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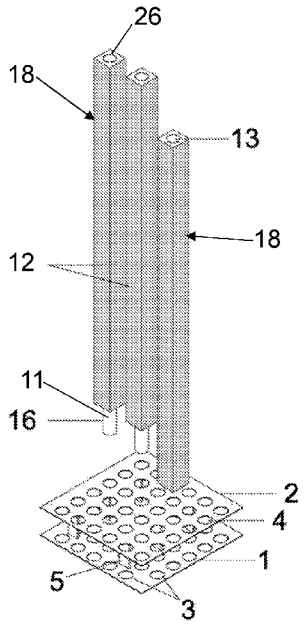

Fig. 3a

(57) Abstract: A system for building a prefab comprising: - at least one first plate (1) provided with a plurality of first holes (3); - at least one second plate (2) provided with a plurality of second holes (4), said at least one second plate (2) being connected to and spaced apart from said at least one first plate (1); each second hole (4) being coaxial to a respective first hole (3); - a plurality of longitudinal prefabricated elements (18) provided with a respective longitudinal tube (11) defining an inner cavity (13), and a casing (12) externally covering said longitudinal tube (11) at least along part of the longitudinal extension thereof; wherein the longitudinal tube (18) has a first end (16) which comes out of the casing (12); wherein the first end (16) is adapted to be inserted into a respective second hole (4) and a respective first hole (3); and wherein the first end (16) has a length which is at least equal to the sum of the distance between the first plate (1) and the second plate (2), the thickness of the first plate (1) and the thickness of the second plate (2); whereby the at least one first plate (1) and the at least one second plate (2) define a base (36) of the prefab, and once the first end (16) of the longitudinal tube (11) is inserted into a respective second hole (4) and into a respective first hole (3), the longitudinal prefabricated elements (18) define outer walls and possibly inner walls of the prefab.

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SYSTEM FOR BUILDING A PREFAB

Field of the invention

The present invention relates to a system for building prefabs used, for example to make buildings in situations of socio-sanitary emergency or housing precariousness.

Background art

The systems for building prefabs currently provide assembling and finishing components made off the jobsite, i.e. in a place other than the jobsite, at the jobsite. The setting up generally requires jobsite equipment for assembling the parts.

Disadvantageously, the known solutions in the background art for building prefabs for the most part provide cases of making use of specialized personnel, both for fastening to the base and for arranging the building elements and the systems. Further, the known solutions require the presence of machinery for handling the building elements due to the weight of the individual components. These aspects are not very functional for making a prefab, especially if it is required for socio-sanitary emergencies or temporary residential units. The construction times often are bound to the drying times of the mortar. Further, setting up the elements requires experts in the field, thus increasing the costs.

The known solutions do not allow an adequate construction versatility, as they are bound to predefined plans.

Therefore, the need is felt to make a system for building prefabs which allows overcoming the limits of the background art.

Summary of the invention

It is an object of the present invention to make a building system, in particular a modular building system, which allows an increased building accuracy and increased level of building flexibility, or versatility, to be obtained.

It is an object of the present invention to make a building system which allows reducing the times for making and assembling a prefab.

It is another object of the invention to make a building system which allows reducing the construction costs and simplifying the prefab assembly and construction operations.

It is another object of the invention to simplify the operations of making the prefab.

Therefore, the present invention proposes to achieve the above objects by means of a system for building a prefab which, according to claim 1, comprises

- at least one first plate provided with a plurality of first holes;
- at least one second plate provided with a plurality of second holes,
  said at least one second plate being connected to and spaced apart from said at least one first plate;
  each second hole being coaxial to a respective first hole;
- a plurality of longitudinal prefabricated elements provided with
  a respective longitudinal tube defining an inner cavity,
  and a casing externally covering said longitudinal tube at least along part of the longitudinal extension thereof;

wherein the longitudinal tube has a first end which comes out of the casing;

wherein the first end is adapted to be inserted into a respective second hole and a respective first hole;

and wherein the first end has a length which is at least equal to the sum of
the distance between the first plate and the second plate,
the thickness of the first plate and
the thickness of the second plate;

whereby the at least one first plate and the at least one second plate define a base of the prefab, and once the first end of the longitudinal tube is inserted into a respective second hole and into a respective first hole, the longitudinal prefabricated elements define outer walls and possibly inner walls of the prefab.

In this context, "prefab" in particular means a construction or building comprising elements made beforehand and in a different place with respect to the location where the building is made.

According to an aspect, the building system comprises at least two first beams and at least two second beams having a plurality of projections; wherein each projection is adapted to be inserted into the cavity of a respective longitudinal prefabricated element at a second end of the longitudinal tube, opposite to the first end;

whereby said at least two first beams and at least two second beams are adapted to be arranged above a respective group of peripheral longitudinal prefabricated elements of the prefab.

The longitudinal prefabricated elements are arranged vertically, in particular with the longitudinal axis thereof substantially perpendicular to the plane defined by the largest surface of the plates.

The invention also comprises a prefab obtained by means of such a system, wherein the first end of each longitudinal tube is inserted into a respective second hole and a respective first hole, and wherein the longitudinal prefabricated elements define outer walls and possibly inner walls of the prefab.

The invention also provides for the construction of a prefab which, according to claim 16, comprises the following stages:

- providing a base defined by the at least one first plate and the at least one second plate;
- inserting the first end of the longitudinal tube of each longitudinal prefabricated element into a respective second hole of the at least one second plate and into a respective first hole of the at least one first plate so as to define outer walls and possibly inner walls of the prefab.

Advantageously, the building system of the invention allows making a building, in particular a prefab, in an accurate, reliable and versatile manner.

The building system in particular allows assembly to be facilitated, reducing the tolerances required.

Advantageously, the number of components of the building system is particularly reduced. Further, certain components preferably may perform more than one function. For example, the modular iteration of the longitudinal prefabricated element allows the outer walls of the prefab to be made and all the inner spaces to be divided.

The building system advantageously is modular and allows an increased building accuracy and increased level of building flexibility, or versatility, to be obtained.

Further, because it is hollow, the longitudinal prefabricated element simultaneously meets several functional requirements: vertical closure, inner partition, equipped wall (plant engineering shaft).

The longitudinal prefabricated element, i.e. defining a longitudinal axis, allows creating different solutions for the interior rooms and leaves non-predetermined configurations available.

The grid defined by the holes of the base advantageously facilitates the design and assembly operations.

The order, proportions and measures of the prefabricated building result from and substantially are controlled by the plates of the base which define the positioning grids. All the components of the outer walls and the inner walls may be made with a single type of longitudinal prefabricated element, or with two types of longitudinal prefabricated elements alone, which differ from each other due to the material with which the tube is made (for example metal and plastic). The accuracy in making the longitudinal prefabricated element involves reducing the assembly tolerances, to the benefit of the ease of the execution, organization and work times.

The handling and installation of the longitudinal prefabricated elements advantageously may be performed by a single operator. Further, the possibility of error advantageously is significantly less with respect to the technologies already on the market.

Optionally, the system for building a prefab object of the present invention favors the actual livability of the dwelling because the cavities integrated in the longitudinal prefabricated element are designed to meet the thermal insulating requirements, to contain the electrical system equipment, water system, and to allow the storage of rainwater, thus resolving the problem of the systems installation and room comfort by means of an integrated system.

The building system optionally also comprises a support frame, or peripheral support, for a covering.

The support frame may comprise two first beams and two second beams each having an L profile to make coplanar the installation plane of the support frame where the covering may be resting. This solution has the advantage of not limiting the type of covering element (green roof, ventilated roof, etc.).

The first beams and the second beams preferably are constrainable to each other, for example by means of a male-female type coupling.

The first beams and the second beams have a plurality of projections, which may be made, for example of wooden or metal material, which are inserted, in particular interlocked, into the upper end of the peripheral longitudinal prefabricated elements to allow the covering to be installed. Further, this support frame preferably provides

anchoring to the base by means of tie rods fastened, at a first end, to the base and, at a second end, to a first beam or to a second beam.

The dependent claims describe particular embodiments of the invention.

Brief description of the Figures

Further features and advantages of the invention will be more apparent in light of the detailed description of non-exclusive embodiments of the invention, with the aid of the accompanying drawings in which:

Figure 1 shows a perspective view of some components of the building system in accordance with the invention;

Figure 1a shows a side view of some components of the system in accordance with the invention;

Figure 1b shows a perspective view of some components of a variant of a building system in accordance with the invention, in which one element is separated from the others for illustrative purposes;

Figure 2a shows a sectional side view of part of a component of the building system in accordance with the invention;

Figure 2b shows a top view of the component in Figure 2a;

Figure 3a shows a perspective view of some components of the building system in accordance with the invention, in which two components are separated from the others for illustrative purposes;

Figure 3b shows a perspective view of the components in Figure 3a, assembled to one another;

Figure 3c shows an enlarged detail of Figure 3a;

Figure 4 shows a perspective view of part of some components of the building system in accordance with the invention;

Figure 5 shows a sectional view of some components of the system in accordance with the invention;

Figure 6a shows a perspective view of some components of the building system in accordance with the invention;

Figure 6b shows a perspective view of some components of the building system in accordance with the invention;

Figures from 7a to 7e show perspective views of some components of the building

system in accordance with the invention;

Figure 8 shows a top plan view of some components of the building system in accordance with the invention;

Figure 8a shows the section A-A' in Figure 8;

Figure 8b shows the section B-B' in Figure 8;

Figure 9 shows a sectional view of some components of the building system in accordance with the invention;

Figure 10 shows a perspective view of a variant of some components of the building system in accordance with the invention;

Figure 11 shows a detail of some components of Figure 10;

Figure 12 shows another perspective view of the variant of some components of the building system in Figure 10;

Figure 13 shows a detail of Figure 12;

Figure 14 shows a perspective view of some components of Figure 10;

Figure 15 shows a perspective view of some components of Figure 14, assembled to one another;

Figure 16 shows the sections of some components of Figure 10.

The same reference numerals in the Figures identify the same elements or components.

Detailed description of embodiments of the invention

With reference to the Figures, the system for building a prefab according to the invention comprises (see in particular Figures 1, 1a, 1b):

at least one first plate 1 provided with a plurality of first holes 3; and at least one second plate 2 (partially shown in Figure 1) provided with a plurality of second holes 4. The second plate 2 is connected to and spaced apart from the first plate 1, for example by means of spacers 5, 6. Preferably, first spacers 5, and optionally second spacers 6, are provided.The spacers 5, 6, for example the first spacers 5 and the second spacers 6, are fastened to the first plate 1 and to the second plate 2.

The first plate 1 and the second plate 2 are integral with each other and define a base 36 of the prefab. The first plate 1 and the second plate 2 preferably are made of metal, for example galvanized iron.

Also the spacers 5, 6, for example the first spacers 5 and the second spacers 6, preferably are made of metal, for example galvanized iron.

The first plate 1, the second plate, 2, the first spacers 5 and the second spacers 6 preferably are made with the same material.

The first spacers 5 optionally are shaped differently from the second spacers 6.

The first spacers 5 have a height equal to the distance between the first plate 1 and the second plate 2. The first spacers 5 are, for example shaped as parallelepipeds. In this case, the width of each of the first spacers preferably is between 0.07 and 0.15 m, and the thickness preferably is between 0.01 and 0.03 m. Alternatively, the first spacers 5 may also have another shape, for example they may be shaped as cylinders (Figure 1b) preferably having a diameter between 0.08 and 0.12 m.

