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(54) BUILDING UNIT AND METHOD OF CONSTRUCTING BUILDINGS THEREWITH

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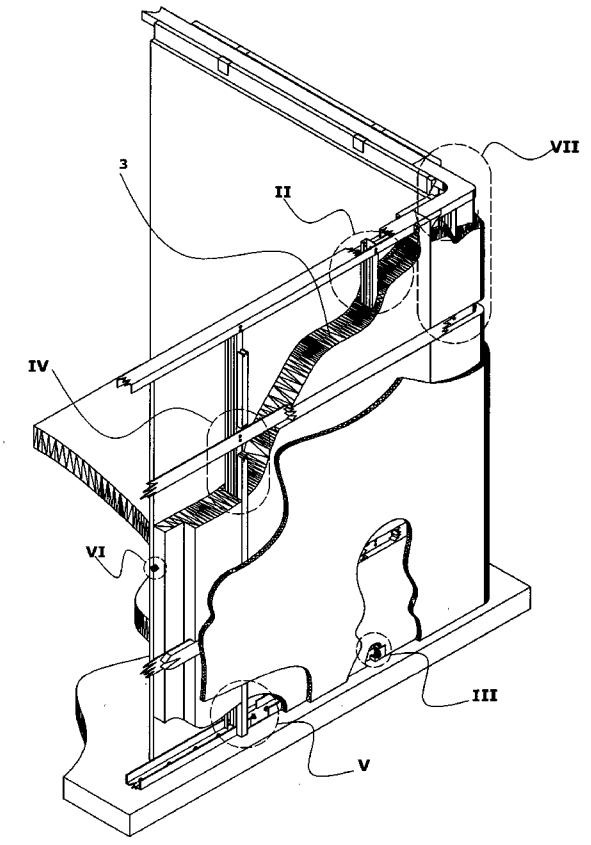
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(57) **ABSTRACT**

A building unit for constructing a wall, a ceiling, a floor, or a roof includes a metal rail, and insulating panel, and an elongated linear stud. The metal rail has a flat surface and at least one flange extending from the flat surface. The insulating panel has a front surface and a back surface bounded by opposing edges. It is made of rigid foamed plastic and it has at least one primary linear passageway extending through it between and perpendicular to two opposing edges. At least one of the opposing edges can be attached to the metal rail. The elongated linear stud has two ends that can be fixed to the rail. The stud fits into the primary linear passageway and is at least as long as the primary linear passageway. Another similar metal rail may be attached to the other end of the stud. The panel may include a second linear passageway that is at right angles to the primary linear passageway. A linear metal strap fits into the second linear passageway. The panel may also include a utility passageway that is supported by a pipe for carrying utilities. A corner post may be used to hold the rails and panels at right angles.



