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(54) MODULAR CONSTRUCTION SYSTEM

(57) Panel (10; 20; 30) for modular construction of a housing module or prefabricated building comprising:
- at least one corrugated element (1) having a perimetral edge;
- at least one insulating sheet (2) having a perimetral edge, shaped to be coupled to the corrugated element (1) with the respective perimetral edge substantially adjacent to the perimetral edge of said at least one corrugated element (1), in a coupling configuration;
- at least one interlocking profiled element (3; 4; 7) configured to block said coupling configuration between the corrugated element (1) and the insulating sheet (2),
wherein said at least one interlocking profiled element (3; 4; 7) comprises at least one substantially U-shaped cross section, comprising at least one longitudinal connection base (33; 43; 73) comprised between two lateral restraining wings (31, 32; 41, 42; 71, 72), delimiting with the connection base (33; 43; 73) one housing seat (34; 44; 74) for said coupling of said at least one corrugated element (1) with said at least one insulating sheet (2), said at least one profiled element (3; 4; 7) being also shaped so as to delimit at least one coupling portion (35; 45 ; 75) configured to provide a shape coupling with a corresponding coupling portion (35; 45; 75) of another panel (10; 20; 30) adjacent, in a connection configuration between two panels.

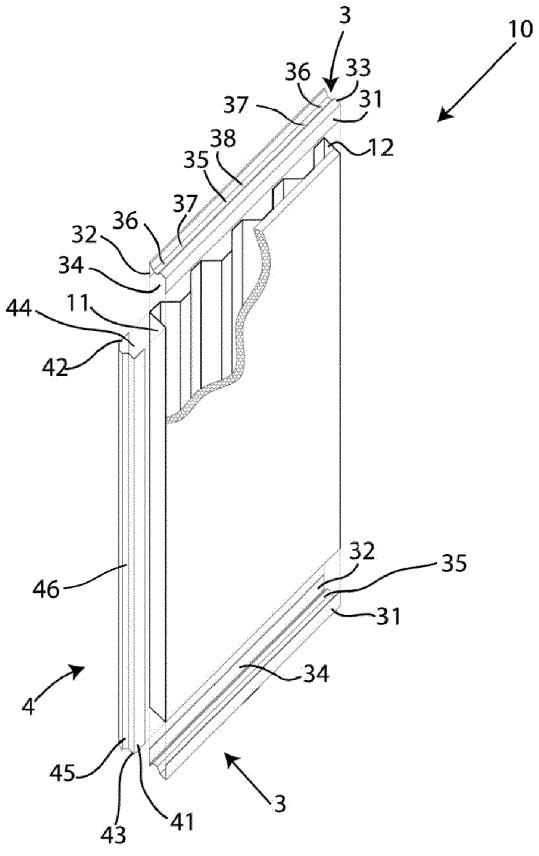

Fig. 1

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Description

[0001] The present invention relates to a modular construction system for prefabricated building, based on the use of a modular panel, in particular a modular construction system for light prefabricated buildings, based on the construction of load-bearing walls by prefabricated modular panels, as well as a corresponding assembly method.

[0002] The modular construction systems for prefabricated buildings of the known art provide for the use of panels, made of steel or aluminium, which are assembled together during the assembly of a desired housing module or prefabricated building, which are connected with each other by interlocking profiled element. The known interlocking profiled element have a "C" or "U" section, and are suitably connected to each other, by means of welding or by means of fasteners such as wall plugs, nails, bolts or rivets, to make framed systems.

[0003] Compared to traditional building systems, the modular construction allows rapid installation and making up times of the bearing elements, while at the same time providing excellent resistance of the elements in relation to their lightness.

[0004] A disadvantage of the modular construction systems for prefabricated buildings of the prior art is that the assembly between the panels and the interlocking profiled elements is carried out on the construction site where therefore the specific connection of each profiled element to the respective panel is also carried out, depending on whetherthis should then be used as a component of the wall or floor.

[0005] The choice of the type of profiled element to be used and the steps for assembling the profiled element to the respective panel require a technical and operational competence that not always conform with the need for ease and rapidity of assembly required in a prefabricated system.

[0006] A further disadvantage of the known art is that the frames obtained, by onsite assembly of the profiled elements and panels, must necessarily be finished with elements for thermal insulation and/or with further panels to obtain a surface planar usable inside a prefabricated residential building.

[0007] A still further disadvantage is that the systems of the known art have poor flexibility from the point of view of the compositional possibilities of the architectural structure, as they do not make possible the design freedom granted by a truly modular type system.

[0008] Therefore, the technical problem established and solved by the present invention is that of providing a modular construction system for prefabricated building that is versatile which allows to overcome the drawbacks mentioned above with reference to the prior art.

[0009] A specific object of the present invention is a panel for the modular construction of a housing module or prefabricated building comprising:

- at least one corrugated element having a perimetral edge;
- at least one insulating sheet having a perimetral edge, shaped to be coupled to the corrugated element with the respective perimetral edge substantially adjacent to the perimetral edge of said at least one corrugated element, in a coupling configuration;
- at least one interlocking profiled element configured to block said coupling

configuration between the corrugated element and the insulating sheet, wherein said at least one interlocking profiled element comprises at least one substantially U-shaped cross section, comprising at least one longitudinal connection base comprised between two lateral restraining wings, delimiting with the connection base one housing seat for said coupling of said at least one corrugated element with said at least one insulating sheet, said at least one profiled element being also shaped so as to delimit at least one coupling portion configured to provide a shape coupling with a corresponding coupling portion of another panel adjacent, in a connection configuration between two panels.

[0010] According to another aspect of the invention, said at least one least one coupling portion can be formed along said at least one connection base of said at least one profiled element.

[0011] According to a further aspect of the invention, said at least one coupling portion can extend longitudinally within the plan footprint of said at least one connection base of said at least one profiled element.

[0012] According to an additional aspect of the invention, said at least one coupling portion can be formed along at least one of said two lateral restraining wings of said at least one interlocking profiled element.

[0013] According to another aspect of the invention, said at least one coupling portion can be shaped as a rail or longitudinal protrusion and can comprise one concavity corresponding or opposite to the concavity of said housing seat.

[0014] According to a further aspect of the invention, said at least one corrugated element can comprise at least one profiled element comprising portions having trapezoidal shape and at least two transversal end flaps, said at least two transversal end flaps extending substantially orthogonal to a main deployment plane of said corrugated element.

[0015] According to an additional aspect of the invention, said at least one insulating sheet can be dimensioned so as to be arranged adjacent to said at least one corrugated element and housed between said at least two transversal end flaps of said at least one corrugated element with one of its faces adjacent thereto.

[0016] According to another aspect of the invention, said panel can comprise at least one spacer element and a counter-wall, said at least one spacer element being fixed to said at least one insulating sheet and acting as a support for said at least one counter-wall, thereby an

inter space is obtained between said at least one insulating sheet and said at least one counter-wall.

[0017] According to a further aspect of the invention, said panel can comprise at least one coating configured to be applied directly to said at least one counter-wall or to be supported by said at least one spacer element.

[0018] According to an additional aspect of the invention, in said at least one interlocking profiled element a first slot and a second slot can be formed, in correspondence with at least one terminal end of said at least one profiled element in said coupling portion, said first slot and said second slot being formed at a different distance from said at least one terminal end of said interlocking profiled element.