The second spacers 6 (optional), for example are shaped like a plate which comprises two side projections 61, 62. Two lower projections 63, 64 are provided between the side projections 61, 62. A recess or indentation 65 is between the two lower projections 63, 64. The lower projections 63, 64 are in contact with the first plate 1. The outline of each lower projection 63, 64 preferably is shaped so as to have three sides arranged as three sides of a trapezoid, for example an isosceles trapezoid, which smaller base is in contact with the first plate 1. An oblique side of the lower projection 63 and an oblique side of the lower projection 64 laterally delimit said indentation 65.

The outline of the second spacer 6 which forms said indentation 65 preferably is shaped so as to have three sides arranged as three sides of a trapezoid, for example an isosceles trapezoid, which smaller base is close to the second plate 2.

The maximum height of the second spacers 6 is equal to the minimum distance between the first plate 1 and the second plate 2.

The second spacers 6 perform also the function of stiffening ribs.

Each second hole 4 is coaxial to a respective first hole 3. The first holes 3 and the second holes 4 preferably are circular in shape.

The thickness of the first plate 1 and/or the thickness of the second plate 2 preferably is between 0.004 and 0.01 m, for example equal to or about equal to 4 mm.

The distance, in particular the minimum distance, between the first plate 1 and the second plate 2 preferably is between 0.004 and 0.01 m.

Such a distance substantially corresponds to the height of the spacers 5, 6, or in other words, corresponds to the minimum distance between the upper surface of the first plate 1 and the lower surface of the second plate 2.

The first holes 3 and the second holes 4 preferably are arranged according to a matrix or grid, for example a rectangular or square matrix.

Preferably, the first holes 3 are at a same distance, in particular at a same minimum distance, from one another; and the second holes 4 are at a same distance, in particular at a same minimum distance, from one another.

The minimum distance between the center of each first hole 3 and the centers of the consecutive first holes 3 thereto preferably is between 0.13 and 0.20 m, and similarly for the second holes 4.

More generally, the center-to-center minimum distance is also called "pitch" of the first holes 3 and "pitch" of the second holes 4.

The first holes 3 and the second holes 4 preferably have the same pitch, or substantially the same pitch.

The first holes 3 and the second holes 4 preferably each have a diameter between 0.08 and 0.10 m, for example equal to or about equal to 85 mm.

The first holes 3 and the second holes 4 preferably have the same diameter, or substantially the same diameter.

The first plate 1 and the second plate 2 are parallel to each other.

The first plate 1 and the second plate 2 preferably have the same shape, in particular the same shape of the outer outline.

The first plate 1 and the second plate 2 preferably also have the same dimensions.

The first plate 1 and the second plate 2 preferably are square- or rectangular-shaped.

Preferably, the width of the first plate 1 is between 0.90 and 1.20 m and the length of the first plate 1 is between 2.40 and 3.60 m. Advantageously, in addition to ensuring great compositional versatility, the presence of the plurality of holes 3 of the first plate 1 and the plurality of holes 4 of the second plate 2 ensures the reduction of the weight with respect to an unperforated plate, for example a reduction of about 33%.

With particular reference to Figures 2a, 2b, 3a, 3b and 3c, the building system further comprises:

a plurality of longitudinal prefabricated elements 18 provided with a respective longitudinal tube 11 defining an inner cavity 13 and a casing 12 externally covering said longitudinal tube 11 at least along part of the longitudinal extension thereof, preferably along only part of the longitudinal extension thereof.

The longitudinal axis of each prefabricated element 18 corresponds to the longitudinal axis of the respective tube 11.

The longitudinal axis of each longitudinal prefabricated element 18 is perpendicular or substantially orthogonal to the plane defined by the first plate 1, or similarly to the plane defined by the second plate 2.

The longitudinal tube 11 preferably may be made of plastic, for example PVC, or of metal, for example galvanized iron.

The longitudinal tubes 11 made of plastic preferably have an inner diameter of about 80 mm and wall thickness equal to about 2.25 mm.

The longitudinal tubes 11 made of metal preferably have an inner diameter of about 76 mm and wall thickness equal to about 3 mm.

The longitudinal prefabricated elements 18 provided with a longitudinal tube 11 made of metal are particularly adapted to be used to make the load-bearing elements of the prefab, for example the pillars, of which some are indicated with reference numeral 34 (Figures 3c and 6b). The inner cavity 13 of the longitudinal tubes 11 is suitable for accommodating insulating materials, electrical wiring and piping of the water system. Casing 12 preferably has the shape of a square-based parallelepiped, preferably with beveled corners, which is coaxial to the longitudinal tube 11.

The side dimension of casing 12 preferably is designed so that the maximum width of the longitudinal prefabricated element 18 is equal to or about equal to the pitch between the first holes 3.

Thereby, two prefabricated elements 18 side-by-side each other, inserted in a respective pair formed by one hole 3 and by one hole 4, are very close to each other.

The weight of the longitudinal prefabricated element 18 preferably is less than 25 kg, a feature which allows the handling thereof by one operator alone, thus reducing labor costs.

The longitudinal tube 11 comprises a first end 16 (or end portion) which comes out of said casing 12.

The first end 16 is suitable for being inserted into a respective second hole 4 and a respective first hole 3 and has a length which is at least equal to the sum of the distance between the first plate 1 and the second plate 2, of the thickness of the first plate 1 and of the thickness of the second plate 2. As mentioned, the first plate 1 and the second plate 2 define a base 36 of the prefab. Once the first end 16 of the longitudinal tube 11 is inserted into a respective second hole 4 and into a respective first hole 3, the longitudinal prefabricated elements 18 define outer walls and possibly inner walls of the prefab as a function of the position of the holes 3, 4 into which they are inserted. When the longitudinal prefabricated elements 18 are inserted into the plates 1, 2, the lower surface of casing 12 abuts with the second plate 2.

Advantageously, the perforation of the plates ensures the tolerances provided allow assembling the longitudinal prefabricated elements 18 by gravity, controlling the friction between the parts, with easy handling operations which ensure the sliding and control of the verticality.

Locking means 7, 7'' preferably are provided for avoiding the slipping of the longitudinal prefabricated elements 18 which serve as pillars (or load-bearing elements). The locking means 7', 7'' preferably are shaped as a corner plate 7' having a base preferably provided with three holes. Further, there may optionally be provided locking means shaped as a plate 7'', the base of which is provided with one hole alone, and/or locking means shaped as a plate provided with two holes.

Preferably, as shown in Figure 1b, elements 70, in particular corner plates 70, are provided. Each element 70 preferably is arranged at a respective locking mean 7', preferably at a respective corner of plate 1. The elements 70 in particular serve as stress countering elements and optionally may be used in place of the spacers 6. Each element 70 comprises, or consists of, a side wall comprising two portions 71', 71''. The portions 71', 71'' preferably are perpendicular to each other. The height of

the side wall of the elements 70 substantially is equal to the distance between the first plate 1 and the second plate 2.

The locking means 7', 7'' preferably are made of metal.

The locking means 7', 7'' are arranged between the first plate 1 and the second plate 2 and preferably are fastened at least to the first plate 1.

The holes of the locking means 7', 7'' are adapted to be crossed by a respective load-bearing longitudinal prefabricated element 18.

The locking means 7', 7'' preferably are arranged in corner positions of the first plate 1, for example at the four corner areas of plate 1.

With particular reference to Figures 4, 5, 6a, 6b, 7a, 7b, 7c, 7d, 7e and 8, 8a, 8b and 9, the building system preferably also comprises a support frame (or peripheral support) and optionally also a covering 27 (Figure 9). Covering 27 is, for example formed by one or more panels resting on the four beams 19, 20.

The support frame preferably comprises, or is formed by, at least two first beams 19 and at least two second beams 20, for example by two beams 19 and by two beams 20. The first beams 19 and the second beams 20 preferably are made of wood. The first beams 19 and the second beams 20 are provided with a plurality of projections 25. Each projection 25 is adapted to be inserted into the cavity 13 of a respective longitudinal prefabricated element 18 at a second end 26 of the longitudinal tube 11 opposite to the first end 16. Therefore, the two first beams 19 and the two second beams 20 are adapted to be arranged above a respective group of peripheral longitudinal prefabricated elements 18 of the prefab.

The projections 25 preferably are made of wood. Each projection 25 preferably is a cylindrical element. Each projection 25 preferably is inserted into a respective hole 23 with which the beams 19 and the beams 20 are provided.

The two first beams 19 are adapted to be arranged parallel to each other above a respective first group of longitudinal prefabricated elements 18, while the two second beams 20 are adapted to be arranged parallel to each other above a respective second group of longitudinal prefabricated elements 18. Further, the two second beams 20 are adapted to be arranged perpendicular to the first beams 19.

The first beams 19 and the second beams 20 preferably are configured so that each end 21 of the first beams 19 is adapted to be coupled with a respective end 22 of

the second beams 20, thus defining the aforesaid peripheral support for covering 27 of the prefab.

Each end 21 of the first beams 19 preferably comprises a male coupling adapted to abut, preferably interlock, with a respective female coupling of the ends 22 of the second beams 20.

Plates 250, preferably corner plates, preferably are provided to fasten each beam 20 to each beam 19. In this regard, screws 251, for example screws for wood, preferably are provided, which may cross plate 250 and the beams 19, 20.

The aforesaid holes 23 are also suitable for the passage of a tie rod 28. The tie rod 28 may be used to fasten the first beams 19 and/or the second beams 20 to the first plate 1 and/or to the second plate 2, i.e. to base 36 (Figure 8).

The first beams 19 and the second beams 20 preferably have an "L" profile, indicated with numeral 24, which horizontal portion 201, 202 (Figure 7c) defines the peripheral support for covering 27 of the prefab. Hole 23, or the holes 23, preferably are made in said horizontal portion. The two ends 21 of the beams 19 preferably also comprise a portion having a rectangular section. The portion with "L" profile extends between the ends 21.

A prefab may be made with the system for building a prefab object of the invention, the prefab comprising a base 36 comprising the first plate1 and the second plate 2; and a plurality of longitudinal prefabricated elements 18. The end 16 of each longitudinal prefabricated element 18 is inserted into a respective first hole 3 and into a respective second hole 4.

The prefab preferably comprises the support frame and preferably also a covering 27 (or roof) arranged on the support frame. The prefab may be made in short periods of time and is easy to assemble.

Advantageously, wet bonding, for example mortars or other compounds comprising a liquid, which require being dried, are not required. This allows the manufacturing and assembly times to be reduced, resulting in an advantage in operational and economical terms. The use preferably is provided of an adhesive for sealing the gaps between the longitudinal prefabricated elements 18, in particular between casing 12 thereof.

The prefab is made by means of a building method which provides the following steps:

- providing a base 36 defined by the at least one first plate 1 and the at least one second plate 2;
- inserting the first end 16 of the longitudinal tube 11 of each longitudinal prefabricated element 18 into a respective second hole 4 of the second plate 2 and into a respective first hole 3 of the first plate 1 so as to define outer walls and possibly inner walls of the prefab.

Once the outer walls and possibly the inner walls are defined, the following steps are preferably carried out:

- providing for at least two first beams 19 and at least two second beams 20 having a plurality of projections 25 to be each arranged above a respective group of longitudinal prefabricated elements 18 defining a respective outer wall of the prefab by inserting each projection 25 into the cavity 13 of a respective longitudinal prefabricated element 18 at a second end 26 of the longitudinal tube 11, opposite to the first end 16;
- providing the coupling between first beams 19 and second beams 20 at the ends 21, 22 thereof, whereby the first beams 19 and the second beams 20 define a peripheral support;
- resting a covering 27 on the peripheral support 33.

