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(54) **LIGHT STRIP AND RELATIVE METHOD OF MANUFACTURE**

(57) Light strip (10), comprising a flexible printed circuit (11) provided with one or more light sources (15) and housed in a substantially "U"-shaped profile (12).

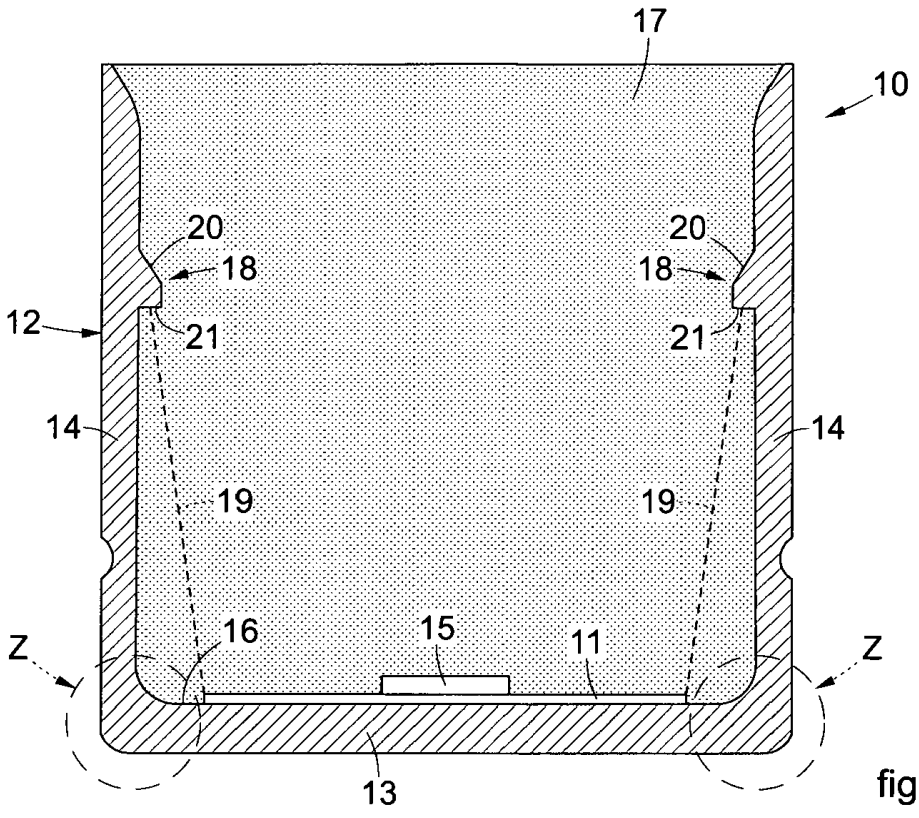

fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention concerns a light strip and the relative method of manufacture, in particular in the field of lighting technology to manufacture light strips that support, on their length, light sources, for example but not only LEDs (Light Emitting Diodes).

[0002] Said strips are applicable on profiles, tables, doors, furniture components in general, wall portions, floors, ceilings and false ceilings, and in other various applications, indoor or outdoor, in which particular aesthetic effects and/or focused and/or distributed lighting are wished.

BACKGROUND OF THE INVENTION

[0003] The light strips that can be used in the lighting and furniture sector to create points/light zones distributed in specific portions of wall elements or furniture components are known.

[0004] The development of LED and OLED (Organic led) technology, together with increasingly advanced architectural requests and proposals, has permitted the development of technologically advanced solutions, allowing to create extremely sophisticated lighting effects, in particular combined with profiles and edges of furniture components, as well as windows and doors, partitions, external walls and more.

[0005] Such a light strip normally consists of a longitudinal support, or profile, with prevailing length over width, made of normally flexible material on which a thin coating of copper, mono- or bi-layer, is applied, which creates the conductive track(s) for the electrical power supply of the light sources.

[0006] This combination between profile and conductive coating forms a so-called PCB (Printed Circuit Board) on which the light sources, as well as the related electrical/electronic power supply and management components are applied, and from which the light sources obtain the electrical power supply.

