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(54) **FLAT LUMINAIRE**

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LUMINAIRE PLAT

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Description

[0001] The present invention is directed to a flat luminaire having a luminaire body, a lighting electronic, a light source and a luminaire cover. The invention is also directed to a method of manufacturing such a flat luminaire.

[0002] Such flat luminaires are known in the prior art and usually used as outdoor luminaires in many applications, lighting road infrastructures, public areas and many more. The current flat luminaire solutions are typically composed of die casted parts, particularly the luminaire housing. Such die casted parts are expensive and require global shipment, which thus make further impact to the environment. Due to the vast range of requirements, this often results in many tools and components needed to fulfil the marked needs. Moreover, die casted parts for luminaires, particularly for outdoor use, are prone to cracking, e.g., when being tightly fastened to a street light pole which requires, due to air streams and other external influences, a tight fit. Luminaires of this type are exemplarily shown in US 2019/0309935 A1, WO 2015/063805 A1, FR 3 073 605 A1, US 2011/0057081 A1, and US 2014/0218941 A1.

[0003] It is thus an object of the present invention to provide low-cost but flexible flat luminaires, e.g. for outdoor use, as well as a comparably simple method of manufacturing the same.

[0004] This object is obtained by the subject-matter of the independent claims. The dependent claims study further the central idea of the present invention.

[0005] According to a first aspect, the present invention is directed to a flat luminaire, like a flat outdoor luminaire. The luminaire comprises a flat, three-dimensional luminaire body being made of a metal sheet. The luminaire further comprises a lighting electronic and a light source being operably connected to the lighting electronic. Further, the luminaire comprises a luminaire cover having a light transmission section to allow light to pass through and a receiving section for at least partially receiving the lighting electronic. The luminaire cover is attached to the luminaire body such that the light transmission section covers the light source so that light of the light source can emit through the light transmission section.

[0006] The luminaire body being made of a metal sheet allows for an easy, flexible and economic production of the luminaire body. As the luminaire body is made of a metal sheet, smooth and flat outer surfaces are provided for an easier surface enhancement. These flat surfaces allow for an easy wrapping or branding by simply painting, printing or attaching stickers or the like. Due to its three-dimensional layout, even though being made of a metal sheet, the luminaire body still has sufficient form stability. As the luminaire body still has a flat layout, its exposure to external influences, like wind, can be minimized. As metal sheets can be easily machined, any flat but three-dimensional layout can be easily obtained to allow for production of a wide range of desired shapes to fulfil customer's technical and aesthetical needs. Hence, a form

factor flexibility can be obtained with minimal investment, i.e. at low costs. Also, the use of a metal sheet versus die casted parts enables greater torques without bending or cracking. The components made of a metal sheet are also easier to store and transport, thus having a reduced environmental impact than die casted parts.

[0007] The luminaire body may comprise a base section substantially extending parallel to a plane. Such a base section allows for a flat layout of the luminaire while providing sufficient space for providing or attaching components, like the lighting electronic, the light source and/or the luminaire cover.

[0008] Further, the luminaire body may comprise at least one side wall section extending from the base section preferably obliquely or perpendicularly to the plane. In a most preferred embodiment, the luminaire body comprises at least two side wall sections laterally flanking the base section. The side wall(s), particularly in connection with the base section, preferably give the luminaire body an advantageous but simple three-dimensional layout to give the luminaire body a desired form stability.

[0009] The luminaire body may have a substantially U-shaped cross-section or even a U-shaped layout. Thus, the luminaire body can be easily manufactured when being made of a metal sheet, it comprises a simple and thus easily producible layout, and still gives the luminaire body a sufficient form stability.

[0010] The luminaire cover, preferably the light transmission section, and the luminaire body, preferably the base section, delimit a lighting space for receiving the light source, preferably sealing enclosing the lighting space. Hence, the light source can be securely provided within the lighting space and can thus be protected against external influences, like wind or any impacts. When being sealingly enclosed, the light source can further be protected against dust and water.

[0011] The luminaire cover, preferably the receiving section, and the luminaire body, preferably the base section, delimit a receiving space for receiving the lighting electronic, preferably sealingly enclosing the lighting electronic. Like for the lighting space with respect to the light source, the same advantages can be obtained for the lighting electronic with the corresponding receiving space.

[0012] The light transmission section and the receiving section can be separately or integrally formed. If being provided separately, higher flexibility, e.g. for maintenance purposes, can be given. When being integrally formed, manufacturing costs can be reduced and assembly facilitated.

[0013] The lighting space and the receiving space, if present, can preferably be connected. They thus can form a connected luminaire space which may result in production as well as assembly be facilitated. When being provided so as to sealingly enclose the housed parts (i.e. light source and/or lighting electronic), a connected and sealed luminaire space for receiving both the lighting electronic and the light source can be provided.

[0014] The luminaire cover may comprise a rim section at least partially and preferably circumferentially surrounding the light transmission section and/or the receiving section. Hence, the luminaire cover can comprise a kind of flange-like section, e.g. for easily attaching the luminaire cover to the luminaire body. Also, the rim section may give the luminaire cover more form stability. In a preferred embodiment, the luminaire cover also has a flat, three-dimensional layout.

[0015] The rim section may extend within a plane. Hence, attachment to the luminaire body can be facilitated; particularly in a case where the luminaire body comprises the base section substantially extending in parallel to a plane. The planes can thus be identical.

[0016] The luminaire cover, preferably the rim section, on the one side and the luminaire body, preferably the base section, on the other side can sandwich a sealing element. Therefore, the luminaire cover and/or the luminaire body may comprise a (circumferential) groove for receiving the sealing element. The sealing element can, for instance, be a cord seal or the like. By providing a sealing element accordingly, sealing between the luminaire body and the luminaire cover can be easily provided. Thus, a corresponding lighting space and/or receiving space, preferably in the form of a connected luminaire space, if present, can be easily sealed.

[0017] The luminaire body can be made of a material having a high thermal conductivity, like aluminium. Hence, the luminaire body can function as a heat sink and additional heat sink elements or structures are not required. Due to the flat layout, air can easily stream along the outer surface of the luminaire body, thus facilitating the heat dissipation especially during operation of the luminaire. The use of aluminium is also favourable with respect to corrosion issues.

[0018] The luminaire body can be made by deep-drawing and/or punching and/or cutting, like laser-cutting, and/or bending of the metal sheet. Hence, the metal sheet can be transferred into many desired shapes thus increasing the flexibility of the luminaire and allow for fulfilling many aesthetical demands.

[0019] The luminaire cover, preferable the receiving section, comprises an electronics cover section for selectively opening and closing, preferably sealingly closing, the receiving section, preferably the receiving space. In a similar manner, also the luminaire cover, preferable the light transmission section, comprises a lighting cover section for selectively opening and closing, preferably sealingly closing, the light transmission section, preferable the lighting space. Hence, the respective section can be easily accessed, e.g. for maintenance reasons. Also, components can be easily exchanged. If desired, also the light emission can be adjusted if the replaceable lighting cover section comes along with optical features, like (e.g. integrally formed) lenses, (e.g. integrated) optical materials (e.g. light defusing materials or light conversion materials) or (e.g. applied) optical structures and the like.

[0020] The luminaire cover, at least the light transmission section or the light cover section, can be made of a translucent material, preferably plastic, glass or any other optical material. If desired, any parts of the luminaire cover which should not allow light passing through can, for instance, be opaque, e.g. by being provided with an opaque (e.g. black) coating or the like.

[0021] The luminaire cover can at least partially be made by injection moulding. Hence, the luminaire cover can be produced easily and economically. Moreover, when being made by injection moulding, the luminaire cover can be made, for instance, by a lightweight material, like plastic. Hence, the overall weight of the luminaire can be minimized. Also, the overall costs for such a luminaire can be reduced and assembly be facilitated.

[0022] The light source may comprise an LED and preferably is or comprises an LED-module. Hence, a low-cost, efficient and long-lasting light source can be used.

[0023] The light source can be provided to be in flat contact with the luminaire body, preferably its base section. This allows for good heat dissipation from the light source to the luminaire body, the latter preferably being exposed to the surrounding air and, if provided as outdoor luminaire, preferably being exposed to strong air streams thus further increasing the heat dissipation.

[0024] The flat luminaire further comprises an attachment element for attaching the luminaire to a mounting feature, like a pole/post, preferably a lamppost for a street light. Hence, the luminaire can be easily attached to any desired mounting feature or mounting area.

[0025] The attachment element can be made by die casting or, like the luminaire body, of a metal sheet. If made by die casting, commonly used attachment elements can be used to thus increase the number of same parts. If being made of a metal sheet, the same advantages as described for the luminaire body being made of a metal sheet also apply for the attachment element, e.g. being easily producible, lightweight but form stable and can be easily formed into various aesthetical and technically desired shapes.

[0026] The attachment element comprises a fixing section forming a mounting opening for receiving a mounting feature (like the mentioned pole) to attach the luminaire. The luminaire can thus be easily attached to a mounting feature by simply inserting the mounting feature into the mounting opening. The luminaire can thus, for instance, be easily fixed to the mounting feature by tightening screws or even simply by frictional connection.

[0027] The fixing section comprises a stepped section facing towards the mounting opening, preferably to at least partially circumferentially delimit the same, so as to allow for receipt of mounting features having different diameters. This design allows for mounting feature (e.g. pole) flexibility in terms of diameter and position (top, side, etc.). The stepped section can be formed by providing steps or waves or any other kind of irregular edge forming of the metal sheet so that the respective irregularity faces towards the mounting opening to thus allow

for different diameters be provided by the mounting opening.

[0028] The fixing section can be adjustable, preferably by a clamping element being even more preferred positioned opposite to the stepped section, to adjust a diameter or cross-section of the mounting opening. Hence, the mounting flexibility of the luminaire can be further increased.

[0029] In a preferred embodiment, the attachment element may further comprise a hinge element so that the luminaire body can be pivoted relatively to the fixing section (i.e. to a mounting feature if being attached thereto). Hence, the luminaire can be adjusted in its mounting angle thus increasing the flexibility of use of the luminaire with respect to its light emission direction. The hinge element is preferably provided between and further preferred connecting the fixing section and the luminaire body.

[0030] According to another aspect, the present invention is directed to a method of manufacturing a flat luminaire comprising the steps of:

- a) Providing a metal sheet,
- b) Producing a flat, three-dimensional luminaire body from the metal sheet, e.g. by deep-drawing and/or punching and/or cutting, like laser-cutting, and/or bending of the metal sheet,
- c) Providing a lighting electronic and a light source and operably connecting the light source to the lighting electronic,
- d) Attaching a luminaire cover having a light transmission section to allow light to pass through and a receiving section to the luminaire body such that the light transmission section covers the light source so that light of the light source can emit through the light transmission section and such that the receiving section at least partially receives the lighting electronic,
- e) Providing an attachment element for attaching the luminaire to a mounting feature, the attachment element comprises a fixing section forming a mounting opening for receiving the mounting feature to attach the luminaire, wherein the fixing section comprises a stepped section facing towards the mounting opening so as to allow for receipt of mounting features having different diameters.