Tie rods 28 preferably are provided, each provided with a first end 29 and a second end 32 (Figure 8), and the method comprises the step of:

- fastening the first end 29 to base 36 and the second end 32 to a first beam 19 or to a second beam 20.

Each of the aforesaid tie rods 28 preferably is inserted into a respective longitudinal prefabricated element 18, preferably in a respective longitudinal prefabricated element 18 which acts as load-bearing element. In particular, the tie rod 28 is inserted into cavity 13 of the longitudinal tube 11. The tie rod 28 also crosses covering 27.

Figures from 10 to 16 in particular show beams 19', 20'. The beams 19', 20' are alternative variants to the beams 19, 20, respectively.

The beams 19' are adapted to be interlocked with the beams 20'. regarding particular, to this end, the beams 19' are provided with two indentations 191. Each indentation 191 in particular is provided in a respective end portion of the respective beam 19'. The indentations 191 in particular are indentations of the upper surface of the respective beam 19'.

Further, the beams 20' are provided with two indentations 211. Each indentation 211 in particular is provided in a respective end portion of the respective beam 20'. The indentations 211 in particular are indentations of the lower surface of the respective beam 20'.

Therefore, each indentation 191 is adapted to engage with a respective indentation 211. Also the beams 19', 20' are provided with the projections 25 and the holes 23 described above.

Said end portions of the beams 19', 20' in particular are mutually opposite end portions along the longitudinal axis of the respective beam 19', 20'.

The method also provides for making a screed 9, for example a concrete sill, which is fastened to the base by means of fastening means 30 (Figure 9), for example comprising threaded bars.

Preferably, but not exclusively, casing 12 is made of a material, in particular a building material, comprising or consisting of:

- hydrated lime in percentage by weight from 54 to 64%;
- hydraulic lime in percentage by weight from 7 to 17%;
- paper in percentage by weight from 13 to 18%;
- pozzolana in percentage by weight from 8 to 18%;
- plastic granules and/or cork granules in percentage from 0 to 7%;
- natural fibers in percentage by weight from 1 to 3%.

The material in the form of fibers in particular serves to improve the mechanical and/or rheological performance.

Preferably

- the hydrated lime is from 58 to 62% by weight;
- and/or the hydraulic lime is from 10 to 14% by weight;
- and/or the paper is from 13 to 15% by weight;
- and/or the pozzolana is from 8 to 14% by weight;

- and/or the plastic granules and/or the cork granules are from 4 to 7% by weight;
- and/or the natural fibers are from 1 to 3% by weight.

Preferably

- the hydrated lime is from 58 to 62% by weight;
- and the hydraulic lime is from 10 to 14% by weight;
- and the paper is from 13 to 15% by weight;
- and the pozzolana is from 8 to 14% by weight;
- and the plastic granules and/or the cork granules are from 4 to 7% by weight;
- and the natural fibers are from 1 to 3% by weight.

The building material is dry, or substantially dry. In all the embodiments, the building material preferably has a water content less than 5% by weight, for example between 0.1 and 5% or between 0 and 5%.

The building material, and therefore casing 3, preferably has a density from 700 to 860 kg/m^3, for example from 700 to 800 kg/m^3.

The hydrated lime preferably is of the hyperventilated hydrated fine-grained lime type.

The hydraulic lime preferably is of the natural hydraulic lime type, NHL. It is particularly preferable for the hydraulic lime to be of the natural hydraulic lime type, NHL 3.5, according to the current Standard EN459-1.

The plastic granules, the cork granules and the pozzolana substantially are inert, in particular natural inert.

The plastic granules comprise or consist of PET, i.e. PET granules.

The plastic granules preferably have a grain size from 2 to 8 mm.

The plastic granules preferably are obtained from processing PET secondary raw material. In particular, the process of recycling the PET transforms the PET material into flakes. The rejects obtained from this process are separated, obtaining said granules preferably having a grain size from 2 to 8 mm.

The group of plastic granules having the aforesaid grain size is also called "plastic flour".

Cork granules, in particular natural cork granules, may be provided in addition or alternatively to the plastic granules.

The cork granules preferably have a grain size from 3 to 7 mm.

The cork granules preferably have a density from 90 to 120 kg/m^3.

The building material preferably comprises said plastic granules or said cork granules.

Said natural fibers preferably are plant fibers, preferably Agave fibers.

Such fibers are particularly useful as anti-cracking or structural reinforcement.

The natural fibers, in particular the Agave fibers, preferably have a length from 8 to 20 mm.

The diameter of the natural fibers, in particular the Agave fibers, preferably is between 0.20 and 0.25 mm.

The pozzolana preferably is micronized.

The paper preferably is in the form of strips.

Each strip preferably has a width from 3 to 4 mm and has a length from 30 to 50 mm.

The paper preferably comprises newsprint.

The newsprint preferably comprises at least 65% by weight (with respect to the newsprint) of mechanical pulp, preferably from 65% to 80% by weight of mechanical pulp.

The newsprint preferably has a grammage from 35 to 70 g/m^2, preferably from 35 to 55 g/m^2 and preferably it does not contain adhesives.

The newsprint preferably is of the improved newsprint type and/or of the standard newsprint type.

In addition to the newsprint, the paper preferably also comprises office paper, preferably white office paper.

The office paper preferably comprises at least 80% of mechanical pulp. The office paper preferably comprises adhesives and/or mineral charges to decrease the transparency thereof. The office paper preferably has a grammage from 70 to 90 g/m^2, for example about 80 g/m^2.

The aforesaid grammages of the newsprint and of the office paper preferably are meant as features of the newsprint or of the office paper prior to the process for making the building material comprising them.

The office paper preferably is of the High Brightness Low Weight Coated type.

The building material preferably comprises from 50 to 65% of said newsprint, and the remaining part of the paper preferably is said office paper.

EXAMPLE 1

In a particular example, the building material comprises or consists of:

59% by weight of hydrated lime, preferably hyperventilated hydrated fine-grained lime;

12% by weight of hydraulic lime, preferably natural hydraulic lime, NHL 3.5;

13% by weight of paper, preferably 50% of which is office paper, preferably completely made of cellulose and preferably having a grammage of 80 g/m^2; and 50% is newsprint, preferably having a grammage from 35 to 55 g/m^2;

8% by weight of micronized pozzolana;

7% by weight of plastic granules, preferably having a grain size from 2 to 8 mm;

1% by weight of Agave fibers.

In this example, the building material preferably has a density equal to or about equal to 755 kg/m^3.

EXAMPLE 2

In another particular example, the building material comprises or consists of:

61% by weight of hydrated lime, preferably hyperventilated hydrated fine-grained lime;

13% by weight of hydraulic lime, preferably natural hydraulic lime, NHL 3.5;

13% by weight of paper, preferably 50% of which is office paper, preferably completely made of cellulose and preferably having a grammage of 80 g/m^2; and 50% is newsprint, preferably having a grammage from 35 to 55 g/m^2;

8% by weight of micronized pozzolana;

4% by weight of cork granules, preferably having a grain size from 2 to 8 mm;

1% by weight of Agave fibers.

Test specimens were produced with the material according to Example 1 to evaluate the mechanical properties of the material.

Three cubic test specimens (140x140x140 mm) in particular were subjected to compression tests.

Further, three cubic test specimens in the shape of beams (140x140x600 mm) were subjected to three-point bending tests.

The compression tests provided the following results:

average maximum breaking load value = 9.67 kN;

average compression strength value = 0.85 MPa.

The bending tests provided the following results:

average maximum breaking load value = 0.73 kN;

average displacement value = 4.62 mm; and

average elastic modulus value = 1.58 daN/mm^2.

An example of process for obtaining a building material according to the invention comprises the steps of:

a) mixing the pozzolana, the plastic granules and/or the cork granules, and the natural fibers to obtain a first compound;

b) mixing the hydrated lime and the hydraulic lime to obtain a second compound;

c) immersing the paper in water; extracting the paper from the water and removing at least part of the water in which the paper was immersed to obtain a third compound;

d) mixing the first compound, the second compound and the third compound to one another by adding water, to obtain a fourth compound;

e) drying the fourth compound to obtain the building material.

The water-to-paper ratio in step c) preferably is between 10:1 and 14:1, preferably equal to or about equal to 12:1; and preferably the paper remains immersed in water for a time between 24 and 72 hours, preferably between 36 and 72 hours, preferably equal to or about equal to 48 hours.

The ratio of the weight in kg of water to the weight in kg given by the sum of the first compound, the second compound and the third compound in step d) preferably is between 1:1.6 and 1:2.2, preferably equal to or about equal to 1:1.9.

Preferably a mechanical operation is performed to remove at least part of the water in which the paper was immersed in step c), for example an operation of pulling and/or pressing and/or twisting the paper, which for example may be wrung.

The aforesaid step e) preferably is a maturation step, which preferably lasts 28 days. The material hardens during the maturation.

Typically, but not exclusively, the building material takes on a whitish color after the maturation step due to the hydrated lime in the mixture.

Step e), the maturation in particular, preferably is performed by arranging the fourth compound in a formwork. The extraction of the building material from the formwork advantageously is easy. Further, the outer surface of the item, which for example is a brick or a casing, appears smooth, or only slightly rippled, and homogeneous without breaks.

The fourth compound related to making the building material according to Example 1 advantageously was of workability class S1, and has shown shrinkage only of 4 mm after the maturation.

CLAIMS

1. A system for building a prefab comprising:

- at least one first plate (1) provided with a plurality of first holes (3);
- at least one second plate (2) provided with a plurality of second holes (4),
  said at least one second plate (2) being connected to and spaced apart from said at least one first plate (1);
  each second hole (4) being coaxial to a respective first hole (3);
- a plurality of longitudinal prefabricated elements (18) provided with
  a respective longitudinal tube (11) defining an inner cavity (13),
  and a casing (12) externally covering said longitudinal tube (11) at least along part of the longitudinal extension thereof;

wherein the longitudinal tube (18) has a first end (16) which comes out of the casing (12);

wherein the first end (16) is adapted to be inserted into a respective second hole (4) and a respective first hole (3);

and wherein the first end (16) has a length which is at least equal to the sum of
the distance between the first plate (1) and the second plate (2),
the thickness of the first plate (1) and
the thickness of the second plate (2);

whereby the at least one first plate (1) and the at least one second plate (2) define a base (36) of the prefab, and once the first end (16) of the longitudinal tube (11) is inserted into a respective second hole (4) and into a respective first hole (3), the longitudinal prefabricated elements (18) define outer walls and possibly inner walls of the prefab.

2. A system according to claim 1, wherein the at least one first plate (1) and the at least one second plate (2) are parallel to each other.

3. A system according to claim 1 or 2, wherein the first holes (3) and the second holes (4) have the same dimensions, preferably wherein the first holes (3) and the second holes (4) have a circular section.

4. A system according to any one of the preceding claims, wherein the longitudinal tube (11) is made of plastic or metal, preferably wherein some longitudinal tubes (11) are made of plastic and some longitudinal tubes (11) are made of metal.

5. A system according to any one of the preceding claims, wherein said longitudinal tube (11) is cylindrical in shape.

6. A system according to any one of the preceding claims, wherein the cavity (13) is adapted to accommodate insulating materials and/or electric cables and/or at least one duct of a water system.

7. A system according to any one of the preceding claims, wherein the casing (12) has an outer parallelepiped shape, preferably having a square base, which is coaxial to the longitudinal tube (11).

8. A system according to any one of the preceding claims, wherein each longitudinal prefabricated element (18) has a maximum width equal or substantially equal to the pitch between the first holes (3).