[0007] At the positioning of the light sources, a base in rigid material is normally provided, which forms a stable support for the correct positioning and maintenance of the light sources in place and guarantees the necessary mechanical tightness of the strip, as well as of the welds and of the electrical connections. Once the desired arrangement of the light sources has been made, the strip is coupled to a profile made of plastic material or silicone, and the whole is then embedded in a resin, or similar material, which seals and defines the final shape of the strip. This resin, usually made of silicone material, ensures high electrical insulation, making the strip applicable also outdoors.

[0008] Said profile has a substantially "U"-shape, so that it can be filled by said protective resination. The walls of the profile have the task of containing the liquid resin during pouring and must have the intrinsic characteristic of keeping the resin adhering to the walls once it has solidified. Said "U"-shaped profile also has the characteristic of having an open side from which the light beam comes out through the protective resin, while the other walls closed by the profile itself do not allow the light to exit.

[0009] The profiles are obtained by extrusion of normal plastic material, such as silicone, polyvinylchloride (PVC) or polyurethane (PU), and packed in the form of a tape or ribbon in reels that limit their overall size and facilitate the transport thereof. Not winding the profiles in reels but keeping them in a linear arrangement would be uneconomical, both from the point of view of transport and storage, and from the point of view of processing. The reel during the manufacture of the light strip will be unwound and the profile cut to the desired length having the possibility of creating strips with lengths that are even different from the standard ones, thus avoiding waste.

[0010] However, there is a problem in making reels with "U"-shaped profiles because their shape makes it difficult to wind them. They should in fact be crushed so as to form a tape or ribbon. Being made of plastic material, this crushing in the tape or ribbon is possible even if it will damage the shape of the "U" because, once the reel is unwound, the profile will hardly return to the starting shape. In fact, the crushing suffered by the profile in order to be wound into a reel compromises not only the shape but also cracks might occur that would affect the mechanical properties of the profile itself.

[0011] In an attempt to obviate these drawbacks at present there are profiles on the internal surface of which parallel and deep incisions are made that facilitate the folding of the edges. These incisions are therefore made in the connection zone between the base of the profile and the side walls that give rise to the substantially "U"-shape.

[0012] In this way it is possible to pass from a ribbon to a "U"-shaped profile thanks to precisely the folding along these incisions. In doing so, however, the incisions become a point that presents much less material, with consequent weakening, which can also lead to the unwanted cutting of the profile itself at the time when the strip is folded in the implementation step.

[0013] A rigid support having the desired shape is often used to allow the profile to pass from the flat shape to the "U"-shape. The ribbon is inserted into said rigid support and is crushed at the walls to make them take the "U"-shape. In order to obtain an effective forming, it is necessary that the side walls of the profile adhere to the side walls of the rigid support.

[0014] Since the ribbon is provided with such deep incisions, this adhesion cannot be obtained so easily because the side walls of the profile once they are inserted in the template will tend to fold inwards. The not perfect adhesion between the side walls of the profile with the template means that the resin pouring is not perfect and the section is not constant throughout the length of the

light strip. In practice, the strips obtained with this profile always have some difference from each other and do not have the characteristics of seriality that these products, which are also designed to be put into operation visually and therefore with a uniform and pleasant appearance, should have.

[0015] The materials with which the profiles are normally made, such as silicone, PVC or polyurethane (PU), with the time passing by and with adverse atmospheric and environmental conditions tend to lose their mechanical qualities. The UV rays of the sun tend to yellow the profile which is usually white in colour for architectural and aesthetic reasons. The sun, in addition to causing pigmentation problems, affects with its heat situations where the application is particularly unfavourable. Think of an installation on a glass facade in the middle of summer, perhaps at latitudes close to the tropics, where temperatures in those places can exceed 50 °C. PVC and polyurethane (PU), for example, tend to soften with consequent problems on the adhesion of the strip on a recessed housing thereof. In an installation where the light strip is pointing downwards, if the strip softens it will tend to come out of the recessed housing resulting in detachment and fall. To avoid dangers, the trend is to avoid using these products in geographical areas or in particular installations where it is known that the temperature may exceed a critical threshold. Another criticality of these profile materials is the non-excellent adhesion with the resin once it has solidified. Excessive bending tends to compromise the adhesion between the two materials limiting their radius of curvature in order to prevent them from detaching.

[0016] There is therefore the need to perfect a light strip and relative method of manufacture that can overcome at least one of the disadvantages of the state of the art.