[0019] According to another aspect of the invention, in said at least one interlocking profiled element a first slot, at one of the two lateral wings at said coupling portion, and a further slot, at the other of the two lateral wings, is formed, said at least one first slot and said at least one further slot being substantially in axis with each other.

[0020] It is still a specific object of the present invention a modular construction system for prefabricated buildings comprising at least two modular panels above disclosed and at least fasteners elements, configured to fasten in position said at least two modular panels with each other, in a coplanar or angled junction configuration, at the respective slots formed in at least one interlocking profiled element of said at least two modular panel.

[0021] It is also a specific object of the invention a method for assembling a modular construction system for prefabricated housing, comprising the following steps:

- arranging at least one plurality of modular panels above disclosed, based on a configuration of the desired module or prefabricated building to build; and
- fasten the modular panels of said at least one plurality of modular panels, which are configured to act as a floor or cover or roof for said housing module or prefabricated building, staggered with respect to the modular panels of said at least one plurality of modular panels, which are configured to form the side walls of said housing module or prefabricated building.

[0022] According to another aspect of the invention, said step of providing at least one plurality of modular panels as above disclosed, based on a configuration of the desired module or prefabricated building to build, can comprise select for each modular panel said at least one corrugated element, said at least one insulating sheet and said at least one interlocking profiled element and optionally said at least one spacer element and said at least one counter-wall, depending on whether said at least one modular panel is configured to form a coplanar or an angled joint between the panels.

[0023] Advantageously, the modular panel according to the present invention allows to reduce the assembly times of a modular construction system for prefabricated building according to a simple, reliable, efficient and economical way.

[0024] A further advantage of the modular panel according to the present invention is the reduction of the possibility of errors in the positioning of the modular panel itself, during assembly, thus allowing the optimization of the quality and structural stability of the construction system obtained.

[0025] A still further advantage of the present invention is that the need for maintenance due to possible disconnections or loosening of the connection elements used in the prior art is drastically reduced.

[0026] Advantageously, these features not only ensure greater structural stability and greater safety for the end user, but at the same time they allow limiting times and waste of material during assembly and construction, as well as the products to be returned to the company, thus allowing the respective costs to be kept low.

[0027] Other advantages, features and methods of use of the present invention will be now described, by way of illustration and not by way of limitation, according to its preferred embodiments, by particularly referring to the Figures of the annexed drawings, wherein:

- Figure 1 shows a perspective view, partially exploded and partially sectioned, of a first embodiment of the modular panel according to the present invention;
- Figure 2 shows an exploded view of a variant of the first embodiment of the modular panel, according to the present invention;
- Figure 3 shows a cross-section view of the panel of Figure 2 in a partially assembled configuration;
- Figure 4 shows a perspective view with parts in transparency of a coupling between a modular panel, according to a second embodiment of the present invention (having the function of floor or covering of a housing module or prefabricated building) and a modular panel, according to the first embodiment of the present invention (having the function of a side wall of a housing module or prefabricated building of the present invention);
- Figure 5 shows a side section view of the modular panel acting as a floor and as a modular panel with the function of a wall of Figure 4, in an assembled configuration;
- Figure 6 shows a further side section view of the assembled configuration of Figure 5;
- Figures 7a - 7d show, respectively, some possible assembly configurations of the modular panels according to the present invention;
- Figure 8 shows a modular panel according to the first embodiment of the present invention, in a configuration fixed to the foundations;
- Figure 9 shows a modular panel according to the first embodiment of the present invention, in a configuration fixed to an anti-seismic foundation system.

[0028] Reference will be made to preferred embodiments of the invention according to the invention as it will be exposed in greater detail below hereinafter.

[0029] All the embodiments reach the same advantages listed above with reference to the panel and to the system according to the invention, by the same technical solution according to a rapid connection between preassembled modular panels.

[0030] In the following description, components common to different embodiments will be identified with the same numbering.

[0031] As shown in Figure 1, a modular panel according to a first embodiment of the invention is indicated with the reference number 10 and comprises a corrugated element 1, an insulating sheet 2, shaped to be coupled to the corrugated element 1 and at least one profiled element 3, 4 for interlocking, configured to constrain a coupling between the corrugated element 1 and the insulating sheet 2.

[0032] In the embodiment herein disclosed and shown in the figures, the modular panel 10 has four sides, preferably having a square or rectangular shape, so as to allow a rapid connection between a plurality of panels according to the invention.

[0033] The corrugated element 1, for example made of a metallic material or a composite material suitable for the purpose, is preferably cold formed and shaped to have a profile comprising portions with a trapezoidal shape and transversal end flaps 11 and 12, which extend substantially orthogonal to a main development plan of the corrugated element itself.

[0034] In the preferred embodiment, the insulating sheet 2 is made of materials with physical-mechanical characteristics suitable for realizing thermal and/or acoustic insulation, characterized by low thermal conductivity, high thermal displacement, and good breathability, such as, for example, rock wool, glass wool, polystyrene, cork, wood fibre, polyurethane and other materials having the aforementioned features.

[0035] In particular, the corrugated element 1 and the insulating sheet 2, which according to an advantageous aspect are square or rectangular shaped, are dimensioned so as to present the respective peripheral edges substantially adjacent in a coupling configuration.

[0036] Optionally, the insulating sheet 2 is dimensioned in such a way to be placed next to the corrugated element 1 and remain engaged - for example by shape coupling - between the two transversal end flaps 11 and 12 of the corrugated element 1 with one face arranged next to the latter.

[0037] The aforementioned coupling between the corrugated element 1 and the insulating sheet 2 is secured by at least one interlocking profiled element 3, 4, as shown in Figure 1, optionally by four interlocking profiled elements 3 or 4, one for each side of the peripheral edge of the connection thus formed.

[0038] Advantageously, each interlocking profiled element 3, 4 comprises a substantially U-shaped cross section, made by a longitudinal connection base from which two lateral restraining wings rise at opposite longitudinal ends of the base, which delimit, with the longitudinal connection base, a housing seat, for the connection of the corrugated element 1 with the insulating sheet 2.

[0039] In particular, a first type of interlocking profiled element, according to the first embodiment of the present invention, the so-called interlocking profiled female element 3, comprises a longitudinal connection base 33 comprised between two lateral restraining wings 31 and 32, which delimit with the longitudinal base 33 a housing seat 34 for coupling the corrugated element 1 with the insulating sheet 2. The longitudinal connection base 33 of the interlocking profiled female element 3 is further shaped to delimit a coupling portion 35, optionally shaped as a longitudinal rail, with a concavity opposite to the concavity of the housing seat 34 of the interlocking profiled female element 3, and configured, as will be seen below, to be coupled, advantageously by shape coupling, with a corresponding coupling portion of another panel according to the invention.

[0040] In fact, the coupling portion 35 defines a channel which extends in a longitudinal direction along the interlocking profiled female element 3. The coupling portion 35, besides defining a coupling element, as indicated above, acts as a stiffening rib for the interlocking profiled female element.

[0041] In particular, the coupling portion 35 stiffens the interlocking profiled female element 3 with respect to the stresses which orthogonally act with respect to the longitudinal direction along which the interlocking profiled female element 3 develops.

[0042] Moreover, it can be observed that the coupling portion 35 develops inside the plan footprint of the profiled element 3, that is to say the plan area of the connection base 33 delimited between the lateral restraining wings 31, 32.

[0043] The coupling section 35, therefore, defines a coupling element comprised in the thickness of the modular panel 10, within the scope of a solution that allows the mutual connection between several modular panels 10 to obtain a wall without joining elements that protrude from the wall itself.