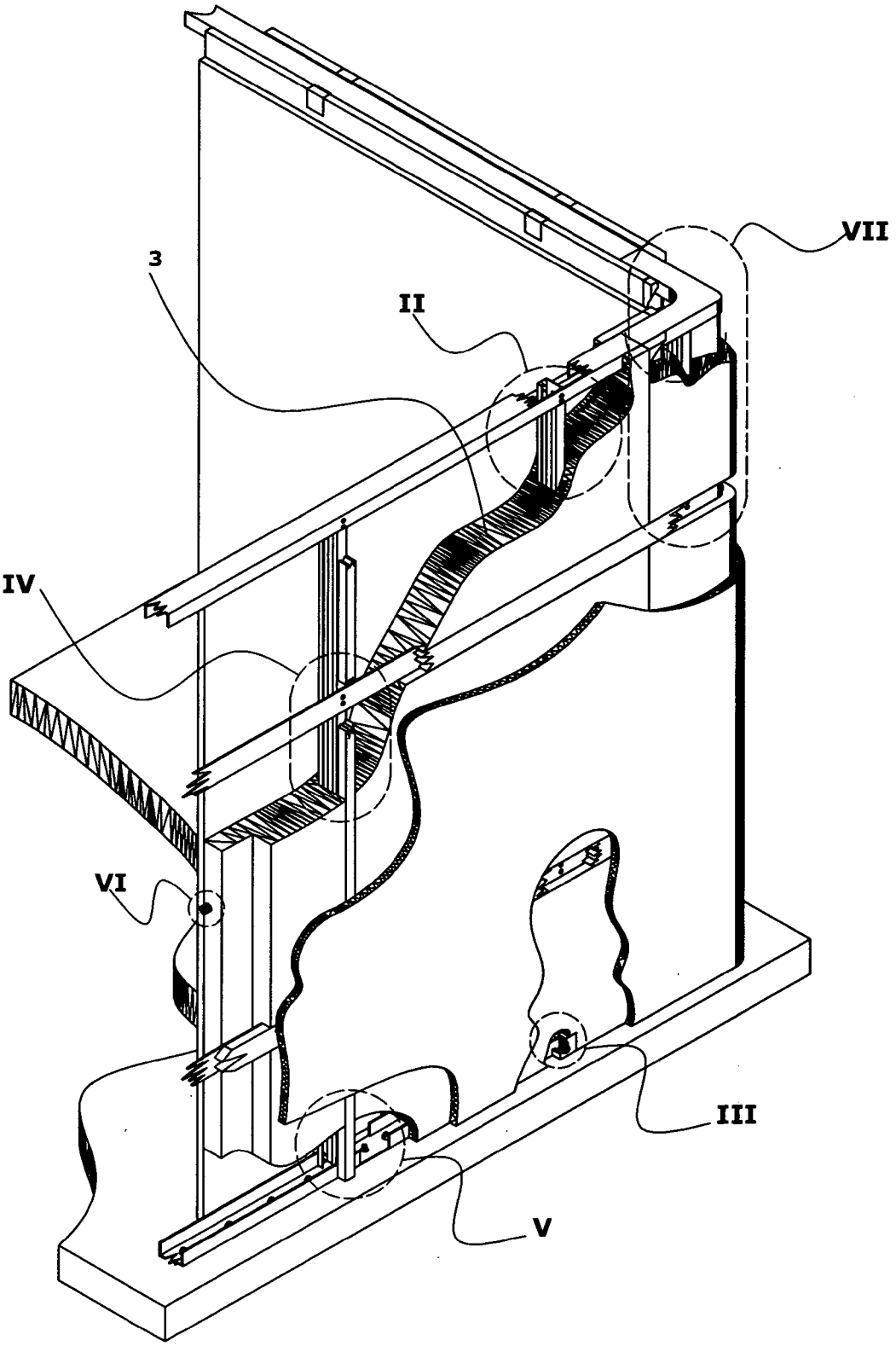


Fig. 1