9. A system according to any one of the preceding claims, wherein there are provided at least two first beams (19, 19') and at least two second beams (20, 20') having a plurality of projections (25);

wherein each projection (25) is adapted to be inserted into the cavity (13) of a respective longitudinal prefabricated element (18) at a second end (26) of the longitudinal tube (11), opposite to the first end (16);

whereby said at least two first beams (19, 19') and at least two second beams (20, 20') are adapted to be arranged above a respective group of peripheral longitudinal prefabricated elements (18) of the prefab.

10. A system according to claim 9, wherein two first beams (19, 19') are adapted to be arranged parallel to each other above a respective first group of longitudinal prefabricated elements; and two second beams (20, 20') are adapted to be arranged parallel to each other above a respective second group of longitudinal prefabricated elements, and perpendicular to the first beams (19, 19'); and preferably wherein the first plate (1) and the second plate (2) have a rectangular or square outer contour and/or said first holes (3) and said second holes (4) are arranged according to the same rectangular or square matrix.

11. A system according to claim 8, 9 or 10, wherein said at least two first beams (19, 19') and at least two second beams (20, 20') are shaped at the ends or end portions thereof so as to couple to each other and define a peripheral support (33) for a covering (27) of the prefab.

12. A system according to claim from 8 to 11, wherein said projections (25) are made of metal or wooden material, and preferably wherein each projection (25) is cylindrical in shape.

13. A system according to any one of claims from 8 to 12, wherein the longitudinal tubes (11) of some longitudinal prefabricated elements (18) are made of metal material, whereby they are adapted to act as pillars (34) of the prefab;
and wherein a tie rod (28) is provided inside the longitudinal tubes (11) made of metal material, the tie rod being adapted to be fastened, at a first end (29) thereof, to the base (36) and, at a second end (32) thereof, to a first beam (19, 19') or to a second beam (20, 20').

14. A system according to any one of the preceding claims, wherein the casing (12) is made of a material comprising:
- hydrated lime in percentage by weight from 54 to 64%;
- hydraulic lime in percentage by weight from 7 to 17%;
- paper in percentage by weight from 13 to 18%;
- pozzolana in percentage by weight from 8 to 18%;
- plastic granules and/or cork granules in percentage from 0 to 7%;
- natural fibers in percentage by weight from 1 to 3%.

15. A prefab made by means of a system according to any one of the preceding claims, wherein the first end (16) of each longitudinal tube (11) is inserted into a respective second hole (4) and into a respective first hole (3),
wherein the longitudinal prefabricated elements (18) define outer walls and possibly inner walls of the prefab.

16. A prefab according to claim 15, wherein there are provided at least two first beams (19, 19') and at least two second beams (20, 20') having a plurality of projections (25); each of said at least two first beams (19, 19') and of said at least two second beams (20, 20') being arranged above a respective group of longitudinal prefabricated elements (18) defining a respective outer wall of the prefab;
wherein each projection (25) is inserted into the cavity (13) of a respective longitudinal prefabricated element (18) at a second end (26) of the longitudinal tube (11), opposite to the first end (16);

and preferably wherein two first beams (19, 19') are arranged parallel to each other and two second beams (20, 20') are arranged parallel to each other and perpendicular to the first beams (19, 19'), and wherein the first beams (19, 19') and the second beams (20, 20') define a peripheral support (33) for a covering (27) of the prefab.

17. A method for building a prefab by means of a system according to any one of claims from 1 to 14, comprising the following steps:

- providing a base (36) defined by the at least one first plate (1) and the at least one second plate (2);
- inserting the first end (16) of the longitudinal tube (11) of each longitudinal prefabricated element (18) into a respective second hole (4) of the at least one second plate (2) and into a respective first hole (3) of the at least one first plate (1) so as to define outer walls and possibly inner walls of the prefab.

18. A method according to claim 17, wherein at least two first beams (19, 19') and at least two second beams (20, 20') having a plurality of projections (25) are each arranged above a respective group of longitudinal prefabricated elements (18) defining a respective outer wall of the prefab by inserting each projection (25) into the cavity (13) of a respective longitudinal prefabricated element (18) at a second end (26) of the longitudinal tube (11), opposite to the first end (16).

19. A method according to claim 18, wherein the coupling is provided between first beams (19, 19') and second beams (20, 20') at the ends (21, 22) thereof, and wherein a covering (27) of the prefab is arranged so as to rest on a peripheral support (33) defined by said first beams (19, 19') and said second beams (20, 20').