[0017] In particular, one purpose of the present invention is to manufacture a light strip in which the profile has and maintains high mechanical properties, which can be wound up without difficulty into a reel and which does not have weakening points, especially in the connection zone between the base and side walls of the profile.

[0018] A further purpose of the invention is to manufacture a light strip in which the profile returns without difficulty to the initial shape after having been unwound from the reel and which does not undergo significant yellowing and softening phenomena at high temperatures.

[0019] A further purpose of the invention is to manufacture an extremely flexible and resistant light strip that can be shaped into various shapes, even three-dimensional ones, without compromising its mechanical properties.

[0020] Another purpose of the present invention is to develop a method of manufacture of the aforementioned light strips that is effective, fast and economical.

[0021] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0022] The present invention is set forth and characterized in the independent claims. The dependent claims describe other characteristics of the present invention or variants to the main inventive idea.

[0023] In accordance with the above purposes, a light strip according to the present invention comprises a flexible printed circuit provided with one or more light sources and housed in a substantially "U"-shaped profile.

[0024] According to one aspect of the invention, said profile is made by means of an elastic memory or shape memory polymeric material and has a substantially constant thickness at least in a connection zone between its base and its side walls.

[0025] Thanks to the use of said elastic memory or shape memory polymeric material and to the uniformity of thickness in said connection zone, the profile_has and maintains high mechanical properties, can be wound up without difficulty into a reel and does not have weakening points, such as grooves, incisions or the like, especially in said connection zone.

[0026] Moreover, said profile can easily return to the initial shape after having been unwound from the reel and does not undergo significant yellowing and softening phenomena at high temperatures.

[0027] The present light strip is therefore extremely flexible and resistant and can be shaped into various shapes, even three-dimensional ones, without compromising its mechanical properties.

[0028] According to a further aspect of the invention, said polymeric material is a thermoplastic elastomer such as TPC-ET copolyester or the like.

[0029] According to a further aspect of the invention, said profile has a substantially smooth internal surface at least at said zone, which is therefore free of grooves, incisions or the like.

[0030] A further purpose of the invention is a method of manufacture of a light strip, comprising at least one step of extruding an elastic memory or shape memory polymeric material so as to obtain a profile and at least one forming step, in which said profile is inserted into a template to give it a substantially final "U"-shape and a flexible printed circuit provided with one or more light sources is housed therein.

[0031] According to a further aspect of the invention, prior to insertion into said template, said profile has a substantially flared or open "U"-shape. Thanks to said partial shape, when said profile is inserted in said template, its side walls tend to press against the side walls of said template. The positioning of said profile in said template is therefore extremely precise and stable.

[0032] According to a further aspect of the invention, said method comprises a step of filling said profile in which a liquid element, such as resin or the like, is poured inside said profile.

[0033] According to a further aspect of the invention, said profile, at the end of said extrusion step, is flattened and wound in a reel, so that it can be easily transported.

[0034] According to a further aspect of the invention, prior to introduction into said template, said profile is unwound from said reel and, following said unwinding, it automatically takes back said "U"-shape it had at the end of said extrusion step.

[0035] Basically, the operation of winding the profile in said reel takes place by applying a certain tension, which flattens said profile. When the reel is unwound, the tension ceases and the profile, thanks to the elastic memory or shape memory material of which it is made up, automatically returns to said substantially "U"-shape.

[0036] According to a further aspect of the invention, said extrusion step takes place at a temperature of about 195°-200°C, which has proved optimal for obtaining a profile with high mechanical and structural properties.

[0037] According to a further aspect of the invention, said method provides for a cooling and calibration step of the profile at the end of said extrusion step.

DESCRIPTION OF THE DRAWINGS

[0038] These and other aspects, characteristics and advantages of the present invention will become apparent from the following description of some embodiments, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a cross-sectional view of a light strip according to the present invention;
- fig. 2 is a schematic axonometric view of a step of manufacture of the present light strip;
- fig. 2a is a larger scale view of a zone of fig. 2;
- fig. 3 is a schematic axonometric view of a step of winding the profile of the present light strip;
- fig. 3a is a larger scale view of an area of fig. 3;
- figs. 4a-4e are schematic views of a sequence of further steps of manufacture of the present light strip.

