or a plurality of sensors, and/or a communication means and/or a processing unit, or any other type of supporting electronic component, and, if required, a separate power supply for powering these electronic components may be established by adding discrete components to the smart packaging, or preferably by at least partially printing them onto the smart packaging.

[0086] Embodiments in accordance with the present invention seek to provide a smart packaging enabling amongst other the following applications:

A smart packaging in accordance with the present invention may be suitable for being applied amongst others in the following examples, in particular beer related, each illustrating that the present invention becomes increasingly relevant by the relentless and fast pace at which digital technologies integrate consumers' lives:

- The smart packaging may display an active label providing interaction to get feedback on what consumers like and don't like.
- The smart packaging may display a dish suggested to pair with beer based on the menu provided in the restaurant, or suggest a recipe based on the food inventory in the refrigerator.
- The decoration, graphics or message displayed may change based on location and environment.
- The smart packaging contains sensors to measure the status of the beer and displays the status in order to give consumer the choice to enjoy the beverage the way they would like: optimal light struck, optimal carbonation, optimal bitterness.
- The smart packaging may amplify the user experience wherein the display or active label, speakers, or haptic elements could be reacting to the environment, to music, to wave movement, sunset, breeze sounds, beach color, etc.
- The smart packaging may connect to your smartphone and display a picture, or drives your

phone to take and display a selfie when you interact with your package in your hand, or may take picture via a camera on the packaging and capture event action.

- The smart packaging may generate brand specific sound on opening, for example via a speaker hidden in a crown
- The display may act as a second screen to show additional content during a virtual or video, or broadcast experience. Examples could be twitter feed, display a different camera angle, instant replays, mvp speeches, custom commentary, etc.
- Via the visual, audio, or haptic output(s), the smart packaging allows to customize your beer digitally so your friends know it's yours.
- The smart packaging may contain specially designed microphones and a processing unit to register and react by visual, audio, haptic output to ultrasonic pitches, inaudible to the human ear, which are embedded in television and/or radio commercials.
- The smart packaging may flash and light up when the same brand's advertisement is being broadcast, or an ultrasonic code may trigger the display.
- The smart packaging generates a visual, audio, or haptic output when something happens in an event I'm interested in, for example a goal scored of my favorite team.
- Any type of sensory perceptible output may communicate "cold" in a perceived way when the liquid inside reached the appropriate drinking temperature.
- A visual, audio, or haptic output may communicate an incoming message on your phone (.cfr a smart watch)
- Any type of sensory perceptible output may communicate a profile match in a dating event.
- At least one sensory perceptible output may communicate your taxi has arrived.
- The smart packaging may have a visual output triggered to emit light making the ice in an ice bucket appear to glow, or to emit UV-light making fluorescent objects in the environment to emit light.
- Via vibrations the smart packaging may create optical effects in the beer, which may be emphasized by the application of light. In particular, effects created might include the following: creating ripples on the surface of the liquid, stimulating bubbles in the beer in specific areas and/or at specific times, creating or recreating foam on the beer etc. The effect may be adapted as the level of beer in the bottle changes.

Example 1 (illustrated by Fig 1)

[0087] A display is constituted on a metal beverage (1) can wherein the aluminum body of a beverage can forms the 'bottom' electrode, which is connected to GND on the driver circuit. The segments illustrated are individual long thin segments running from top to bottom of the can. However, they could in principle be any arbitrary shape. The segments comprise an active layer, top electrode conductive layer, insulating layers as required, and a top encapsulation layer.

