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(54) Lighting appliance based on strip of lighting elements with magnetic coupling

(57) A lighting apparatus comprising at least one flexible strip of one or more lighting elements (105), at least one support element (110) for the strip of lighting elements (105), and coupling means (205,410l,410r,435l, 435r) for coupling the strip of lighting elements (105) with the support element (110); the coupling means (205,410l, 410r,435l,435r) comprises at least one flexible coupling strip (205) fixed to the strip of lighting elements (105), the coupling strip (205) and the support element (110) comprising a magnetic material and/or a ferromagnetic material for exerting a magnetic attraction force between the coupling strip (205) and the support element (110).

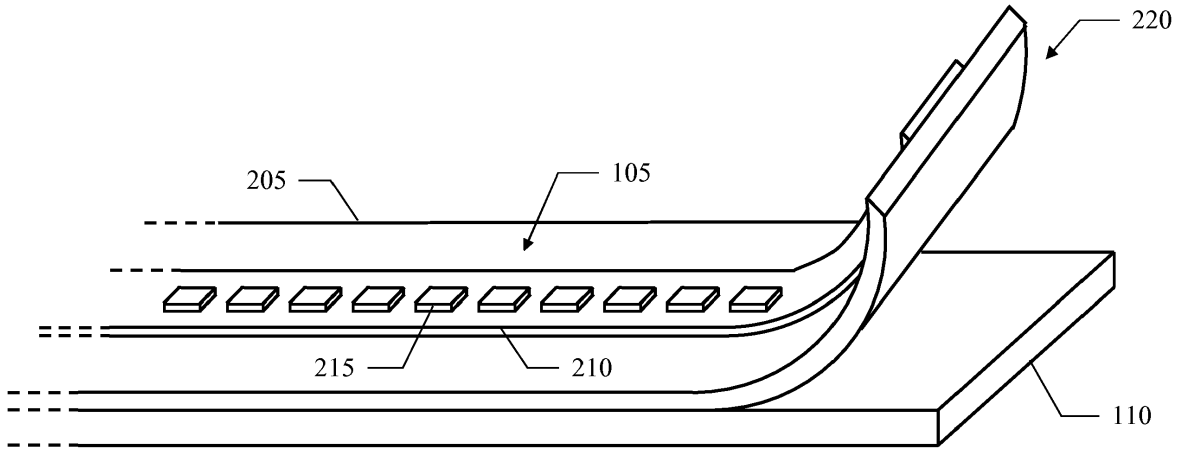

FIG.2

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Description

Technical field

[0001] The present disclosure relates to the lighting technology field. More specifically, this disclosure relates to lighting apparatuses based on strips of lighting elements.

Background art

[0002] Lighting apparatuses are commonly used to provide artificial lighting to objects in the broadest meaning of the term (for example, indoor environments). Particularly, lighting apparatuses based on strips of lighting elements (for example, LEDs) are becoming increasingly popular, in replacement of the lighting apparatuses based on conventional lighting sources (such as halogen or fluorescent lamps).

[0003] In general, a LED (Light Emitting Diode) is a PN junction diode, which is capable of emitting light when forward biased (thanks to the emission of energy of the electrons coming from its N region that recombine with the holes of its P region); the LEDs have long life, high efficiency, and they are very safe (since they operate at extremely low voltages). A LED strip comprises a strip of flexible printed circuit, on which a battery of LED is mounted. The LED strips are very versatile, thereby allowing achieving creative and appealing aesthetic effects.

[0004] Each LED strip is normally applied on a support element. This allows forcing the LED strip to take well defined shapes, and to maintain them in a stable manner. Moreover, the support element may also be used to dissipate the heat that is produced by the LED strip in operation. The application of the LED strip on the support element is facilitated by the typical presence of a layer of adhesive material on its rear surface (opposite a front surface where the LEDs are mounted); for this purpose, it is sufficient to remove a strip of protective paper covering the layer of adhesive material, to position the LED strip onto the support element and to make it adhere thereto with a slight pressure.

[0005] Alternatively, MI2011A000164 (the entire disclosure of which is herein incorporated by reference) describes a flexible lighting element. This flexible lighting element comprises a strip of lighting sources based on LEDs, which is covered by an outer coating of silicone-based elastomeric material that may be cold extruded and vulcanized; the lighting strip is interposed between the outer coating and a support of thermally conductive material on which the strip rests.

[0006] However, the coupling between the LED strip and the support element may be problematic in specific conditions.

[0007] Particularly, the support element may be flexible (for example, a metal foil) to allow modelling its shape, and then the one of the LED strip as well, as desired according to personal needs (for example, to obtain different decorative effects). In this case, when the support element is bent the LED strip being integral therewith is subject to stresses that may damage it. Particularly, if the LED strip is arranged inside a curve of the support element, it is subject to a compression that may detach its flexible printed circuit from the support element; this creates a ridge in the flexible printed circuit that may cause a detachment of the LEDs mounted thereon. On the contrary, if the LED strip is arranged outside a curve of the support element, it is subject to a traction that may tear its flexible printed circuit.

[0008] Moreover, in case of break of the LED strip it is rather difficult to detach it from the support element on which it is glued. Consequently, in many practical situations the entire assembly formed by the LED strip and the support element is replaced, with an increase of the operating costs of the corresponding lighting apparatus.

[0009] Alternatively, it would be possible to attempt binding the LED strip to the support element by means of clips that act on lateral edges of the LED strip; the clips would maintain the LED strip coupled with the support element thereby allowing a relative sliding thereof (so as to avoid the above-mentioned risk of damage). However, the LED strip would not be integral with the support element any longer. Consequently, the LED strip might detach at various points from the support element with the formation of a corresponding gap. This would adversely affect the aesthetic quality of the lighting apparatus (so that it might be unacceptable in many applications). In any case, the gap between the LED strip and the support element would hinder the transmission of the heat produced by the LED strip to the support element, with the risk of its overheating and consequent damage.

Summary

[0010] A simplified summary of the present disclosure is herein presented in order to provide a basic understanding thereof; however, the sole purpose of this summary is to introduce some concepts of the disclosure in a simplified form as a prelude to its following more detailed description, and it is not to be interpreted as an identification of its key elements nor as a delineation of its scope.

[0011] In general terms, the present disclosure is based on the idea of exploiting a magnetic attraction force.

[0012] Particularly, an aspect provides a lighting apparatus comprising at least one strip of one or more lighting elements and at least one support element for the strip of lighting elements, wherein a magnetic attraction force is exerted between at least one coupling strip being fixed to the strip of lighting elements and the support element.

[0013] A further aspect provides a lighting component for use in this lighting apparatus.

[0014] A further aspect provides a corresponding

method for mounting a lighting apparatus.

[0015] More specifically, one or more aspects of the present disclosure are set out in the independent claims and advantageous features thereof are set out in the dependent claims, with the wording of all the claims that is herein incorporated verbatim by reference (with any advantageous feature provided with reference to any specific aspect that applies *mutatis mutandis* to every other aspect).