[0044] A further type of interlocking profiled element, according to the first embodiment of the present invention, the so-called interlocking profiled male element 4, comprises a longitudinal connection base 43 comprised between two lateral restraining wings 41 and 42, which delimit with the longitudinal connection base 43 a housing seat 44 for the coupling of the corrugated element 1 with the insulating sheet 2. The connection base 43 of the interlocking profiled male element 4 is furthermore shaped to delimit a coupling portion 45, optionally shaped as a longitudinal protuberance 46, configured, as will be seen below, to be positioned by coupling, advantageously by shape coupling, with a corresponding coupling portion of another panel according to the invention, for example the coupling portion 35 of an interlocking profiled

female element 3 disclosed above.

[0045] The longitudinal protuberance 46 of the connection base 43 of the interlocking profiled male element 4 delimits a concavity portion corresponding to the concavity of the housing seat 44.

[0046] Analogously to what has been observed regarding the coupling portion 35 of the interlocking profiled female element 3, the longitudinal protuberance 46 of the coupling portion 45 acts as a stiffening element for the profiled element 4.

[0047] In detail, the coupling portion 45 stiffens the interlocking profiled male element 4 with respect to the stresses which orthogonally act with respect to the longitudinal direction along which the interlocking profiled female element 3 develops.

[0048] Moreover, the longitudinal protuberance 46 is comprised within the footprint of the connection base 43.

[0049] The coupling portions 35 and 45, respectively, of the interlocking profiled female element 3 and of the interlocking profiled male element 4 according to the first embodiment of the present invention, are configured in a substantially complementary manner to provide, between them, a shape coupling. Obviously, these coupling portions 35 and 45 can also be configured differently from the one described above, as long as they allow a shape coupling between the respective profiled elements 3 and 4 to be achieved.

[0050] As mentioned, the coupling portion 35 of the interlocking profiled female element 3 and the coupling portion 45 of the interlocking profiled male element 4 develop longitudinally along, respectively, the connection base 33 of the profiled female element 3 female and the connection base 43 of the profiled element 4 male. Therefore, by connecting the coupling portion 35 and the coupling portion 45 to each other, a shape coupling which remains within the footprint of the modular panel 10 is obtained (see the detail of the connection between the profiled female element 3 and the profiled male element 4 shown in figure 3).

[0051] Depending on the requirements, the aforementioned interlocking profiled elements 3 and 4 can be inserted on one or more sides of the peripheral edge of the coupling obtained between the corrugated element 1 and the lateral sheet 2, vertically and/or horizontally in the enclosed Figures, to close a modular panel 10 which can be used as a wall of the modular construction system according to the invention.

[0052] As shown in Figure 1, in an advantageous operating configuration, the corrugated element 1 of the modular panel 10 is positioned so as to present a longitudinal extension of main rails of the substantially vertical corrugated element 1 with respect to a ground or support plane. In this way the structural rigidity of the element 1 is maximized and the resistance of the modular panel 10 is optimized in the same way.

[0053] The modular panel 10 according to the first embodiment, shown in Figure 1, comprises at least one interlocking profiled male element 4 (lateral and vertical in Figure 1) and at least one interlocking profiled female element 3 (one at the top and horizontal and another at bottom and horizontal in Figure 1), and is configured to be laterally coupled, at the interlocking profiled male element 4, with at least one further modular panel 10 - not shown in the figure - which comprises a corresponding interlocking profiled female element 3, so as to form a continuous wall, as shown for example in Figure 3 (left).

[0054] With such a configuration of the modular panels 10, a shape coupling can be realized which allows to obtain a coplanar side wall of a housing module or prefabricated building, comprising at least two modular panels 10 (see Figs. 7c and 7d).

[0055] The coupling between the at least one interlocking profiled male element 4 and a respective at least one interlocking profiled female element 3, in fact, remains within the thickness of the modular panels 10, thus keeping both faces of the coplanar side wall obtainable through the connection of at least two modular panels 10 free from (i.e. without) any appendix.

[0056] A variant of the first embodiment of the invention according to the present invention provides a modular panel 20, as shown in Figure 2.

[0057] The modular panel 20 has the technical features disclosed above with reference to the modular panel 10 and further comprises at least a spacer element 5 and a counter-wall 6.

[0058] Advantageously, the spacer elements 5, for example conformed as oblong elements, are fixed - for example screwed, glued, stuck or otherwise properly constrained - on the insulating sheet 2 and act as a support for the counter-wall 6, so they allow the formation of a housing between insulating sheet 2 and counter-wall 6 which can act as an interspace for plant engineering.

[0059] The modular panel 20 can also be provided with a coating element 60, for example made of metal sheet or any other suitable material, configured to be applied to the counter-wall 6 (for example glued or bolted to it), which can act as base for the realization of a customized internal finish of a housing module or prefabricated building or prefabricated building.

[0060] For the realization of the plant engineering interspace I, in addition to or as an alternative to the spacer elements 5, optionally uniformly distributed on the surface of the insulating sheet 2, additional spacer elements 51 or 52 can be provided, as uprights and/or beams, at the insulating sheet 2, which act as a support for the coating elements 60 or internal finishing panels, according to the specific requirements, as shown for example in Figures 5 and 6 and with the possible interposition of the counter wall 6. The coating elements 60 or internal finishing panels, as seen in Figures 5 and 6, may have different dimensions, optionally reduced, with respect to the dimensions of a respective insulating sheet 2 to which they are applied.

[0061] The realization of a modular panel 10 or 20, according to what has been described above, in which the aforesaid components are constrained to each other

in a configuration coupled by interlocking profiled elements 3 and 4, allows to reduce the times of realization and installation of the modular panel itself, the various components of the modular panels 10 and 20 being able to be assembled beforehand, before laying on the site for the construction of a housing or prefabricated building.

[0062] The modular panels 10, 20 - as shown in figures 7a-7d - are configured to provide a coplanar junction with other modular panels in a modular construction system and therefore in the following will also be said modular panels with coplanar junction.

[0063] According to a second embodiment of the present invention, a modular panel 30 is instead provided, advantageously configured to provide a right-angle joint between adjacent modular panels, for example in the case of the realization of a floor, a roof or roof or even a right-angled side wall, in a modular construction system. Such a modular panel 30, hereinafter, will also be referred to as an angled modular panel.

[0064] As shown in Figures 4, 5 and 6, the modular panel 30 according to the second embodiment of the present invention differs from the modular panels 10 or 20 described above, for the configuration of an interlocking profiled element, indicated with the reference 7 in the Figures above indicated, configured to constrain a coupling between the corrugated element 1 and the insulating sheet 2.

[0065] Such interlocking profiled element 7 is substantially U-shaped, and comprises a longitudinal connection base 73 from which there are, at its opposite longitudinal ends, two lateral restraining wings 71 and 72, which delimit, together with the connection base 73, a housing seat 74, for the coupling of a corrugated 1 with the respective insulating plate 2.

[0066] In such an interlocking profiled element 7, at least one of the two side wings - in the case of Figure 4 the wing 71 - is shaped so as to present a coupling section 75, optionally a longitudinal protuberance, sized to be positioned in coupling, preferably in shape coupling, with a corresponding coupling section of another profiled element, for example a respective longitudinal track 35 of an interlocking profiled female joint 3 provided at an upper edge of a modular panel 10, 20, thus creating an angled junction between the two panels.