[0088] Therefore:

- Insulating layer areas (not shown) may be printed onto the aluminum (11), to create custom electrode shapes, or may be provided by the spray coat epoxy applied in the process immediately after fabrication of the can.
- An active layer (12) is printed depending on what type of sensory perceptible output to implement. Different areas of the can may have different active layers, in order to put multiple functions on one can.
- Distinct, electrically separate top conductive layer segments (13) are then printed. In the case of a display, this layer will be transparent. This could be either Indium Tin Oxide (ITO), a transparent organic conducting material, or other transparent conductor.
- Both the active layer and top level conductive layer may be printed on using additional rollers on the offset printing process, which already exists to apply paint to the outside of the can.
- in addition, electronic components may be attached, with electrical connections to one or more conducting layer(s) present. One of these conducting layers is the aluminum can body itself, which acts as a circuit ground or power plane.
- A protective encapsulation layer (14) is then printed as the top conductive layer. This may be the same paint or lacquer as is already used to paint and/or protect the can, as already produced. Where light is required to be emitted, the top layer should be a transparent lacquer. Paint may be used to create shadow mask, as an additional optical effect.
- Baking and curing of all the layers is performed in the existing baking and curing process provided to manufacture the can.

[0089] In the case of a reflective display, the metal used as ground plane may also form the mirror of the reflective display.

Example 2 (illustrated by Fig 2)

[0090] A pixelated, light emitting display is integrated onto the outside of a glass bottle (2). This is realised by the deposition of row and column electrodes, either side of an active layer that is also deposited onto the bottle..

[0091] Therefore:

- The glass (21) is embossed, patterned or shaped in such a way as to guide the light in a specific designed pattern, from a light source or multiple light sources. For example, in the conventional glass bottle manufacturing process, the molten glass is formed into a bottle by blowing it into a mould. To this mould additional patterns may be added in order to:

- (i) Create geometries for active and conducting coating layers to be deposited by printing processes. e.g. 'ridges' and 'peaks' may pick up ink/paint/coating, whereas troughs won't.
- (ii) Create features in the bottle which effect light guiding effects around the bottle
- (iii) Create features in the bottle that enhance mechanical resonant effects, or amplify sound from a speaker element.

- Laser etch/decoration may be applied when hot or indeed cold, to add additional embossed features to achieve features above.
- Following forming, a 'hot end coating' is normally applied to a bottle using spray coating and/or chemical vapour deposition. The nature of the coating applied may be varied, such that the coating is conducting to form the bottom electrode layer (22). It may also be semi conducting and, by applying multiple iterations of this process, used to form part of a set of thin film transistors in the context of being an active matrix display.
- The active optical layer (23), comprising any of the technologies described above is then printed.
- A transparent top conducting layer (24) is then printed. This could be either Indium Tin Oxide (ITO), a transparent organic conducting material, or other transparent conductor.
- The active layer and top level conductive layer may be printed on using additional rollers on the offset printing process, which already exists to apply paint to the outside of the can.
- A protective encapsulation layer is then printed as the top layer. This may be the same paint or lacquer as is already used to paint and/or protect the can, as already produced. Where light is required to be emitted, the top layer should be a transparent lacquer. Paint may be used to create shadow mask, as an additional optical effect.
- Baking and curing of all the layers is performed in the existing baking and curing process provided to manufacture the can.
- The light sources are added to the packaging, either as printed electroluminescent or OLED light sources, or as discrete components such as conventional LEDs.

Example 3 (illustrated by Fig 3)

[0092] This example comprises a piezo-electric vibra-

tion element (31) attached to the top section of an aluminum beverage can (3).

The aluminum of the can forms the bottom electrode (32) for the piezo device. It also forms a mechanically resonant structure to amplify and distribute the sound or vibration from the piezo device to the user. The piezo layer, other electrode, and encapsulation are formed by printing or otherwise depositing the layers onto the can lid.

[0093] The following existing manufacturing process steps may be used:

- The lid is stamped/punched to form in the normal manufacturing process. Features may be put into the stamp to control and implement specific resonant functions of the metal. They may also be used to create patterns into which the device layers may be deposited.
- Insulating layer (not shown) between aluminum can and active layer is provided by the spray coat epoxy applied in the process immediately after fabrication of the can.
- The active layer (31) and top level conductive layer (33) are printed on using additional rollers on the offset printing process, which already exists to apply paint to the outside of the can.
- The top conductive layer may be added by the anodizing plating process already present to plate a metallic layer onto the lid.
- The encapsulation layer (not shown) is formed by the varnish already provided in the manufacturing process.
- Baking and curing of all the layers is performed in the existing baking and curing process provided to manufacture the can.