[0031] By using a metal sheet for producing the luminaire body, the latter can be produced easily and cost-efficiently. Also, the so produced luminaire body with its three-dimensional but still flat layout allows for the form stable luminaire body which can easily carry the luminaire cover, the lighting electronic and the light source while still having a flat layout so that the luminaire can be easily used as an outdoor luminaire with increased flow properties.

[0032] Further aspects, advantages and features of the present invention will now be described with reference to the drawings of the enclosed Figures.

Fig. 1 shows five different perspective views of a flat luminaire according to a first embodiment of the present invention,

5 Fig. 2 shows five different perspective views of a flat luminaire according to a second embodiment of the present invention,

Fig. 3 shows a schematic view (Fig. 3A) of a functional use of the luminaire according to a third embodiment of the present invention being shown in a perspective bottom view in Fig. 3B,

10 Fig. 4 shows a perspective view of a part of the luminaire cover of the luminaire according to Fig. 2,

15 Fig. 5 shows a bottom view of the luminaire body of the flat luminaire according to Fig. 2 with the part of the luminaire cover according to Fig. 4,

20 Fig. 6 shows a top view of a metal sheet for producing a luminaire body of the flat luminaire according to Figs. 1 and 2,

25 Fig. 7 shows the flat, three-dimensional luminaire body of the flat luminaire according to Fig. 1 and 2 being made of a metal sheet according to Fig. 6,

30 Fig. 8 shows a top view of a metal sheet for producing at least part of an attachment element of the luminaire according to Fig. 1,

35 Fig. 9 shows five different views of the part of the attachment element produced from the metal sheet according to Fig. 8,

40 Fig. 10 shows a top view of a metal sheet for producing the hinge element of the attachment element of the flat luminaire according to Fig. 1,

45 Fig. 11 shows five different views of the hinge element of the luminaire according to Fig. 1 being made from the metal sheet according to Fig. 10,

50 Fig. 12 shows a perspective view of the attachment element of the flat luminaire according to Fig. 1 based on the parts of the attachment element according to Figs. 9 and 11.

[0033] Figures 1 to 3 show flat luminaires 1 and particularly flat outdoor luminaires according to the present invention. Figures 4 to 12 show different components at different steps of manufacturing of the flat luminaire 1 as described in the present application.

[0034] The flat luminaire 1 according to the present invention is particularly made for outdoor use. It can, for

instance, be used as a streetlight. Therefore, the flat luminaire 1 may be attached to a lamppost 8 or the like as will also be described herein below.

[0035] The flat luminaire 1 comprises a flat, three-dimensional luminaire body 2 as shown, for instance, in Figure 7. The luminaire body 2 is made of a metal sheet 2' as exemplarily shown in Figure 6. The luminaire body 2 is preferably made of a material having a high-thermal conductivity, like aluminum. Such a material is also lightweight.

[0036] As can be seen with reference to Figures 6 and 7, the luminaire body 2 can be made by deep-drawing and/or bending of the metal sheet 2'; here to produce its general three-dimensional layout. Moreover, the luminaire body 2 can be made by punching and/or cutting, like laser-cutting, to produce contours and/or through-holes 20, 21 in the metal sheet 2' or the luminaire body 2. The through holes 20, 21 can be used for different purposes, e.g., insertion of screws for fixture reasons or insertion of other elements, like sensors, or leading-through external cables or the like for electrical purposes, and many more.

[0037] Moreover, as can be clearly seen in Figure 7, additional fixing elements 22 can be provided to the luminaire body 2 to allow for attachment of luminaire features within the luminaire body 2. The fixing elements 22 can, for instance, be bolts or stud bolts attached to the luminaire body 2, e.g., by stud welding or the like.

[0038] The luminaire body 2 may comprise, as exemplarily shown in Figure 7, a base section 23 here preferably substantially extending parallel to a plane (i.e. having a flat or plane or laminar layout). The luminaire body 2 may further comprise at least one side wall section (in the shown embodiments there are shown two side wall sections) 24 extending from the base section 23 preferably obliquely (as shown in the embodiments of Figures 1 to 7) or perpendicularly to the plane. As can be seen in Figure 7, the here shown two side wall sections 24 are laterally flanking the base section 23. In cross-section the luminaire body 2 may have a substantially U-shape or even a U-shape at all.

[0039] The luminaire 1 further comprises a lighting electronic 3 as can be seen, for instance, in Figure 2A. The lighting electronic 3 may comprise a driver 31 or any other means for driving the luminaire 1. The lighting electronic 3 may also comprise any other electronic means like sensors 30 (e.g. light sensors, motion sensors, and the like). The lighting electronic 3 can be supplied with power by a battery and/or external power supply.

[0040] Moreover, the luminaire 1 further comprises a light source 4 being operably connected to the lighting electronic 3. Therefore, the light source 4 and the lighting electronic 3 can, for instance, be connected by wiring to allow for operation of the light source 4 by the lighting electronic 3.

[0041] The light source 4 may comprise an LED (light-emitting diode) 41 and preferably is an LED-module 40 usually being made up of a PCB (printed circuit board)

42 carrying one or a plurality of LEDs 41 as, for instance, shown in Figures 1A, 2A or 3B.

[0042] The luminaire 1 further comprises a luminaire cover 5 as can be seen, for instance, in Figure 4. The luminaire cover 5 has a light transmission section 50 to allow light to pass through and a receiving section 51 for at least partially receiving the lighting electronic 3. As can be clearly seen in Figure 5, the luminaire cover 5 is attached to the luminaire body 2 for the mentioned purpose. With reference also to Figures 1 to 3, the luminaire cover 5 is attached to the luminaire body 2 such that the light transmission section 50 covers the light source 4 so that light of the light source 4 can emit through the light transmission section 50 and, as mentioned, such that the lighting electronic 3 is at least partially received by/in the receiving section 50. This can be seen, for instance, in Figures 1A, 2A and 3B. "Emit through" is to be understood in the sense of the present invention, that the light transmission section 50 comprises an opening 52 through which the light may exit the luminaire 1 for light emission. This opening 52 can, for instance, be closed by a lighting cover section 53 through which the light of the light source 4 can emit. The luminaire cover 5, at least the light transmission section 50 or the lighting cover section 53, can be made of a translucent material, preferably plastic, glass or another optical material. The luminaire cover 5 can at least partially be made by injection moulding, if made of a corresponding material. The light transmission section 50, preferably the lighting cover section 53, may comprise optical features, like (e.g. integrally formed) lenses, (e.g. integrated) optical materials (e.g. light defusing materials or light conversion materials) or (e.g. applied) optical structures and the like to allow for a desired light emission.

[0043] The luminaire cover 5, preferably the light transmission section 50, and the luminaire body 2, preferably the base section 23, may delimit a lighting space 54 for receiving the light source 4, preferably sealingly enclosing the lighting space 54. This can be seen, for instance, in Figures 1A, 2A, 3B and 5. By the use of LEDs as light source 4, a very flat layout of the flat luminaire 1 can be obtained.

[0044] The luminaire cover 5, preferably the receiving section 51, and the luminaire body 2, preferably the base section 23, can delimit a receiving space 56 for receiving the lighting electronic 3, preferably sealingly enclosing the lighting electronic 3. This can be seen, for instance, in Figures 5 and 2A. To allow for external power supply, the receiving section 51 may comprise a cable guiding section or element 57 through which wiring for external power supply or even data transfer can be led through. The cable guiding section 57 can comprise a sealing element for sealingly receiving the cable to provide a sealing of the receiving space 56 to the outside even in case wiring is provided from the outside.

[0045] The light transmission section 50 and the receiving section 51 can be separately provided or formed. Alternatively, the light transmission section 50 and the

receiving section 51 can also be integrally provided or formed as, for instance, shown in Figures 4 and 5. In either case, the lighting space 54 and the receiving space 56 can be connected. If so, the lighting space 54 and the receiving space 56 may thus form a connected luminaire space 500 in which preferably the whole electric and electronic 3 of the luminaire 1 can be housed.

[0046] The luminaire cover 5 may comprise a rim section 58 at least partially surrounding the light transmission section 50 and/or the receiving section 51. In the shown embodiment, the rim section 58 completely (i.e. circumferentially) surrounds the light transmission section 50 and the receiving section 51. The rim section 58 may extend within a plane. In case the base section 23 also substantially extends parallel to a plane, a flat contact between the luminaire cover 5 via the rim section 58 and the luminaire body 2 via the base section 23 can be obtained to thus allow for a tight and secure fit between these two elements. The fixing elements 22 can be used to cooperate with corresponding fixing elements 59 of the luminaire cover 5 for secure attachment of the luminaire cover 5 to the luminaire body 2 (see Fig. 4 and 5).

[0047] The luminaire cover 5, preferably the rim section 58, on the one side and the luminaire body 2, preferably the base section 23, on the other side may sandwich a sealing element (not shown). Therefore, a sealing receiving section 6, like a circumferential groove, can be provided at the luminaire cover 5 and/or the luminaire body 2, as exemplarily shown in Figure 4. By means of the sealing element, the lighting space 54 and/or the receiving space 56 can be sealingly enclosed as described herein above.

[0048] In the preferred embodiment and as exemplarily shown in Figure 2, the luminaire cover 5, preferably the receiving section 51, may comprise an electronics cover section (here a cover element) 55 for selectively opening and closing, preferably sealingly closing, the receiving section 51, preferably the receiving space 56. A sealing element (not shown) may be provided to allow for the receiving section 51 be sealingly enclosed. The sealing element may be provided to be sandwiched between the electronics cover section 55 and the corresponding part of the receiving section 51 cooperating with each other for closing the receiving space 56. Therefore, a corresponding (circumferential) groove 61 may be provided to receive the sealing element in a manner similar to the sealing element as described herein above.

[0049] In a same way like the electronics cover section 55, the luminaire cover 5, preferably the light transmission section 50, may comprise a lighting cover section 53 for selectively opening and closing, preferably sealingly closing, the light transmission section 50, preferably the lighting space 54. As already described herein above, the lighting cover section 53 is preferably made of a light translucent material, while the other parts of the luminaire cover 5 can be made of any type of material and are preferably opaque. Therefore, the luminaire cover 5 can be coated with an opaque material. A sealing element

(not shown) may be provided to allow for the light transmission section 50 be sealingly enclosed. The sealing element may be provided to be sandwiched between the lighting cover section 53 and the corresponding part of the light transmission section 50 cooperating with each other for closing the lighting space 54. Therefore, a corresponding (circumferential) groove 60 may be provided to receive the sealing element in a manner similar to the sealing elements as described herein above.