Brief description of the drawings

[0016] The solution of the present disclosure, as well as further features and the advantages thereof, will be best understood with reference to the following detailed description thereof, given purely by way of a non-restrictive indication, to be read in conjunction with the accompanying drawings (wherein, for the sake of simplicity, corresponding elements are denoted with equal or similar references and their explanation is not repeated, and the name of each entity is generally used to denote both its type and its attributes - such as value, content and representation). In this respect, it is expressly intended that the figures are not necessary drawn to scale (with some details that may be exaggerated and/or simplified) and that, unless otherwise indicated, they are merely used to illustrate the structures and procedures described herein conceptually. Particularly:

FIG.1 shows a schematic representation in perspective of a lighting apparatus wherein the solution according to an embodiment of the present disclosure may be applied,
FIG.2 shows a detail of this lighting apparatus according to an embodiment of the present disclosure,
FIG.3A-FIG.3B show a conceptual representation of the lighting apparatus according to an embodiment of the present disclosure in different configurations,
FIG.4 shows an exploded partial schematic representation of the lighting apparatus according to an embodiment of the present disclosure, and
FIG.5A-FIG.5D show a schematic representation of a detail of the lighting apparatus according to an embodiment of the present disclosure in various operative conditions.

Detailed Description

[0017] With reference in particular to FIG.1, a schematic representation in perspective is shown of a lighting apparatus 100 wherein the solution according to an embodiment of the present disclosure may be applied.

[0018] Particularly, the lighting apparatus 100 is a flexible lamp of tape type, which comprises one or more base modules (of which only one shown in the figure). Each base module of the lighting apparatus 100 comprises a flexible strip 105 of lighting elements (for example, LEDs). The LED strip 105 is formed by a flexible printed circuit (*i.e.*, a substrate of electrically insulating material on which electrically conductive tracks are made); generally, the flexible printed circuit is long and narrow (for example, with the length higher than 5-50 times the width, such as 5-100 cm and 1-2 cm, respectively) and thin (for example, with the thickness equal to 0.01-0.05 times the width, such as 0.1-1 mm and 10-20 mm, respectively). The flexible printed circuit may be easily folded along its length under the action of a force with a component perpendicular to a longitudinal axis thereof (for example, it is not capable of self-sustaining in vertical, so that it buckles under the action of its own weight). One or more rows of LEDs (for example, 100/1,000 per meter) are mounted on a front surface of the flexible printed circuit; for example, each LED is implemented (together with possible other optical components, such as a lens) in a package of surface mounting (SMT) type, which exposes corresponding terminals that are soldered on the tracks of the flexible printed circuit. The LED strip 105 further comprises other electrical components for the operation of the LEDs (for example, power connectors, resistors and capacitors), which are mounted on the flexible printed circuit as well.

[0019] The LED strip 105 is coupled with a support element 110 (as described in detail below). In the specific case at issue, the support element 110 is a (support) metal foil. Generally, the metal foil 110 as well is long, narrow and thin; for example, the metal foil 110 has the same length as the LED strip 105 but greater width, such as equal to 2-10 times the width of the LED strip 105. The metal foil 110 is made of a hard material (for example, with a Vickers hardness of 30-80 HV); the metal foil 110 may, however, be elastically bent along its length (*i.e.*, it flexes under the action of a force, comprising the force of gravity, with a component perpendicular to its longitudinal axis, however returning to its original shape in absence thereof in normal use). The metal foil 110 is, however, more (bending) rigid than the LED strip 105 is, and particularly when it is arranged vertically it bends under the action of its own weight but without buckling (for example, with a ratio between the bending stiffness of the metal foil 110 and the bending stiffness of the LED strip, measured by fixing them at both their ends, higher than 10-30, such as between 20-50). In this way, the lighting apparatus may be mounted (as described below) so that the metal foil 110 takes a variety of well-defined shapes (for example, inverted Ω like in the figure) and maintains them in a stable manner. The metal foil 110 is thermally conductive (for example, with a thermal conductivity higher than 100-200 W/mK), so as to further act as a heat sink for the LED strip 105. In this way, the LED strip 105 may also be not self-dissipating, and have a power (for example, higher than 2-10 W/m) such as to provide a rather high lighting intensity (for example, higher than 1,000-2,000 lm/m); indeed, the heat produced by the LED strip 105 in operation may be dissipated effectively by the metal foil 110 without causing an excessive heating thereof. For example, the metal foil 110 may be made of

tempered spring steel, with a length of 50-100 cm, a width of 5-10 cm and a thickness of 0.5-1 mm.

[0020] The base module of the lighting apparatus 100 is provided with two (installation) supports 115 and 120, which are arranged at corresponding ends of the metal foil 110 and of the LED strip 105 (transversely thereto). Particularly, the (main) support 115 (for example, oval-base prism shaped) houses a supply transformer of the LED strip 105 (for example, of 12-24 V), which is electrically coupled with its power connectors. The (secondary) support 120 (for example, cylindrical shaped) is instead used as a termination element of the lighting apparatus 110 or as a (series) connecting element of further base modules (not shown in the figure). The supports 115,120 are fixed to a bearing structure (for example, a wall or a ceiling) so as to support the lighting apparatus 100, in a position such as to give the metal foil 110 (and then the LED strip 105 as well) the desired shape.

[0021] With reference now to FIG.2, a detail is shown of this lighting apparatus according to an embodiment of the present disclosure.

[0022] In this case, a coupling strip 205 is fixed to the LED strip 105 (for example, by gluing the LED strip 105 onto the coupling strip 205 by means of a layer of adhesive material provided on a rear surface of its flexible printed circuit, denoted with the reference 210, opposite a front surface thereof where its LEDs are mounted, denoted with the reference 215), so as to obtain a corresponding lighting component 220. The coupling strip 205 as well is long, narrow and thin (for example, with the same length as the LED strip 105, width equal to or greater than the LED strip 105, and thickness of 0.2-0.8 mm). The coupling strip 205 is flexible, similarly to the LED strip 105 and in any case less rigid than the metal foil 110 is (for example, with a ratio between the bending stiffness of the coupling strip 205 and the bending stiffness of the metal foil 110 between 0.5 and 5, such as with the coupling strip 205 as well being not capable of self-sustaining in vertical).

[0023] The coupling strip 205 and the metal foil 110 (or more generally, any support element) comprise a magnetic material (*i.e.*, which generates its own persistent magnetic field) and/or a ferromagnetic material (*i.e.*, which magnetizes when subject to an external magnetic field). For example, the metal foil 110 is made of ferromagnetic material (such as of steel as indicated above), whereas the coupling strip 205 is made of magnetic material (such as ferrite rubber magnet, also known as magnetic rubber).