Example 4 (illustrated by Fig 4)

[0094] This example is based upon a secondary packaging made from fibre board coated with a metallised film and laminated polymer layer.

[0095] In existing packaging applications, such secondary packaging typically comprises a stack up from inside to outside as follows:

- Fibre board layer as a sheet.
- Metallised layer, either deposited by metallised paint or by a sheet of foil laminate
- Transparent polymer layer, as a sheet, laminated upon the metallised layer
- Printed paint layer
- Varnish

[0096] This type of packaging material is already widely used to make packaging with a high quality visual appearance whereby the fibre board adds mechanical structure and durability, the metallised layer is used not only to create a shiny visual appearance but also for enhancing water resistance and rigidity, and the laminated

polymer layer gives a smooth finish and water resistance.

[0097] Constituting a display on this packaging may be done as follows:

- Fibre board layer is unchanged. 5
- The metallized layer (41) is a conducting layer and is used as the bottom electrode for the display (45), and also as a mirror layer for a reflective display. 10
- The transparent polymer layer (42) is functionalized by the addition of material to the polymer when it is molten, before it is formed into the sheet which is laminated into the package. The functionalization makes the sheet electro-optically active, such that it emits light (e.g. electroluminescent) or modulates existing light when appropriate field is applied. 15
- The top level conductive layer (43) may be printed on using additional rollers or print stages on the offset printing process, which already exists to apply paint to the outside of the can. A transparent conducting material shall be used in the case of a display. 20
- The encapsulation layer (44) is formed by the varnish already provided in the manufacturing process. 25
- Baking and curing of all the layers is performed in the existing baking and curing process provided already for the coatings on the package.

Claims

1. An smart metal, glass, paper-based, wood-based, or plastic packaging for beverage comprising at least one sensory perceptible output, **characterized in that** a structural component of the packaging forms a component of the at least one sensory perceptible output. 30 35
2. A smart packaging for beverage according to claim 1, wherein said structural component of the packaging is a metal structural component forming an electrically conductive layer of the at least one sensory perceptible output. 40
3. A smart packaging for beverage according to claims 2, wherein the metal structural component may be a metal layer of a beverage bottle or can, or the aluminum of a beverage bottle or can, in particular the aluminum of the lid, the tab, the body of a beverage can, or a combination thereof, or a metal layer of beverage keg or any other type of metal beverage container, or wherein the metal structural component is a component of a paper-based, wood-based or plastic-based smart packaging. 45 50
4. A smart packaging for beverage according to claim 1, wherein a glass, wood-based, paper-based, or plastic structural component of the smart packaging may form an electrically non-conductive layer of the at least one sensory perceptible output. 55
5. A smart packaging for beverage according to claim 4, wherein the glass or plastic structural component of the smart packaging is the glass body or neck of glass bottles, or the plastic body or neck of plastic bottles, or plastic lids, or the plastic or paper/card-board of secondary packaging. 5
6. A smart packaging for beverage according to claim 1, wherein said structural component of the packaging is a metal, glass, plastic, or wooden structural component forming a mechanically resonant component of an audio, or haptic output. 10
7. A smart packaging for beverage according to claim 1, wherein metal, glass, plastic, or paper-based, wood-based structural component of the smart packaging comprises additives functionalizing the structural component for being used as an active layer of at least one sensory perceptible output, or functionalizing an electrically non-conductive structural component for being used as an electrically conductive layer of at least one sensory perceptible output. 15 20
8. A method for manufacturing a smart packaging for a beverage comprising the steps of manufacturing a packaging for a beverage and constituting at least one sensory perceptible output on or in the packaging, wherein a structural component of the packaging is taken for constituting a component of the at least one sensory perceptible output. 25 30
9. A method according to claim 8, wherein the manufacturing of the packaging and constituting the at least one sensory perceptible output share at least one additional process step for constituting the remaining parts of the sensory perceptible output. 35
10. A method according to claim 8, comprising a step of functionalizing the structural component of the packaging for being used as a component of the at least one sensory perceptible output. 40
11. A method according to claim 10, wherein the step of functionalizing the structural component of the packaging may be performed in the process of manufacturing the packaging. 45
12. A method according to claims 10 or 11, wherein the step of functionalizing the structural component of the packaging for being used as a component of the at least one sensory perceptible output comprises adding additives to the structural component. 50
13. A method according to claims 10 or 11, comprising the step of geometrically functionalizing the structural component for being used as a component of at least one sensory perceptible output. 55