[0067] Clearly, it is easily to be understood how an interlocking profiled element 7 can comprise a coupling portion 75 on only one or on both lateral restraining wings 71 and 72, each coupling portion 75 being shaped and sized to be positioned at coupling, preferably in form coupling, with a respective coupling portion 35 or 45 provided at a lower or upper edge of a modular panel 10 or 20.

[0068] Even a modular panel 30 according to the invention optionally comprises at least one spacer element 5 and can also comprise a counter-wall 6.

[0069] Advantageously, the spacer elements 5, for example conformed as oblong elements, are fixed - for example screwed, glued, stuck or otherwise suitable constrained - on the insulating sheet 2 of the modular panel 30 and act as a support for the counter-wall 6, whereby they allow the formation of a housing that can act as a plant engineering interspace II.

[0070] The modular panel 30 can also be provided with a coating element 61, for example made of metal sheet or any other suitable material, configured to be applied to the counter-wall 6 (for example glued or bolted to it), which can act as base for the realization of a customized internal finish of a housing module or prefabricated building, such as a counter-wall.

[0071] The modular panel 30 according to the present invention, for the realization of the plant engineering interspace II, in addition to or as an alternative to the spacer elements 5, optionally uniformly distributed on the surface of the insulating slab 2, comprises additional spacer elements 51 and/or 52 mounted on the insulating plate 2, as uprights and beams, which act as a support for the covering element 61 which acts as a false ceiling, according to specific requirements, as shown for example in Figures 5 and 6.

[0072] The covering element 61, as seen in Figures 5 and 6, may have different dimensions, optionally reduced, with respect to the dimensions of a respective insulating sheet 2 to which it is applied, through the respective spacer elements 5, 51 and/or 52.

[0073] As will be noted, the particular configuration of the connecting portion (of the protuberances and of the longitudinal tracks) of the interlocking profiled elements 3, 4, and 7 allows, as mentioned above, to connect two or more modular panels according to the present invention, by a shape coupling, in a substantially transverse direction, with respect to the longitudinal extension direction of the respective coupling portion 35, 45, 75, which:

- in the case of coplanar junction coupling of two modular panels 10 or 20, according to the first embodiment, it is also coplanar with the extension plane of the wall formed by them; or,
- in the case of an angled junction coupling, it is also substantially perpendicular to the extension plane of a modular panel 10 or 20, according to the first embodiment of the present invention, and parallel to the modular panel extension plane 30 according to the second embodiment of the present invention. Instead, to prevent sliding between coupled panels, along the direction of longitudinal extension of the respective coupling portion 35, 45, 75, in each of the interlocking profiled elements 3, 4, and 7 of the aforesaid panels 10 or 20 and 30 a plurality of slots is provided, which allow the panels to be constrained to each other, by means of suitable fastening elements, which will be discussed below, in a desired configuration, for example, illustrated in any one of Figure 7a - 7d.

[0074] In this regard, in each interlocking profiled element 3, 4 of a modular panel with coplanar junction 10 or 20, for convenience reference is made to the interlock-

ing profiled female element 3 of a panel 10 in Figure 1 or 4, is obtained a first slot 36 and a second slot 37, at a terminal end of the profiled element itself, in the respective coupling section, in the case illustrated in the longitudinal track 35.

[0075] The two slots 36 and 37 are obtained at different distances from a terminal end of the respective interlocking profiled element.

[0076] In each interlocking profiled element 7 of a modular panel with an angled junction 30, for convenience reference is made to the interlocking profiled element 7 in Figure 4, a first slot 70 is obtained, in correspondence with at least one of the two lateral wings, in particular at the coupling portion 75, designed to couple with a respective coupling portion of a modular panel 10 or 20. In the other lateral wing, opposite to that provided for coupling with the modular panel 10 or 20, there is provided a further slot 70', optionally substantially in axis with the first slot 70, which allows the insertion of a clamping tool for a fixing element between the two panels 10 or 20 and 30.

[0077] In particular, the first slot 36 of a coplanar junction modular panel section 10 or 20, and the first slot 70 of the interlocking profiled element 7 of a modular panel with angled junction 30, are equally spaced with respect to the terminal end of the respective profiled elements and the distance between the first slot 36 and the second slot 37 of the section of a modular panel with a coplanar joint 10 or 20 is substantially equal to twice the distance of the first slot 36 with respect to the terminal end of the respective profiled element.

[0078] The slots shown in Figure 4, at a first terminal end of each profiled element, are formed symmetrically also at the second terminal end of each profiled element.

[0079] Preferably, in each profiled element 3, 4 and 7 further slots can be formed, for example at least another central slot (38 in Figure 1) or more slots uniformly distributed along the length of each interlocking profiled element, which are aligned with corresponding slots of the other interlocking profiled elements, when the respective coupling portions 35, 45 or 75 are coupled.

[0080] With such a configuration of the modular panels 10 or 20 and 30 it is possible to provide a modular construction system for simple and versatile prefabricated buildings.

[0081] Such a modular construction system comprises at least two modular panels of the type described above and at least fixing elements, provided to constrain the aforementioned modular panels in position to obtain a desired configuration, for example one of the configurations shown in the figures. 7a to 7d.

[0082] The fastening elements included in the modular construction system according to the invention comprise one or more bolts, which can be fixed at the respective slots of the interlocking profiled elements, by means of a clamping tool, which can be inserted as above, in the further slot 70', of a profile of a modular panel with angled junction 30.

[0083] Depending on the configuration of a housing module or pre-fabricated building that one wishes to build and the type of junction (coplanar or angled) between modular panels to be realized, it will be necessary to select the components of each modular panel 10, 20 or 30, to be used, or at least at the corrugated element 1, the insulating sheet 2 and the profiled elements 3, 4, or 7 to be used, as well as the dimension of the possible counterwalls 6, 61, 62 with the respective spacer elements 5, 51 and/or 52.

[0084] In any case, the modular panels 10, 20 and 30 described above can advantageously be easily assembled before laying on the construction site for the construction of the housing module or prefabricated building, thus allowing to drastically reduce the laying time of the prefabricated building itself and limiting the operations on site to the fixing operations of the modular panels previously assembled, in a desired configuration, by means of the fixing elements described above.

[0085] The subject of the present invention is also a method of assembly of a modular construction system for prefabricated building.

[0086] Such an assembly method comprises mounting the modular panels with angled junction 30, intended to serve as the floor or covering or roof of a prefabricated housing module or building, staggered with respect to the modular panels with coplanar junction, i.e. intended to constitute the side walls of a housing module or prefabricated building, as advantageously shown in Figures 7a - 7d.

[0087] As can be seen for example from Figure 7d, according to a preferred variant of the assembly method of the present invention, a modular panel with an angled junction 30' is mounted in a staggered manner with respect to a modular panel with a coplanar junction 10'. The offset between the modular panel 30 and the modular panel 10' is obtained with the first slot 70 formed in the interlocking profiled element 7, arranged at the second slot 37 of the interlocking profiled element 3. In a corresponding manner, another slot 70 is formed in the interlocking profiled element 7 of the modular panel with angled junction 30' (the one formed at the opposite terminal end of the profile 7), is positioned, during assembly, at the first slot 36 of the interlocking profiled element 3 of a coplanar junction panel 10" adjacent and coupled to the modular panel 10', thus allowing to fix the modular panel 30' on two modular panels 10', 10 " connected to each other and coplanar.