[0024] The magnetic material of the coupling strip 205 is arranged so that the corresponding magnetic moment is transverse to the metal foil 110 (for example, with the north pole and the south pole on a lower surface and on an upper surface, respectively, of the coupling strip 205 that are facing and opposite, respectively, the metal foil 110); in this way, when the lighting component 220 is arranged on the metal foil 110, a magnetic field generated by the coupling strip 205 completely encloses the metal foil 110. Therefore, the ferromagnetic material of the metal foil 110 magnetizes (with the south pole and the north pole on an upper surface and a lower surface, respectively, of the metal foil 110 that are facing and opposite, respectively, the coupling strip 205). Accordingly, a magnetic attraction force is generated between the coupling strip 205 and the metal foil 110 (perpendicularly thereto), so as to press the coupling strip 205 (and then the entire lighting component 220) against the metal foil 110. This magnetic attraction force (depending on the intensity of the magnetic field generated by the coupling strip 205, in turn depending on the characteristics of its magnetic material and on its size) has a value such as to enable detaching the lighting component 220 manually from the metal foil 110 (for example, corresponding to a pressure of the order of 0.01-0.1 N/cm^2); in this way, the lighting component 220 may be moved away from the metal foil 110 up to when the magnetic field generated by the coupling strip 205 no longer affects the metal foil 110 substantially, and thus the corresponding magnetic attraction force is negligible. At the same time, the magnetic attraction force generates a corresponding sliding friction force between the coupling strip 205 and the metal foil 110 (parallel thereto), which friction force depends on such magnetic attraction force and on a coefficient of friction between the materials of the coupling strip 205 and of the metal foil 110. This friction force has a maximum value (in a rest condition corresponding to a coefficient of static friction) such as to lock the lighting component 220 firmly on the metal foil 110. At the same time, however, this does not prevent the lighting component 220 to slide along the metal foil 110 when it is bent; this means that a corresponding tension applied to the lighting component 220 is higher than the friction force (for example, with the friction force of the order of 2.5-25 N).

[0025] The above-described solution allows coupling the LED strip 105 and the metal foil 110 (or any other support element) effectively.

[0026] Particularly, the sliding of the lighting component 220 along the metal foil 110 prevents (or at least substantially reduces) the application of any tension to the LED strip 105 when the metal foil 110 is bent, thereby limiting the risks of its damage.

[0027] In addition, the lighting component 220 may be easily detached from the metal foil 110. This allows replacing the lighting component 220 (for example, when the LED strip 105 is broken) in a simple and fast way; moreover, in this way it is possible to avoid replacing its support element, with a corresponding reduction of the operating costs of the entire lighting apparatus.

[0028] The specific embodiment described above offers further advantages.

[0029] Particularly, the choice of making the coupling strip 205 of the magnetic material and the metal foil 110 of the ferromagnetic material makes the latter simpler and easier to handle.

[0030] Moreover, the making of the coupling strip 205 of ferrite rubber magnet is very effective and inexpensive.

[0031] With reference now to FIG.3A-FIG.3B, they show a conceptual representation of the lighting apparatus according to an embodiment of the present disclosure in different configurations.

[0032] Starting from FIG.3A, the metal foil 110 and the lighting component 220 (with the same length) are bent so that the lighting component 220 is arranged inside a curve of the metal foil 110. In this case, the lighting component 220 has a radius of curvature lower than the metal foil 110 has. Therefore, the lighting component 220 has an angular extent greater than the metal foil 110 has, and then the lighting component 220 slides with respect to the metal foil 110 projecting outside it. This prevents (or at least substantially reduces) the risk of subjecting the LED strip 105 to any compression that might detach the lighting component 220 from the metal foil 110 (creating a ridge in the flexible printed circuit of its LED strip that might cause a detachment of the LEDs mounted thereon).

[0033] On the contrary, in FIG.3B the metal foil 110 and the lighting component 220 (again with the same length) are bent so that the lighting component 220 is arranged outside a curve of the metal foil 110. In this case, the lighting component 220 has a radius of curvature higher than the metallic foil 110 has. Therefore, the lighting component 220 has an angular extent smaller than the metal foil 110 has, and then the lighting component 220 slides with respect to the metal foil 110 retracting inside it. This prevents (or at least substantially reduces) the risk of subjecting the lighting component 220 to any traction that might tear its LED strip.

[0034] Turning now to FIG.4, an exploded partial schematic representation is shown of the lighting apparatus according to an embodiment of the present disclosure.

[0035] In this case, in each base module the coupling strip 205 has the same length and a greater width (for example, 2-6 times) of the LED strip 105. The LED strip 105 is fastened at the centre (transversely) of the coupling strip 205. Two stiffening strips 4051 and 405r are fastened on the entire remaining portion of the coupling strip 205 cleared by the LED strip 105 to the left and to the right thereof, respectively. Each stiffening strip 4051, 405r as well is long, narrow and thin (for example, with the same length of the LED strip 105, a width equal to 0.5-2 times that of the LED strip 105, and a thickness equal to 1-5 times that of the LED strip). The stiffening strips 405l,405r are flexible, but however more (bending) rigid than the LED strip 105 is (for example, with a ratio between the bending stiffness of the stiffening strips 4051,405r and the bending stiffness of the LED strip 105 between 2 and 5) but less (bending) rigid than the metal foil 110 is (for example, with a ratio between the bending stiffness of the stiffening strips 4051, 405r and the bending stiffness of the metal foil 110 between 0.1 and 0.5). For example, the stiffening strips 4051,405r may be made of PVC, with a length of 5-100 cm, a width of 2-4 cm and a thickness of 1-2 mm. The stiffening strips 4051,405r increase the stability of the locking of the lighting component 220 on the metal foil 110.

[0036] A slot 4101 and 410r crosses each stiffening strip 4051 and 405r, respectively, and the coupling strip 205 at each of their two longitudinal ends. The slots 410l,410r extend along the lighting component 220 (for example, with a width of 0.8-1 cm and a length of 3-8 cm). A pair of (smooth) through holes 4151 and 415r corresponding to the slots 4101 and 410r, respectively, cross the metal foil 110 at each of its two longitudinal ends. The through holes 415l,415r are narrower than the slots 410l,410r are (for example, with a width of 3-5 mm).

[0037] Each (secondary) support 120 comprises a (fixing) plate 420 (for example, circular-shaped), which is used to fix the support 120 to the desired bearing structure (for example, by means of two dowels inserted through corresponding slots that cross them). A bracket 425 (for example, rectangular-shaped with rounded corners) extends perpendicularly from the centre of the plate 420, with a length substantially equal to the width of the metal foil 110. Two pairs of threaded pegs 4301 and 430r (for example, inserts) corresponding to the pairs of through holes 4151 and 415r, respectively, of two aligned base modules extend perpendicularly from the bracket 425 at each of its two side edges. The threaded pegs 4301,430r have a width matching the through-holes 415l,415r and a height greater than the thickness of the metal foil 110 (for example, 3-5 mm). Two pairs of (fixing) nuts 4351 and 435r are provided for the two pairs of threaded pegs 4301 and 430r, respectively. The support 120 further comprises a cover 440 (for example, cylindrical-shaped) for enclosing the bracket 425, which is equipped with a locking mechanism (for example, of snap type) on the plate 420. The cover 440 has a pair of slots 445 (of which only one visible in the figure) corresponding to the metal foil 110 and to the lighting component 220 of the two aligned base modules, which extend longitudinally from a free edge thereof. Similar considerations apply to the main support of the lighting apparatus, not shown in the figure (with the main support and a terminal secondary support that have only one slot).