[0039] We must clarify that in the present description the phraseology and terminology used, as well as the figures in the attached drawings also as described, have the sole function of better illustrating and explaining the present invention, their function being to provide a non-limiting example of the invention itself, since the scope of protection is defined by the claims.

[0040] To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one embodiment can be conveniently combined or incorporated into other embodiments without further clarifications.

DESCRIPTION OF SOME EMBODIMENTS OF THE PRESENT INVENTION

[0041] Detailed reference will now be made to the possible embodiments of the invention, one or more instances of which are shown in the attached figures by way of example only. The phraseology and terminology used herein is also for non-limiting exemplary purposes.

[0042] With reference to the accompanying drawings, see in particular fig. 1, a light strip 10 according to the present invention comprises a flexible printed circuit 11, provided with one or more light sources 15 and housed in a profile 12 provided with a base 13 and side walls 14 that give it a substantially "U"-shape. Said profile 12 has a substantially constant thickness at least in a connection zone Z between said base 13 and said side wall 14 and is made by means of an elastic memory or shape memory polymeric material.

[0043] Said profile 12, in said connection zone Z, is therefore free of grooves or deep incisions. In particular, said profile 12 has a smooth internal surface 16 at least at said zone Z.

[0044] Said material with which said profile 12 is made is in particular a thermoplastic elastomer such as TPC-ET copolyester or the like.

[0045] Copolyester (TPC-ET) is substantially a technopolymer that possesses elastic or shape memory characteristics as well as intrinsic qualities such as the ability to make the resin adhere more to the side walls 14 with consequent higher bending radii than what happens in the known profiles and the resistance to UV rays and to high temperatures without softening and losing the mechanical qualities. The ability of a technopolymer to return to the initial shape at the end of a stress depends mainly on two parameters: the "Compression Set" and the "Tension Set". The first one measures the permanent deformation at the end of a compressive force while the second one measures the permanent deformation after a tensile force. The copolyester (TPC-ET) has both these low values so at the end of a stress it returns to the starting shape. Other polymers such as PVC or silicone tend to elongate even during the step of positioning on the rigid resination support, with the drawback that the final light strips will hardly have a constant length due to these uncontrolled elongations.

[0046] Said light strip 10 comprises a filling covering 17 of said profile 12. Said covering 17 is obtained by pouring a liquid element, such as resin or the like, inside the profile 12 so as to cover the flexible printed circuit 11 and ensure a high degree of protection. The resin can be above flush with the profile 12 and ensures a high electrical insulation, making the strip applicable also outdoors.

[0047] Said light strip 10 may have, on each of the opposite side walls 14 of the profile 12, teeth 18 comprising above an inclined plane 20 and below a striking surface 21. Said teeth 18 preferably extend over each of said side walls 14 throughout the entire extension of the profile

12.

[0048] Said teeth 18 are useful in the case of using a flexible printed circuit 11 with fins 19 on the side or the like, illustrated schematically in hatching.

[0049] Said teeth 18 are configured to allow a mechanical coupling of the fins 19 with said profile 14. Said teeth 18 substantially allow the insertion from above and by snapping of the flexible printed circuit 11 inside the profile 12. The fins 19 can in fact slide along the inclined plane 20 and then abut against the striking surface 21.

[0050] A method according to the invention for the manufacture of said light strip 10 provides at least one step of extruding an elastic memory or shape memory polymeric material so as to obtain said profile 12 provided with said base 13 and said side walls 14 and at least one forming step, in which said profile 12 is inserted into a template 25 to give it a final substantially "U"-shape. Said flexible printed circuit 11 provided with one or more light sources 15 is housed in said profile 12.

[0051] The elastic memory or shape memory polymeric material, see figures 2 and 2a, is extruded, in particular at a temperature of about 195-200°C, through an extrusion die 22 which gives it a substantially partial "U"-shape. Said partial shape is like a flared, or open, "U" therefore with decreasing width from the top of the side walls 14 to the base 13, see fig. 4a.

[0052] Subsequently, said profile 12 passes through a calibration device 23, where it is progressively cooled down by means of water jets, for example. This passage in said calibration device 23 is useful for maintaining the desired measurements and avoiding deformations in said cooling step.