[0050] With reference to Figures 1 and 2 as well as Figures 8 to 12, the luminaire 1 may further comprise an attachment element 7 for attaching the luminaire 1 to a mounting feature 8, like a pole/post, preferably a lamp-post for a street light, a wall or any other mounting feature. The attachment element 7 can be made by die-casting in a common way as, for instance, shown by the embodiment of Figure 2. In an alternative and preferred embodiment (see Figure 1), the attachment element 7 can also be made of a metal sheet 70', 71' (see Figures 8 and 10) in a similar manner as the luminaire body 2.

[0051] With reference to Figures 1, 9 and 12, the attachment element 7 comprises a fixing section 70 forming a mounting opening 72 for receiving the mounting feature 8 to attach the luminaire 1. As can be clearly seen in Figures 9 and 12, the fixing section 70 preferably comprises a stepped section 73 facing towards the mounting opening 72 to (at least partially circumferentially) delimit the same. This stepped section 73 allows for receipt of mounting features 8 (e.g. lampposts) having different diameters.

[0052] In a preferred embodiment as exemplarily shown in Figure 1 and best seen in Figure 12, the fixing section 70 can be adjustable to adjust a diameter or cross-section of the mounting opening 72. The fixing section 70 being adjustable is preferably obtained by a clamping element 74 also delimiting the mounting opening 72 at least partially so that due to its adjustable attachment the diameter or cross-section of the mounting opening 72 can be varied. In a preferred embodiment, the clamping element 74 is positioned opposite to the stepped section 73 as can be clearly seen in Figure 12. The clamping element 74 as well as the stepped section 73 may thus together circumferentially delimit the mounting opening 72. The combination of the adjustable fixing section 70, e.g. by the clamping element 74, and the stepped section 73 allows for a most flexible mounting of the luminaire 1.

[0053] In a preferred embodiment, the attachment element 7 may allow for a pivotable attachment of the luminaire 1 to a mounting feature 8. In this regard, the attachment element 7 can comprise a hinge or pivoting section 75 to be positioned between the luminaire body 2 and the mounting feature 8. Preferably, the attachment element 7 further comprises a mounting section 71 to be attached to the luminaire body 2 and which is pivotally connected to the fixing section 70 in a pivotable manner. The hinge or pivoting section 75 is then provided between the mounting section 71 and the fixing section 70 to allow

for the pivoting connection. The hinge or pivoting section 75 may allow for the luminaire body 2 to be pivoted with respect to the fixing section 70 in a stepless or stepwise manner. The hinge or pivoting section 75 can be obtained by a screw connection as shown in Figure 12 according to which the fixing section 70 and the mounting section 71 are connected and pivotable about the rotating axis being coaxially arranged to the screw connection, here the fixing screws 78. It is, however, also possible to provide another hinge or pivoting section 75 as exemplarily shown in Figures 2 and 3B, in which the fixing section 70 and the mounting section 71 have a rounded connection surface 77 in a manner that the cooperating surfaces of the rounded connection surface 77 can be adjusted along the surface to thus obtain different attachment angles of the luminaire body 2 with respect to the fixing section 70. Fixing screws 79 here extend through elongated slots 76 which extend along the rounded connection surface 77 to form the hinge or pivoting section 75.

[0054] The fixing section 70 and the mounting section 71 of the attachment element 7 are preferably provided as separate elements (i.e. fixing element 70, mounting element 71), as can be seen in Figures 9, 11 and 12.

[0055] As can also be seen with respect to Figures 1E, 2B and 2C, the luminaire 1 may further comprise additional lighting electronics, like sensors 30, here being attached on top of the luminaire body 2, i.e. on an outer surface thereof, particularly of the base section 23. The sensor 30 can be any type of sensor, like a light sensor or a motion sensor or any other kind of sensor. The sensor 30 is preferably operably connected to the lighting electronic 3 for operating the luminaire 1. Therefore, the sensors 30 can be attached to the luminaire body 2 and connected to the lighting electronic 3 via the through-hole 21 in the luminaire body 2, here in the base section 23. The sensor 30 is preferably sealingly connected to the through-hole 21 to provide a sealed connection of the cooperating elements.

[0056] The luminaire body 2 being made of a metal sheet 2' results in smooth and flat outer surfaces of the luminaire 1 which allows for an easier surface enhancement. These flat surfaces allow for an easy wrapping or branding by simply painting, printing or attaching stickers or the like.

[0057] Moreover, the luminaire 1 and preferably the lighting electronic 3 can be further provided with wireless technology like NFC (near field communication) technology preferably operably coupled to the lighting electronic 3 to thus allow for an easy wireless communication with the luminaire 1, e.g. for configuration of the lighting electronic 3. For instance, NFC drivers enable an installer to program the luminaire 1 - e.g. by an external NFC device 32 or smartphone 33 - without the need to open the luminaire 1, as is exemplarily shown in Figure 3A.

[0058] In the following, a method of manufacturing a flat luminaire 1 is described.

[0059] In a first step, a metal sheet 2' is provided. The metal sheet 2' is preferably made of a heat-conductive

material, like aluminum.

[0060] From the metal sheet 2', a flat, three-dimensional luminaire body 2 is produced as exemplarily shown in Figure 7, e.g., by deep-drawing and/or punching and/or cutting, like laser-cutting and/or bending of the metal sheet 2'. If an attachment element 7 is provided, the same can be made by die-casting or made of a corresponding metal sheet 70', 71', as exemplarily shown in Figures 8 and 10, thus obtaining the elements (fixing section 70, mounting section 71) as shown in Figures 9 and 11.

[0061] In a third step a lighting electronic 3 and a light source 4 are provided and operably connected to each other. The lighting electronic 3 can be supplied with power by an integrated battery and/or by an external power supply as described here in the above.

[0062] In a fourth step, a luminaire cover 5 having a light transmission section 50 to allow light to pass through and a receiving section 51 is attached to the luminaire body 2 such that the light transmission section 50 covers the light source 4 so that light of the light source 4 can emit through the light transmission section 50 and such that the receiving section 51 at least partially receives the lighting electronic 3. The light transmission section 50 and the receiving section 51 can be integrally formed and may delimit and preferably sealingly enclose a lighting space 54 and receiving space 56, respectively, together with the luminaire body 2.

[0063] The so manufactured flat luminaire 1 can be attached to a mounting feature 8, like a lamppost 8, by means of an attachment element 7, if present. Therefore, the attachment element 7 can comprise the fixing section 70 being preferably adjustable to allow for a flexible attachment of the luminaire 1 to any desired mounting feature 8, e.g. having any desired diameter or cross-section. Therefore, the mounting feature 8 can be inserted into the mounting opening 72 and then fixed by any desired fixing means, like the clamping element 74 to firmly attach the luminaire 1 to the mounting feature 8. If the attachment element 7 comprises a hinge or pivoting section 75, the luminaire body 2 can be pivoted in the desired orientation and then fixed in this pivoting angel, e.g. by tightening corresponding screw members 78, 79 between the fixing section 70 and the corresponding mounting section 71. Different fixing angles are exemplarily shown in Figures 1C and 1D. In Figure 1C, the top end of the mounting feature 8 extends horizontally which requires the luminaire body 2 to extend from the fixing section 70 also in a horizontal manner. In Figure 1D, the top end of the mounting feature 8 extends vertically, so that the luminaire body 2 here is pivoted in an orientation with respect to the fixing section 70 to extend orthogonally therefrom, so that in each of the two before-mentioned cases the light source 4 is directed to emit light downwards, e.g. towards a ground G, like a sidewalk or a street, as exemplarily shown in Figure 3A.

[0064] The present invention is not limited by the embodiments as described herein above as long as being covered by the appended claims.

Claims

1. Flat luminaire (1), like a flat outdoor luminaire, comprising:

a flat, three-dimensional luminaire body (2),
 a lighting electronic (3),
 a light source (4) being operably connected to the lighting electronic (3),
 a luminaire cover (5) having a light transmission section (50) to allow light to pass through and a receiving section (51) for at least partially receiving the lighting electronic (3), and
 an attachment element (7) for attaching the luminaire (1) to a mounting feature (8),
 wherein the luminaire cover (5) is attached to the luminaire body (2) such that the light transmission section (50) covers the light source (4) so that light of the light source (4) can emit through the light transmission section (50),
 wherein the attachment element (7) comprises a fixing section (70) forming a mounting opening (72) for receiving the mounting feature (8) to attach the luminaire (1),
characterized in that
 the luminaire body (2) is made of a metal sheet (2'),
 the fixing section (70) comprises a stepped section (73) facing towards the mounting opening (72) so as to allow for receipt of mounting features (8) having different diameters.

2. Flat luminaire (1) according to claim 1, wherein the luminaire body (2)

comprises a base section (23) substantially extending parallel to a plane and at least one side wall section (24) extending from the base section (23) preferably obliquely or perpendicularly to the plane, and/or
 wherein the luminaire body (2) has a substantially U-shaped cross-section.

3. Flat luminaire (1) according to any one of the preceding claims, wherein the luminaire cover (5), preferably the light transmission section (50), and the luminaire body (2), preferably the base section (23), delimit a lighting space (54) for receiving the light source (4), preferably sealingly enclosing the lighting space (54).

4. Flat luminaire (1) according to any one of the preceding claims, wherein the luminaire cover (5), preferably the receiving section (51), and the luminaire body (2), preferably the base section (23), delimit a receiving space (56) for receiving the lighting electronic (3), preferably sealingly enclosing the lighting electronic (3).

5. Flat luminaire (1) according to any one of the preceding claims, wherein the light transmission section (50) and the receiving section (51) are separately or integrally formed, wherein preferably the lighting space (54) and the receiving space (56) are connected.

6. Flat luminaire (1) according to any one of the preceding claims, wherein the luminaire cover (5) comprises a rim section (58) at least partially surrounding the light transmission section (50) and/or the receiving section (51), wherein the rim section (58) preferably extends within a plane, and/or wherein the luminaire cover (5), preferably the rim section (58), on the one side and the luminaire body (2), preferably the base section (23), on the other side sandwich a sealing element.

7. Flat luminaire (1) according to any one of the preceding claims, wherein the luminaire body (2) is made of a material having a high thermal conductivity, like aluminum, and/or wherein the luminaire body (2) is made by deep-drawing and/or punching and/or cutting, like laser-cutting, and/or bending of the metal sheet (2').

8. Flat luminaire (1) according to any one of the preceding claims, wherein the luminaire cover (5), preferably the receiving section (51), comprises an electronics cover section (55) for selectively opening and closing, preferably sealingly closing, the receiving section (51), preferably the receiving space (56), and/or
 wherein the luminaire cover (5), preferably the light transmission section (50), comprises a lighting cover section (53) for selectively opening and closing, preferably sealingly closing, the light transmission section (50), preferably the lighting space (54).