14. A method according to claim 8, comprising the step of adding a power source or energy harvesting element for powering the at least one sensory perceptible output by at least partially printing it onto the smart packaging. 5
15. A method according to claim 8, comprising the step of adding a sensor and/or a communication means and/or a processing unit by at least partially printing it onto the smart packaging. 10

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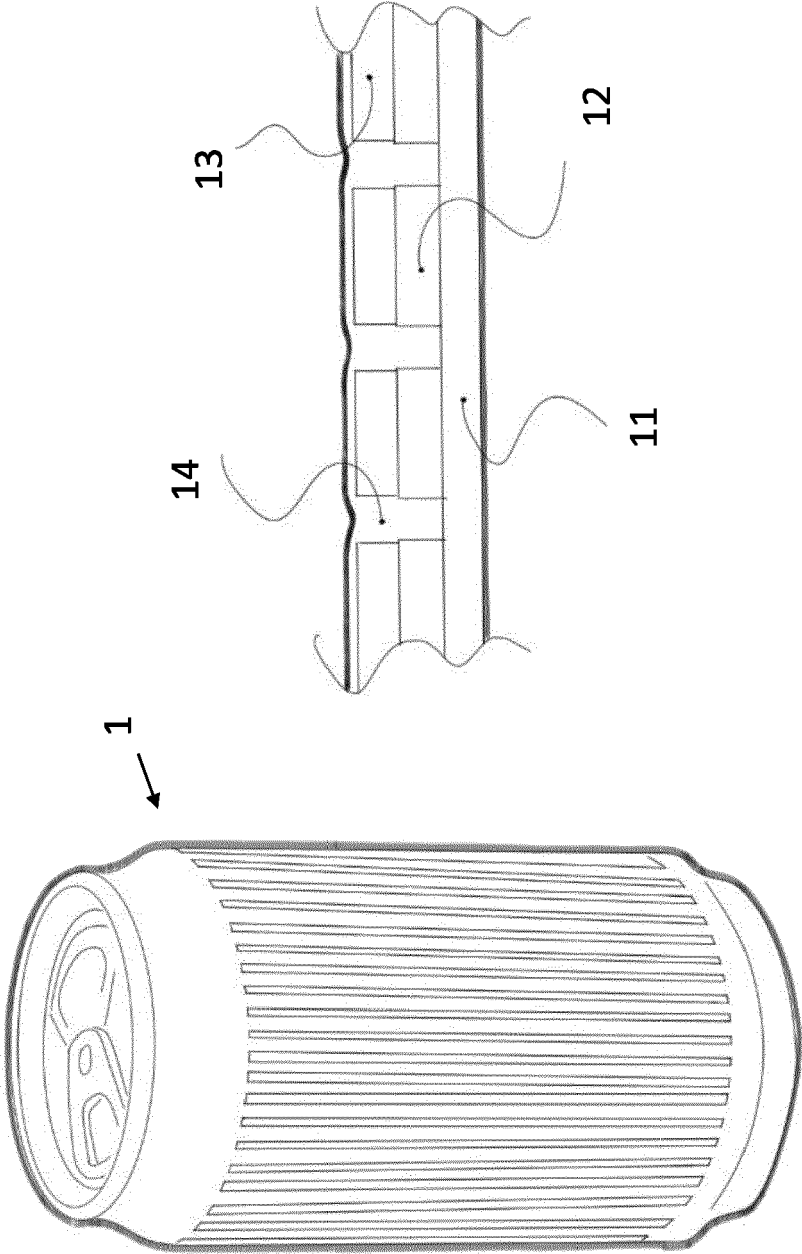
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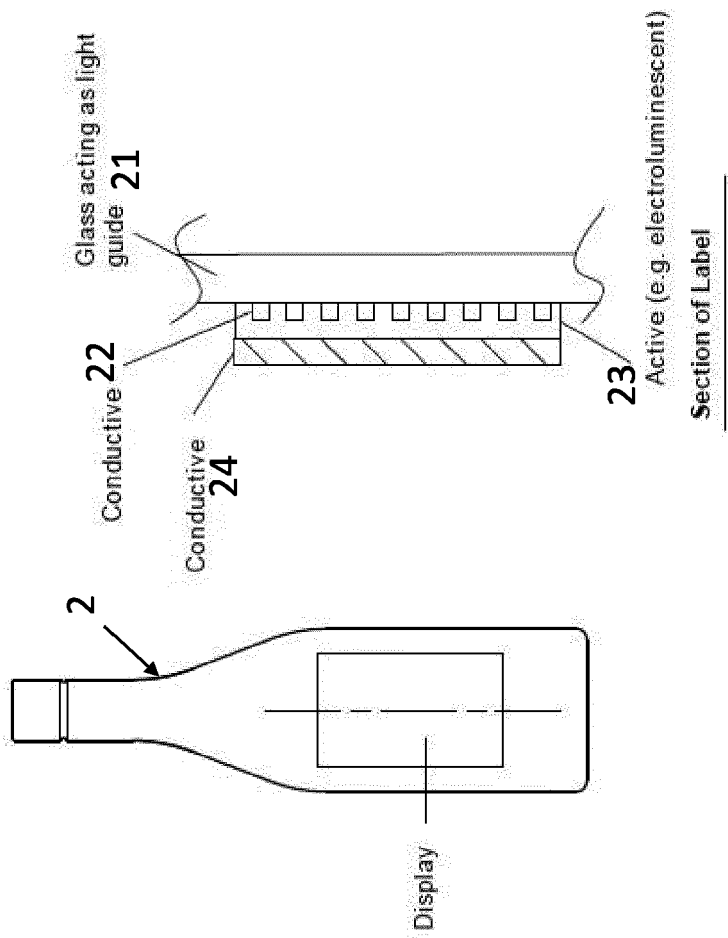