[0053] At the exit from the calibration step, the profile 12 has reached room temperature and is wound into a reel 24, see figures 3 and 3a. During winding, the profile 12 passes from the partial open "U" shape to the ribbon shape, then it is flattened. The ribbon shape of fig. 3a is obtained by tensioning said profile 12 on said reel 24. It can be further noted in fig. 3a the internal surface 16 of the profile 12 which is smooth and free of grooves or incisions.

[0054] Once the reel 24 is unwound and the tension ceases, the profile 12 returns to the starting partial "U"-shape, that is, that it had at the end of the extrusion step. Said elastic memory or shape memory polymeric material of which said profile 12 is made therefore has the ability to return to the original configuration, i.e. "U"-shaped, once the load that kept it in an alternative configuration, i.e. flattened, is removed. In this case the load is represented by the tension to which the profile 12 is subjected during the winding into the reel 24.

[0055] In the step of forming the light strip 10, said reel 24 with the profile 12 is unwound and then the profile 12 that is again like a "U" is inserted in said template 25, also substantially "U"-shaped. See fig. 4a. Said template 25 has in particular a base 26 and side walls 27 orthogonal to said base 26. Said template 25 therefore has a shape conjugated to the external shape of the light strip 10 that is to be obtained and in particular to the final external shape of said profile 12.

[0056] Advantageously, said profile 12 has a partially flared "U"-shape, therefore, as schematized in fig. 4b, once it has been inserted into the template 25, its side walls 14 tend to exert a thrust S towards the side walls 27 of said template 25, adhering perfectly to its internal shape. The material with which the profile 12 is made up, i.e. the elastic memory or shape memory polymeric material, also contributes to improving the adaptation to the shape of said template 25.

[0057] Subsequently, the flexible printed circuit 11 is inserted into said profile 12 and the resin pouring or the like is carried out, so as to manufacture said covering 17, see figures 4c and 4d.

[0058] The ability of the elastic memory or shape memory polymeric material to adhere optimally to the resin, causes the finished light strip 10, i.e. with the covering 17, to have upon extraction a final "U"-shape with side walls 14 orthogonal to the base 13, therefore no longer the partial flared shape that the profile 12 had before insertion into the template 25.

[0059] It is clear that modifications and/or additions of parts can be made to the light strip or to the relative method of manufacture as described heretofore, without departing from the field and scope of the present invention, as defined by the claims.

[0060] It is also clear that, although the present invention has been described with reference to some specific examples, a person skilled in the art shall certainly be able to achieve other equivalent forms of light strip and relative method of manufacture, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

[0061] In the following claims, the sole purpose of the references in brackets is to facilitate their reading and they must not be considered as restrictive factors with regard to the field of protection defined by the claims.

Claims

1. Light strip (10), comprising a flexible printed circuit (11) provided with one or more light sources (15) and housed in a substantially "U"- shaped profile (12), **characterized in that** said profile (12) is made by means of an elastic memory or shape memory polymeric material with a substantially constant thickness at least in a connection zone (Z) between its base (13) and its side walls (14).

2. Light strip (10) as in claim 1, **characterized in that** said polymeric material is a thermoplastic elastomer such as TPC-ET copolyester or the like.

3. Light strip (10) as in claim 1 or 2, **characterized in that** said profile (12) has a substantially smooth internal surface (16), free of grooves, incisions or the

like, at least at said zone (Z).

4. Method of manufacture of a light strip (10), **characterized in that** it comprises at least one step of extruding an elastic memory or shape memory polymeric material, so as to obtain a profile (12) and at least one forming step, in which said profile (12) is inserted into a template (25) to give it a substantially final "U"-shape and a flexible printed circuit (11) provided with one or more light sources (15) is housed therein.

5. Method as in claim 4, **characterized in that,** prior to insertion into said template (25), said profile (12) has a substantially flared or open "U"-shape.

6. Method as in claim 4 or 5, **characterized in that** it comprises a step of filling said profile (12) in which a liquid element, such as resin or the like, is poured inside said profile (12).

7. Method as in any claim hereinbefore, **characterized in that** said profile (12) at the end of said extrusion step is flattened and wound in a reel (25).

8. Method as in claim 7, **characterized in that** before introduction into said template (25), said profile (12) is unwound from said reel (25) and, following said unwinding, it automatically takes back said "U"-shape it had at the end of said extrusion step.

9. Method as in any claim hereinbefore, **characterized in that** said extrusion step is brought to an end at a temperature of about 195°-200°C.

