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(54) **A prefabricated modular building**

(57) The present invention relates to a prefabricated modular building for easy and quick construction, formed of a (skeleton of) steel piles and wooden bearing structure and rigid self-supporting insulation panels adapted to act as external walls, whereby such an assembly is obtained according to a basically "fit-in" logic, wherein each panel is rapidly and firmly coupled with the metal components designed to support it, without requiring the use of additional connection means (such as screws, nails, etc.) or highly-skilled workers.

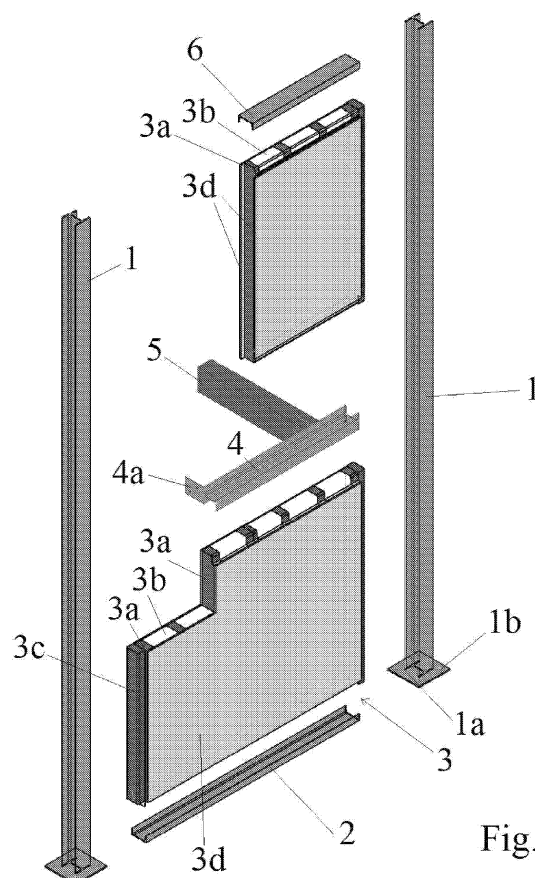


Fig. 1

## Description

**[0001]** The present patent application for industrial invention relates to a modular apparatus for construction of buildings, and to the building constructed with such apparatus.

**[0002]** US2003/079428 discloses a construction system of buildings, comprising a plurality of rigid connectors adapted to form a self-bearing skeleton. Each connector is provided with interconnection means and fixing means of panels.

**[0003]** US2004/261349 discloses a framework structure for buildings, wherein a surface element is connected to a lower framework element, to vertical elements and to an upper element in such a way to form a panel of the lateral wall.

**[0004]** The present invention has been devised to simplify and accelerate construction of a building designed for any type of use, that is to say housing, industrial, commercial and artisanal use.

**[0005]** Although the logic of the present invention is prefabrication, it must be noted that such logic is implemented by means of totally innovative modular components. In particular, the peculiar inventive solution is to construct a building that combines steel and wooden components, which are prefabricated and easy and quick to assemble.

**[0006]** First of all, it must be noted that the vertical structures of such an innovative building are obtained from a skeleton of steel piles, it being provided that the vertical spaces comprised between each consecutive pair of said piles are covered by means of special self-supporting panels (preferably of composite structure), stacked edgewise one on top of the other and ultimately designed to originate the walls of the building of the invention in correspondence of the various floors of said building.

**[0007]** Special attention is paid to the construction of the metal components used to install said panels; said metal components, in fact, are expressly designed to provide easy and quick assembly of said self-supporting panels in the building to be constructed.

**[0008]** Such an assembly is obtained according to a basically "fit-in" logic, wherein each panel is rapidly and firmly coupled with the metal components designed to support it, without requiring the use of additional connection means (such as screws, nails, etc.) or highly-skilled workers.

**[0009]** It can be otherwise said that the vertical and horizontal borders of such a panel are adapted to be engaged - for correct operational positioning and stable support - into corresponding rectilinear housings obtained in vertical and horizontal position on the metal components of the apparatus of the invention.

**[0010]** Moreover, it must be noted that, in the building provided with them, said panels have both a structural function and a bracing function (as hereinafter illustrated in detail) that are certainly useful to guarantee the stability

and sturdiness of the entire building.

**[0011]** The same panels are also used to realize the horizontal roofing structures of the building of the invention, in cooperation with steel beams and wooden beams.

**[0012]** For purposes of clarity, the description of the present invention continues with reference to the enclosed drawings, which are intended for purposes of illustration only and not in a limiting sense, wherein:

- fig. 1 is an exploded axonometric view of a vertical section of the building constructed with the apparatus of the invention;
- fig. 2 is a cross-sectional view of a "ground to roof" section of the building of the invention;
- fig. 3 is an enlarged view of a detail of fig. 2 at the height of the base of the building;
- fig. 4 is an enlarged view of a detail of fig. 2 at the height of the floor that divides two floors;
- fig. 5 is an additional enlarged view of a detail of fig. 2 at the height of the roof;
- fig. 6 is a cross-sectional view of fig. 5 with vertical plane VI-VI;
- fig. 7 is a cross-sectional view of the panel of composite structure of said modular structure.

**[0013]** Referring to fig. 1, the first modular element comprised in the apparatus of the invention consists in a H-shaped steel pile (1) that protrudes vertically from a ground stabilization plate (1a), commonly defined as "anchoring plate", which is provided with circular through holes (1b). In particular, such a plate (1a) is laid on a reinforced concrete foundation beam (TCA) wherein metal reinforcement rods with vertical axis (TV) are embedded and arranged in such a way that the upper threaded ends can be inserted, from down up, into said through holes (1b) of the plate (1a), protruding in upper position. The pile (1) is fixed to the foundation beam (CA) by screwing fixing nuts (D) to said threaded ends of the metal rods (T), until said fixing nuts (D) touch the upper side of the plate (1a).