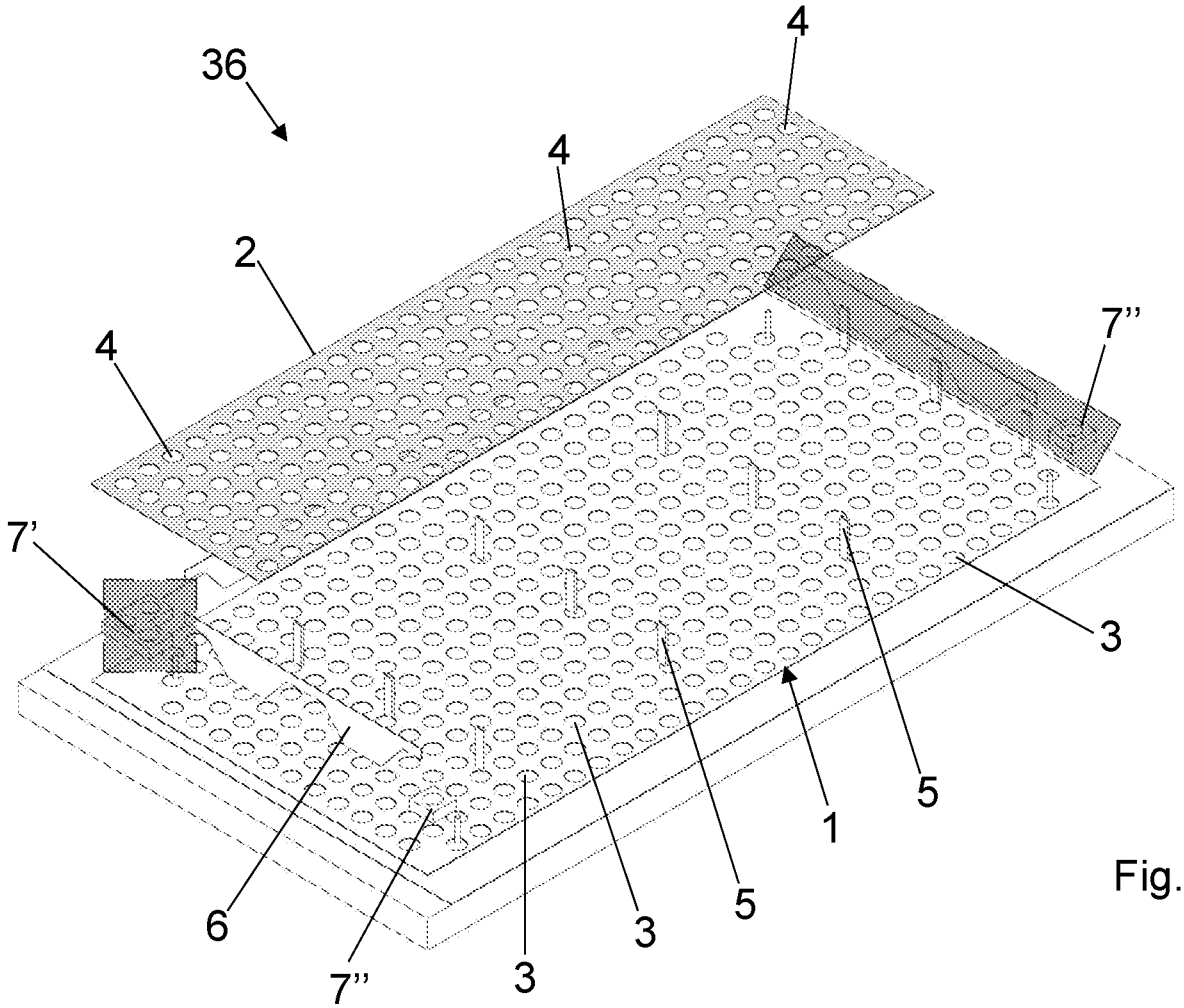


Fig. 1

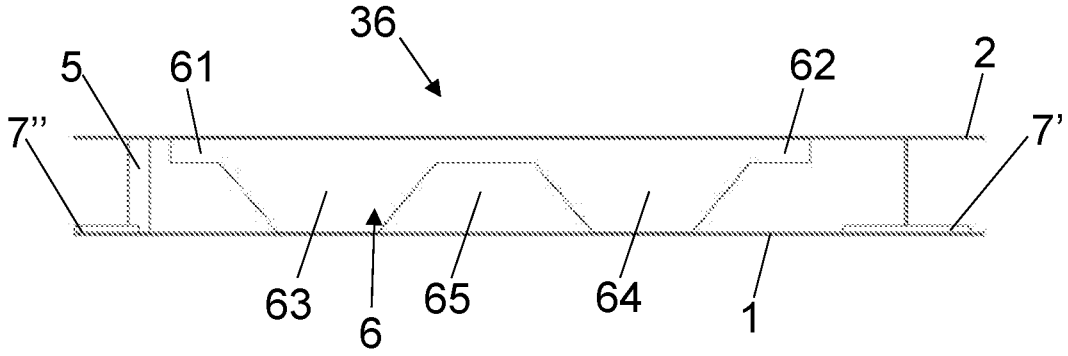


Fig. 1a

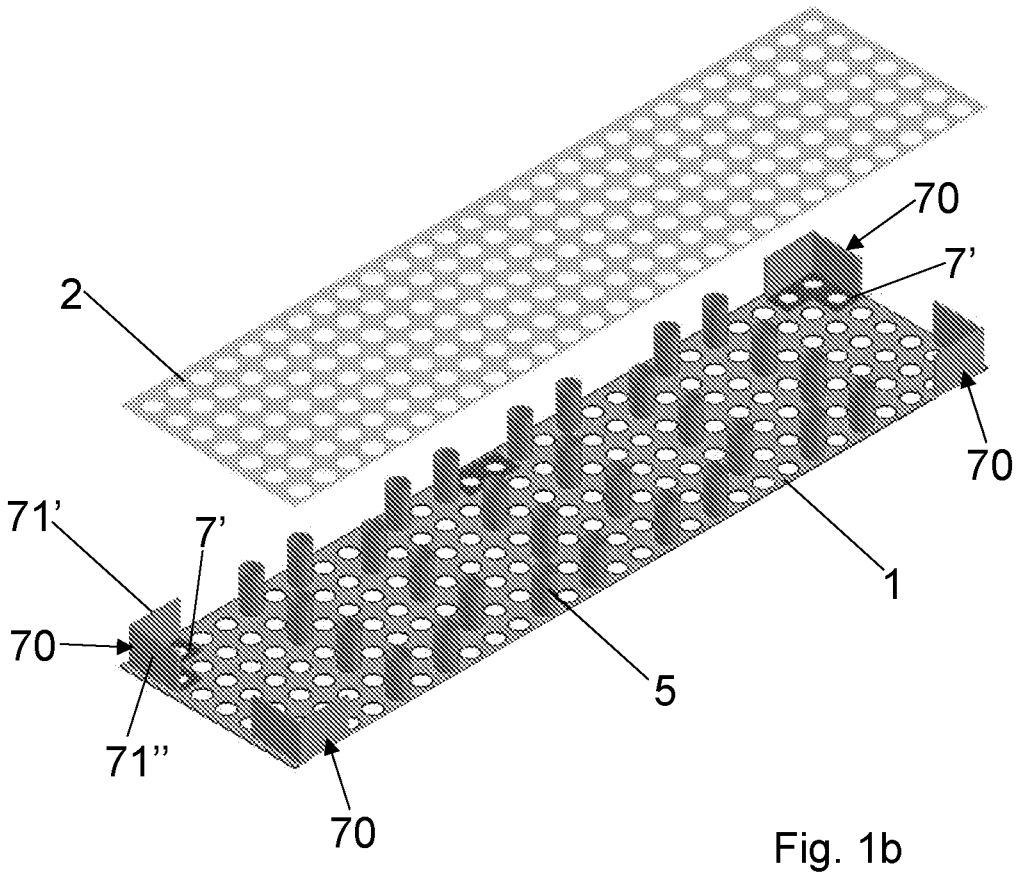


Fig. 1b

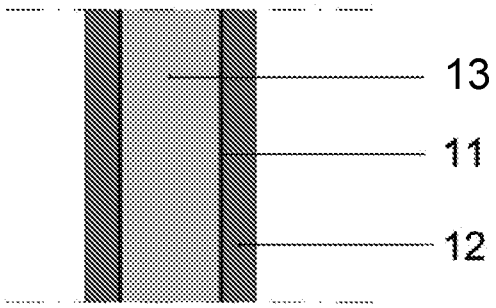


Fig. 2a

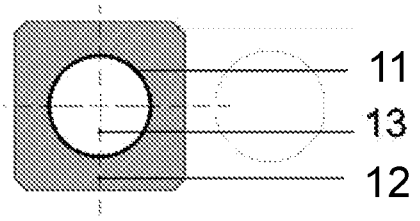


Fig. 2b

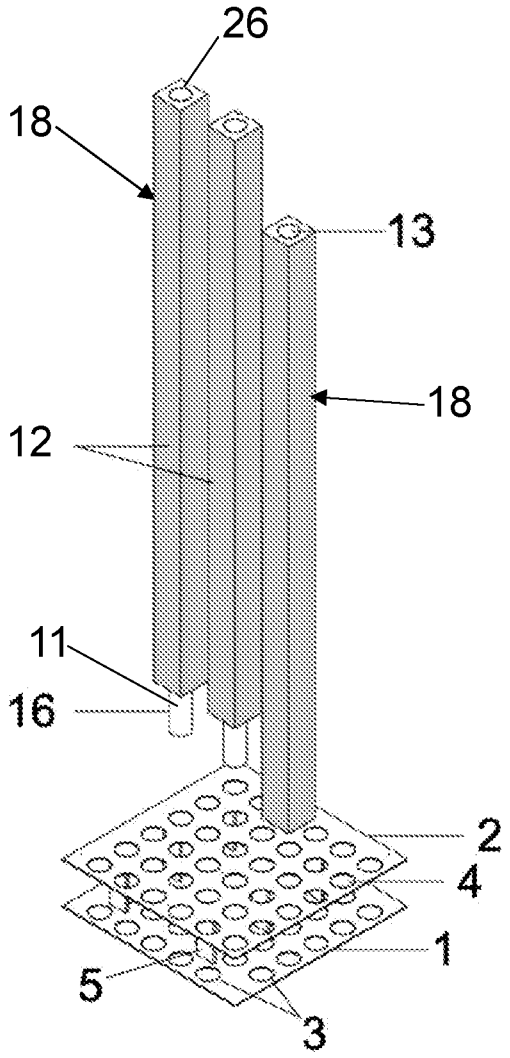


Fig. 3a

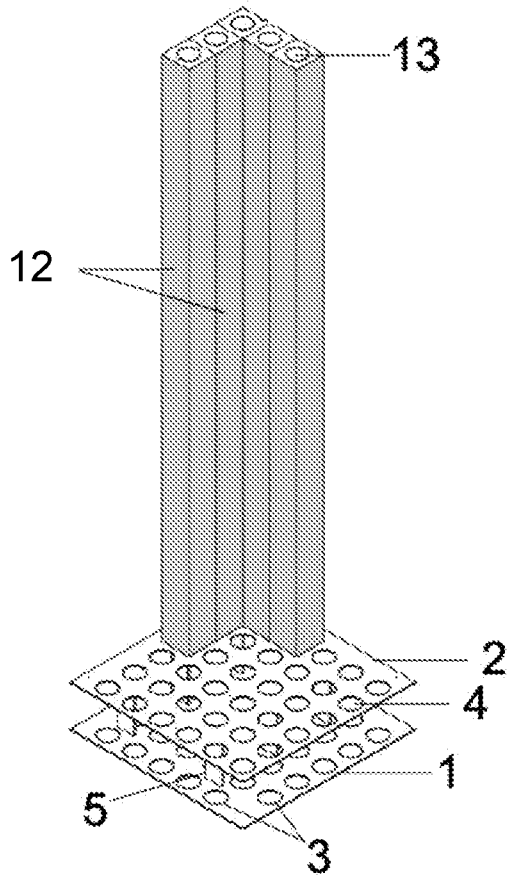


Fig. 3b

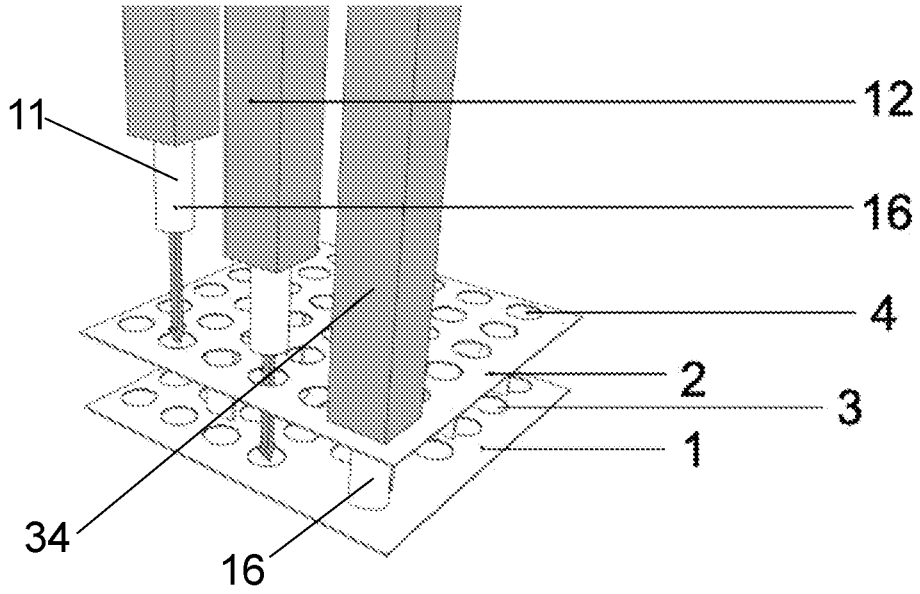


Fig. 3c

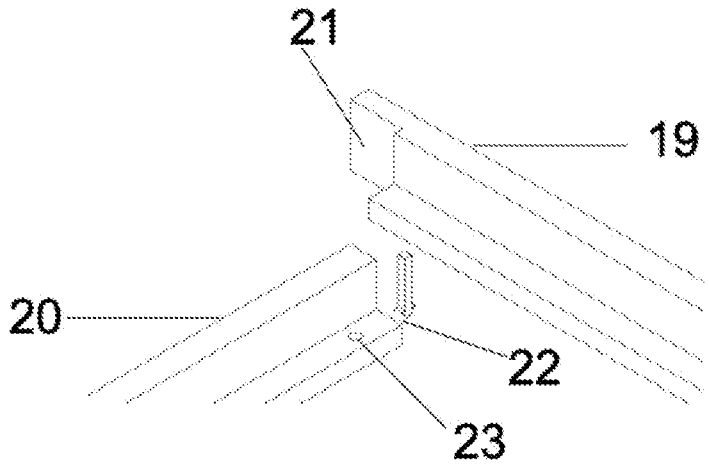


Fig. 4

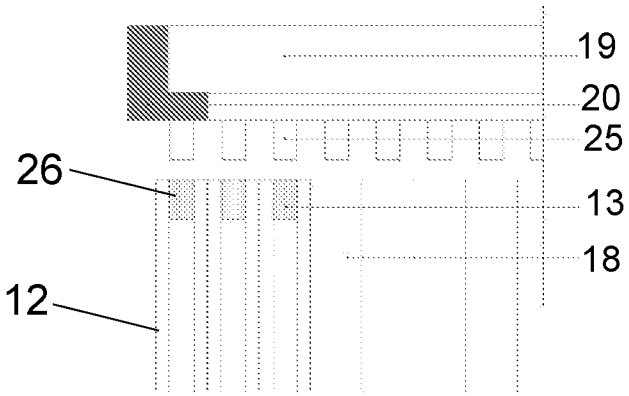