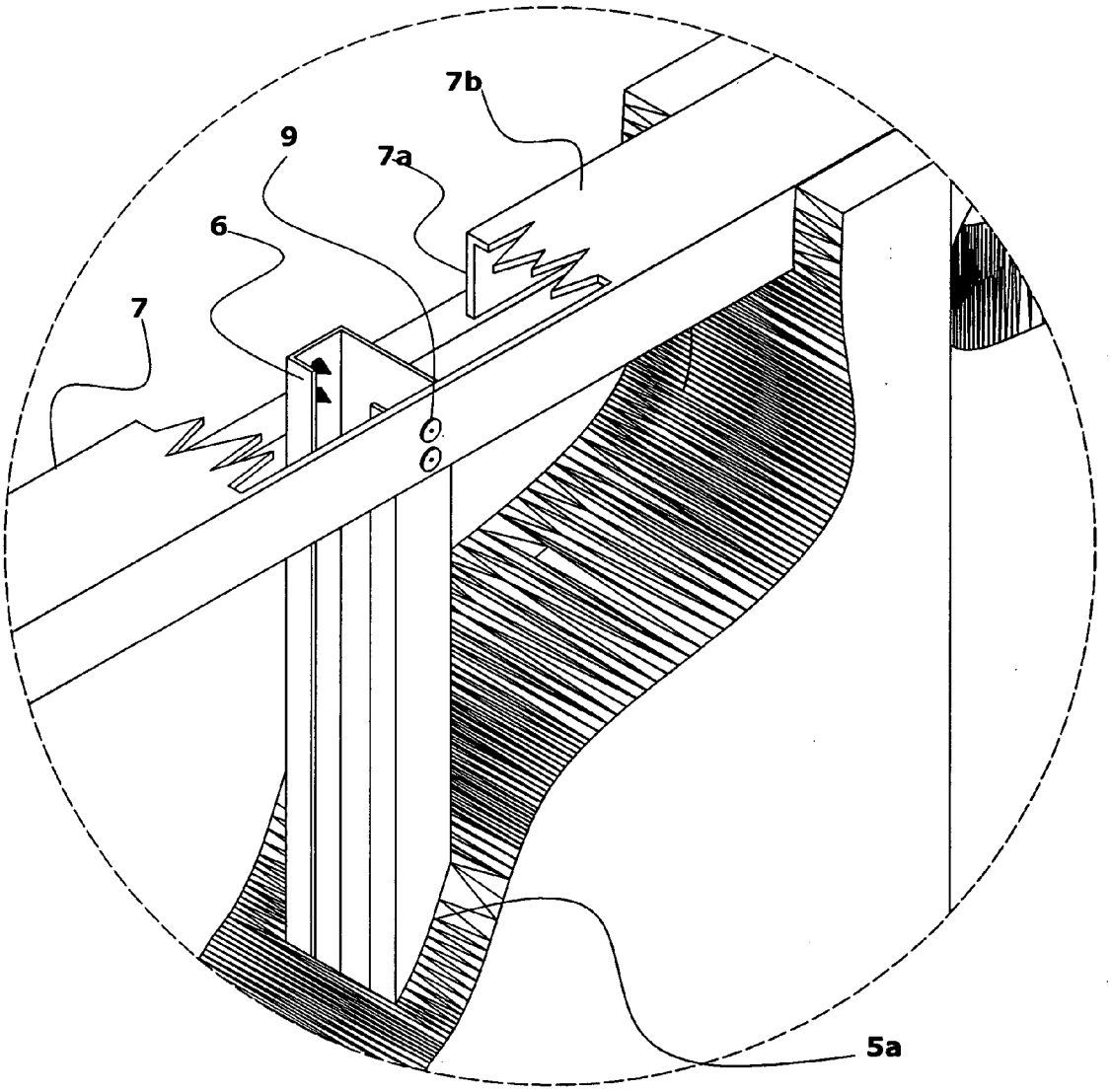


Fig. 2