[0038] The lighting apparatus 100 is installed by fixing (to the wall in the example at issue) the main support (in correspondence to a mains power supply) and each required (secondary) support 120, according to the number of base modules, in a position corresponding to the desired shape of the lighting apparatus. For each base module, the lighting component 220 is superimposed onto the metal foil 110 (remaining locked thereon by the magnetic attraction force between the coupling strip 205 and the metal foil 110), so that each slot 4101,410r is coaxial with the corresponding through hole 415l,415r. The longitudinal ends of the metal foil 100 with the lighting component 220 mounted thereon are supported on the brackets of a corresponding pair of adjacent supports 120 (or of the main support and a first support 120). In this way, each threaded peg 4301,430r crosses the corresponding through hole 415l,415r (projecting into the corresponding slot 410l,410r). Each nut 435l,435r is screwed onto the

corresponding threaded peg 430l,430r (as described in detail below). The LED strip 105 is electrically connected to the LED strip 105 of the preceding base module (or to the power transformer in the main support). The cover 440 is fitted onto the bracket 425, so that the foil 110 with the lighting component 220 is inserted into the slot 445, until it is locked onto the plate 420.

[0039] With reference now to FIG.5A-FIG.5D, they show a schematic representation of a detail of the lighting apparatus according to an embodiment of the present disclosure in various operative conditions.

[0040] Particularly, FIG.5A shows a top view of a generic installation support 120 (without cover) and FIG.5B shows a side cross-section view thereof (with the cover 440) along the section plane A-A of FIG.5A at a slot 405r (with similar considerations that apply to the slot 4051).

[0041] As shown in FIG.5B, each nut 435l,435r comprises a (sliding) shank 505l,505r (for example, with circular cross-section) having a size matching the width of the slot 4101,410r and a height corresponding to a thickness of the coupling strip 205 plus the stiffening strip 405l,405r. The nut 435r,435l further comprises a (driving) head 510l,510r (for example, slightly wider than the shank 505l,505r and provided with a recess for an Allen key). The shank 505l,505r and the head 510l,510r are separated by a (stop) collar 515l,515r larger than the width of the slot 410l,410r. A blind threaded hole 520l,520r (matching the corresponding threaded peg 4301,430r) extends upward from a base of the shank 505l,505r. The shank 505l,505r acts as guide peg for the sliding of the slot 410l,410r, while the collar 515l,515r acts as stop of the lighting component 220 against the metal foil 110 (without however preventing its sliding in parallel thereto).

[0042] When the base module is bent so that the lighting component 220 is arranged inside the metal foil 110, as shown in FIG.5C, the lighting component 220 slides toward the outside of the metal foil 110 (to the right in the figure), thereby retracting into the support 120 through the slot 445; the shank 505l,505r guides this sliding of the slot 4101,410r (at most when its left end abuts against it).

[0043] On the contrary, when the base module is bent so that the lighting component 220 is arranged outside the metal foil 110, as shown in FIG.5D, the lighting component 220 slides toward the inside of the metal foil 110 (to left in the figure), thereby projecting from the support 120 through the slot 445; the shank 505l,505r guides this sliding of the slot 4101,410r as above (at most when its right end abuts against it).

[0044] In this way, the nuts 435l,435r prevent any detachment of the lighting component 220 from the metal foil 110 (for example, when excessively bent). Furthermore, they maintain the correct alignment of the lighting component 220 with the metal foil 110 during their relative sliding (limiting their travel as well).

[0045] Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply many logical and/or physical modifications and alterations to the present disclosure. More specifically, although this disclosure has been described with a certain degree of particularity with reference to one or more embodiments thereof, it should be understood that various omissions, substitutions and changes in the form and details as well as other embodiments are possible. Particularly, different embodiments of the present disclosure may even be practiced without the specific details (such as the numerical values) set forth in the preceding description to provide a more thorough understanding thereof; conversely, well-known features may have been omitted or simplified in order not to obscure the description with unnecessary particulars. Moreover, it is expressly intended that specific elements and/or method steps described in connection with any embodiment of the present disclosure may be incorporated in any other embodiment as a matter of general design choice. In any case, ordinal or other qualifiers are merely used as labels to distinguish elements with the same name but do not by themselves connote any priority, precedence or order. Moreover, the terms include, comprise, have, contain and involve (and any forms thereof) should be intended with an open, non-exhaustive meaning (*i.e.*, not limited to the recited items), the terms based on, dependent on, according to, function of (and any forms thereof) should be intended as a non-exclusive relationship (*i.e.*, with possible further variables involved), the term a/an should be intended as one or more items (unless expressly indicated otherwise), and the term means for (or any means-plus-function formulation) should be intended as any structure adapted or configured for carrying out the relevant function.

[0046] For example, an embodiment provides a lighting apparatus. The lighting apparatus comprises at least one flexible strip of one or more lighting elements, at least one support element for the strip of lighting elements, and coupling means for coupling the strip of lighting elements with the support element. The coupling means comprises at least one flexible coupling strip fixed to the strip of lighting elements. The coupling strip and the support element comprise a magnetic material and/or a ferromagnetic material (for exerting a magnetic attraction force between the coupling strip and the support element).

[0047] However, the lighting apparatus may be of any type (for example, with any number of base modules, each arranged in any configuration such as straight, wavelike, S-like, U-like, O-like, ?-like, or in any combination thereof, with any support even all equal among them when the power transformer is remote). The lighting apparatus may comprise any number of strips of lighting elements, each one with any shape and size; furthermore, the strip of lighting elements may be of any type (for example, self-dissipating as well) and it may comprise different, additional or alternative components, with the lighting elements that may be in any number (one or more) and of any type (for example, LEDs, OLEDs, AMOLEDs, electroluminescence elements, ELs), with

any operating characteristic, and in any position and number. The support element may be of any type (see below). The lighting apparatus may comprise any number of coupling strips (even with more strips of lighting elements for each coupling strip or *vice-versa* more coupling strips for each strip of lighting elements), each one with any shape and size. The strip of lighting elements and the coupling strip may be fixed to each other in any way (for example, mechanically or even with the coupling strip being an integral part of the strip of lighting elements). The flexibility of the strip of lighting elements and of the coupling strip may be defined by other values, either different or equal to each other (measured in any way). The magnetic material and the ferromagnetic material may be of any type (for example, of natural, ceramic, sintered type for the magnetic material and iron, cobalt, nickel, rare earths for the ferromagnetic material) and in any combination (see below).

[0048] In an embodiment, the coupling strip comprises said magnetic material and the support element comprises said ferromagnetic material.

[0049] However, the possibility of making the support element of magnetic material and the coupling strip of ferromagnetic material, both of magnetic material (either equal or different), or in any combination of magnetic and ferromagnetic materials (for example, one in part of magnetic material and in part of ferromagnetic material and the other only of magnetic material, only of ferromagnetic material or of both of them) is not excluded.

[0050] In an embodiment, said magnetic material comprises ferrite rubber magnet.

[0051] However, the magnetic material may comprise rubber (*i.e.*, a material with high elasticity, either of natural or synthetic type as defined in the standard ISO1629) of any type (for example, NBR, HNBR, latex, CPE, TPE) that acts as a binder for magnetic particles of any type (either of natural or synthetic type); in any case, the magnetic particles may also be embedded in another more or less electrically insulating material (such as Kapton), and the possibility is not excluded of providing a strip entirely of magnetic material.

[0052] In an embodiment, said support element comprises a thermally conductive material for dissipating heat produced by the strip of lighting elements in operation.

[0053] However, the support element may be made of any thermally conductive material (for example, iron), with other values of thermal conductivity; in any case, the use of a support element of thermally insulating material is not excluded (for example, for self-dissipating LED strips).