Fig. 5

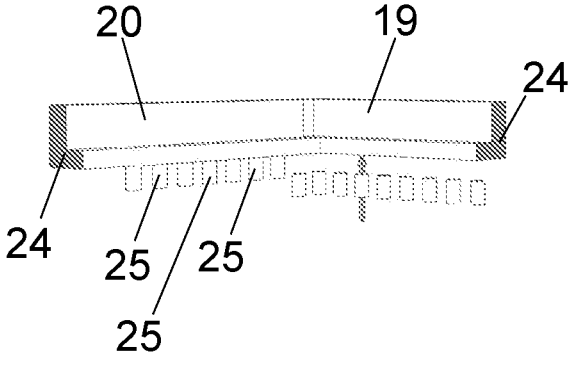


Fig. 6a

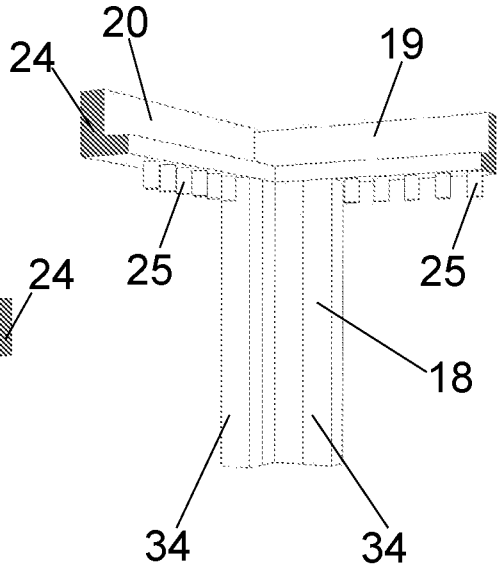


Fig. 6b

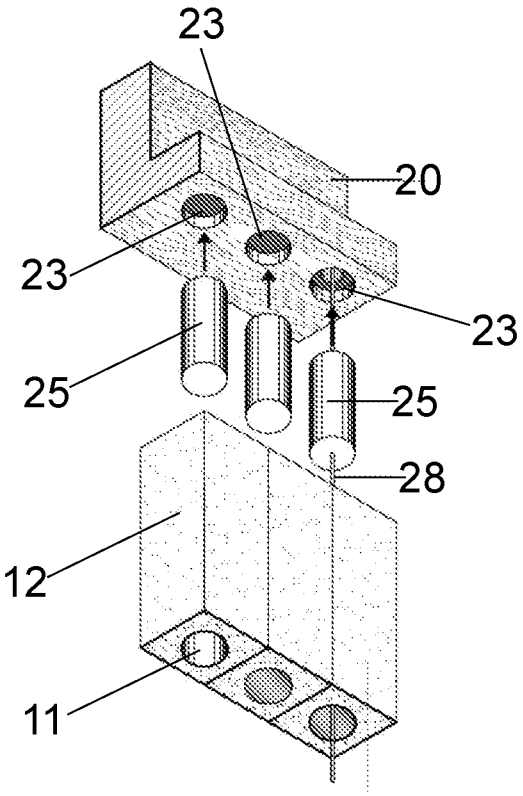


Fig. 7a

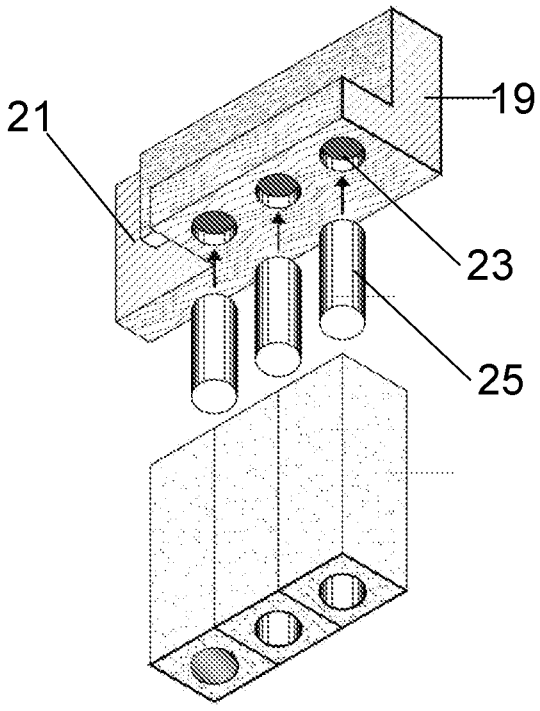


Fig. 7b

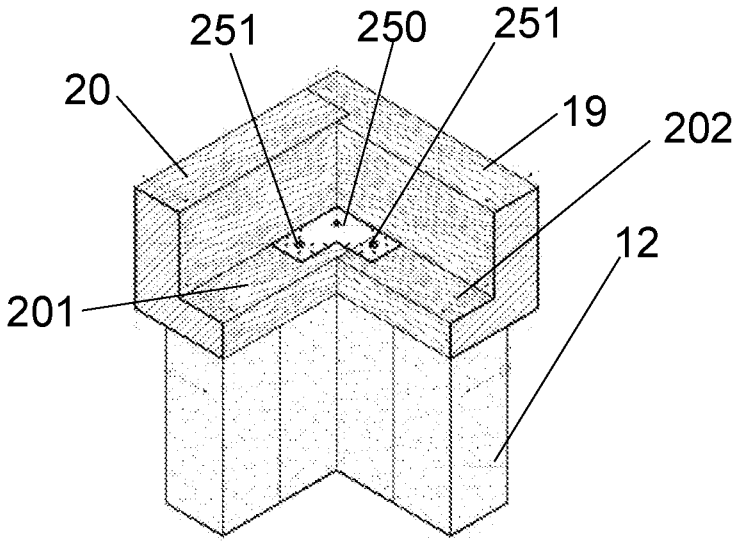


Fig. 7c

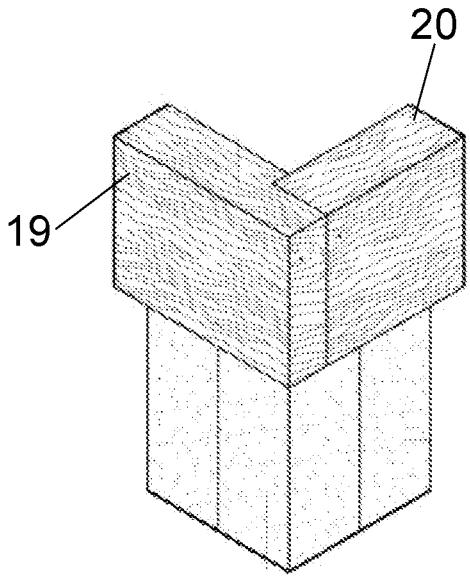


Fig. 7d

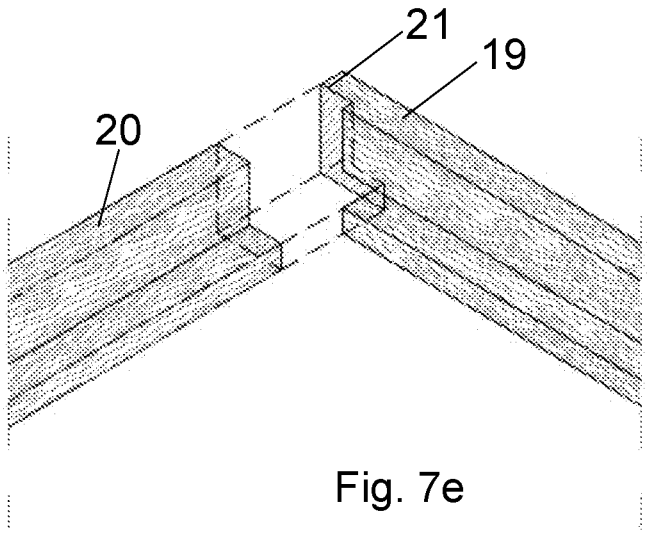


Fig. 7e

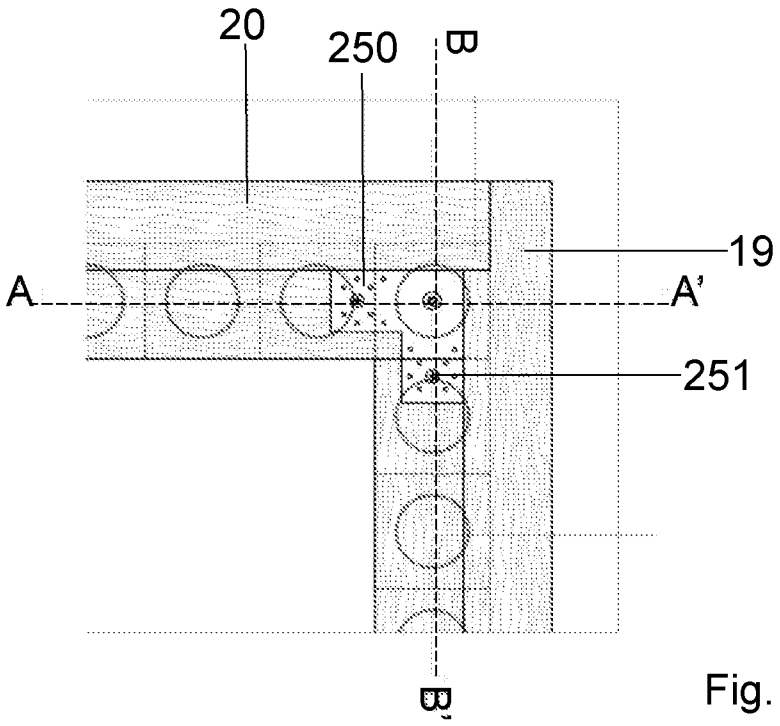


Fig. 8

Fig. 8a

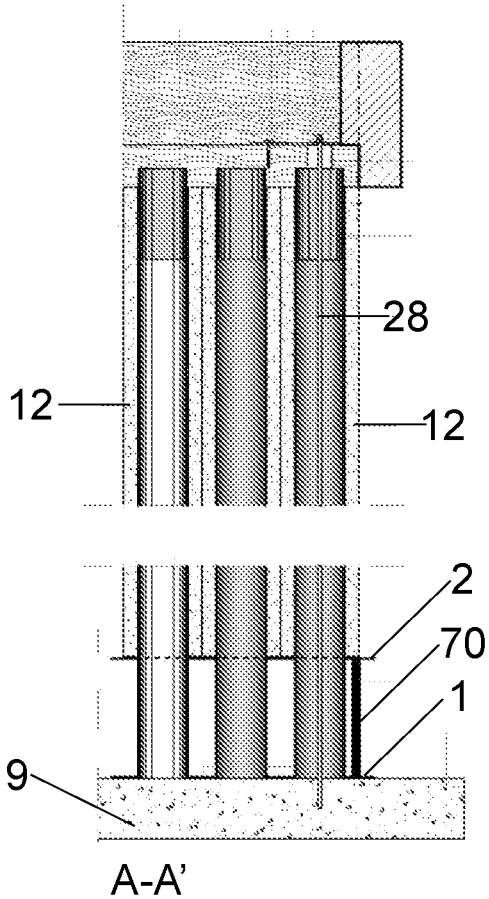
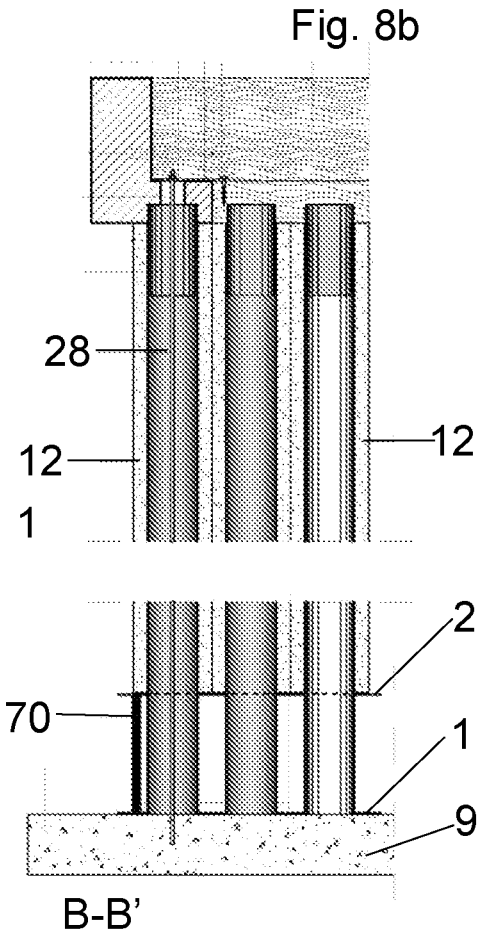