9. Flat luminaire (1) according to any one of the preceding claims, wherein the luminaire cover (5), at least the light transmission section (50) or the lighting cover section (53), is made of a translucent material, preferably plastic, glass or another optical material, and/or wherein the luminaire cover (5) is at least partially made by injection molding.

10. Flat luminaire (1) according to any one of the preceding claims, wherein the light source (4) comprises an LED (41) and preferably is an LED-module (40), and/or wherein the light source (4) is in flat contact with the luminaire body (2), preferably the base section (23).

11. Flat luminaire (1) according to any one of the preceding claims, wherein the attachment element (7) is adapted for attaching the luminaire (1) to a pole as the mounting feature (8).

12. Flat luminaire (1) according to claim 11, wherein the attachment element (7) is made by die casting or made of a metal sheet (70', 71').
13. Flat luminaire (1) according to any one of the preceding claims, wherein the fixing section (70) is adjustable, preferably by a clamping element (74) being positioned opposite to the stepped section (73), to adjust a diameter or cross-section of the mounting opening (72).
14. Method of manufacturing a flat luminaire (1), comprising the steps of:
- a) Providing a metal sheet (2'),
 - b) Producing a flat, three-dimensional luminaire body (2) from the metal sheet (2'), e.g. by deep-drawing and/or punching and/or cutting, like laser-cutting, and/or bending of the metal sheet (2'),
 - c) Providing a lighting electronic (3) and a light source (4) and operably connecting the light source (4) to the lighting electronic (3),
 - d) Attaching a luminaire cover (5) having a light transmission section (50) to allow light to pass through and a receiving section (51) to the luminaire body (2) such that the light transmission section (50) covers the light source (4) so that light of the light source (4) can emit through the light transmission section (50) and such that the receiving section (51) at least partially receives the lighting electronic (3),
 - e) Providing an attachment element (7) for attaching the luminaire (1) to a mounting feature (8), the attachment element (7) comprises a fixing section (70) forming a mounting opening (72) for receiving the mounting feature (8) to attach the luminaire (1), wherein the fixing section (70) comprises a stepped section (73) facing towards the mounting opening (72) so as to allow for receipt of mounting features (8) having different diameters.

Patentansprüche

1. Flache Leuchte (1), wie eine flache Außenleuchte, umfassend:
- einen flachen, dreidimensionalen Leuchtenkörper (2),
 - eine Beleuchtungselektronik (3),
 - eine Lichtquelle (4), die betriebsfähig mit der Beleuchtungselektronik (3) verbunden ist,
 - eine Leuchtenabdeckung (5), die einen Lichtübertragungsabschnitt (50) zum Ermöglichen eines Durchtretens von Licht und einen Aufnahmeabschnitt (51) zum zumindest teilweisen Auf-

nehmen der Beleuchtungselektronik (3) aufweist, und
 ein Befestigungselement (7) zum Befestigen der Leuchte (1) an einer Montagevorrichtung (8), wobei die Leuchtenabdeckung (5) derart an dem Leuchtenkörper (2) befestigt ist, dass der Lichtübertragungsabschnitt (50) die Lichtquelle (4) so abdeckt, dass Licht der Lichtquelle (4) durch den Lichtübertragungsabschnitt (50) hindurchstrahlen kann, wobei das Befestigungselement (7) einen Fixierungsabschnitt (70) umfasst, der eine Montageöffnung (72) zur Aufnahme der Montagevorrichtung (8) zum Befestigen der Leuchte (1) bildet,
dadurch gekennzeichnet, dass
 der Leuchtenkörper (2) aus einem Metallblech (2') hergestellt ist,
 der Fixierungsabschnitt (70) einen gestuften Abschnitt (73) umfasst, der der Montageöffnung (72) zugewandt ist, um eine Aufnahme von Montagevorrichtungen (8) mit unterschiedlichen Durchmessern zu ermöglichen.

2. Flache Leuchte (1) nach Anspruch 1, wobei der Leuchtenkörper (2) einen sich im Wesentlichen parallel zu einer Ebene erstreckenden Basisabschnitt (23) und mindestens einen sich von dem Basisabschnitt (23) vorzugsweise schräg oder senkrecht zu der Ebene erstreckenden Seitenwandabschnitt (24) umfasst, und/oder
 wobei der Leuchtenkörper (2) einen im Wesentlichen U-förmigen Querschnitt aufweist.
3. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei die Leuchtenabdeckung (5), vorzugsweise der Lichtübertragungsabschnitt (50), und der Leuchtenkörper (2), vorzugsweise der Basisabschnitt (23), einen Beleuchtungsraum (54) zur Aufnahme der Lichtquelle (4) begrenzen, wobei sie den Beleuchtungsraum (54) vorzugsweise abdichtend umschließen.
4. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei die Leuchtenabdeckung (5), vorzugsweise der Aufnahmeabschnitt (51), und der Leuchtenkörper (2), vorzugsweise der Basisabschnitt (23), einen Aufnahmeraum (56) zur Aufnahme der Beleuchtungselektronik (3) begrenzen, wobei sie die Beleuchtungselektronik (3) vorzugsweise abdichtend umschließen.
5. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei der Lichtübertragungsabschnitt (50) und der Aufnahmeabschnitt (51) getrennt oder einstückig ausgebildet sind, wobei der Beleuchtungsraum (54) und der Aufnahmeraum (56) vorzugsweise verbunden sind.

6. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei die Leuchtenabdeckung (5) einen Randabschnitt (58) umfasst, der den Lichtübertragungsabschnitt (50) und/oder den Aufnahmeabschnitt (51) zumindest teilweise umgibt, wobei sich der Randabschnitt (58) vorzugsweise innerhalb einer Ebene erstreckt, und/oder wobei die Leuchtenabdeckung (5), vorzugsweise der Randabschnitt (58), auf der einen Seite und der Leuchtenkörper (2), vorzugsweise der Basisabschnitt (23), auf der anderen Seite ein Dichtungselement dazwischen einschließen. 5
7. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei der Leuchtenkörper (2) aus einem Material mit hoher Wärmeleitfähigkeit, wie Aluminium, hergestellt ist, und/oder wobei der Leuchtenkörper (2) durch Tiefziehen und/oder Stanzen und/oder Schneiden, wie Laserstrahlschneiden, und/oder Biegen des Metallblechs (2') hergestellt wird. 10 15 20
8. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei die Leuchtenabdeckung (5), vorzugsweise der Aufnahmeabschnitt (51), einen Elektronikabdeckungsabschnitt (55) zum wahlweisen Öffnen und Schließen, vorzugsweise zum dichten Schließen, des Aufnahmeabschnitts (51), vorzugsweise des Aufnahmeraums (56), umfasst, und/oder wobei die Leuchtenabdeckung (5), vorzugsweise der Lichtübertragungsabschnitt (50), einen Beleuchtungsabdeckungsabschnitt (53) zum wahlweisen Öffnen und Schließen, vorzugsweise zum dichten Schließen, des Lichtübertragungsabschnitts (50), vorzugsweise des Beleuchtungsraums (54), umfasst. 25 30 35
9. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei die Leuchtenabdeckung (5), zumindest der Lichtübertragungsabschnitt (50) oder der Beleuchtungsabdeckungsabschnitt (53), aus einem lichtdurchlässigen Material, vorzugsweise Kunststoff, Glas oder einem anderen optischen Material, hergestellt ist, und/oder wobei die Leuchtenabdeckung (5) zumindest teilweise durch Spritzgießen hergestellt wird. 40 45
10. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei die Lichtquelle (4) eine LED (41) umfasst und vorzugsweise ein LED-Modul (40) ist, und/oder wobei die Lichtquelle (4) in flächigem Kontakt mit dem Leuchtenkörper (2), vorzugsweise dem Basisabschnitt (23), steht. 50
11. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei das Befestigungselement (7) zum Befestigen der Leuchte (1) an einer Stange als Montagevorrichtung (8) ausgebildet ist. 55
12. Flache Leuchte (1) nach Anspruch 11, wobei das Befestigungselement (7) durch Druckgießen hergestellt wird oder aus einem Metallblech (70', 71') hergestellt ist.
13. Flache Leuchte (1) nach einem der vorhergehenden Ansprüche, wobei der Fixierungsabschnitt (70) einstellbar ist, vorzugsweise durch ein Spannelement (74), das dem gestuften Abschnitt (73) gegenüberliegt, um einen Durchmesser oder Querschnitt der Montageöffnung (72) einzustellen.
14. Verfahren zur Herstellung einer flachen Leuchte (1), umfassend die Schritte:
- a) Bereitstellen eines Metallblechs (2'),
 - b) Anfertigen eines flachen, dreidimensionalen Leuchtenkörpers (2) aus dem Metallblech (2'), z. B. durch Tiefziehen und/oder Stanzen und/oder Schneiden, wie Laserstrahlschneiden, und/oder Biegen des Metallblechs (2'),
 - c) Bereitstellen einer Beleuchtungselektronik (3) und einer Lichtquelle (4) und betriebsfähiges Verbinden der Lichtquelle (4) mit der Beleuchtungselektronik (3),
 - d) Befestigen einer Leuchtenabdeckung (5), die einen Lichtübertragungsabschnitt (50) zum Ermöglichen eines Durchtretens von Licht und einen Aufnahmeabschnitt (51) aufweist, an dem Leuchtenkörper (2) derart, dass der Lichtübertragungsabschnitt (50) die Lichtquelle (4) so abdeckt, dass Licht der Lichtquelle (4) durch den Lichtübertragungsabschnitt (50) hindurchstrahlen kann, und so, dass der Aufnahmeabschnitt (51) die Beleuchtungselektronik (3) zumindest teilweise aufnimmt,
 - e) Bereitstellen eines Befestigungselements (7) zum Befestigen der Leuchte (1) an einer Montagevorrichtung (8), wobei das Befestigungselement (7) einen Fixierungsabschnitt (70) umfasst, der eine Montageöffnung (72) zur Aufnahme der Montagevorrichtung (8) zum Befestigen der Leuchte (1) bildet, wobei der Fixierungsabschnitt (70) einen gestuften Abschnitt (73) umfasst, der der Montageöffnung (72) zugewandt ist, um eine Aufnahme von Montagevorrichtungen (8) mit unterschiedlichen Durchmessern zu ermöglichen.