[0088] Considering Figures 7a -7d, it is possible to examine the assembly diagrams of the modular prefabricated panels according to the present invention: it is shown how the union of the structural elements is obtained by superimposing the modular panels with angled junction 30 on modular panels with coplanar joint 10 or 20, which perform the function of vertical support, to which is added an offset of the first with respect to the second, providing an adequate fixing and support for each individual panel.

[0089] The modular construction system according to the present invention therefore allows a better connection and, therefore, a better collaboration in the distribution of the structural loads and of the tensions between the different structural elements joined, allowing an increase in the mechanical behaviour under load.

[0090] Moreover, as shown in the Figures, the construction system according to the present invention allows a considerable flexibility and versatility in the choice of the constructive configuration.

[0091] In particular, in Figure 7a, it is possible to identify the general method of approaching and subsequently joining the various modular panels: it is possible to identify, synthetically, a sort of basic element of a substantially trilithic form, i.e. a portal formed by two panels with a coplanar junction (10, 20) arranged vertically which act as a support for a third panel with angled covering junction 30 resting horizontally above them.

[0092] In Figure 7a it is also possible to identify the offset which allows an anchor point to be left free in each modular panel with coplanar junction 10, 20 in order to provide support for a modular panel with angled junction 30, or a floor panel, cover or roof, continuous and the consequent solidarity and collaboration of all the adjacent modular panels.

[0093] Therefore, the modular construction system according to the present invention allows to increase the structural stability through a double connection of the panels, the one which defines the relative positioning between the modular panels through a coupling, preferably a male-female shaped coupling, and the other which confers sufficient mechanical strength through the use of fixing elements, which can be positioned according to the required design specifications.

[0094] Preferably, as shown in Figures 5 and 6, between the coupling surfaces of two coupled interlocking profiled elements, a sealing element 80 is positioned, for example an insulating sheath, preferably made of elastic material, which allows to reduce the formation of thermal bridges and to obtain continuity between the insulating elements of the prefabricated panel. Moreover, advantageously, the insulating sheath prevents transpiration phenomena and prevents the ingress of moisture or water.

[0095] It is possible to identify, even in the area of the foundations of the modular construction system according to the present invention, different methods of intervention.

[0096] In particular, in Figure 8 it can be seen how a concrete plate P, connected with the elevation structure, results to be an element made completely in place, directly on the foundation ground T.

[0097] In the embodiment shown in Figure 9, the only element of the construction system carried out during construction is at the foundation, consisting of a prefabricated plate F, for example of concrete, with a variable thickness depending on the design requirements which is connected, in turn, to the deeper part P obtained by casting, by means of seismic isolation devices S, which also are completely customizable on the basis of the characteristics of the individual building.

[0098] To obtain the connection of the modular panel 10, 20 with a foundation element which can be made in situ or prefabricated, the use of a steel track 90 is provided which is fixed to the concrete plate F.

[0099] The track is fixed to the ground by anchoring with threaded plugs and is shaped in such a way as to fit in a specular manner in the interlocking profiled female element 3 for the closure of the a coplanar junction panel 10, 20 of the first level, so as to allow a shape coupling and subsequent fixing of the coupling made.

[0100] Even in this case, a sealing element 80 is positioned between the mating surfaces, for example an insulating sheath to block the passage of water and humidity.

[0101] Advantageously, the track 90 has a profile 96 for water-tightness at a base of the track itself, in such a way as to avoid possible infiltrations below the pavement of the building in a configuration of coupling between the metal track 90 and upper part of the concrete plate.

[0102] Despite the need to carry out part of the prefabricated system's connection to the ground, this application methodology allows the introduction of isolators S below the plate F, that is the most superficial foundation, increasing the safety level of the entire construction.

[0103] In the foregoing, the preferred embodiments of this invention have been described and a number of variations have been suggested, but it should be understood that those skilled in the art can make other variations and changes without so departing from the scope of protection thereof, as defined by the attached claims.

Claims

1. Panel (10; 20; 30) for modular construction of a housing module or prefabricated building comprising:

   - at least one corrugated element (1) having a perimetral edge;
   - at least one insulating sheet (2) having a perimetral edge, shaped to be coupled to the corrugated element (1) with the respective perimetral edge substantially adjacent to the perimetral edge of said at least one corrugated element (1), in a coupling configuration;
   - at least one interlocking profiled element (3; 4; 7) configured to block said coupling configuration between the corrugated element (1) and the insulating sheet (2),

   wherein said at least one interlocking profiled element (3; 4; 7) comprises at least one substantially U-shaped cross section, comprising at least one longitudinal connection base (33; 43; 73) comprised between two lateral restraining wings (31, 32; 41, 42;

71, 72), delimiting with the connection base (33; 43; 73) one housing seat (34; 44; 74) for said coupling of said at least one corrugated element (1) with said at least one insulating sheet (2), said at least one profiled element (3; 4; 7) being also shaped so as to delimit at least one coupling portion (35; 45 ; 75) configured to provide a shape coupling with a corresponding coupling portion (35; 45; 75) of another panel (10; 20; 30) adjacent, in a connection configuration between two panels.

2. Panel (10; 20) according to claim 1, where said at least one coupling portion (35; 45) is formed along said at least one connection base (33; 43) of said at least one profiled element (3; 4).

3. Panel (10; 20) according to claim 1 or 2, wherein said at least one coupling portion (35; 45) longitudinally extends within the plan footprint of said at least one connection base (33, 43) of said at least one profiled element (3; 4).

4. Panel (30) according to claim 1, wherein said at least one coupling portion (75) is formed along at least one of said two lateral restraining wings (71, 72) of said at least one interlocking profiled element (7).

5. Panel (10; 20; 30) according to any of the previous claims, wherein said at least one coupling portion (35; 45; 75) is shaped as a rail or longitudinal protrusion and comprises one concavity corresponding or opposite to the concavity of said housing seat (34; 44; 74).

6. Panel (10; 20; 30) according any one of the previous claims, wherein said at least one corrugated element (1) comprises at least one frame section comprising portions having trapezoidal shape and at least two transversal end flaps (11, 12), said at least two transversal end flaps (11, 12) extending substantially orthogonal to a main deployment plane of said corrugated element (1).

7. Panel (10; 20; 30) according to claim 6, wherein said at least one insulating sheet (2) is dimensioned so as to be arranged adjacent to said at least one corrugated element (1) and housed between said at least two transversal end flaps (11, 12) of said at least one corrugated element (1) with one of its faces adjacent thereto.

8. Panel (20; 30) according to any one of the previous claims, comprising at least one spacer element (5; 51, 52) and a counter-wall (6), said at least one spacer element (5; 51, 52) being fixed to said at least one insulating sheet (2) and acting as a support for said at least one counter-wall (6), thereby an inter space (I, II) is obtained between said at least one insulating sheet (2) and said at least one counter-wall (6).

9. Panel (20; 30) according to claim 8, comprising at least one coating (60, 61) configured to be applied directly to said at least one counter-wall (6) or to be supported by said at least one spacer element (51, 52).

10. Panel (10; 20) according to any one of the previous claims, wherein in said at least one interlocking profiled element (3; 4) a first slot (36) and a second slot (37) is formed, in correspondence with at least one terminal end of said at least one profiled element (3; 4) in said coupling portion (35; 45), said first slot (36) and said second slot (37) being formed at a different distance from said at least one terminal end of said interlocking profiled element (3; 4).