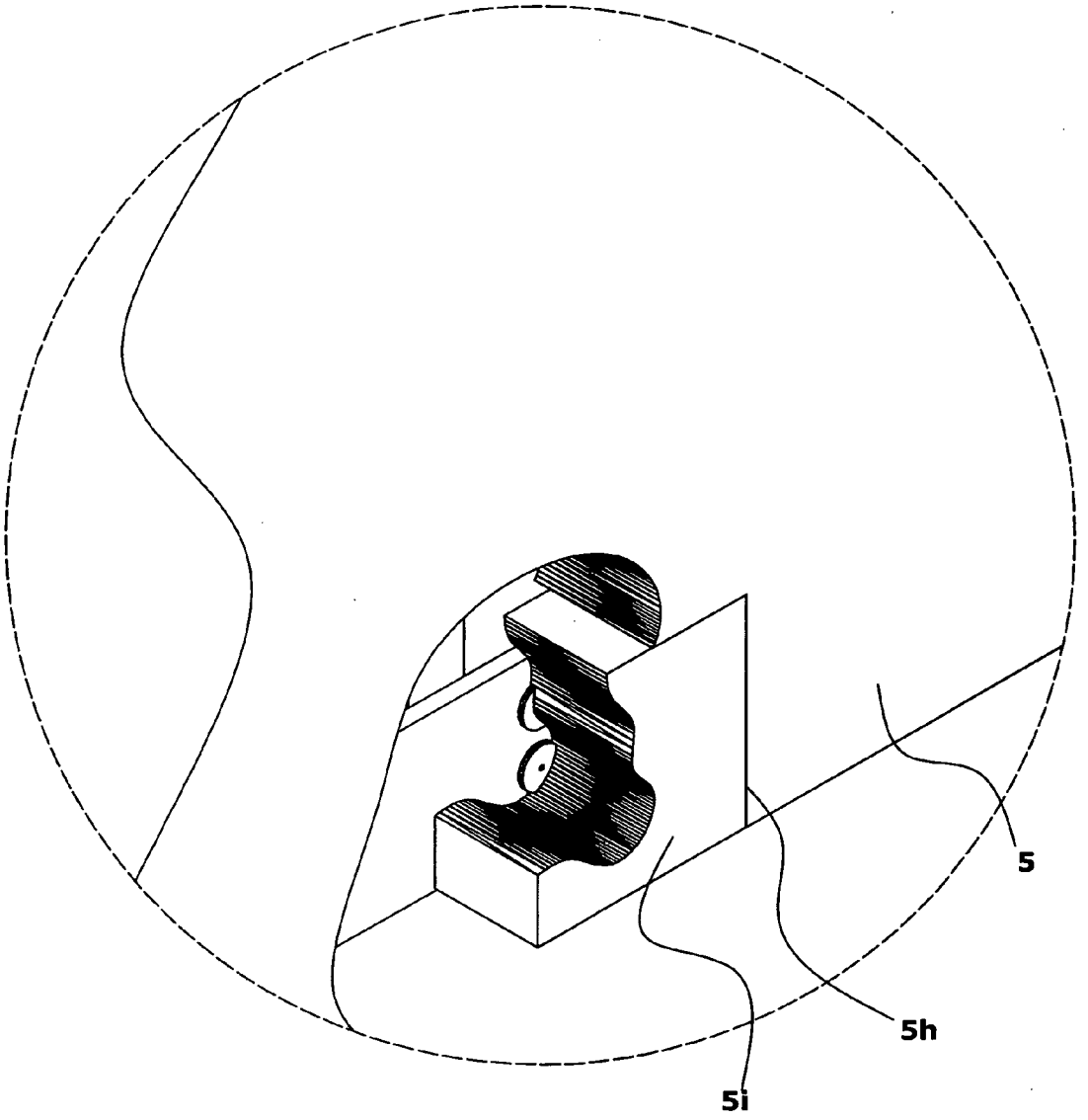


Fig. 3

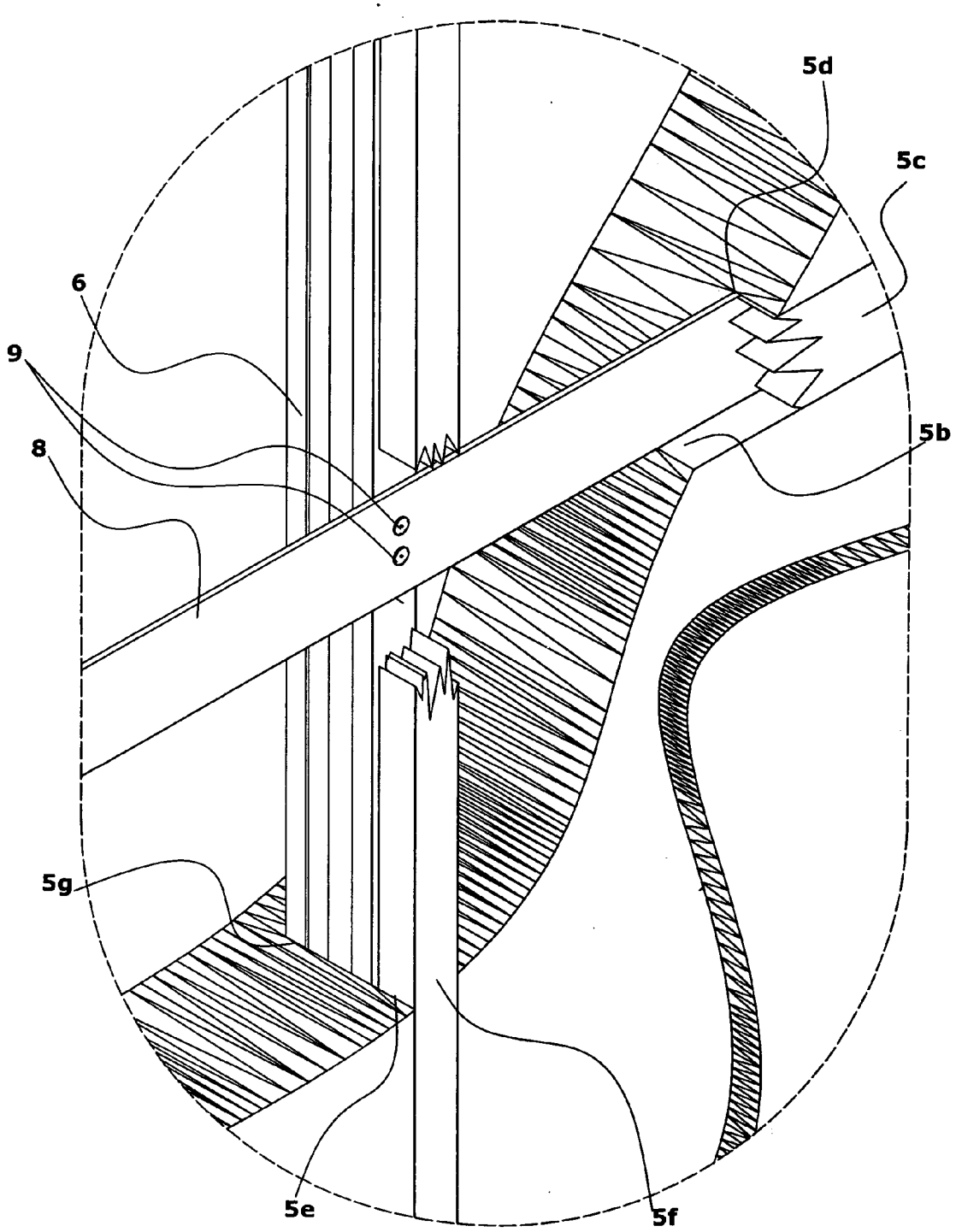