10. Method as in claim 9, **characterized in that** downstream of said extrusion step there is provided a cooling and calibration step of said profile (12).

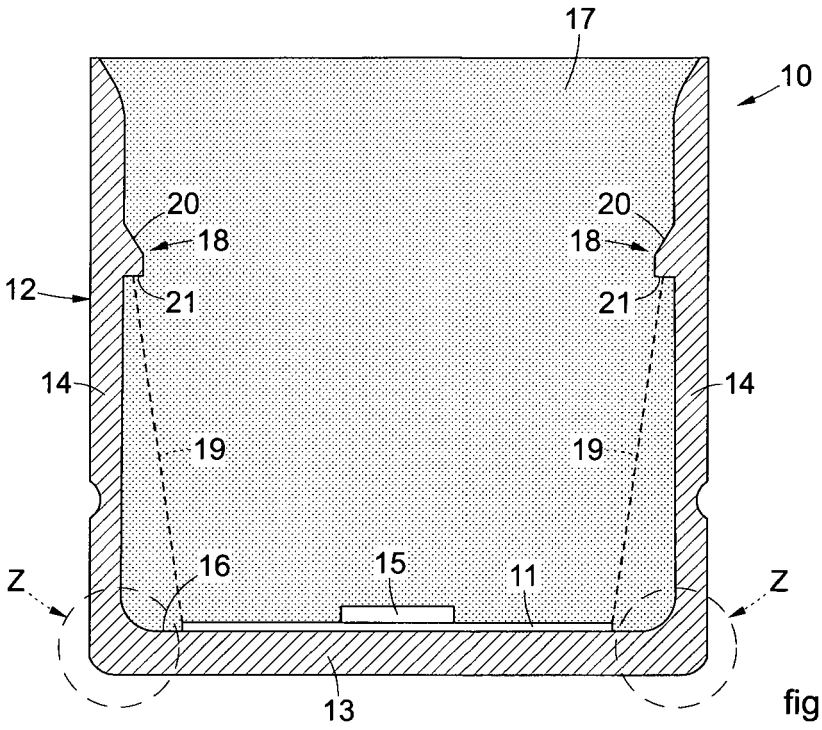

fig. 1

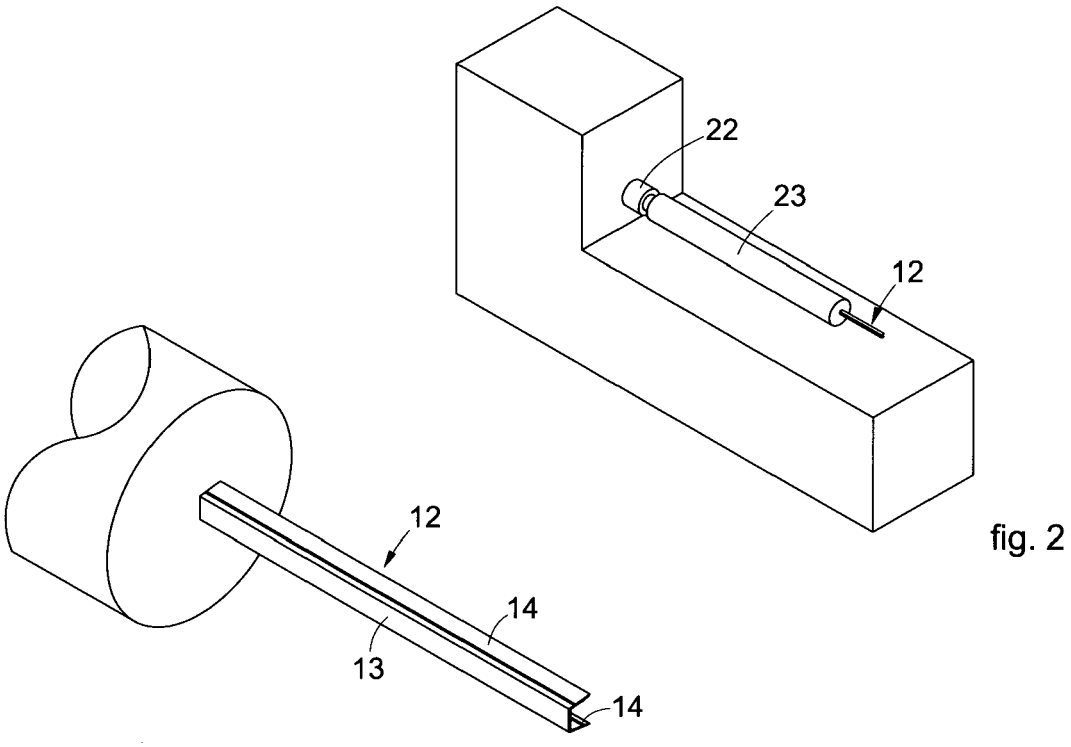

fig. 2

fig. 2a

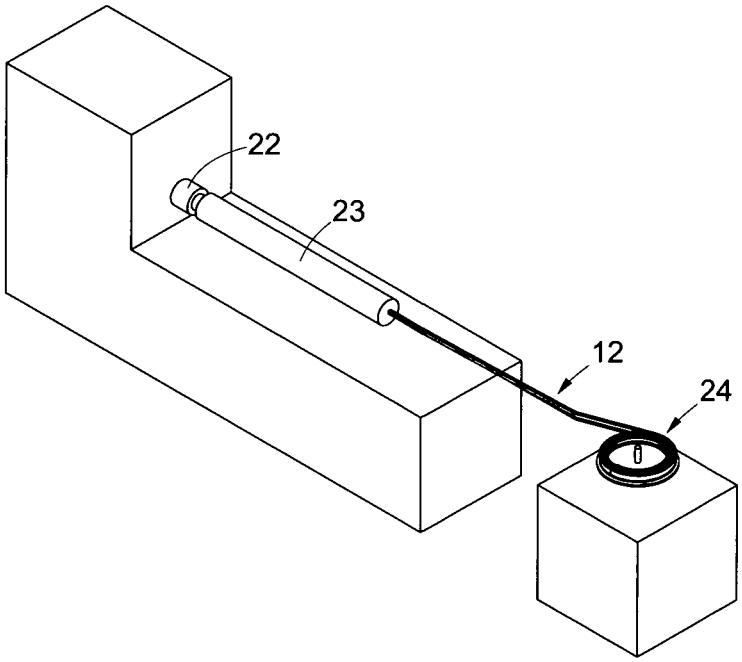