**[0014]** The realization of the building of the invention provides for laying a perimeter series of said steel piles (1), thus forming the bearing skeleton of the vertical structures of the building.

**[0015]** Then, a suitable number of the second element of the apparatus of the invention is laid, consisting in a steel base beam (2) with basically U-shaped section. In particular, each of said base beams (2) is fixed to the ground, above a traditional reinforced concrete slab (SCA) that is the base of the building to be constructed, in intermediate position between each consecutive pair of said vertical piles (1).

**[0016]** Then a third element of the apparatus of the invention is laid, consisting in a special self-supporting panel (3) adapted to be mounted in edgewise position in the vertical space formed on the two sides by a consecutive pair of said piles (1) under said base beam (2) in intermediate position between the latter. More precise-

ly, said insertion must be carried out from up down, in such a way that the vertical borders of the panel (3) are inserted into the vertical grooves of the two corresponding H-shaped piles (1).

**[0017]** So the panel (3) makes a controlled downward sliding inside a pair of vertical grooves, and, at the end of such a sliding movement, the lower horizontal border is exactly engaged inside a longitudinal upward concavity of the U-shaped base beam (2).

**[0018]** The good outcome of such an operation requires that the longitudinal cavity of the U-shaped base beam (2) is perfectly aligned with the vertical grooves of the two adjacent H-shaped piles (1). In any case, when laying is completed, each of said panels (3) is able to laterally cover the ground floor of the building for the section comprised between the two piles (1) used to support it.

**[0019]** According to the preferred embodiment of the invention shown in the aforesaid figures, the panel (3) has a composite structure obtained with wood and polystyrene or other similar materials with insulation properties. In fact, it is formed of a regularly spaced series of wooden blocks (3a) with basically square section, alternated with a series of synthesized polystyrene blocks (3b); it being provided that the lateral borders of such a panel (3) are finished with the application of additional wooden strips (3c) adapted to be engaged and slide inside said vertical grooves of the H-shaped piles (1).

**[0020]** Moreover, each of said panels (3) is laterally covered, on both sides, by means of OSB plates (3d).

**[0021]** As mentioned above, said panels (3) have an especially advantageous double function in the building to be constructed. In fact, they have a static structural function, which is guaranteed by the bearing capacity of said wooden blocks (3a) embedded inside them, in association with a bracing structural function, which is in turn guaranteed by the resistant capacity of said opposite lateral OSB plates (3d).

**[0022]** In any case, after laying, each of said panels (3) is fixed inside said vertical space comprised between two adjacent piles (1).

**[0023]** Such an operation is carried out because of the presence of a second steel beam (4) that is the fourth element of the apparatus of the invention, which can be traditionally defined as "reinforcement beam" of the floor (S) of the upper floor with the floor that has been previously covered with a perimeter series of panels (3).

**[0024]** Each specimen of said reinforcement beam (4) is provided with H-shaped section, with lower longitudinal concavity exactly engaged, from up down, to embrace the upper horizontal border of a corresponding panel (3).

**[0025]** The beam (4) is then fixed to the two piles (1) that define the space where the panel (3) is inserted. In particular, the mutual stable anchoring between the two ends of a similar reinforcement beam (4) and the two adjacent piles (1) is advantageously obtained by means of traditional connection squares, suitably provided with holes for fixing bolts (not shown in the attached figures).

**[0026]** Additionally, one or more perforated brackets (4a) protrude in edgeways position from the inside of each reinforcement beam (4), adapted to be used, with the cooperation of corresponding series of bolts, to fix one or more specimens of a wooden beam (5) that is the fifth element of the apparatus of the invention and is adapted to form the bearing truss of the floor (S).

**[0027]** In order to realize an additional floor in the building, an additional specimen of the panel (3) is inserted inside the vertical grooves of each pair of H-shaped piles (1), sliding downwards until its lower horizontal border is engaged inside the upper longitudinal concavity of the H-shaped reinforcement beam (4) mounted on top of a similar panel (3) laid on the lower floor.

**[0028]** If the building to be constructed has more than two floors, said second series of panels (3) is provided with a corresponding series of reinforcement beams (4), not only to lay said wooden beams (5) for the realization of the corresponding floor, but also to lay an additional vertical series of similar panels (3).

**[0029]** When the realization of floors is completed, on top of the series of panels (3) forming the last floor, a corresponding number of specimens of a steel beam (6), defined as crown beam, is laid, being the sixth element of the apparatus of the invention.

**[0030]** Each beam (6) has a basically overturned U-shaped cross-section and is adapted to be exactly inserted from up down on the upper horizontal border of the corresponding wooden panel (3), before being fixed, possibly by means of traditional connection squares, between the two pillars (1) between which the panel (3) is situated.

**[0031]** The apparatus of the invention comprises a seventh element consisting in an additional H-shaped steel beam (7) used during the realization of the sloped roof of the building of the invention.

**[0032]** Referring to figs. 5 and 6, each sloping of such a roof (T) uses two specimens of said steel beam (7) in correspondence of the lateral borders; it being provided, in particular, that each of said beams rests in inclined position on a row of said piles (1) suitably provided with a progressively increasing height towards the top of the roof.

**[0033]** The function of the two steel beams (7) is to support from opposite sides the ends of a transversal series of wooden beams (5), adapted to form the truss of the sloped side of the roof (T).