[0054] In an embodiment, the support element comprises a flexible support foil; a bending stiffness of the support foil is higher than a bending stiffness of the strip of lighting elements and of the coupling strip.

[0055] However, the support foil may have any shape and size (even equal to the strip of lighting elements) and its flexibility may be defined by other values (even measured in a different way), either in absolute terms or in relative terms with respect to the flexibility of the strip of lighting elements and of the coupling strip. In any case, the support foil may mount one or more strips of lighting elements only on a side thereof or on both; more generally, one or more strips of lighting elements may be mounted on a support element of any other type, being rigid as well (such as a cabinet, a reflector).

[0056] In an embodiment, the lighting apparatus further comprises a pair of stiffening strips fixed to the coupling strip alongside the strip of lighting elements; a bending stiffness of the stiffening strips is higher than a bending stiffness of the strip of lighting elements and of the coupling strip.

[0057] However, the stiffening strips may have any shape and size, and may be made of any material (either electrically insulating or electrically conductive, such as Teflon or stainless steel, respectively). The flexibility of the stiffening strips may be defined by other values, even different between them, either in absolute terms or in relative with respect to the strip of lighting elements and to the coupling strip, and possibly in relative terms with respect to the support strip as well (measured in different ways as well). In any case, the stiffening strips may be arranged in another position, may be in different number (one or more than two), may be replaced with strips of pure ornament (with any bending stiffness even lower than that of the strip of lighting elements and of the coupling strip) or may be completely omitted.

[0058] In an embodiment, the coupling means comprises mechanical restraining means; the restraining means prevents at least in part a detachment of the coupling strip from the support element but allows a sliding at least partial of the coupling strip along the support element.

[0059] However, the restraining means may prevent the detachment of different, additional or alternative parts of the coupling strip (up to its entirety), and may allow its complete or only partial sliding. In any case, such constraining means may be implemented in any way (see below), or may even be entirely omitted.

[0060] In an embodiment, the restraining means comprises the following elements at each end of the coupling strip. Particularly, one or more slots are provided, each one of them crossing the coupling strip. Moreover, one or more pegs are provided integral with the support element, each one of them crossing a corresponding one of the slots for guiding a sliding thereof; each peg comprises a stop collar of the coupling strip against the support element.

[0061] However, the slots, the pegs and the collars may have any shape and size, and the collars may act either directly or indirectly (for example, via the stiffening strips) on the coupling strip. In any case, nothing prevents providing any number of such elements, arranged in any position (even when the stiffening strips are not provided); more generally, the same result may also be achieved with other elements (for example, lateral stopping clips).

[0062] An embodiment provides a lighting component for use in such lighting apparatus; said lighting component comprises said at least one strip of lighting elements and said at least one coupling strip fixed to the strip of lighting elements.

[0063] However, the lighting component may comprise any other element (such as the stiffening strips, the slots, a fuse). This lighting component lends itself to be made and put on the market as a stand-alone product, even for use in lighting apparatuses already existing.

[0064] Generally, similar considerations apply if the lighting apparatus and the lighting component each has a different structure or comprises equivalent components (for example, of different materials), or it has other operative characteristics. In any case, every component thereof may be separated into more elements, or two or more components may be combined together into a single element; moreover, each component may be replicated to support the execution of the corresponding operations in parallel. Moreover, unless specified otherwise, any interaction between different components generally does not need to be continuous, and it may be either direct or indirect through one or more intermediaries.

[0065] An embodiment provides a method for mounting a lighting apparatus. The method comprises the following steps. At least one flexible strip is provided of one or more lighting elements. At least one support element is provided for the strip of lighting elements. The strip of lighting elements is coupled with the support element. Said step of coupling comprises exerting a magnetic attraction force between at least one flexible coupling strip fixed to the strip of lighting elements and the support element; the coupling strip and the support element comprise a magnetic material and/or a ferromagnetic material for exerting said magnetic attraction force.

[0066] However, these steps may be performed either during the preparation of the lighting apparatus (for example, in the factory) or during installation/maintenance (for example, at home).

[0067] Generally, similar considerations apply if the same solution is implemented with an equivalent method (by using similar steps with the same functions of more steps or portions thereof, removing some steps being non-essential, or adding further optional steps); moreover, the steps may be performed in a different order, concurrently or in an interleaved way (at least in part).

Claims

1. A lighting apparatus (100) comprising at least one flexible strip of one or more lighting elements (105), at least one support element (110) for the strip of lighting elements, and coupling means (205,410l,410r,435l,435r) for coupling the strip of lighting elements with the support element,
characterized in that
the coupling means comprises at least one flexible coupling strip (205) fixed to the strip of lighting elements, the coupling strip and the support element comprising a magnetic material and/or a ferromagnetic material for exerting a magnetic attraction force between the coupling strip and the support element.

2. The lighting apparatus (100) according to claim 1, wherein the coupling strip (205) comprises said magnetic material and the support element (110) comprises said ferromagnetic material.

3. The lighting apparatus (100) according to claim 1 or 2, wherein said magnetic material comprises ferrite rubber magnet.

4. The lighting apparatus (100) according to any one of claims 1 to 3, wherein said support element (110) comprises a thermally conductive material for dissipating heat produced by the strip of lighting elements (105) in operation.

5. The lighting apparatus (100) according to any one of claims 1 to 4, wherein the support element (110) comprises a flexible support foil (110), a bending stiffness of the support foil being higher than a bending stiffness of the strip of lighting elements (105) and of the coupling strip (205).

6. The lighting apparatus (100) according to any one of claims 1 to 5, further comprising a pair of stiffening strips (405l,405r) fixed to the coupling strip (205) alongside the strip of lighting elements (105), a bending stiffness of the stiffening strips being higher than a bending stiffness of the strip of lighting elements and of the coupling strip.

7. The lighting apparatus (100) according to any one of claims 1 to 6, wherein the coupling means (205,410l,410r,435l,435r) comprises mechanical restraining means (410l,410r,435l,435r), the restraining means preventing at least in part a detachment of the coupling strip (205) from the support element (110) but allowing a sliding at least partial of the coupling strip along the support element.

8. The lighting apparatus (100) according to claim 7, wherein the restraining means (410l,410r,435l,435r) comprises, at each end of the coupling strip (205), one or more slots (4101;410r) each one crossing the coupling strip, and one or more pegs (435l,435r) integral with the support element (110) each one crossing a corresponding one of the slots for guiding a sliding thereof, each peg comprising a stop collar (515l,515r) of the coupling strip against the support element (110).

9. A lighting component (220) for use in the lighting

apparatus according to any one of claims 1 to 8, wherein said lighting component comprises said at least one strip of lighting elements (105) and said at least one coupling strip (205) fixed to the strip of lighting elements.

10. A method for mounting a lighting apparatus (100) comprising:

providing at least one flexible strip of one or more lighting elements (105),
providing at least one support element (110) for the strip of lighting elements, and
coupling the strip of lighting elements with the support element,
characterized in that

said coupling comprises:

exerting a magnetic attraction force between at least one flexible coupling strip (205) fixed to the strip of lighting elements and the support element, the coupling strip and the support element comprising a magnetic material and/or a ferromagnetic material for exerting said magnetic attraction force.