fig. 3

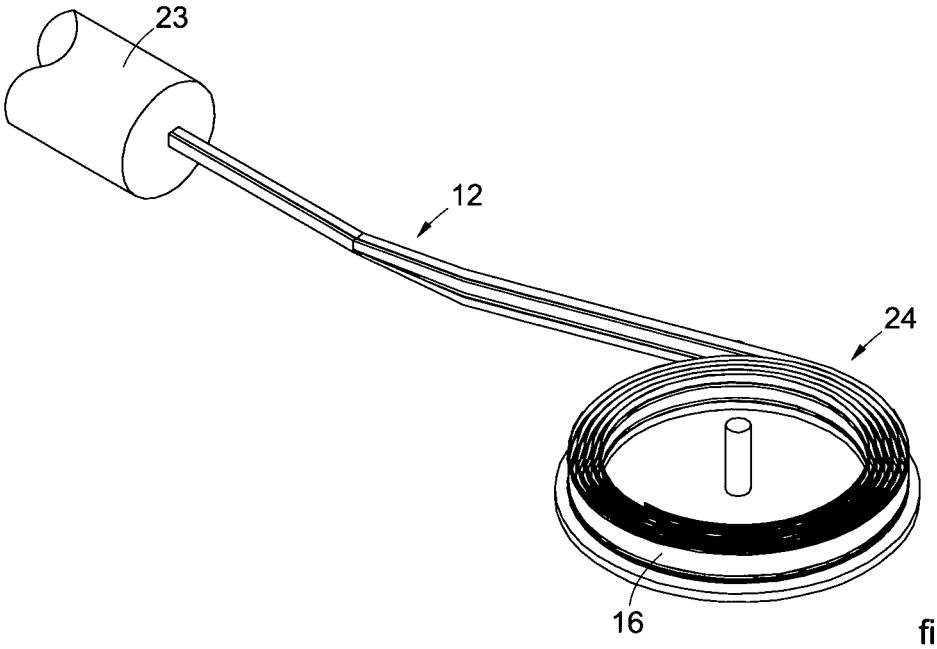

fig. 3a

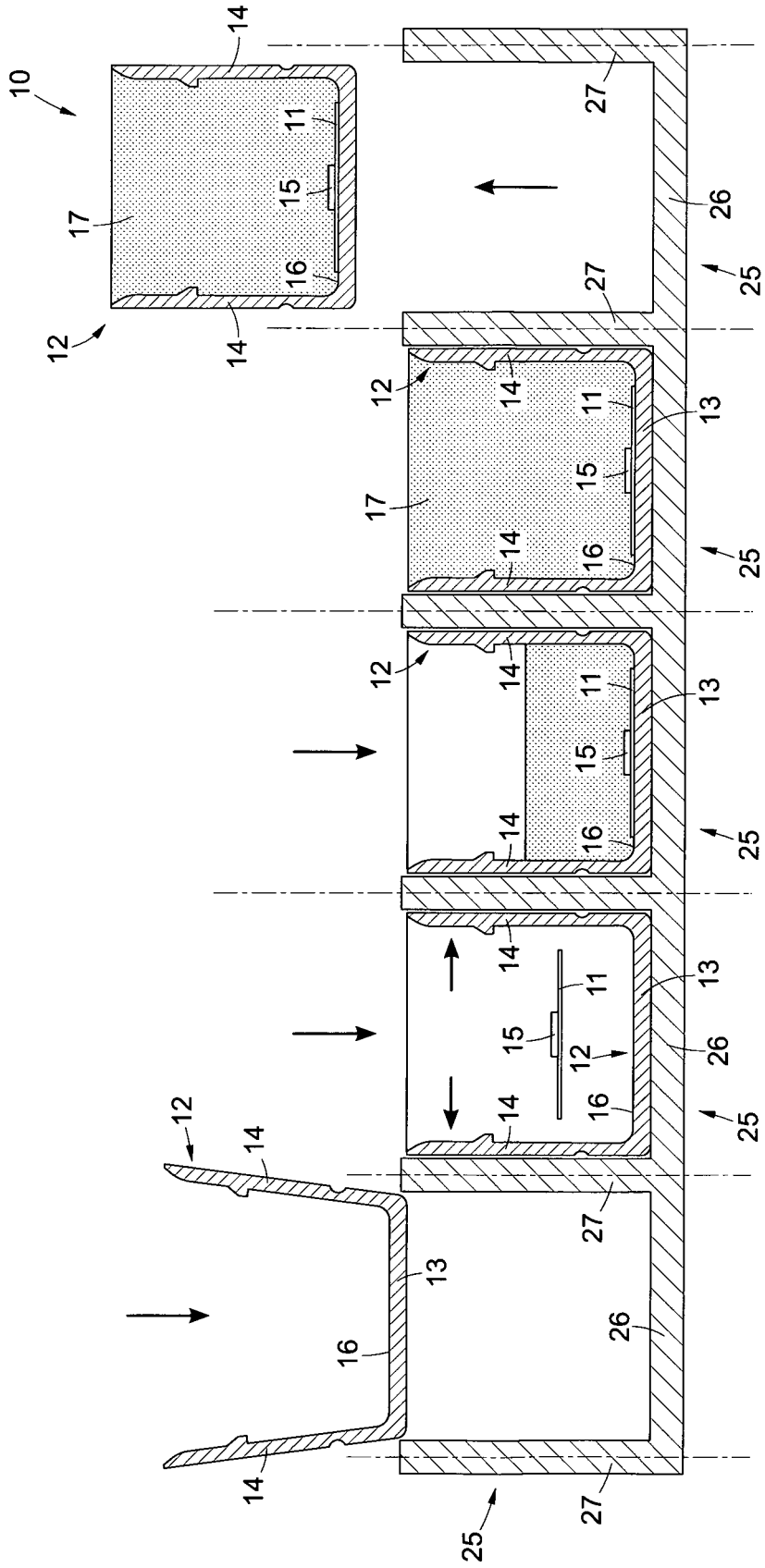

fig. 4a fig. 4b fig. 4c fig. 4d fig. 4e

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EUROPEAN SEARCH REPORT

Application Number
EP 23 42 5007

DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	* figures 1-9 *	9,10	F21V31/04
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F21S
F21V
F21K
H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 July 2023	Kebemou, Augustin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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