**[0034]** Each of said beams (7) internally supports a corresponding series of perforated brackets (7a) in edgeways position used to fix the ends of said wooden beams (5) with the cooperation of a suitable series of connection screws.

**[0035]** When such a truss is completed, each side of the sloped roof is provided with a suitable number of specimens of said panel with composite structure (3) adapted in such a case to be laid in basically "lying-down" position in view of the support provided by said wooden beams (5).

**[0036]** Referring to fig. 6, each of said steel beams (7) of the roof (T) is externally provided with an additional series of perforated brackets (7b) used to fix, by means of a corresponding series of bolts, conventional stumps of laminated wood (M) that protrude at the base of the roof on the outside of the building of the invention. When the bearing structure of the building is completed, completion and finishing works are carried out according to traditional modes. Said works refer to realization of floors (S), internal and external roof lining, laying of plastered plasterboard panels (IN) in correspondence of the internal side of the panels (3) forming the vertical walls of the building, as well as laying of external plastered coating (CE) to guarantee thermal and acoustic insulation of said vertical walls.

**[0037]** Fig. 7 illustrates a specific solution provided for realization of said wooden panel (3). Two symmetrically opposite steps (3e, 3f) are obtained in external position on said panel (3) in correspondence of its horizontal borders.

**[0038]** The function of said steps (3e, 3f) is to receive the external longitudinal edge of the steel beams (2, 4, 6) respectively adapted to be coupled with the lower longitudinal border and the upper longitudinal border of the panel (3). More precisely, the step (3e) provided on top of the panel (3) is adapted to receive the downward edge of a reinforcement beam (4) or crown beam (6), whereas the step (3f) provided at the base of the panel (3) is adapted to receive the upward edge of a base beam (2).

**[0039]** Such a coupling between said steps (3e, 3f) and the edges of corresponding steel beams (2, 4, 6) guarantees stable fixing and favors mutual centering during laying.

## Claims

### 1. Building wherein:

- each vertical wall of the ground floor is composed of a lower self-supporting panel (3) adapted to be maintained in operative position by a steel bearing structure formed of a pair of H-shaped piles (1) fixed to the ground, a U-shaped horizontal base beam (2) and an upper H-shaped horizontal reinforcement beam (4) both fixed between said H-shaped piles (1); the lateral borders of the lower panel (3) are engaged inside the vertical grooves of said adjacent H-shaped piles (1), the lower horizontal border of said lower panel (3) is engaged inside the concavity of the lower U-shaped horizontal base beam (2) and the upper horizontal border is engaged inside the downward concavity of the upper horizontal reinforcement beam (4);
- the floor (S) of the ground floor is provided with a bearing structure composed of a plurality of wooden beams (5) positioned in such a way that

each end is engaged against the internal lateral side of said horizontal reinforcement beam (4) in the vicinity of a corresponding perforated bracket (4a) protruding in edgeways position for permanent fixing by means of a suitable series of bolts;

- each vertical wall of the floors that occupy a higher level than the ground floor, but are not situated immediately under the roof (T), is composed of an additional self-supporting panel (3) adapted to be maintained in operative position by means of a steel bearing structure composed of the same pair of H-shaped piles (1) that supports the lower panel (3) of the lower floor, the lower H-shaped horizontal reinforcement beam (4) coupled with the upper horizontal border of the lower panel (3) of the lower floor and an additional upper H-shaped horizontal reinforcement beam (4); the lateral borders of said additional panel (3) being engaged inside the vertical grooves of said H-shaped piles (1), the lower horizontal border of the additional panel (3) being engaged inside the upward concavity of the lower H-shaped horizontal reinforcement beam (4) and the upper horizontal border of the additional panel (3) being engaged inside the downward concavity of the upper horizontal reinforcement beam (4);

- the floor (S) of each floor that occupies a higher level than the ground floor, but is not situated immediately under the roof, is provided with a bearing structure composed of a plurality of wooden beams (5) positioned in such a way that each end is engaged against the internal lateral side of said horizontal reinforcement beam (4) in the vicinity of a perforated bracket (4a) protruding in edgeways position for permanent fixing by means of a suitable series of bolts;

- each vertical wall of the attic floor is composed of an additional self-supporting panel (3) adapted to be maintained in operative position by means of a steel bearing structure composed of the same pair of H-shaped piles (1) that supports the corresponding lower panel (3) of the lower floor, the lower H-shaped horizontal reinforcement beam (4) already coupled with the upper horizontal border of the lower panel (3) of the lower floor and an upper U-shaped horizontal crown beam (6); the lateral borders of said additional panel (3) being engaged inside the vertical grooves of said H-shaped piles (1), the lower horizontal border of the upper panel (3) being engaged inside the upward concavity of the lower H-shaped horizontal reinforcement beam (4) and the upper horizontal border of the additional panel (3) being engaged inside the concavity of the upper horizontal crown beam (6);
- each sloping side of the roof (T) is provided

with an opposite pair of additional H-shaped steel beams (7), each of them resting in inclined position at the top of a row of said H-shaped piles (1) suitably provided with height progressively increasing towards the top of the roof (T); it being provided, in intermediate position between said H-shaped inclined beams (7), with additional specimens of said wooden beam (5), each of them being situated in such a way that each end is engaged against the internal lateral side of the inclined beam (7) in the vicinity of a perforated bracket (7a) that protrudes in edgewise position for permanent fixing by means of a suitable series of bolts;

- the structure of each of the sloped sides of the roof (T) incorporates, in cooperation with said H-shaped inclined beams (7) and said wooden beams (5), a series of upper panels (3) arranged in basically lying-down position.