Fig. 8b



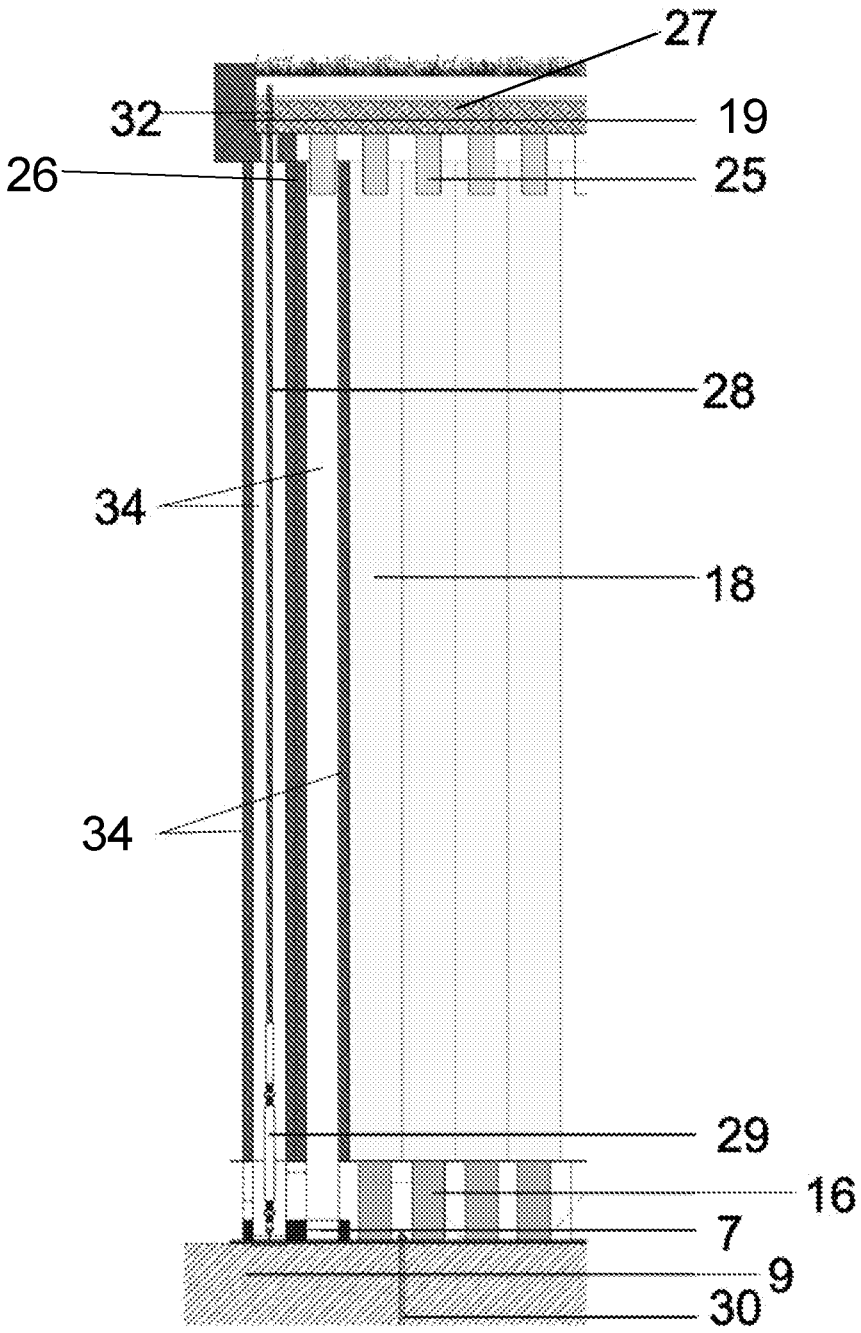
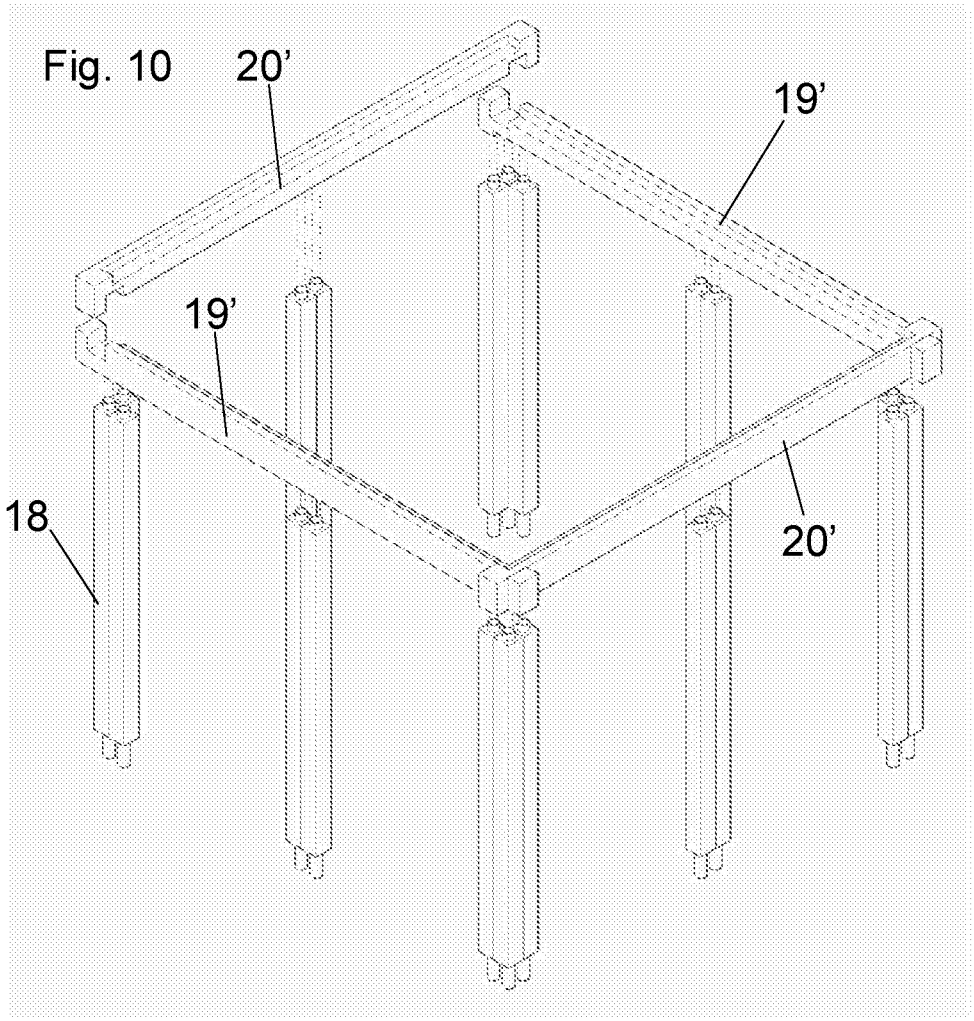


Fig. 9

Fig. 10



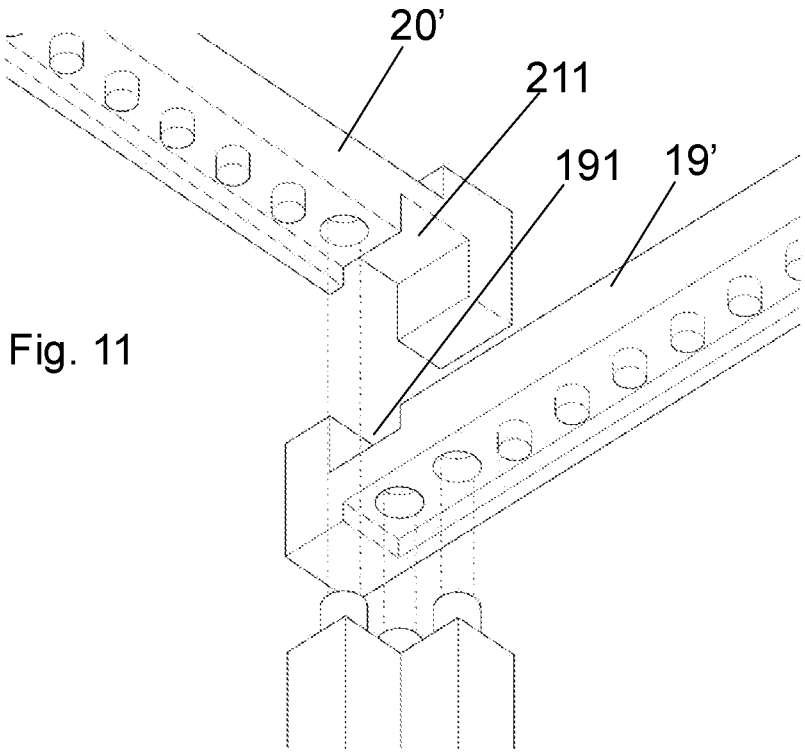
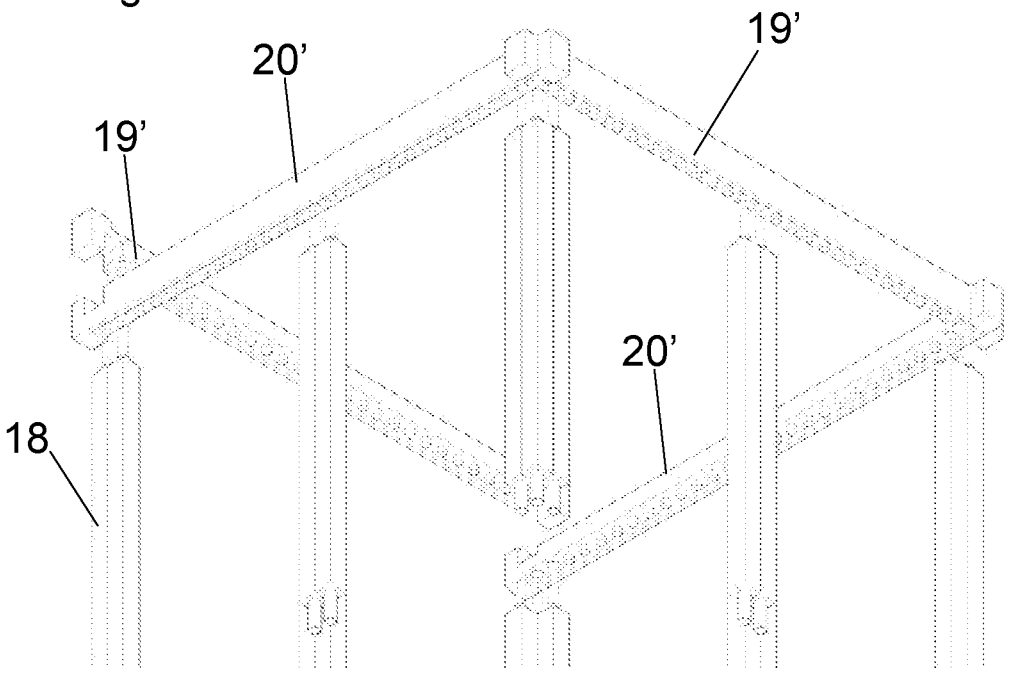