11. Panel (30) according to any of the previous claims, wherein in said at least one interlocking profiled element (7) a first slot (70), at one of the two lateral wings (71, 72) at said coupling portion (75), and a further slot (70'), at the other of the two lateral wings (72, 71), is formed, said at least one first slot (70) and said at least one further slot (70') being substantially in axis with each other.

12. Modular construction system for prefabricated buildings comprising at least two modular panels (10, 20; 30) according to any one of the previous claims and at least fasteners elements, configured to fasten in position said at least two modular panels (10, 20; 30) with each other, in a coplanar or angled junction configuration, at the respective slots (36, 37; 70) formed in at least one interlocking profiled element (3; 4; 7) of said at least two modular panels (10, 20; 30).

13. Method of assembling a modular construction system for prefabricated housing, comprising the following steps:

- arranging at least one plurality of modular panels (10, 20; 30) according to any one of claims 1 to 11, based on a configuration of the desired module or prefabricated building to build; and
- fasten the modular panels (30) of said at least one plurality of modular panels (10, 20; 30), which are configured to act as a floor or cover or roof for said housing module or prefabricated building, staggered with respect to the modular panels (10, 20) of said at least one plurality of modular panels (10, 20; 30), which are configured to form the side walls of said housing module or prefabricated building

14. Method according to claim 13, wherein said step of providing at least one plurality of modular panels (10, 20; 30) according to any one of the claims 1 to 11,

based on a configuration of the desired module or prefabricated building to build, comprises to select for each modular panel (10, 20; 30) said at least one corrugated element (1), said at least one insulating sheet (2) and said at least one interlocking profiled element (3; 4; 7) and optionally said at least one spacer element (5) and said at least one counter-wall (6), depending on whether said at least one modular panel (10; 20; 30) is configured to form a coplanar or an angled joint between the panels.