2. Building as claimed in claim 1, **characterized in that** it is provided, for each of said panels (3) that act as vertical walls, with internal coating obtained with plastered plasterboard panels (IN) and external coating obtained with plastered coat (CE).
3. Building as claimed in claim 1 or 2, **characterized in that** it is provided with reinforced concrete foundation beams (TCA) wherein metal reinforcement rods with vertical axis (TV) are embedded and arranged in such a way that the upper threaded ends protrude from the concrete structure, in such a way to cross, from down up, the through holes (1b) obtained on the stabilization plates (1a) of corresponding H-shaped piles (1) and engage with suitable fixing nuts (D).
4. Building as claimed in anyone of the preceding claims, **characterised in that** it is provided, in external position on each specimen of said H-shaped inclined beam (7), with an additional series of perforated brackets (7b) in edgewise position used to fix, by means of series of bolts, corresponding pieces of laminated wood (M) situated in horizontal position at the base of the roof.

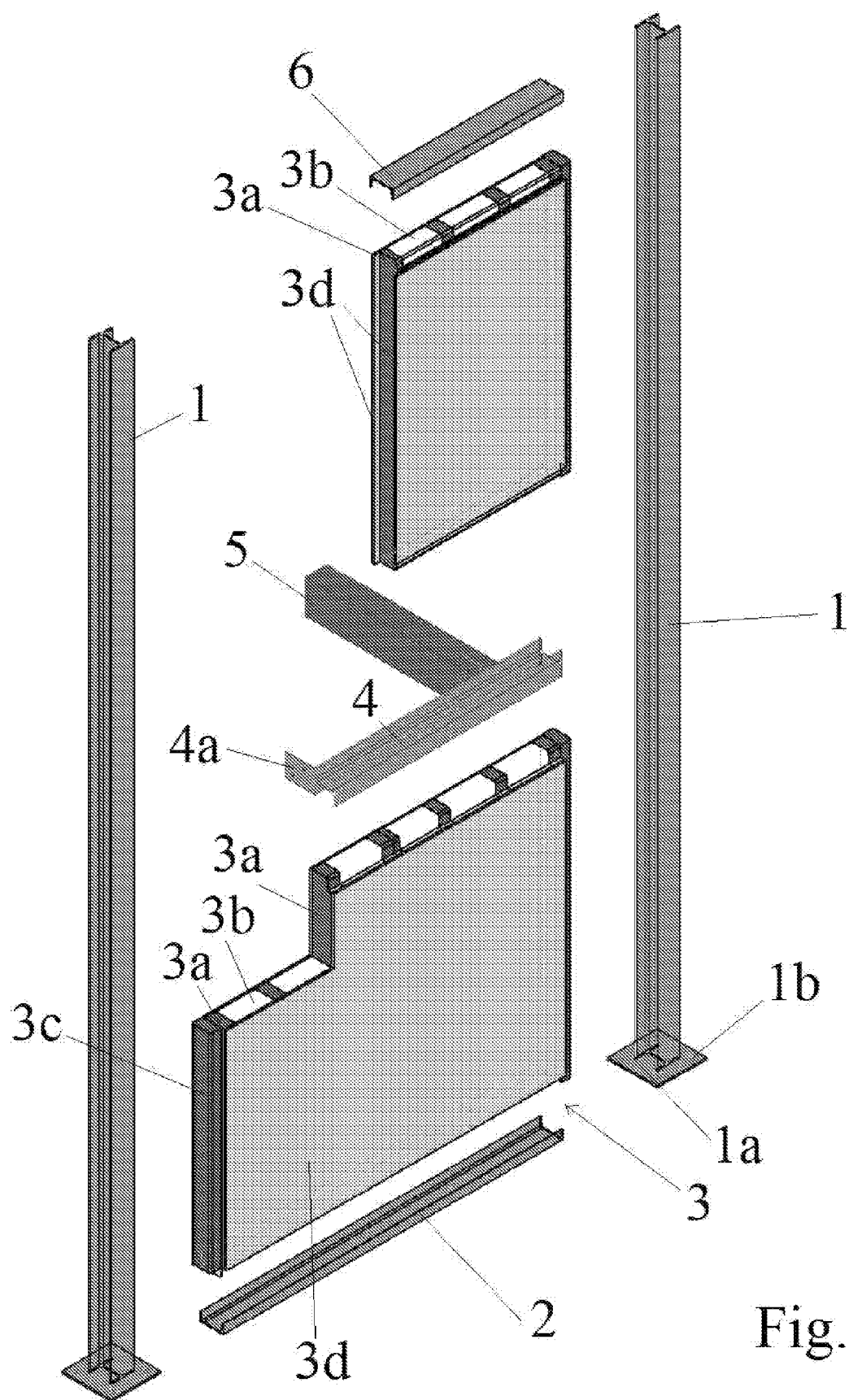


Fig. 1

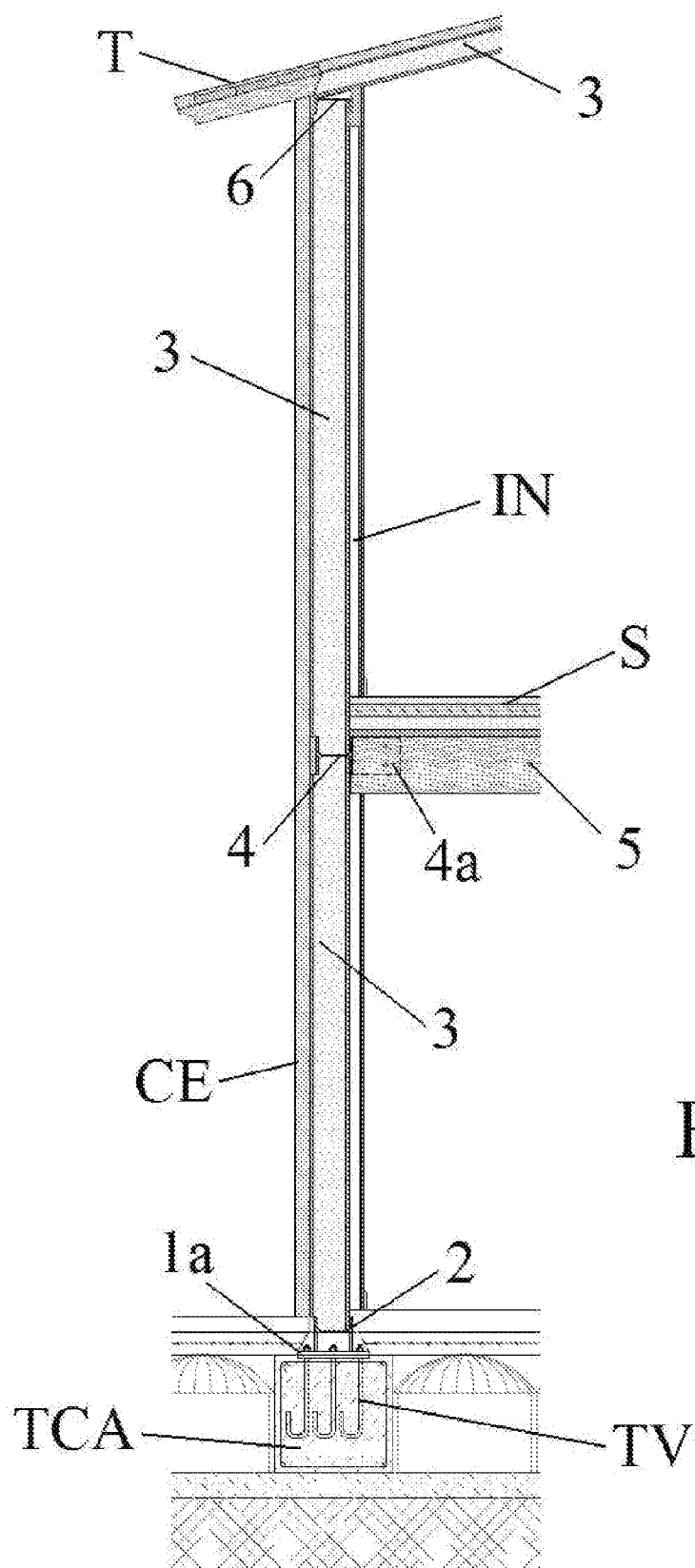
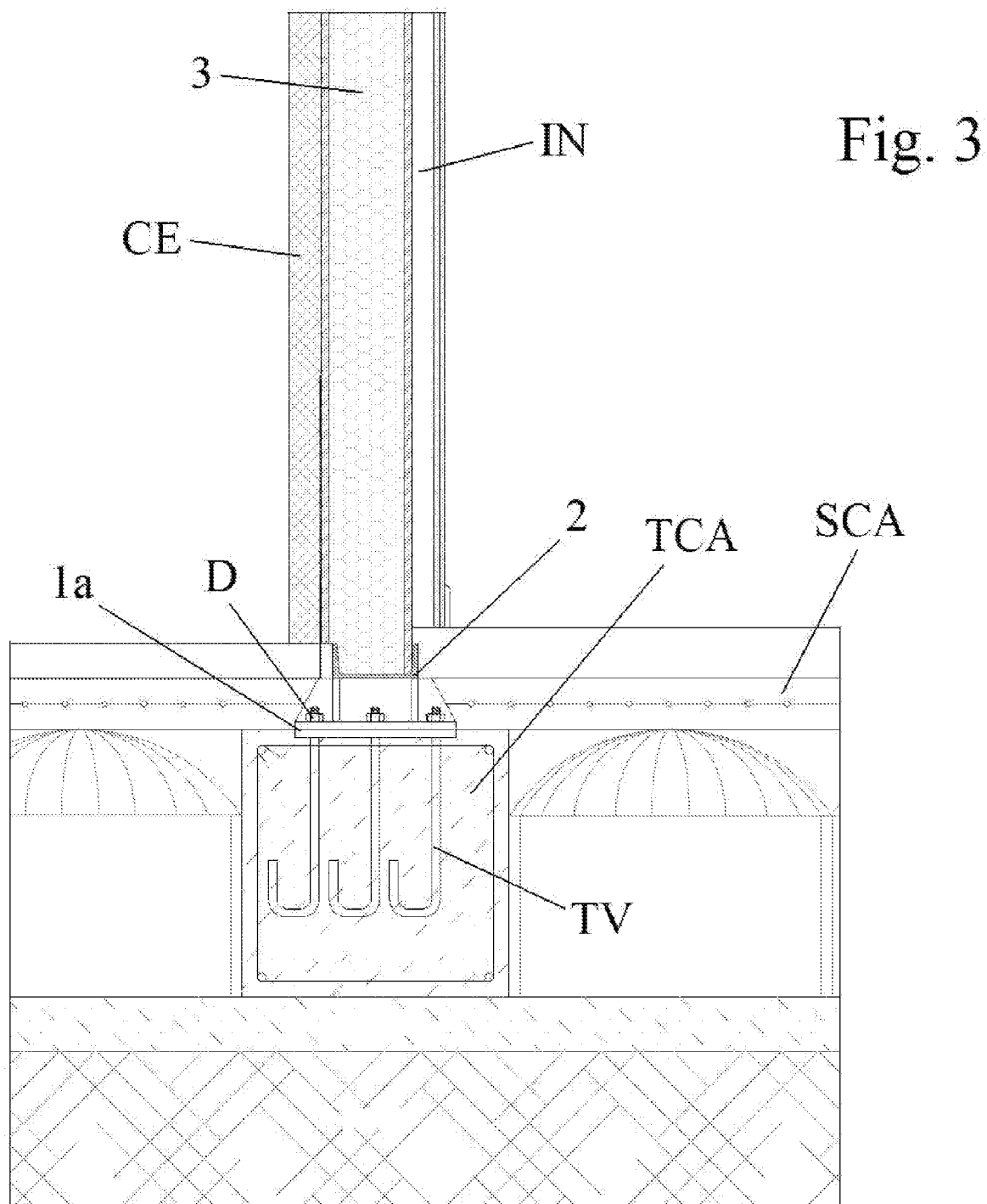