Fig. 11

Fig. 12



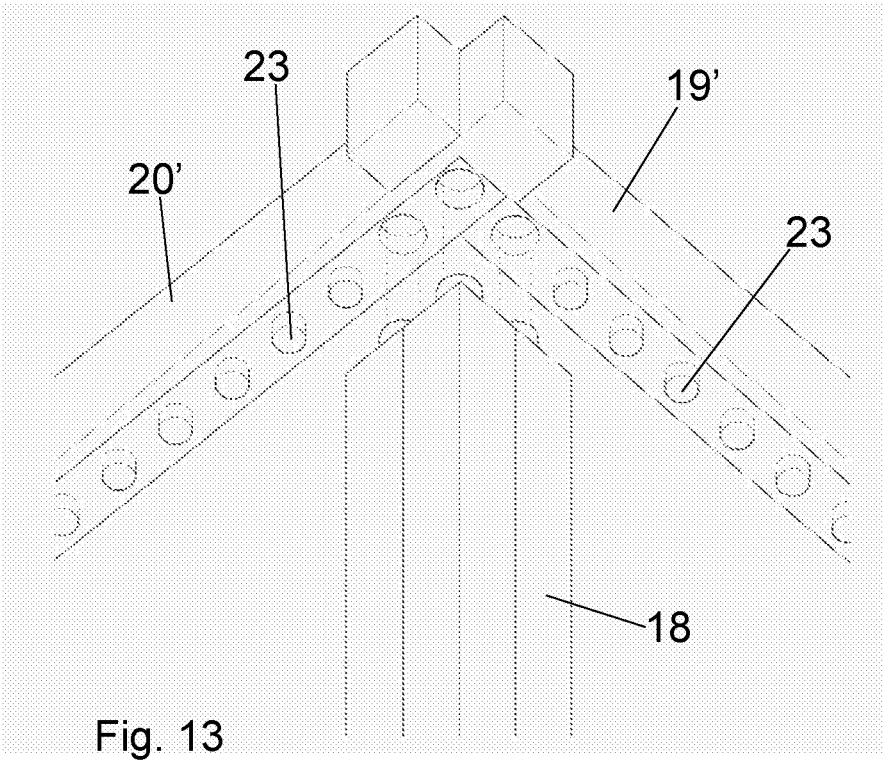


Fig. 13

Fig. 14

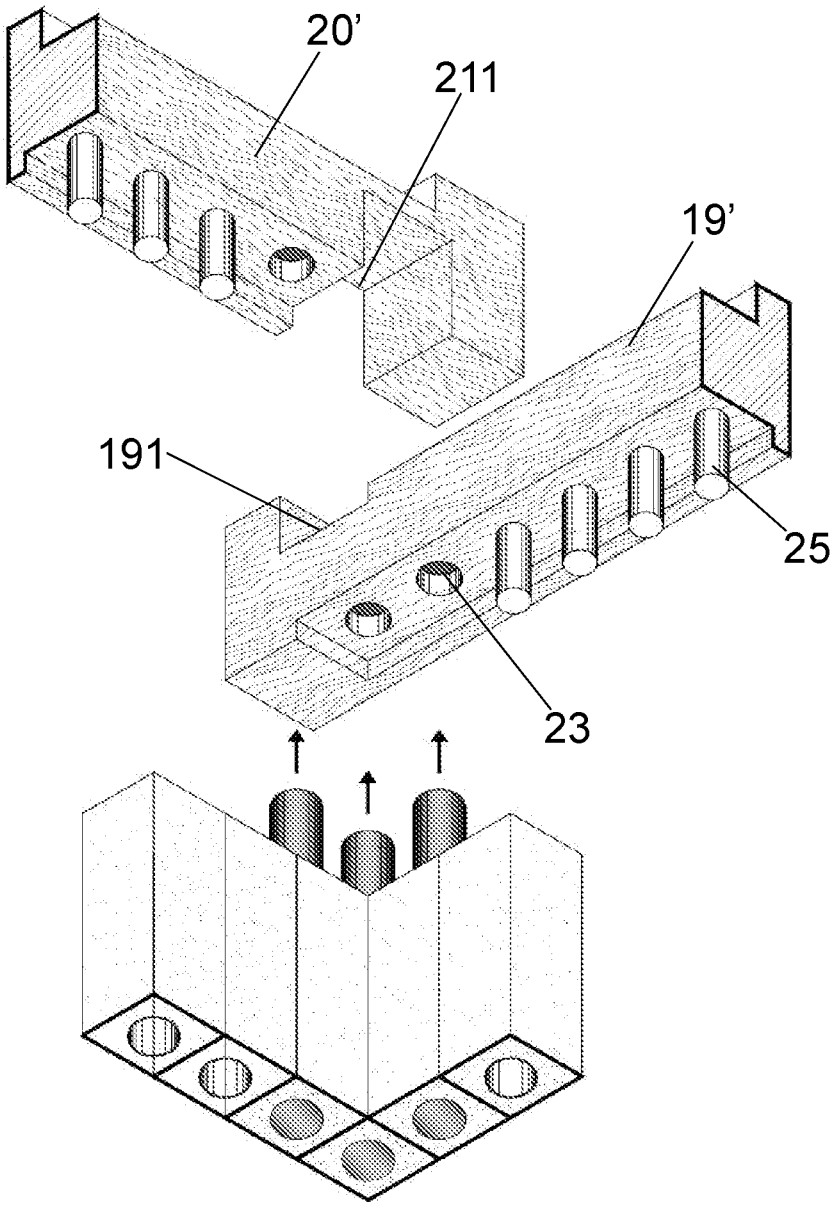


Fig. 15

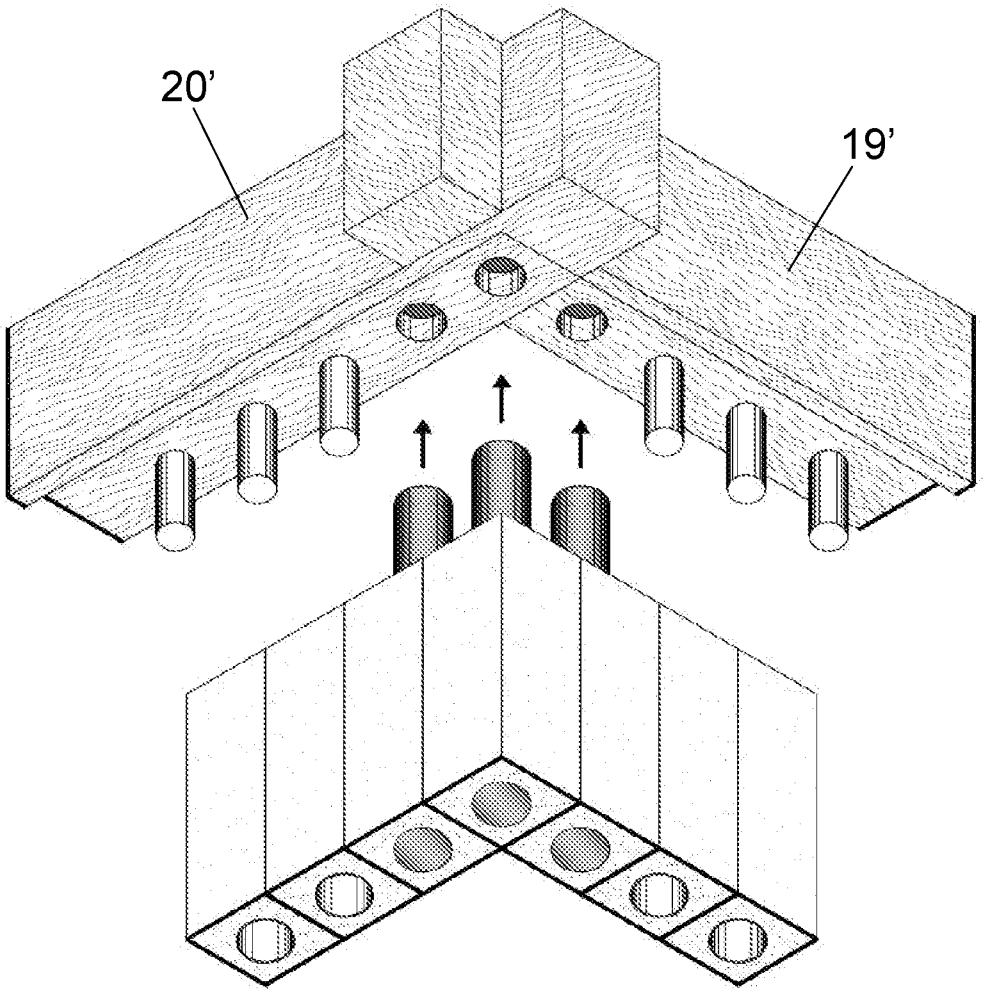
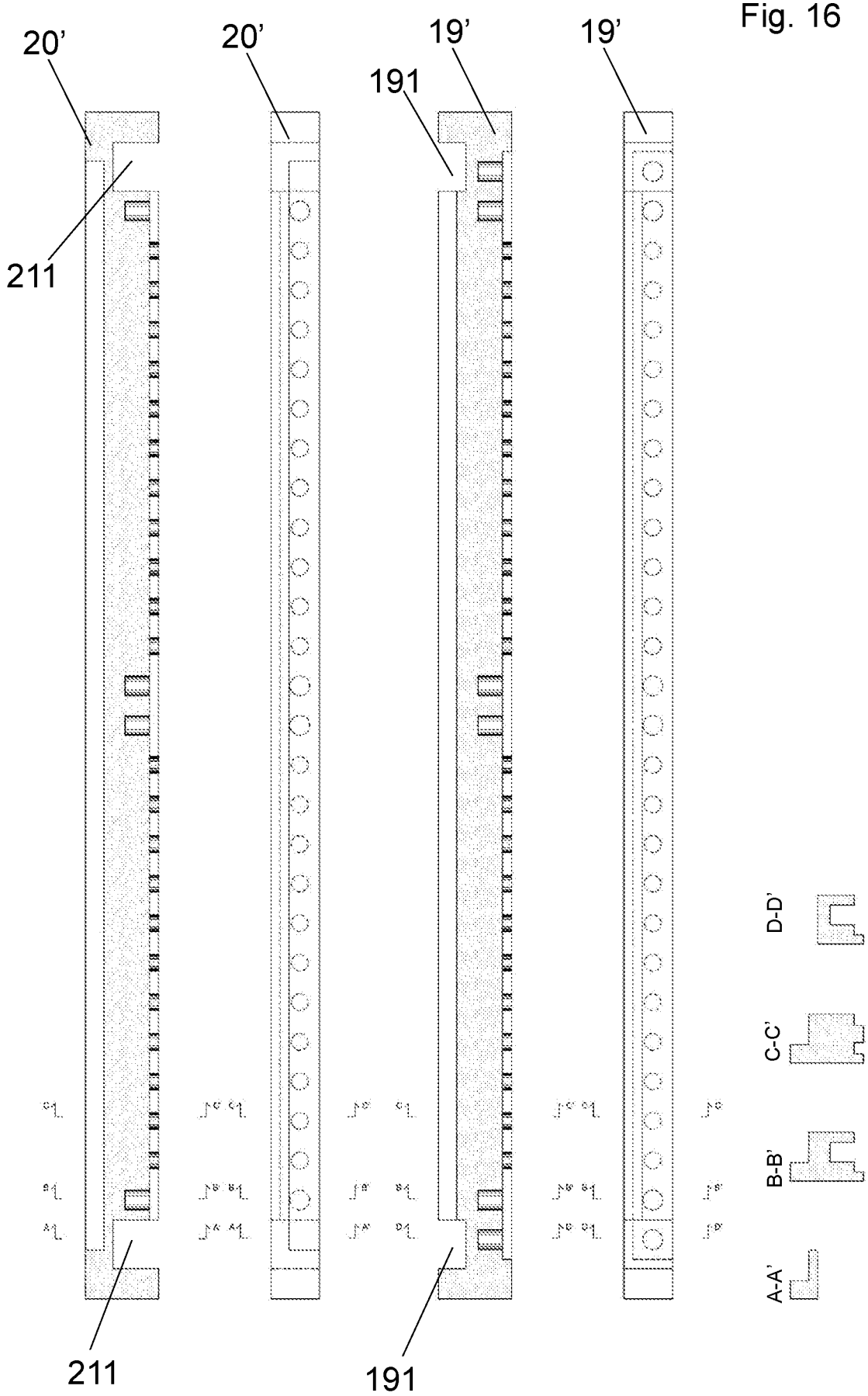


Fig. 16



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/054324

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04B2/56 E04H1/12
ADD. E04B1/35

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04B E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CH 701 732 B1 (ETH ZUERICH [CH]) 15 March 2011 (2011-03-15) paragraph [0001] - paragraph [0010]; figures 1-3c	1-19
A	US 2 241 169 A (OTTO YOKES) 6 May 1941 (1941-05-06) page 1, column 1, line 1 - page 3, column 2, line 59; figures 1-8	1-19
A	US 5 921 047 A (WALKER MARSHALL P [US]) 13 July 1999 (1999-07-13) column 2, line 23 - column 9, line 22; figures 1-16b	1-19
A	EP 3 375 765 A1 (GENIAL MAT S R L [IT]) 19 September 2018 (2018-09-19) paragraph [0001] - paragraph [0030]	1-19

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 July 2020	20/08/2020

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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