Fig.4

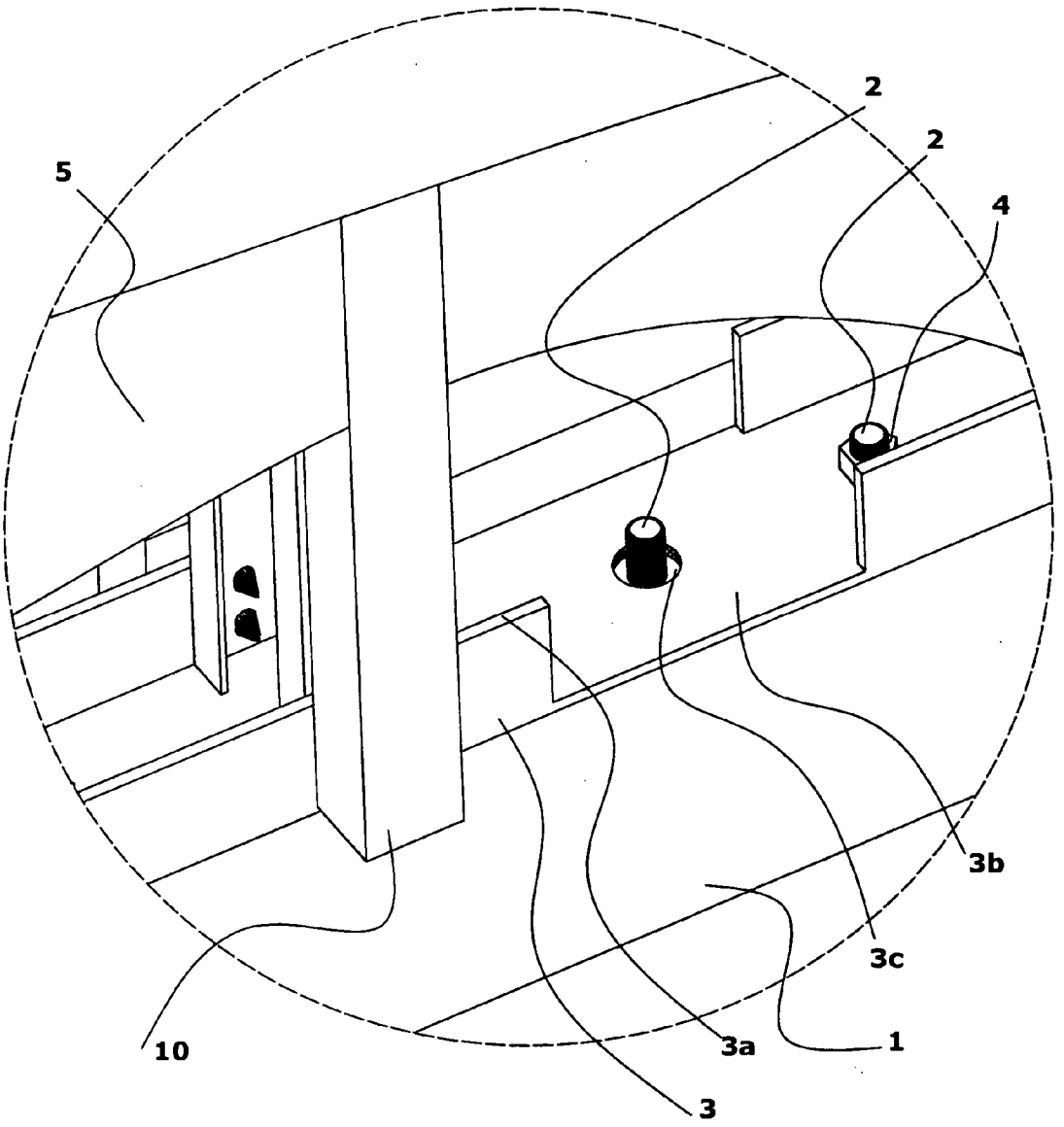