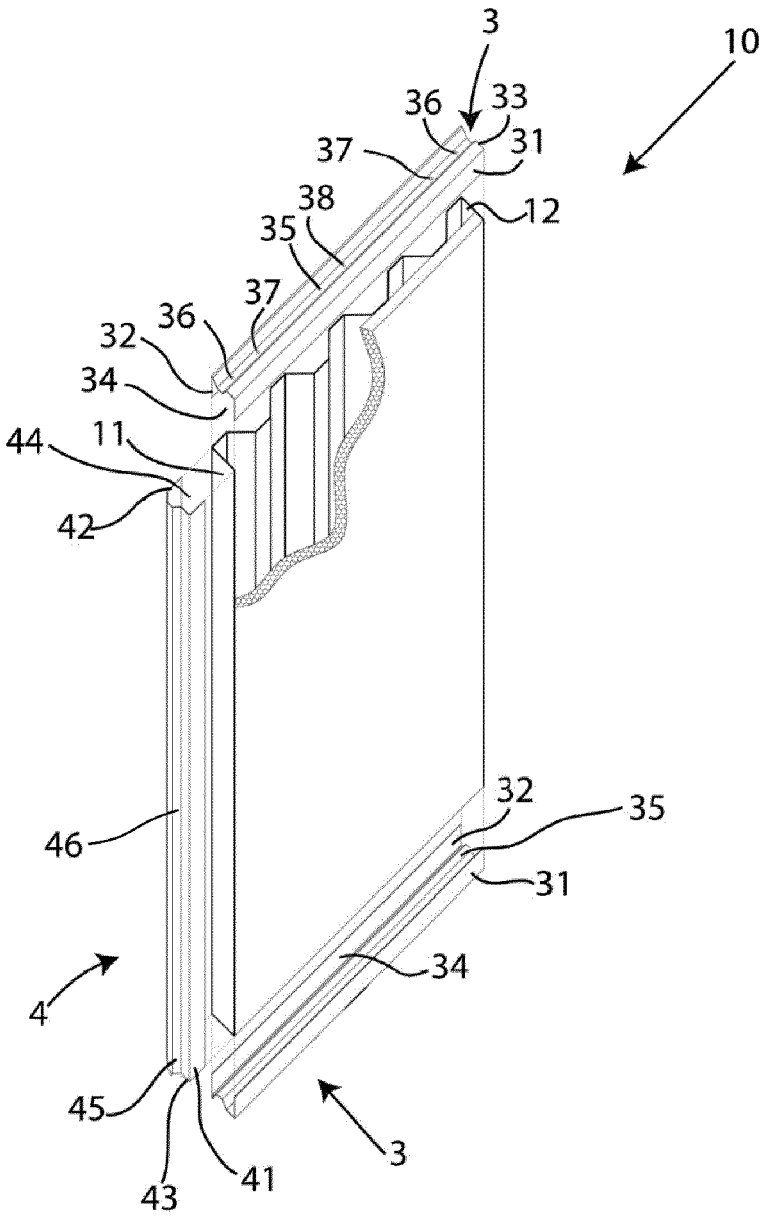

Fig. 1

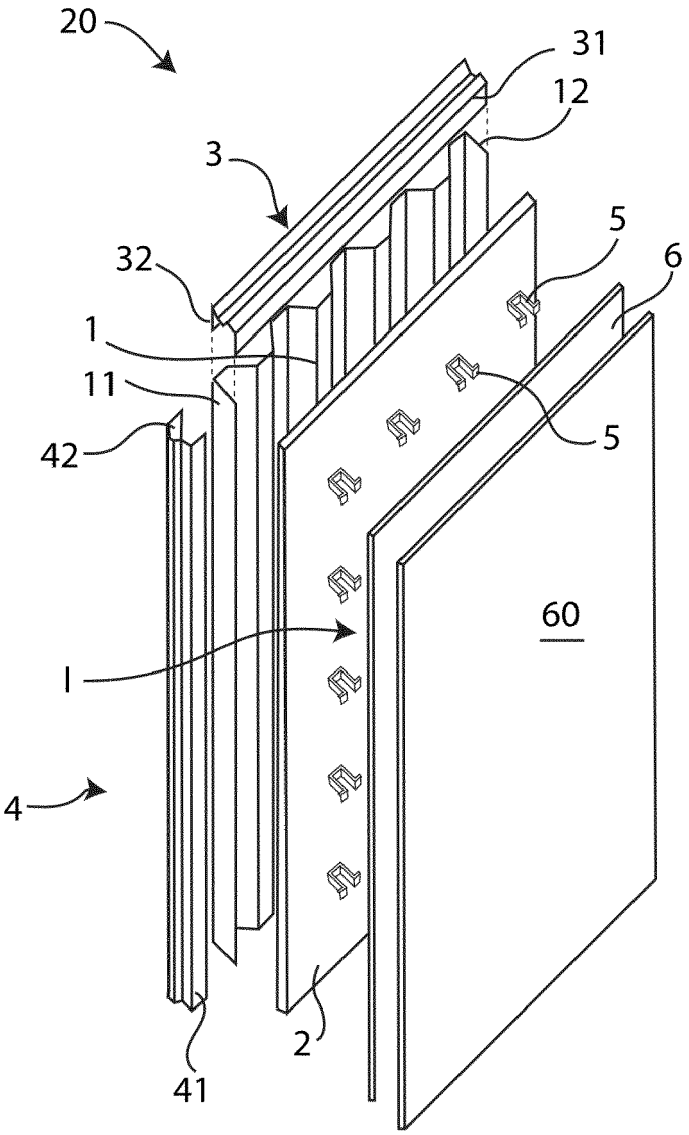

Fig. 2

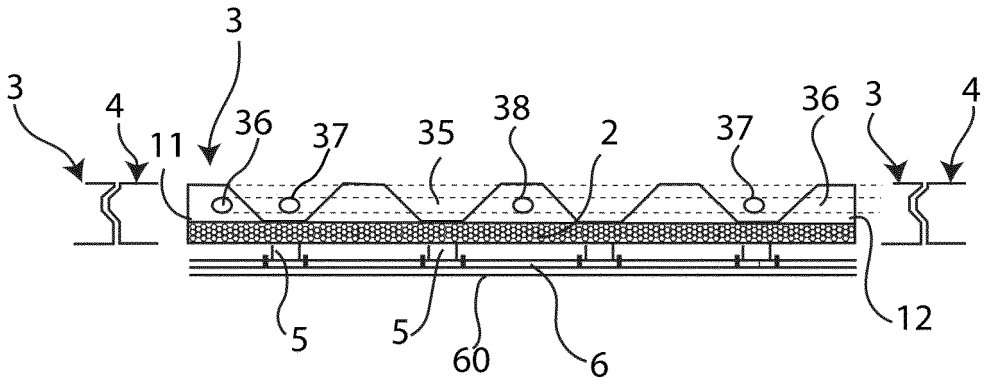
3
3
4
11
36
37
35
38
2
37
36
3
4
5
5
60
6
12

Fig. 3

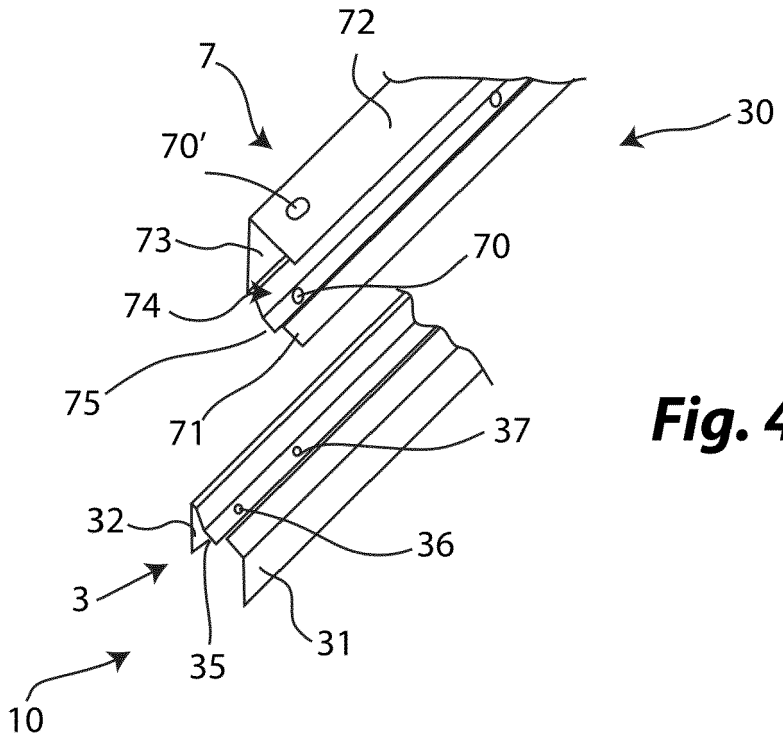
72
7
30
70'
73
70
74
75
71
37
32
36
3
31
35
10

Fig. 4

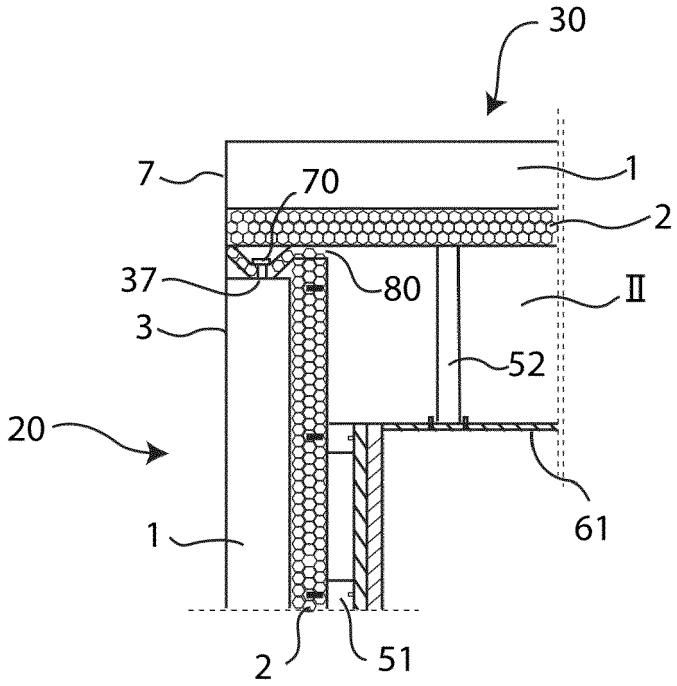
30
7
70
1
2
37
80
II
3
52
20
61
1
2
51

Fig. 5

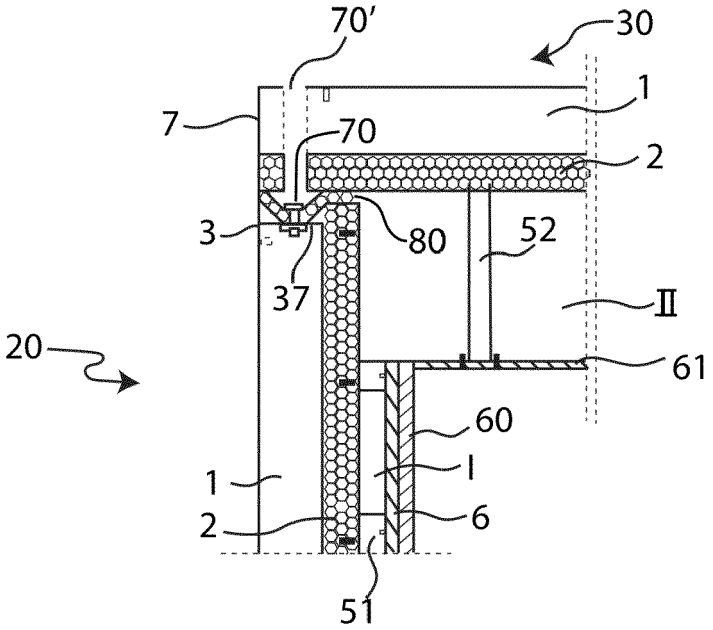
70'
30
1
7
70
2
3
80
52
37
II
20
61
60
I
1
2
6
51