FIG 2

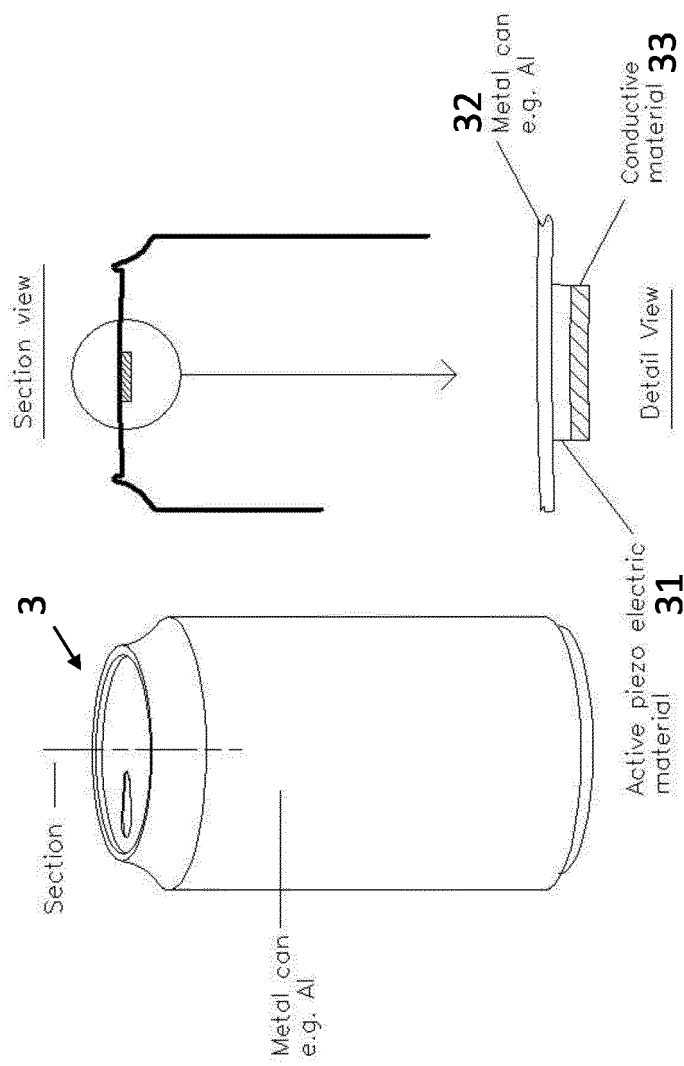


FIG 3

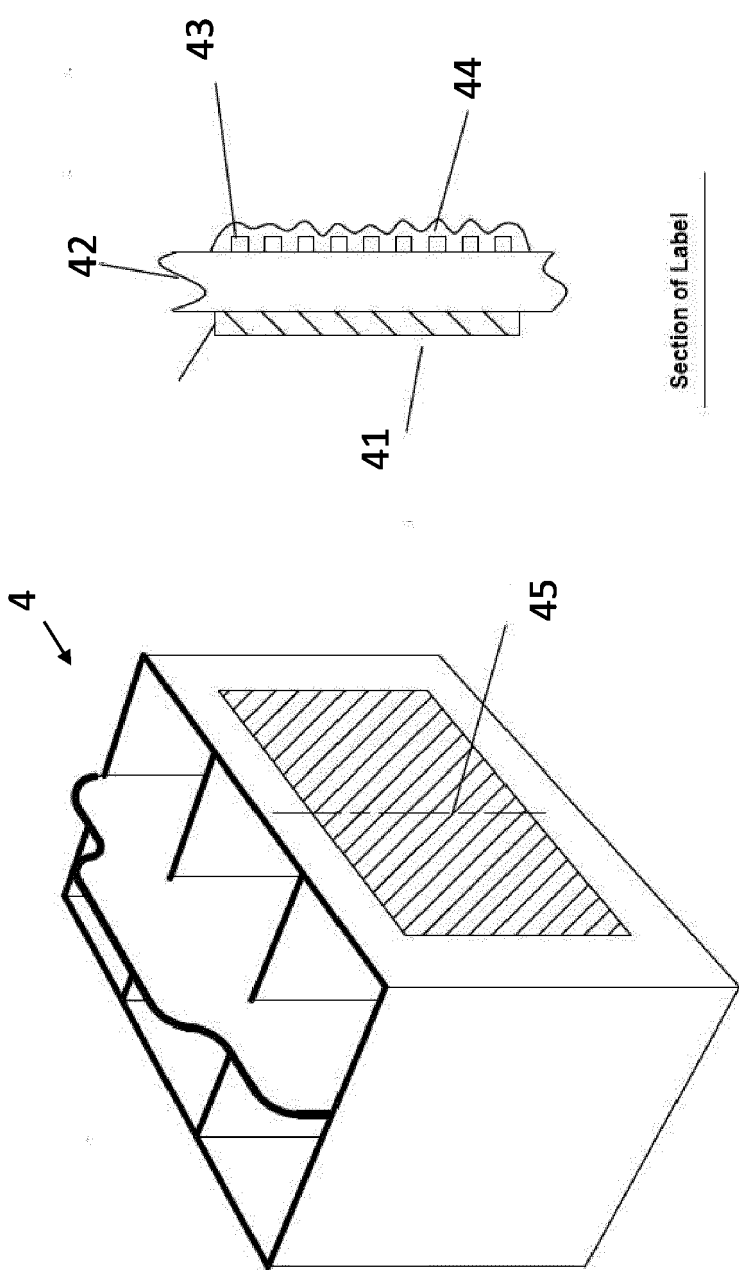


FIG 4



EUROPEAN SEARCH REPORT

Application Number
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	* column 2, line 2 - line 22; figure 3 *		
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Place of search		Date of completion of the search	Examiner
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