Fig. 5

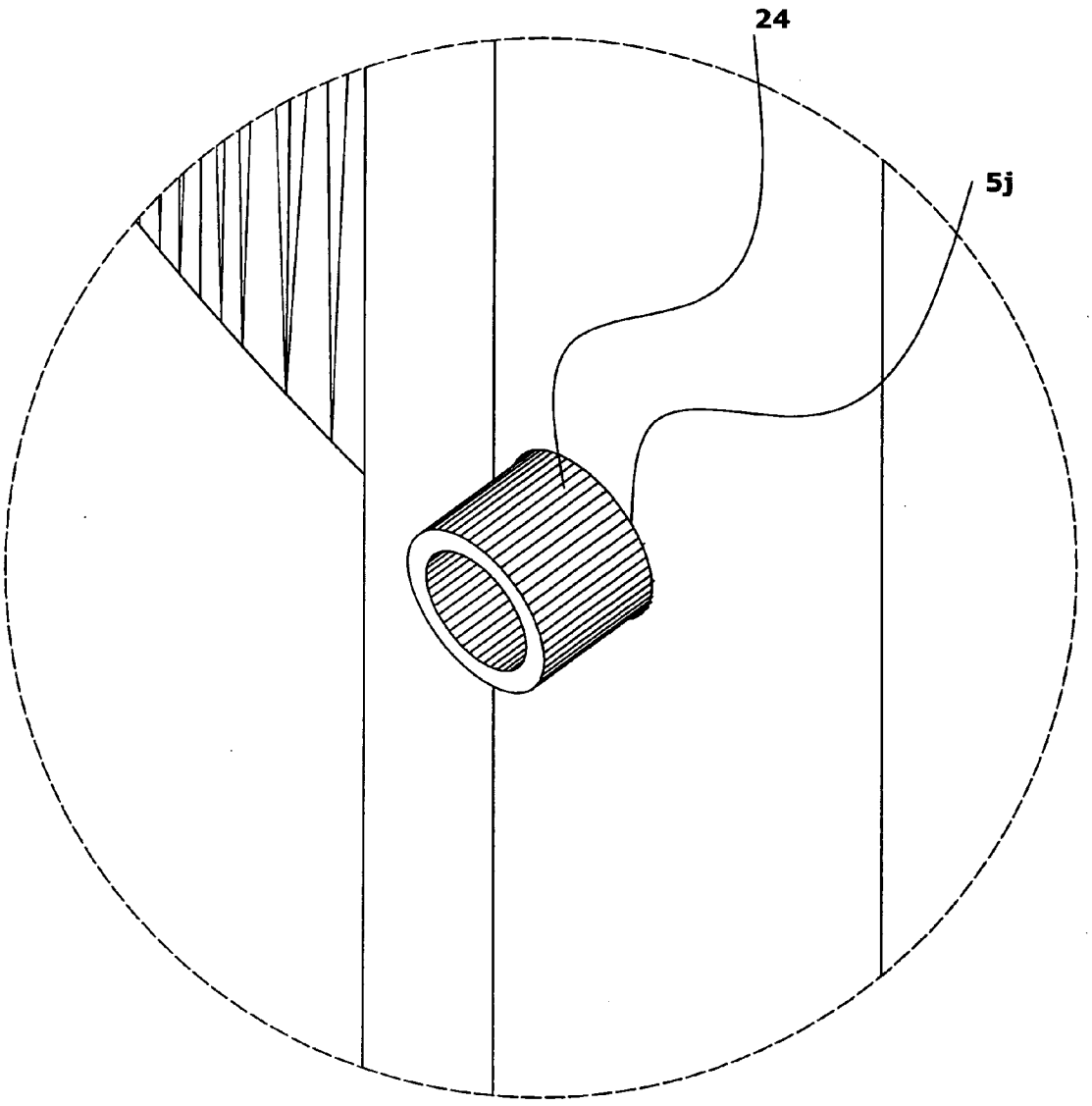