Revendications

1. Luminaire plat (1), comme un luminaire plat extérieur, comprenant :
- un corps de luminaire tridimensionnel plat (2),
 - une électronique d'éclairage (3),
 - une source de lumière (4) qui est connectée de

manière opérationnelle à l'électronique d'éclairage (3),

un capot de luminaire (5) ayant une section de transmission de lumière (50) pour permettre à la lumière de passer à travers et une section de réception (51) pour recevoir au moins partiellement l'électronique d'éclairage (3), et

un élément d'attache (7) destiné à fixer le luminaire (1) à un composant de montage (8), dans lequel le capot de luminaire (5) est attaché au corps de luminaire (2) de telle sorte que la section de transmission de lumière (50) recouvre la source de lumière (4) de sorte que la lumière de la source de lumière (4) peut émettre à travers la section de transmission de lumière (50), dans lequel l'élément d'attache (7) comprend une section de fixation (70) formant une ouverture de montage (72) destinée à recevoir le composant de montage (8) pour attacher le luminaire (1),

caractérisé en ce que

(2'), le corps de luminaire (2) est constitué d'une plaque de métal

la section de fixation (70) comprend une section étagée (73) faisant face à l'ouverture de montage (72) de manière à permettre la réception de composants de montage (8) ayant différents diamètres.

2. Luminaire plat (1) selon la revendication 1, dans lequel le corps de luminaire (2) comprend une section de base (23) s'étendant sensiblement parallèlement à un plan et au moins une section de paroi latérale (24) s'étendant à partir de la section de base (23) de préférence obliquement ou perpendiculairement au plan, et/ou dans lequel le corps de luminaire (2) a une section transversale sensiblement en forme de U.
3. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel le capot de luminaire (5), de préférence la section de transmission de lumière (50), et le corps de luminaire (2), de préférence la section de base (23), délimitent un espace d'éclairage (54) destiné à recevoir la source de lumière (4), de préférence enfermant de manière étanche l'espace d'éclairage (54).
4. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel le capot de luminaire (5), de préférence la section de réception (51), et le corps de luminaire (2), de préférence la section de base (23), délimitent un espace de réception (56) destiné à recevoir l'électronique d'éclairage (3), de préférence enfermant de manière étanche l'électronique d'éclairage (3).

5. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel la section de transmission de lumière (50) et la section de réception (51) sont formées séparément ou d'un seul tenant, dans lequel de préférence l'espace d'éclairage (54) et l'espace de réception (56) sont connectés.
6. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel le capot de luminaire (5) comprend une section de bord (58) entourant au moins partiellement la section de transmission de lumière (50) et/ou la section de réception (51), dans lequel la section de bord (58) s'étend de préférence dans un plan, et/ou dans lequel le capot de luminaire (5), de préférence la section de bord (58), d'un côté et le corps de luminaire (2), de préférence la section de base (23), de l'autre côté prennent un élément d'étanchéité en sandwich.
7. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel le corps de luminaire (2) est constitué d'un matériau ayant une conductivité thermique élevée, comme l'aluminium, et/ou dans lequel le corps de luminaire (2) est fabriqué par emboutissage profond et/ou poinçonnage et/ou découpage, comme le découpage au laser, et/ou pliage de la plaque métallique (2').
8. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel le capot de luminaire (5), de préférence la section de réception (51), comprend une section de capot d'électronique (55) pour ouvrir et fermer sélectivement, de préférence fermer de manière étanche, la section de réception (51), de préférence l'espace de réception (56), et/ou dans lequel le capot de luminaire (5), de préférence la section de transmission de lumière (50), comprend une section de capot d'éclairage (53) pour ouvrir et fermer sélectivement, de préférence fermer de manière étanche, la section de transmission de lumière (50), de préférence l'espace d'éclairage (54).
9. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel le capot de luminaire (5), au moins la section de transmission de lumière (50) ou la section de couvercle d'éclairage (53), est constitué d'un matériau translucide, de préférence en matière plastique, en verre ou en un autre matériau optique, et/ou dans lequel le capot de luminaire (5) est au moins partiellement fabriqué par moulage par injection.
10. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel la source de lumière (4) comprend une DEL (41) et est de préférence un module de DEL (40) et/ou dans lequel la source de lumière (4) est en contact plat avec le corps de luminaire (2), de préférence la section de

base (23).

11. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel l'élément d'attache (7) est adapté pour attacher le luminaire (1) à un poteau en tant que composant de montage (8). 5
12. Luminaire plat (1) selon la revendication 11, dans lequel l'élément d'attache (7) est fabriqué par moulage sous pression ou fabriqué à partir d'une plaque de métal (70', 71'). 10
13. Luminaire plat (1) selon l'une quelconque des revendications précédentes, dans lequel la section de fixation (70) est réglable, de préférence par un élément de serrage (74) positionné en face de la section étagée (73), pour régler un diamètre ou une section transversale de l'ouverture de montage (72). 15
14. Procédé de fabrication d'un luminaire plat (1), comprenant les étapes consistant à : 20
 - a) fournir une feuille métallique (2'),
 - b) produire un corps de luminaire tridimensionnel plat (2) à partir de la feuille métallique (2'), par exemple par emboutissage profond et/ou poinçonnage et/ou découpage, tel que le découpage au laser, et/ou le cintrage de la feuille métallique (21), 25
 - c) fournir un dispositif électronique d'éclairage (3) et une source de lumière (4) et connecter de manière opérationnelle la source lumineuse (4) à l'électronique d'éclairage (3), 30
 - d) attacher un capot de luminaire (5) ayant une section de transmission de lumière (50) pour permettre à la lumière de passer à travers et une section de réception (51) dans le corps de luminaire (2) de telle sorte que la section de transmission de lumière (50) recouvre la source de lumière (4) de sorte que la lumière de la source de lumière (4) peut émettre à travers la section de transmission de lumière (50) et de telle sorte que la section de réception (51) reçoit au moins partiellement l'électronique d'éclairage (3), 35
 - e) fournir un élément d'attache (7) pour attacher le luminaire (1) à un composant de montage (8), l'élément d'attache (7) comprend une section de fixation (70) formant une ouverture de montage (72) pour recevoir le composant de montage (8) afin d'attacher le luminaire (1), dans lequel la section de fixation (70) comprend une section étagée (73) faisant face à l'ouverture de montage (72) de manière à permettre la réception de composants de montage (8) ayant différents diamètres. 40 45 50 55

Fig. 1

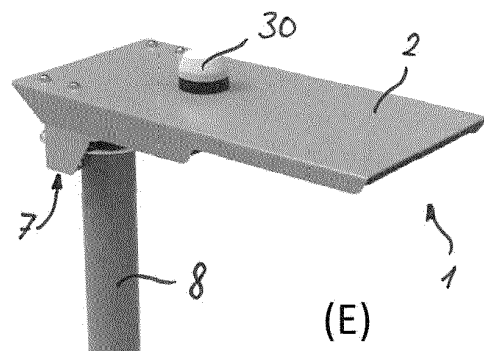
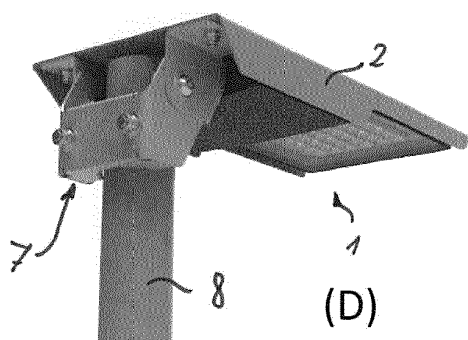
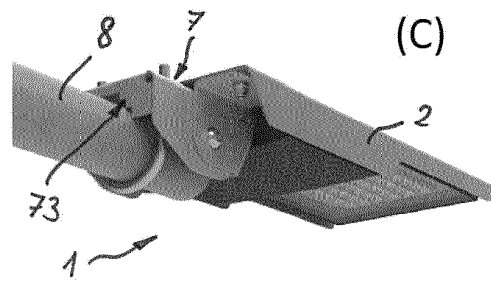
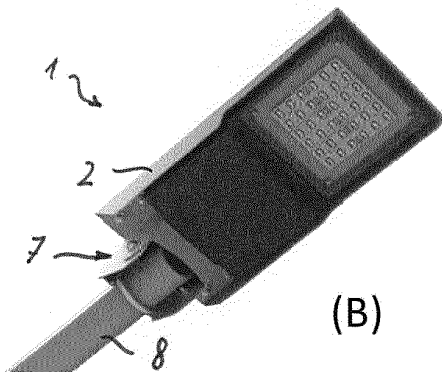
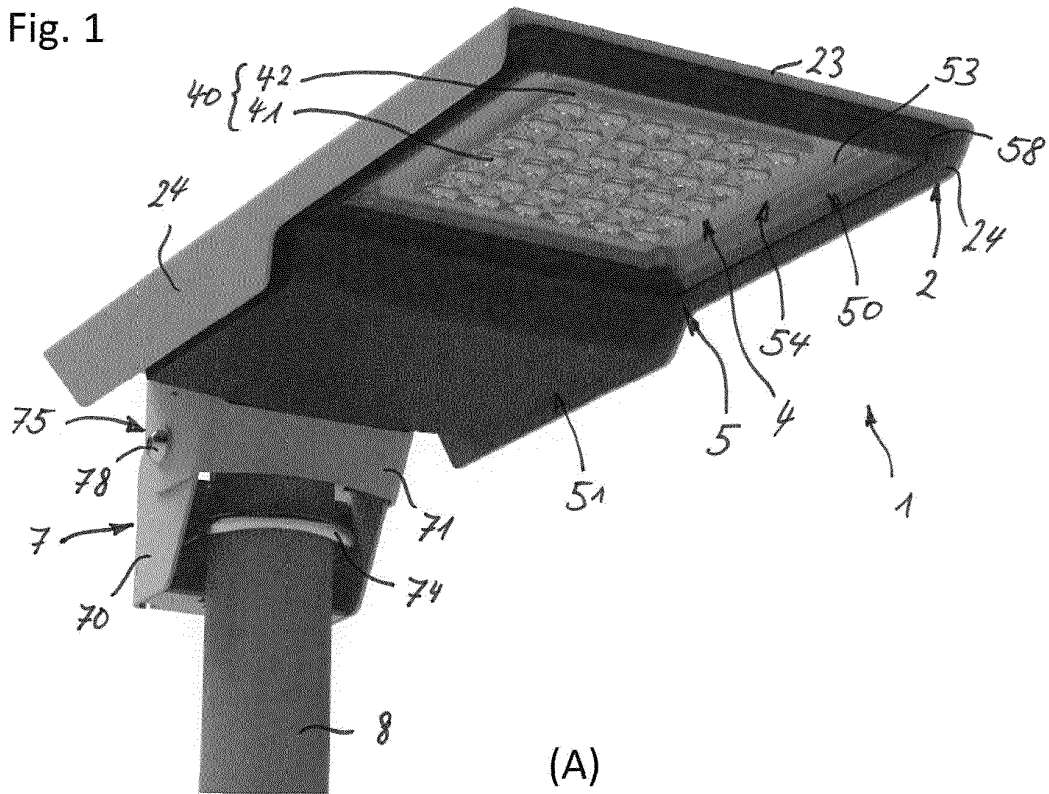
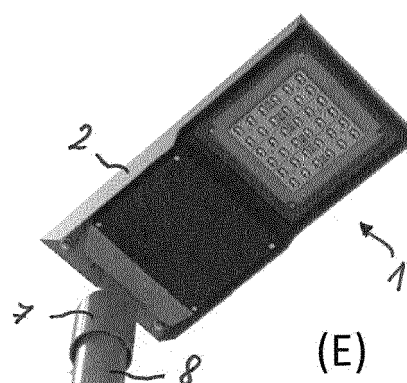
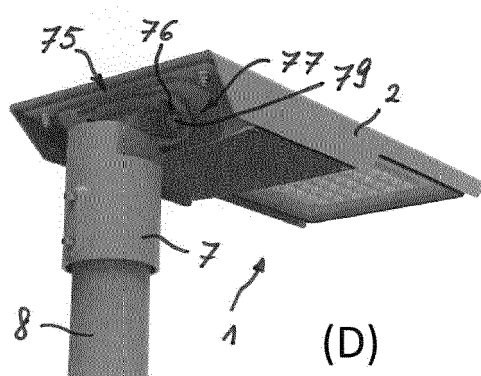
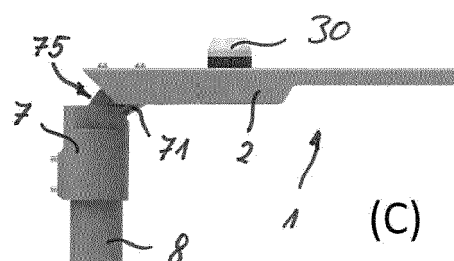
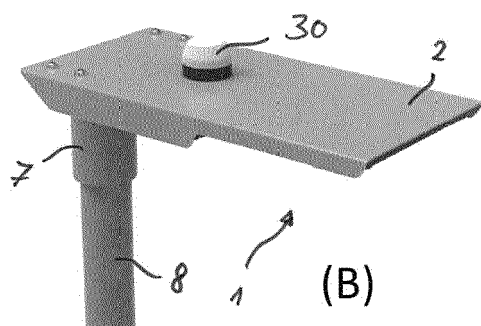
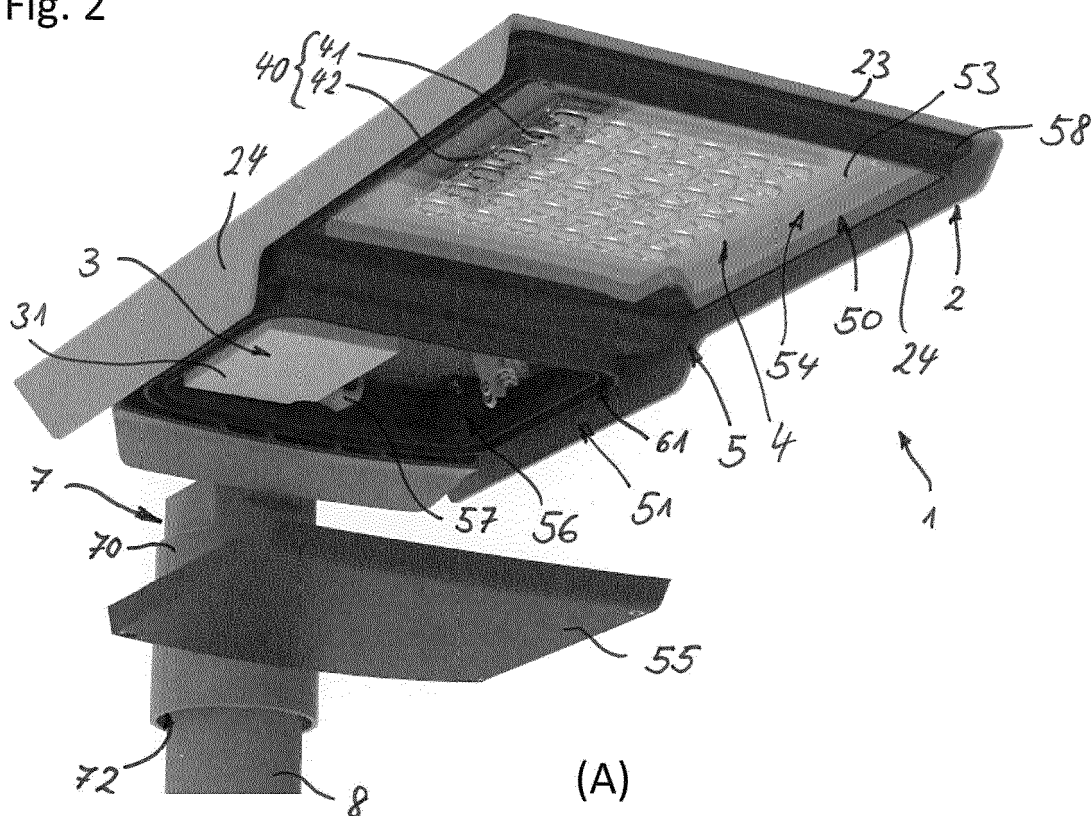