Fig. 2





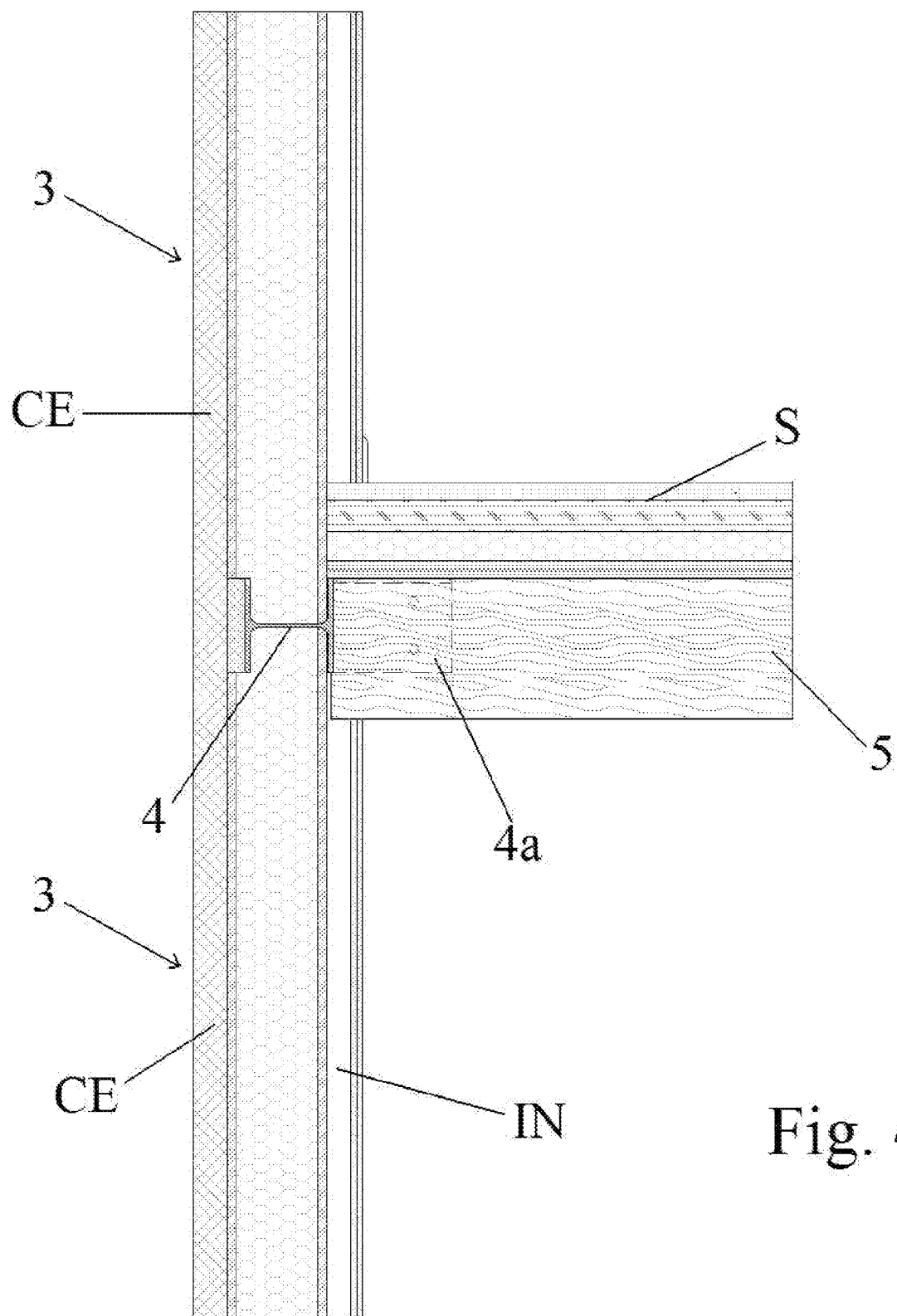


Fig. 4

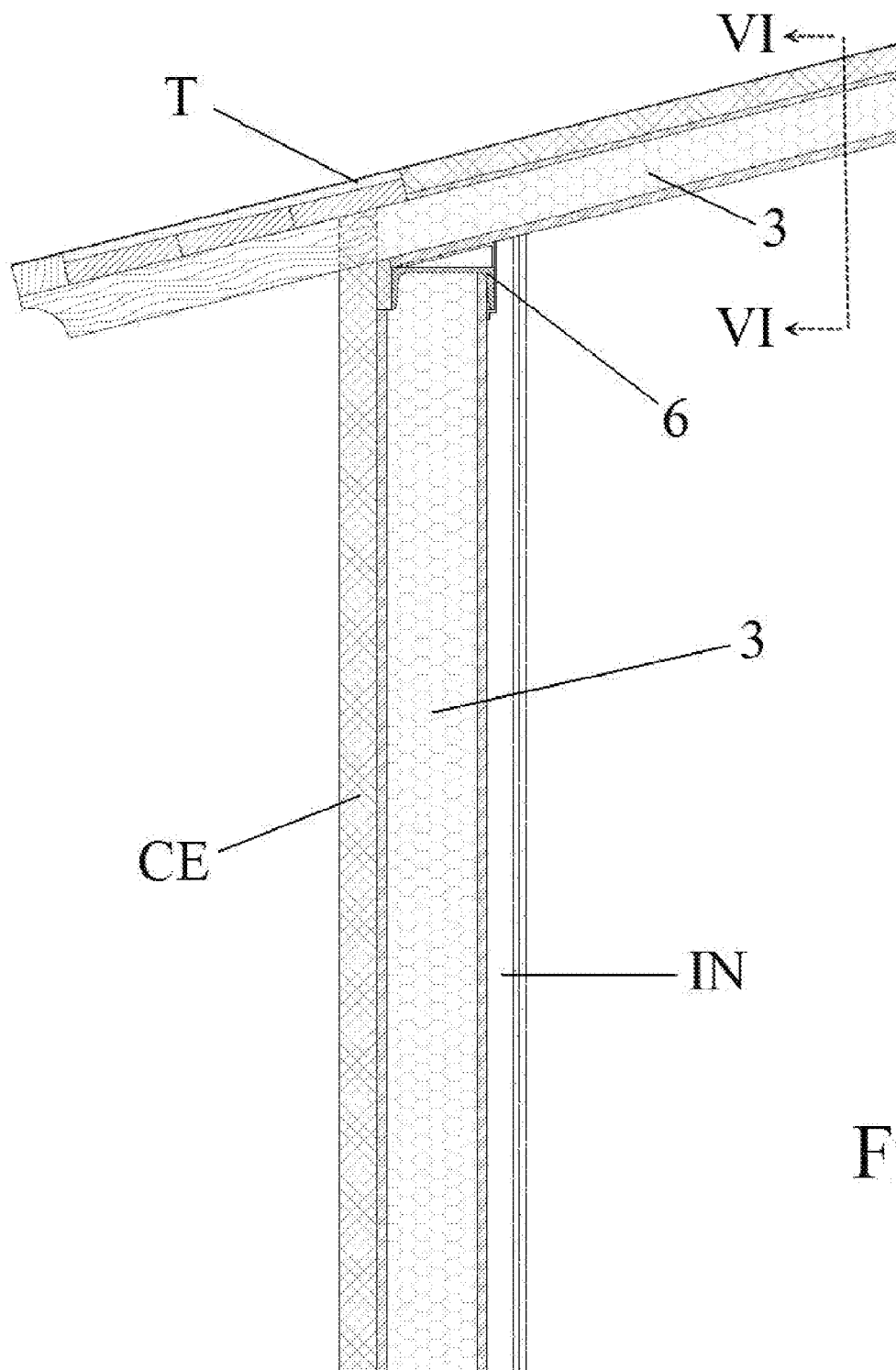


Fig. 5

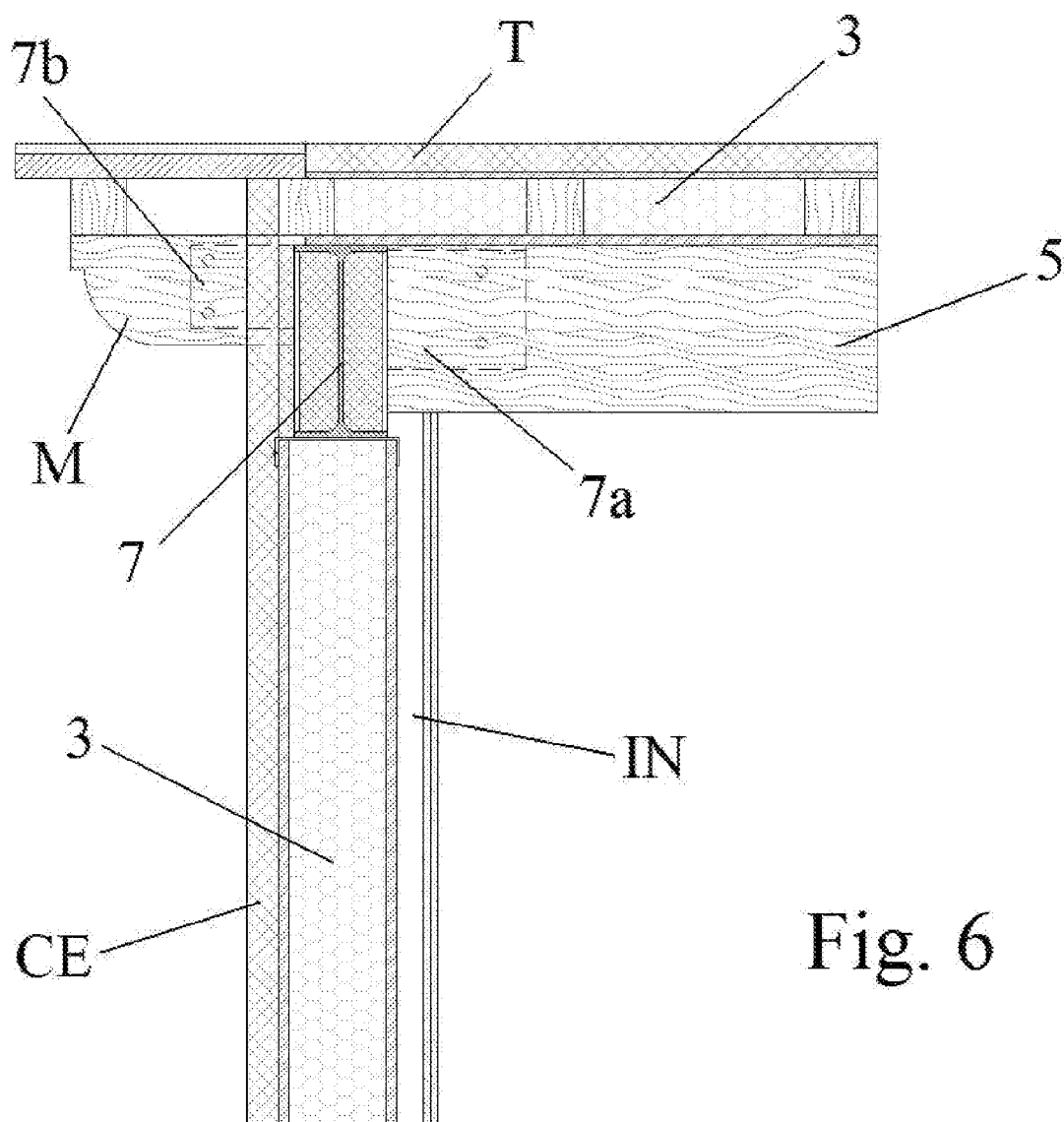


Fig. 6

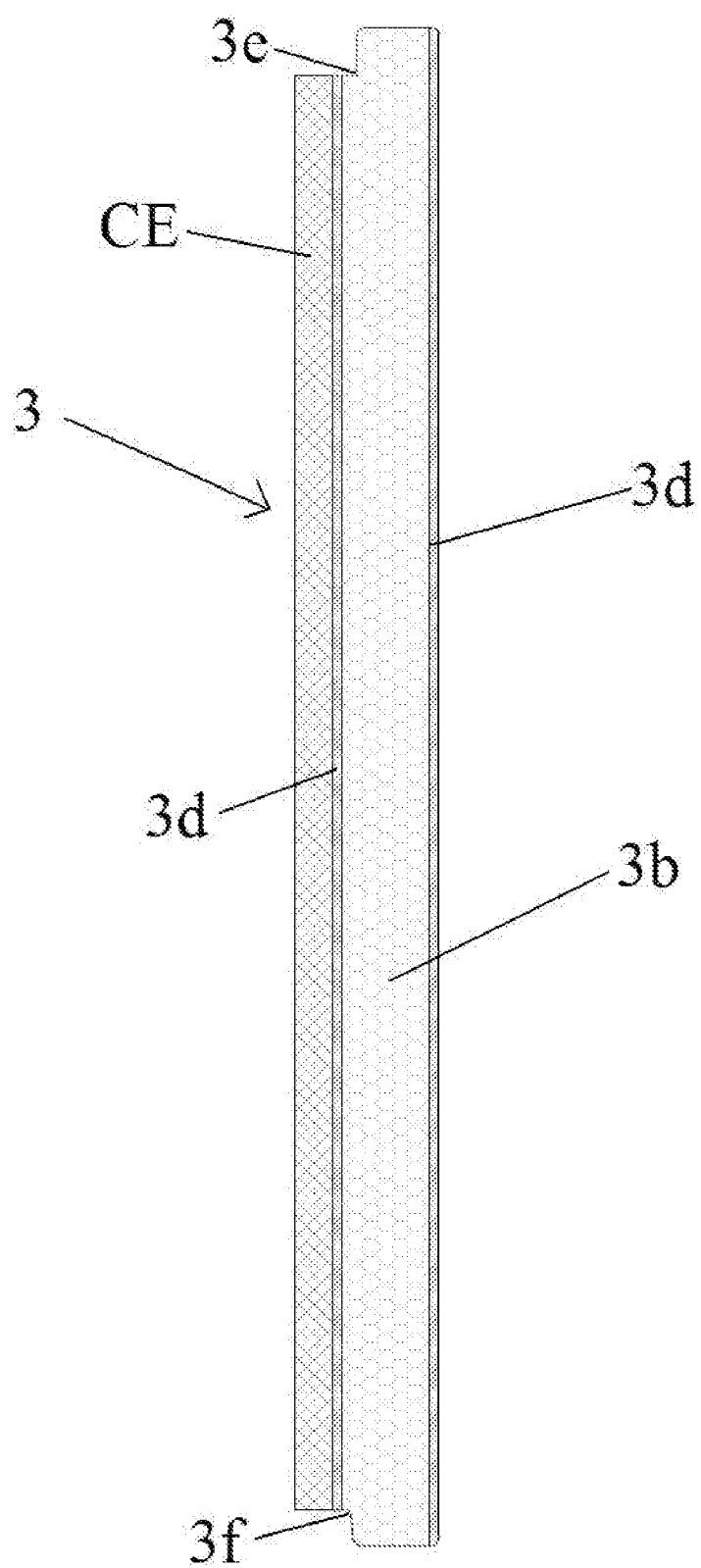


Fig. 7



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Application Number  
EP 11 15 6718

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Place of search Munich		Date of completion of the search 8 July 2011	Examiner Schnedler, Marlon
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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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