Fig.6

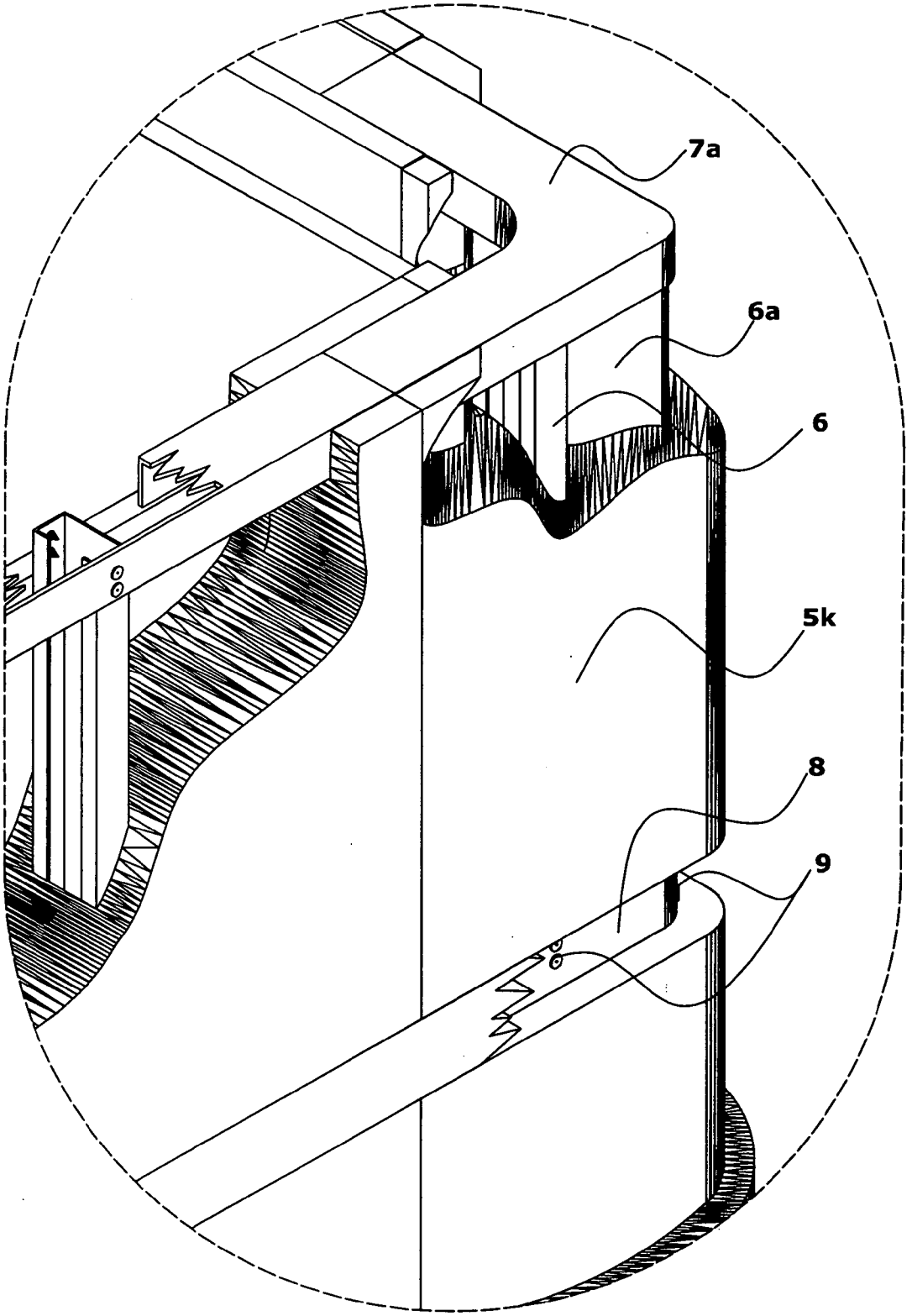