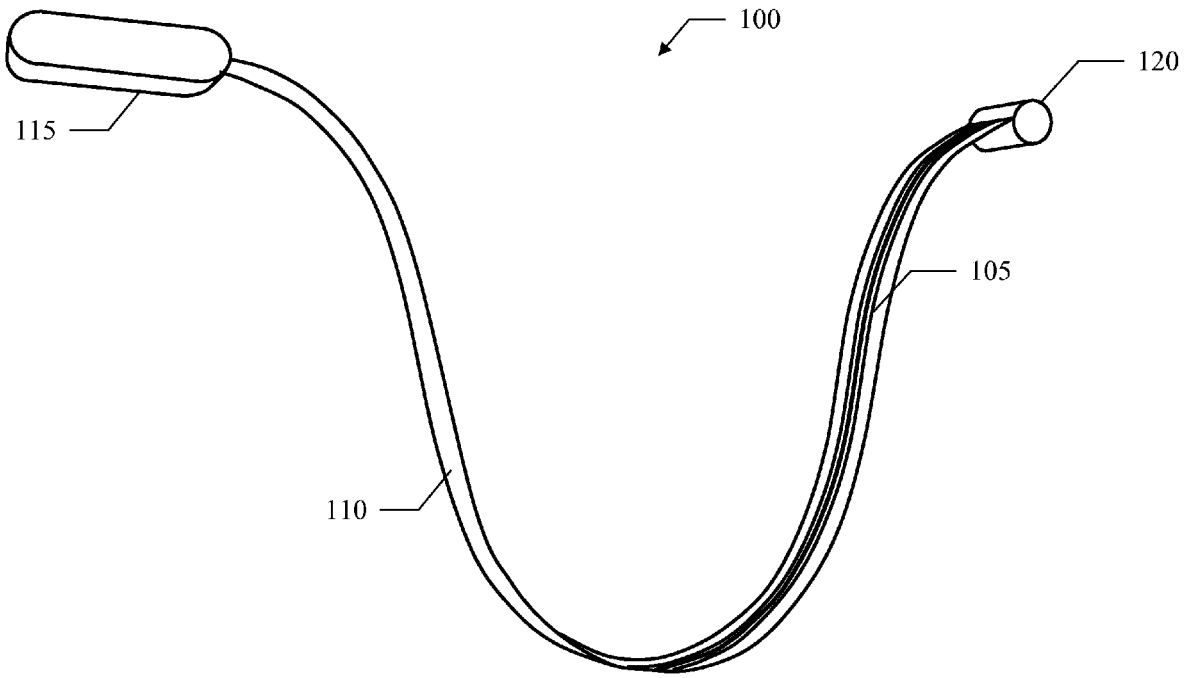


FIG.1

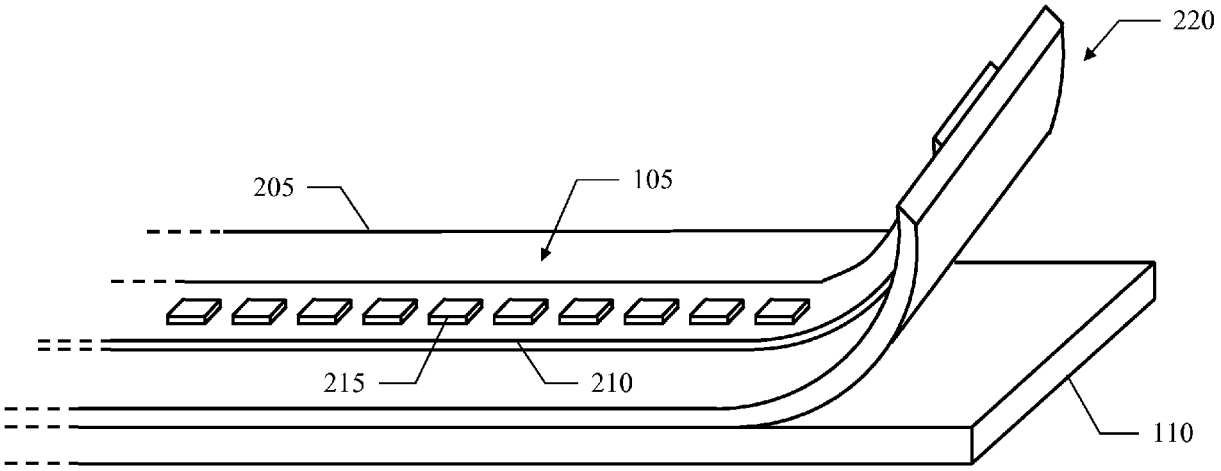


FIG.2

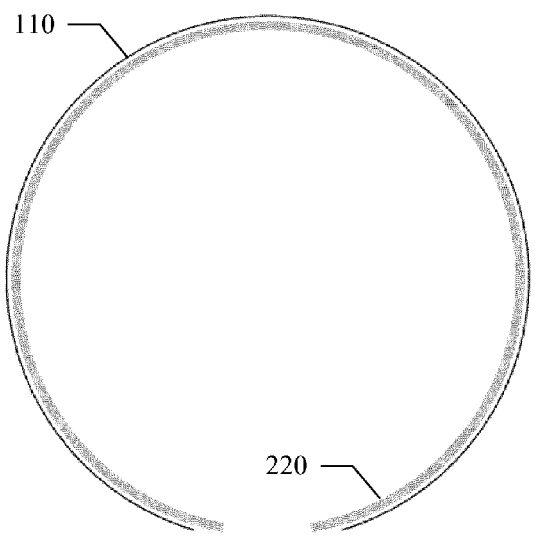


FIG.3A

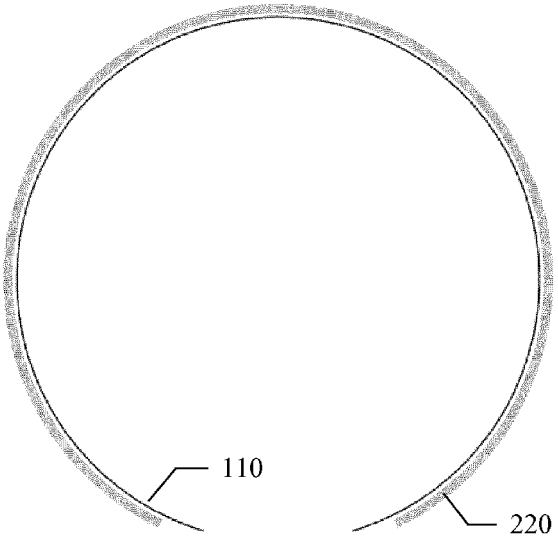
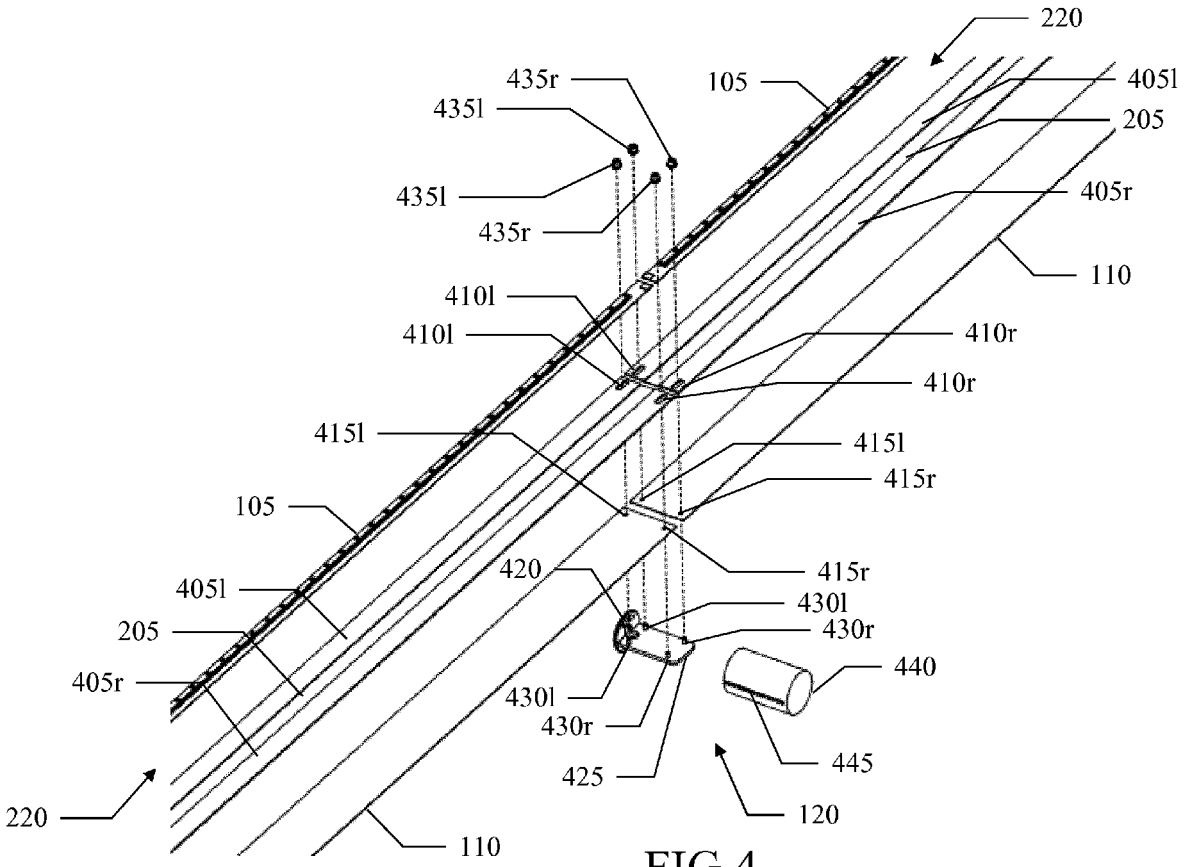


FIG.3B


220
435r
105
4051
435l
205
435l
405r
435r
110
410l
410l
410r
410r
415l
415l
415r
105
415r