Fig. 6

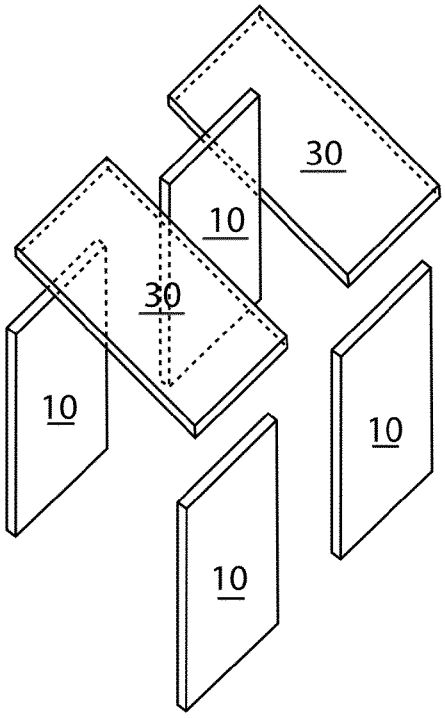

Fig. 7a

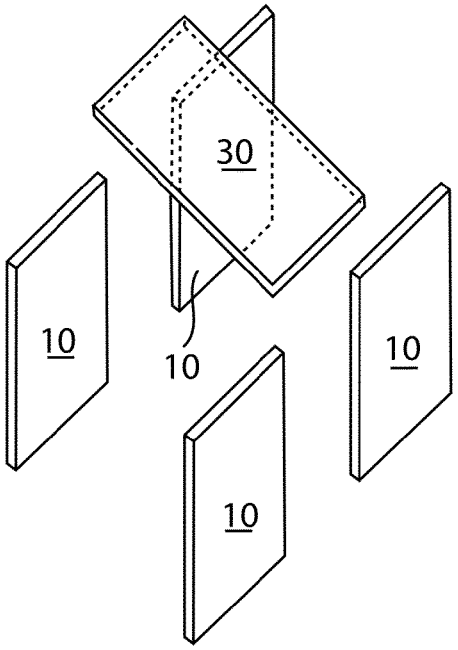

Fig. 7b

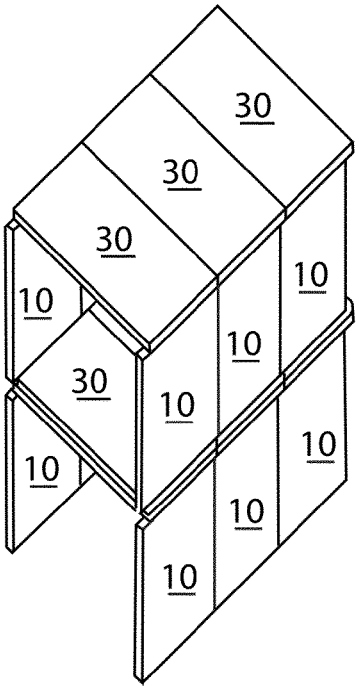

Fig. 7c

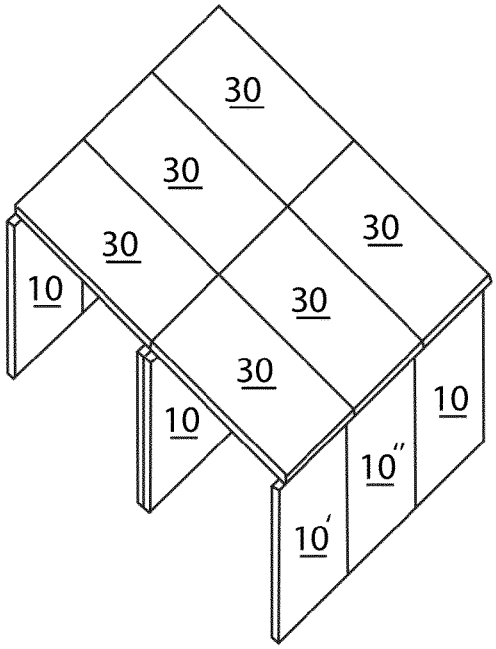

Fig. 7d

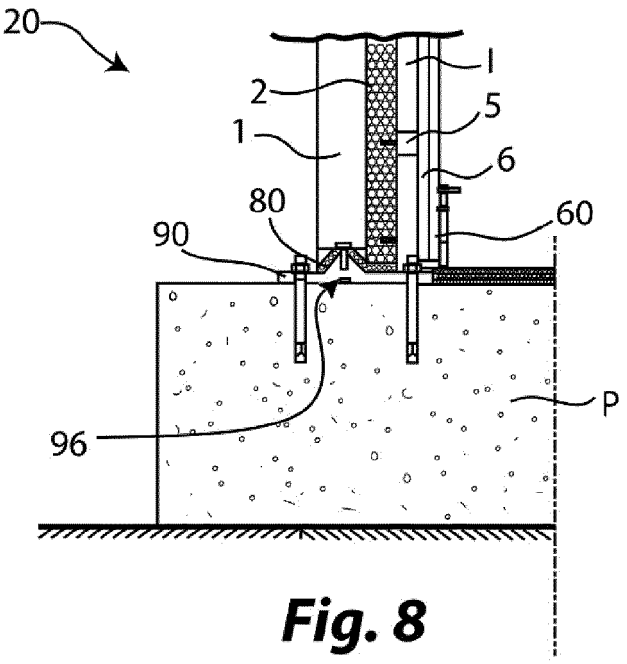

Fig. 8

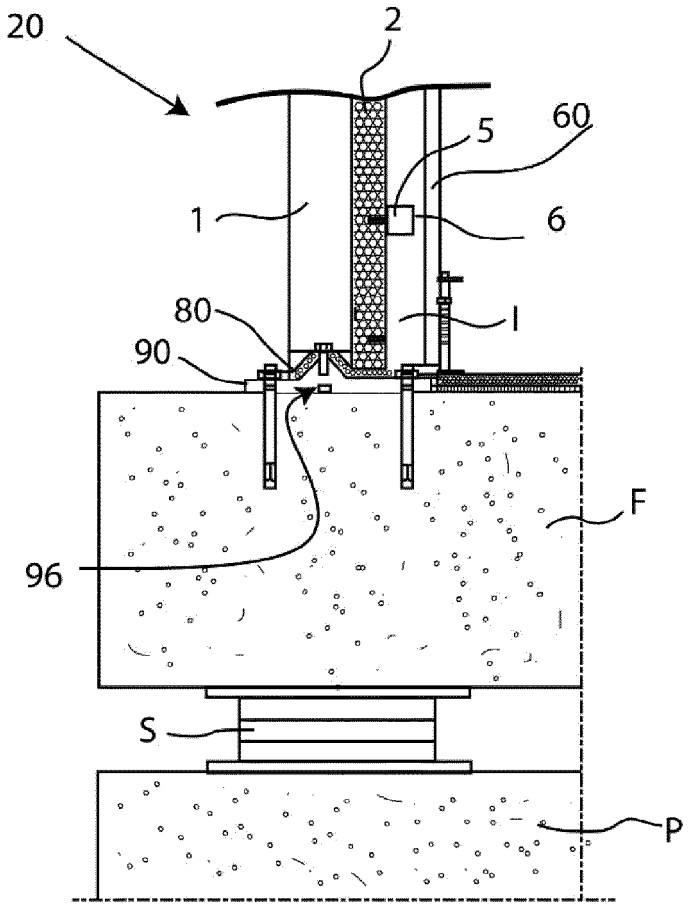

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 6994

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2007/057513 A1 (PIIKKIO WORKS OY [FI]; WACKER JARMO [FI]) 24 May 2007 (2007-05-24) * page 1, line 26 - page 7, line 29; figures 1-8 *	1,4-14	INV. E04C2/38 ADD. E04C2/34
X	ES 1 017 604 U (URALITA) 1 January 1992 (1992-01-01)	1-3,5-9	
A	* column 1, line 42 - column 4, line 43; figures 1-2 *	10-14	
A	US 4 037 379 A (OZANNE LEROY) 26 July 1977 (1977-07-26) * column 1, line 67 - column 4, line 64; figures 1-6 *	1-14	

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E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 July 2019	Dieterle, Sibille

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 17 6994

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11-07-2019

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82