Fig. 2



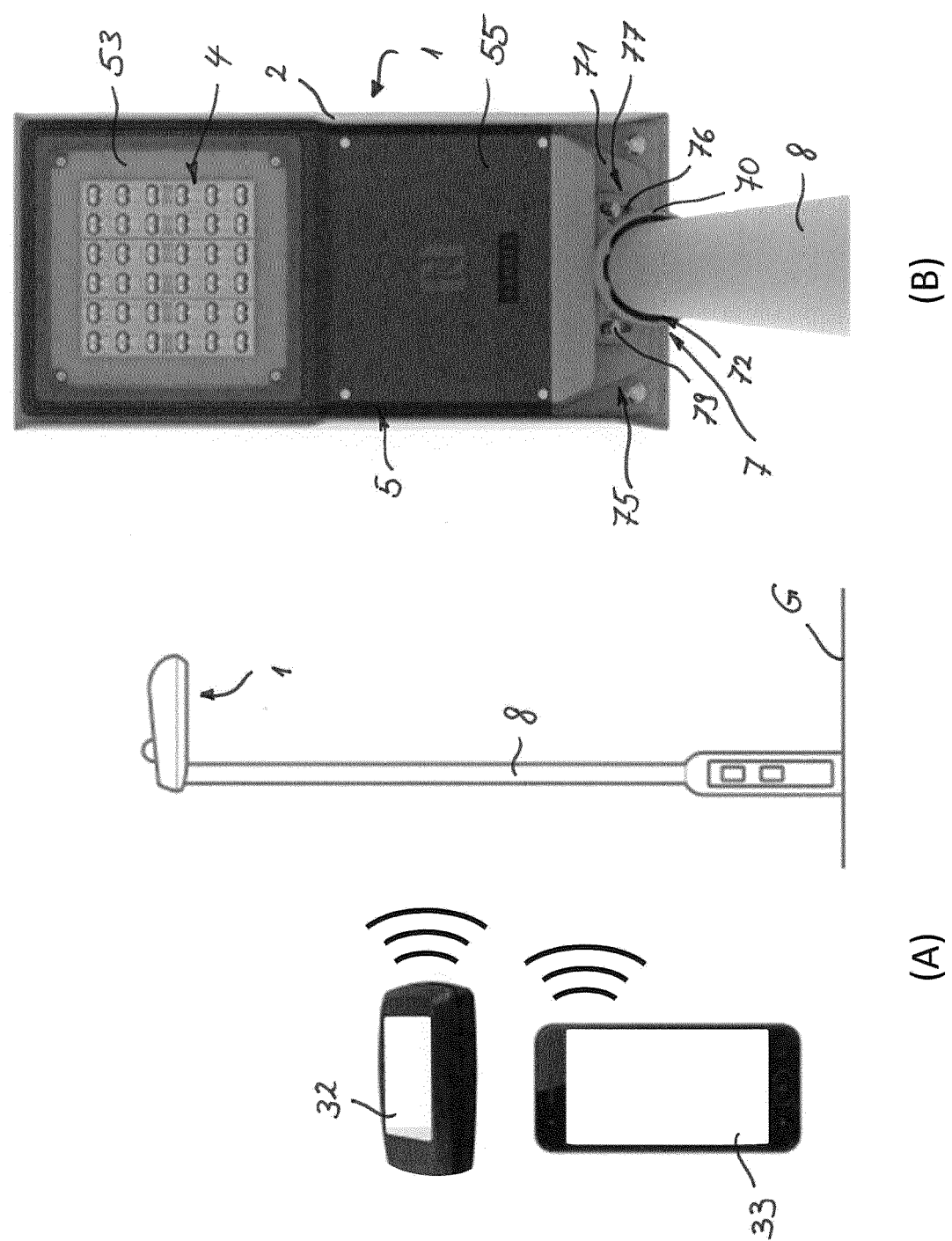


Fig. 3

Fig. 4

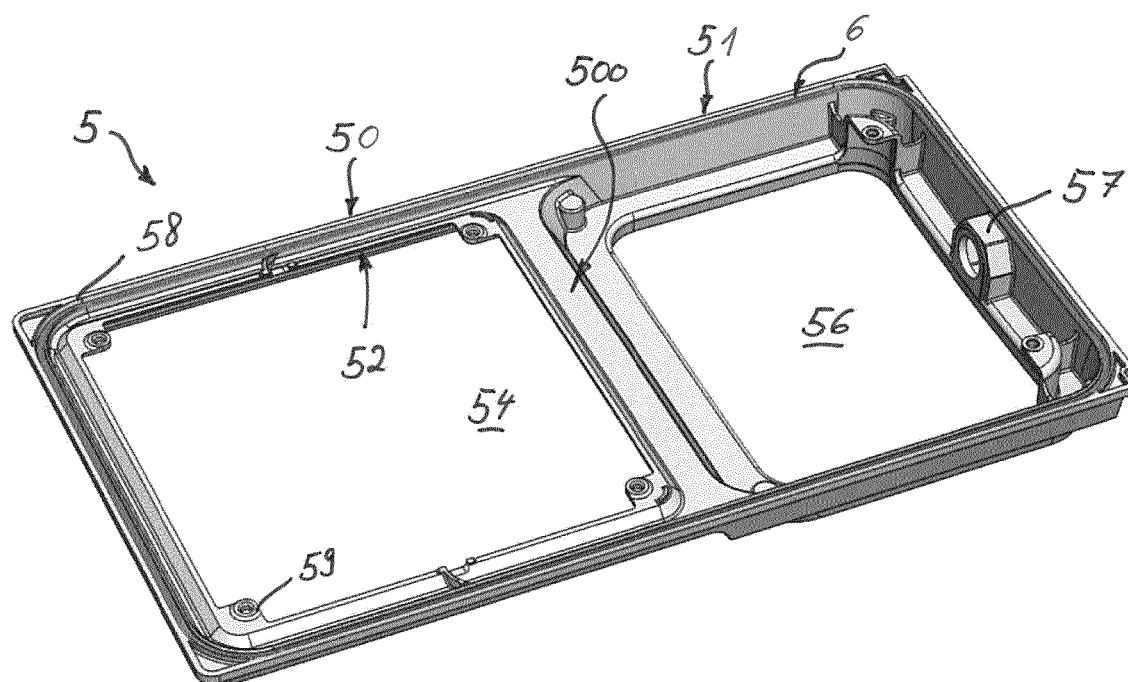


Fig. 5

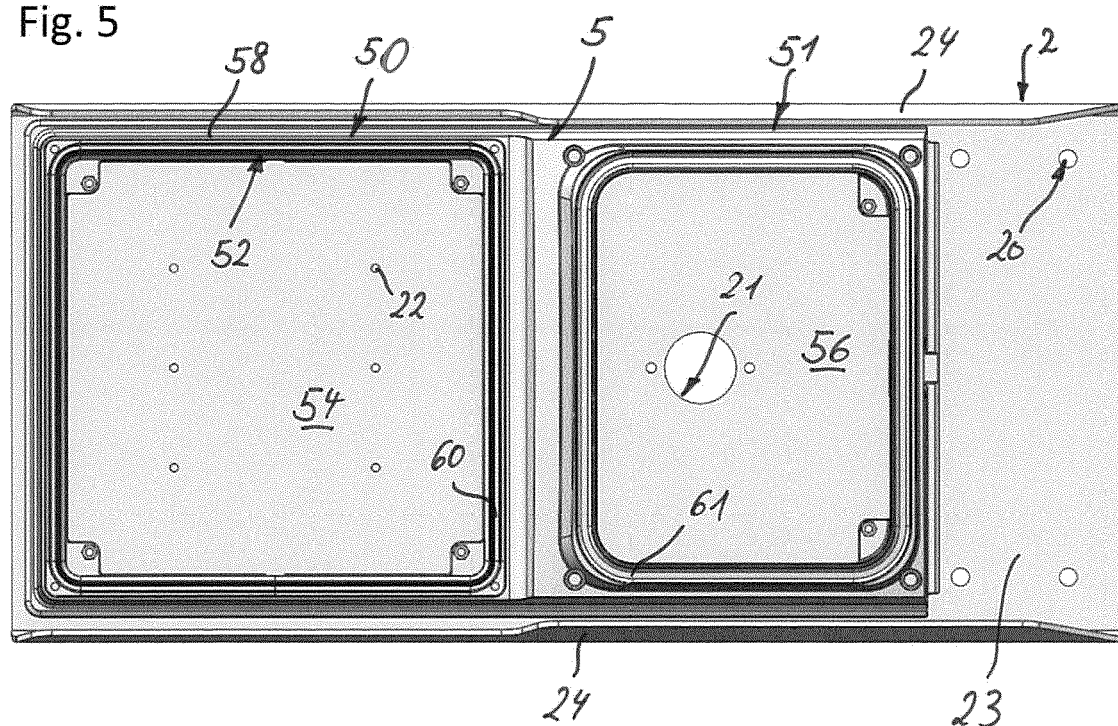


Fig. 6

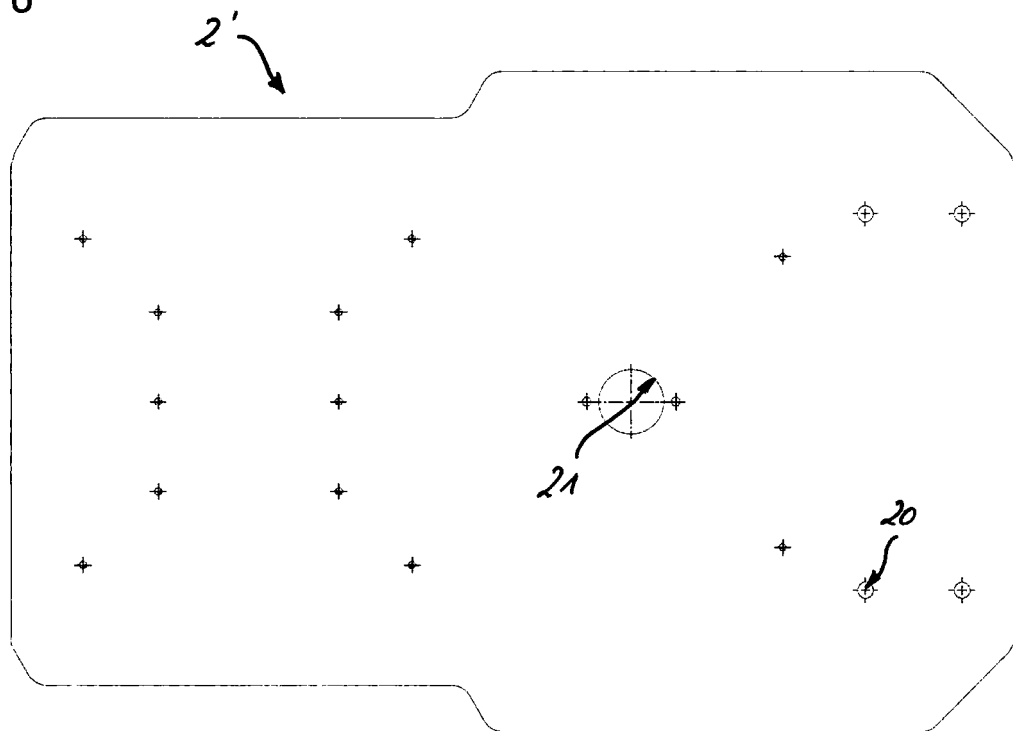