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205
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405r
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430l
430r
445
425
220
120
110

FIG.4

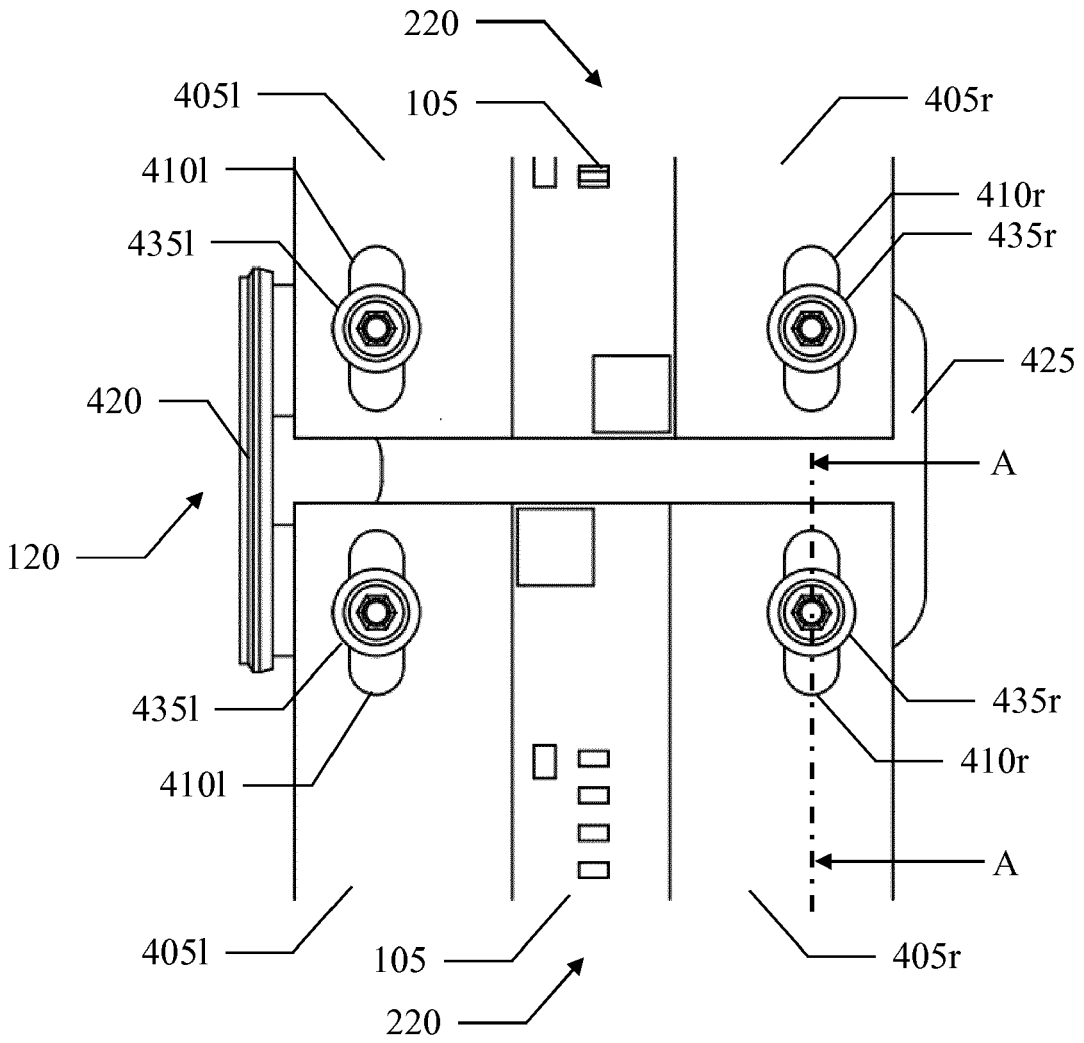

220
4051
105
405r
4101
410r
4351
435r
425
420
A
120
4351
435r
4101
410r
A
4051
105
405r
220