Fig. 7

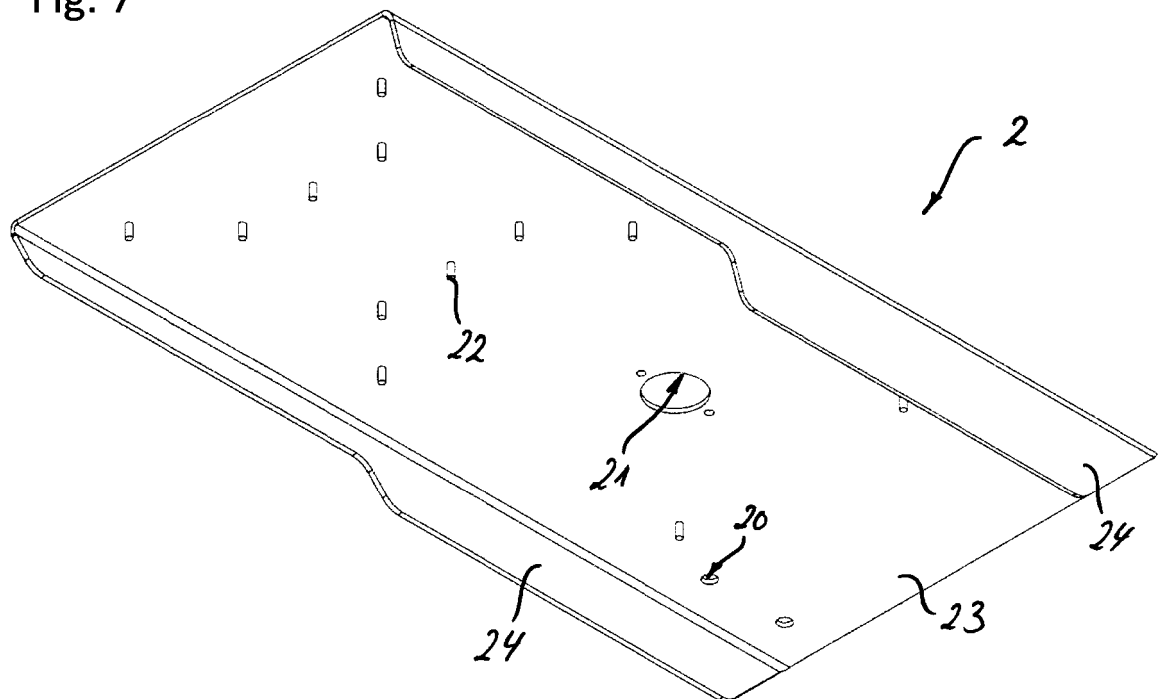


Fig. 8

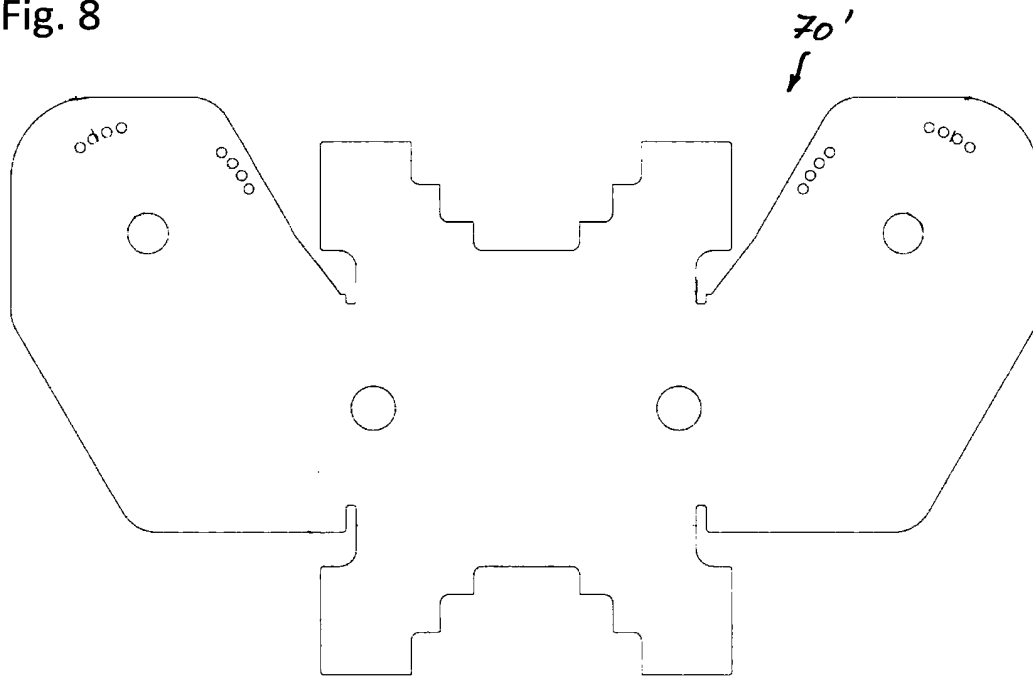


Fig. 9

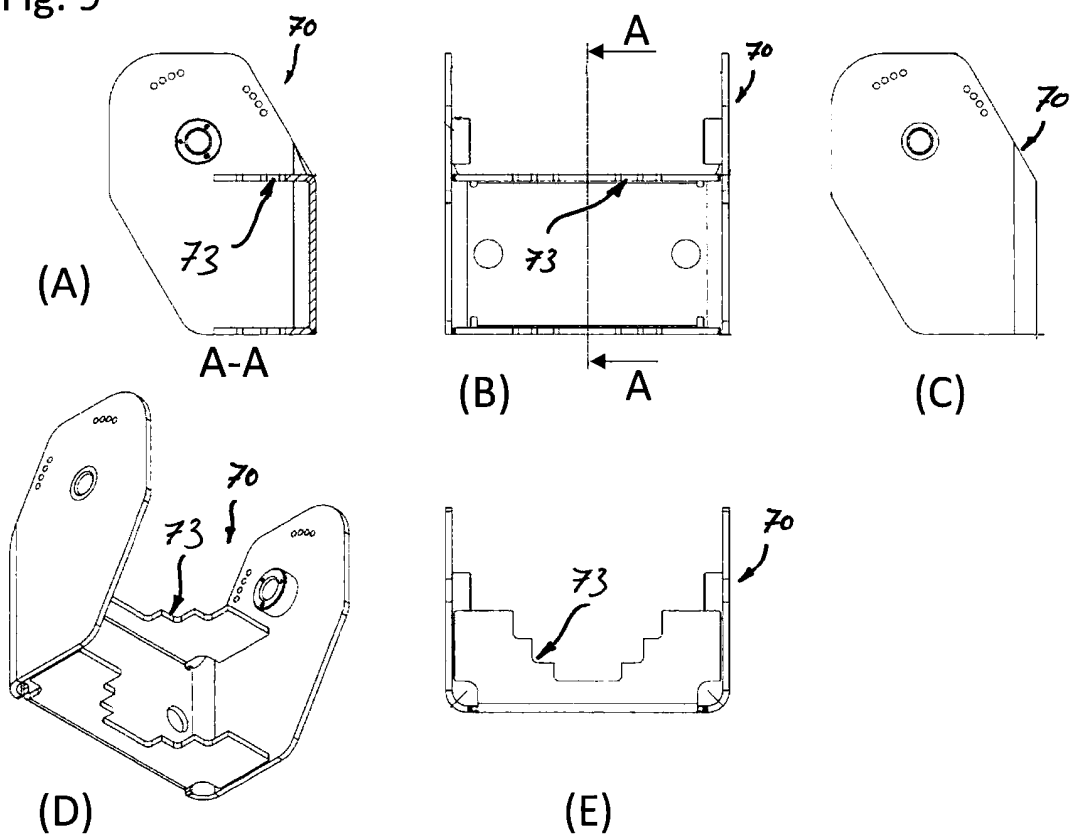


Fig. 10

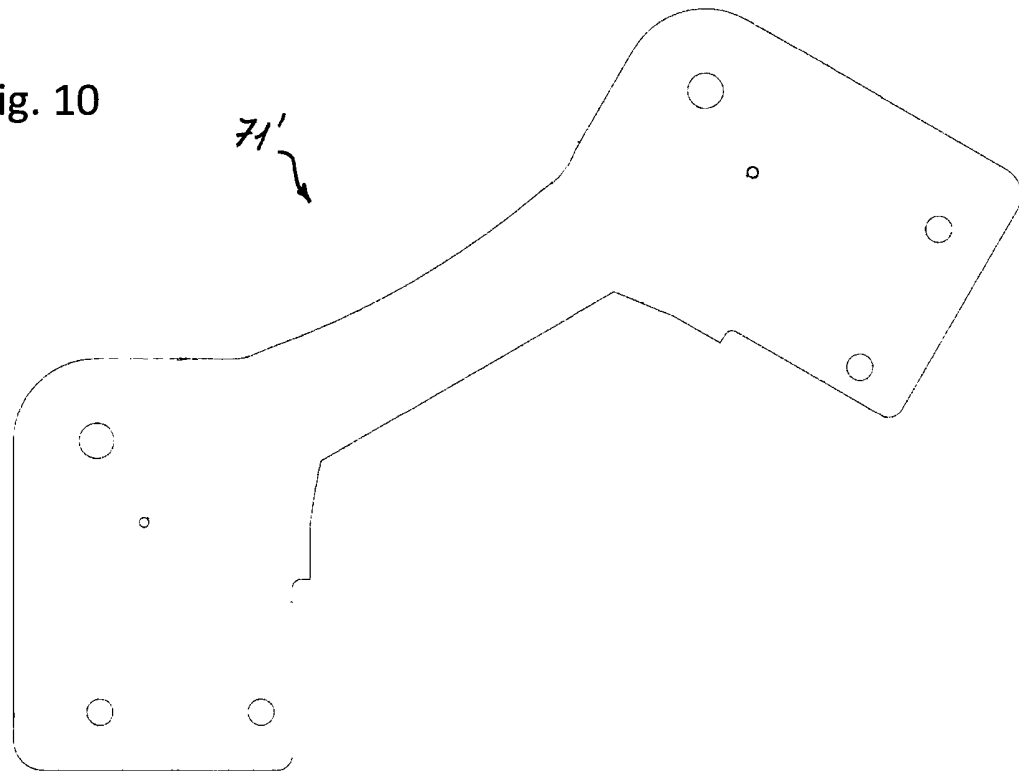


Fig. 11

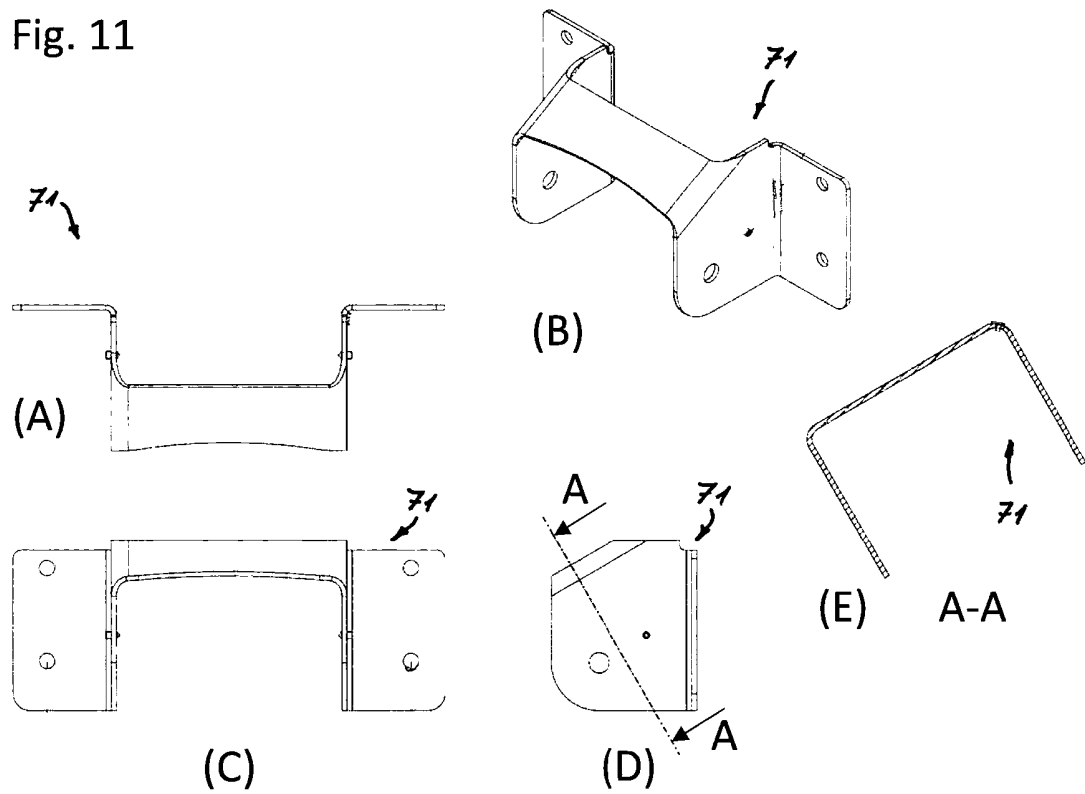
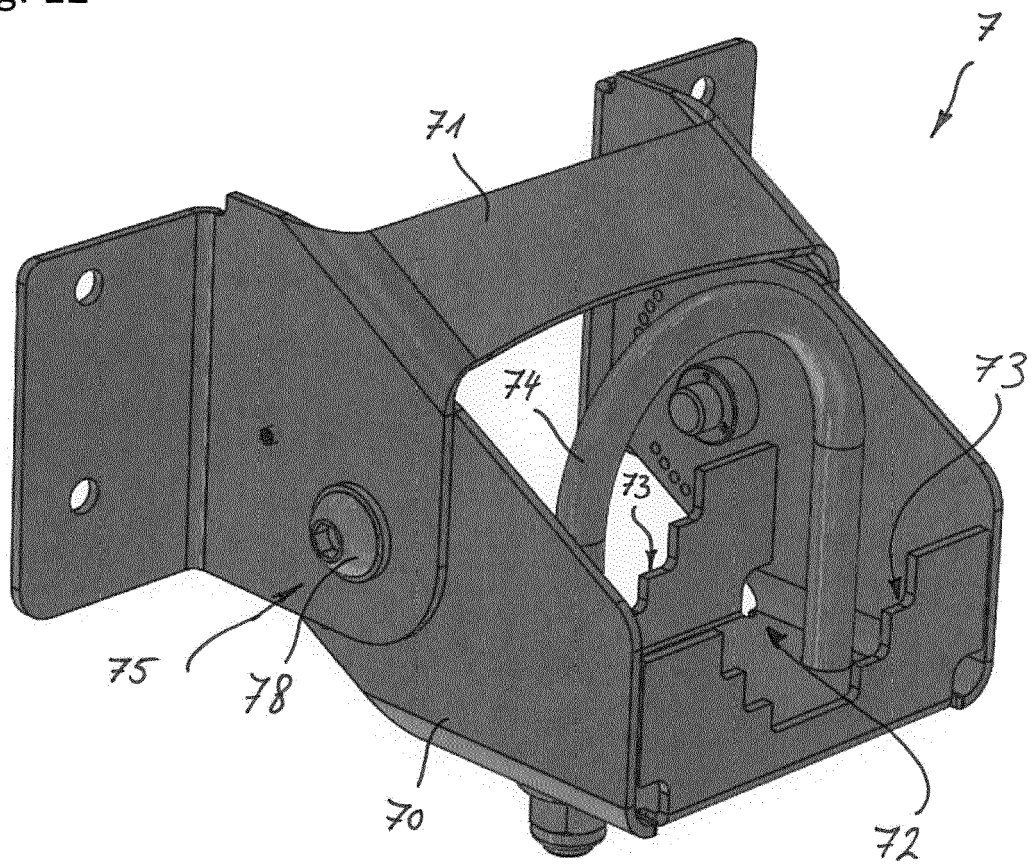


Fig. 12



REFERENCES CITED IN THE DESCRIPTION

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