FIG.5A

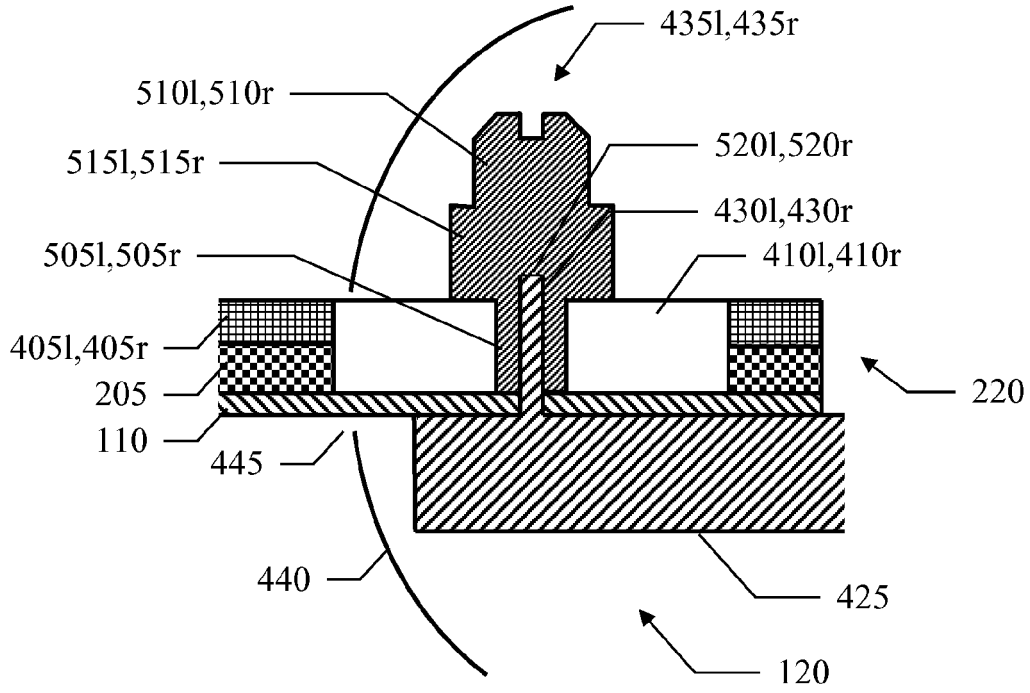
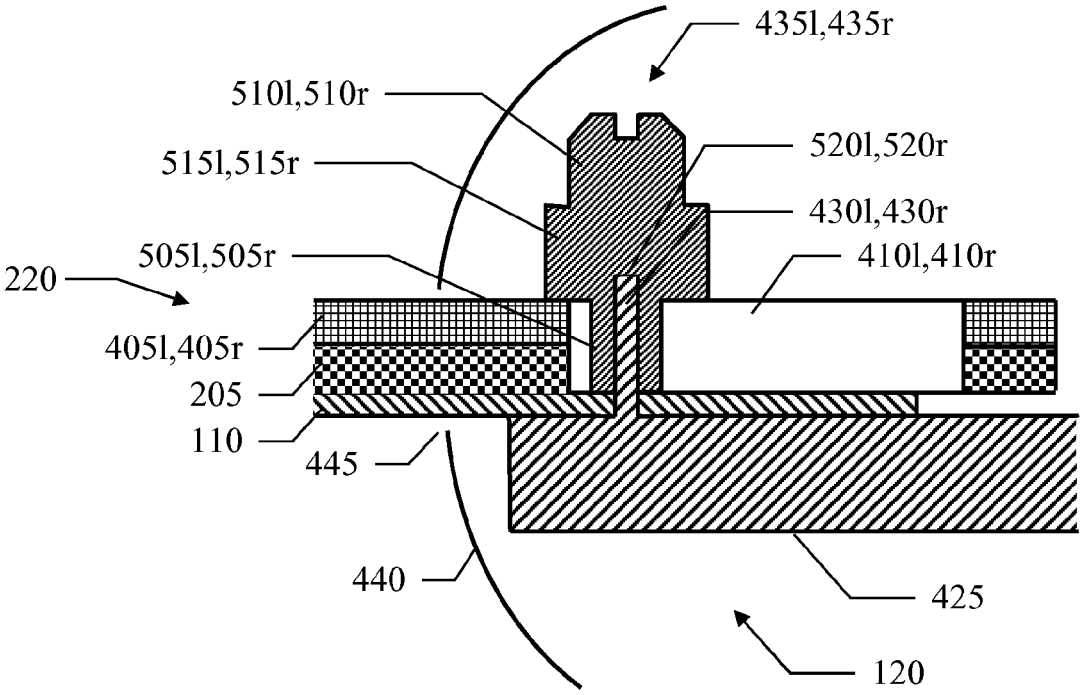

435l,435r
510l,510r
520l,520r
515l,515r
430l,430r
505l,505r
410l,410r
405l,405r
220
205
110
445
440
425
120

FIG.5B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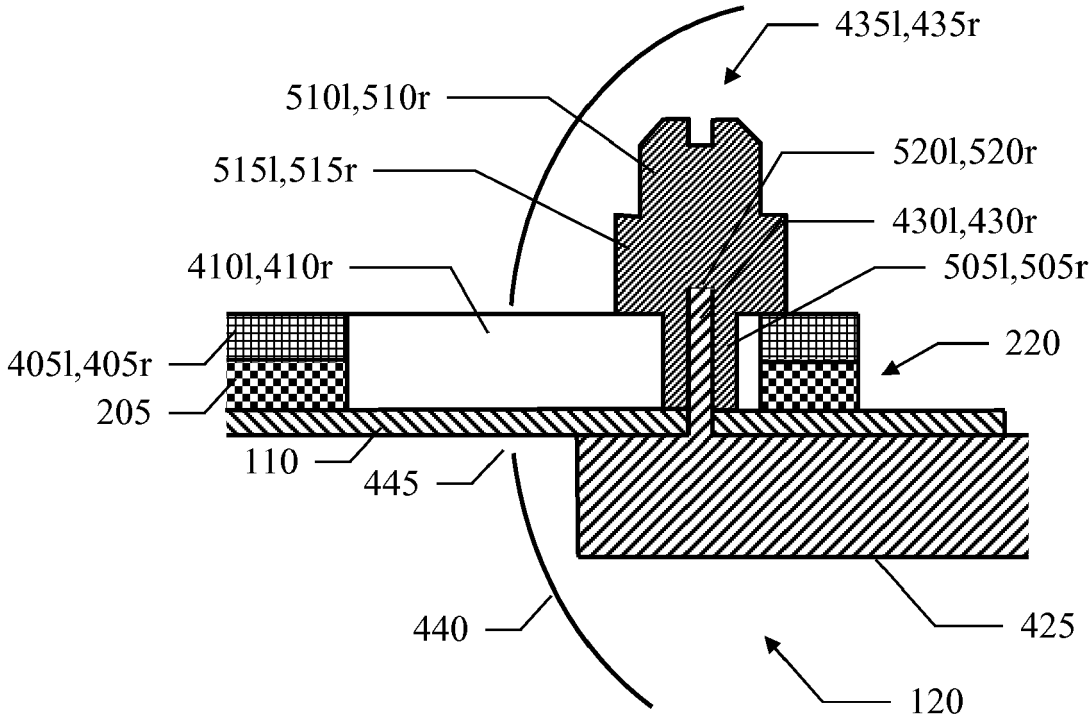
440
425
120

FIG.5C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510l,510r
520l,520r
515l,515r
430l,430r
410l,410r
505l,505r
220
405l,405r
205
110
445
440
425
120

FIG.5D

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EUROPEAN SEARCH REPORT

Application Number
EP 15 15 3610

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F21S F21V F21Y

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 June 2015	Menn, Patrick

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