Fig.7

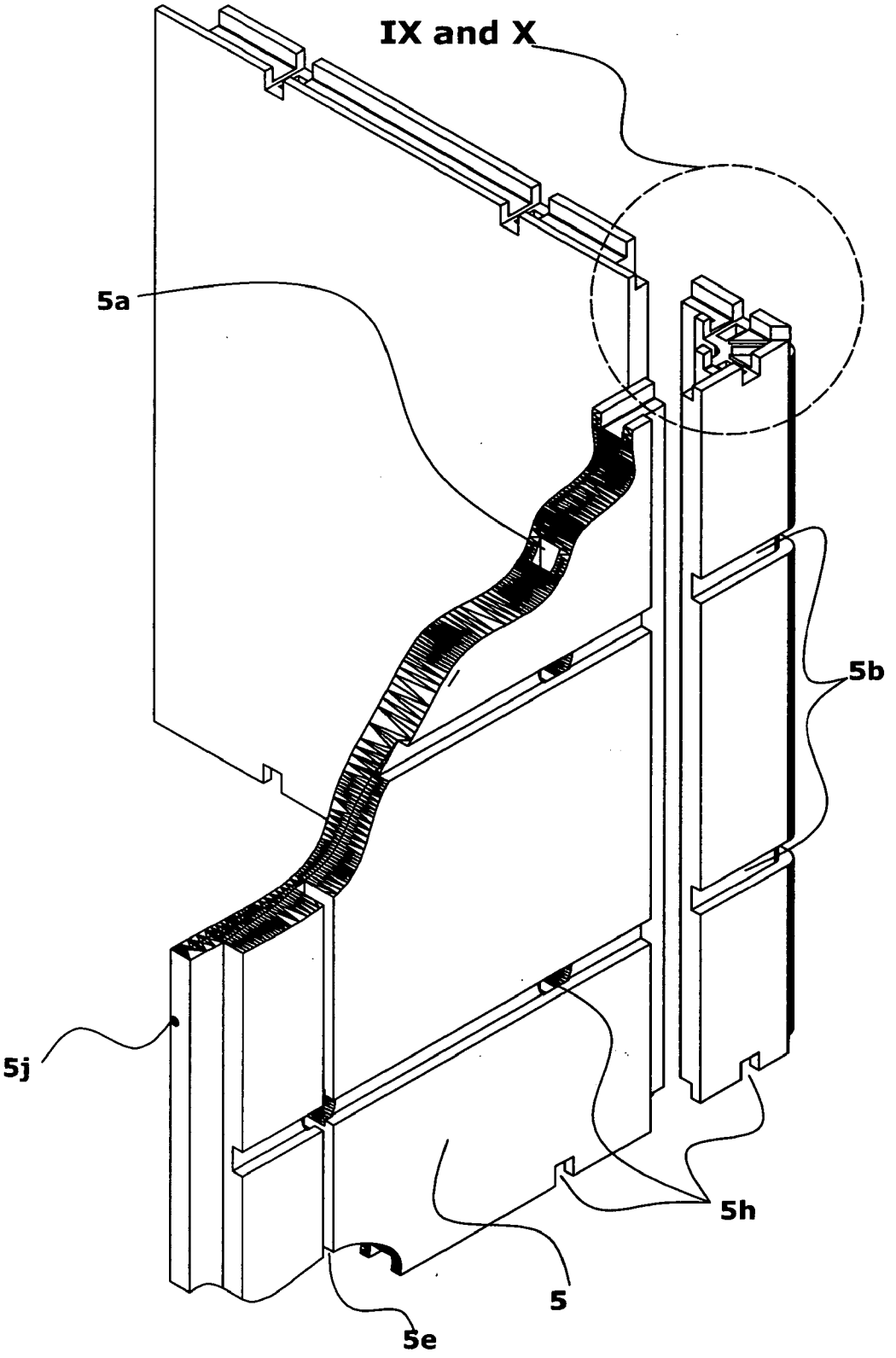


Fig. 8

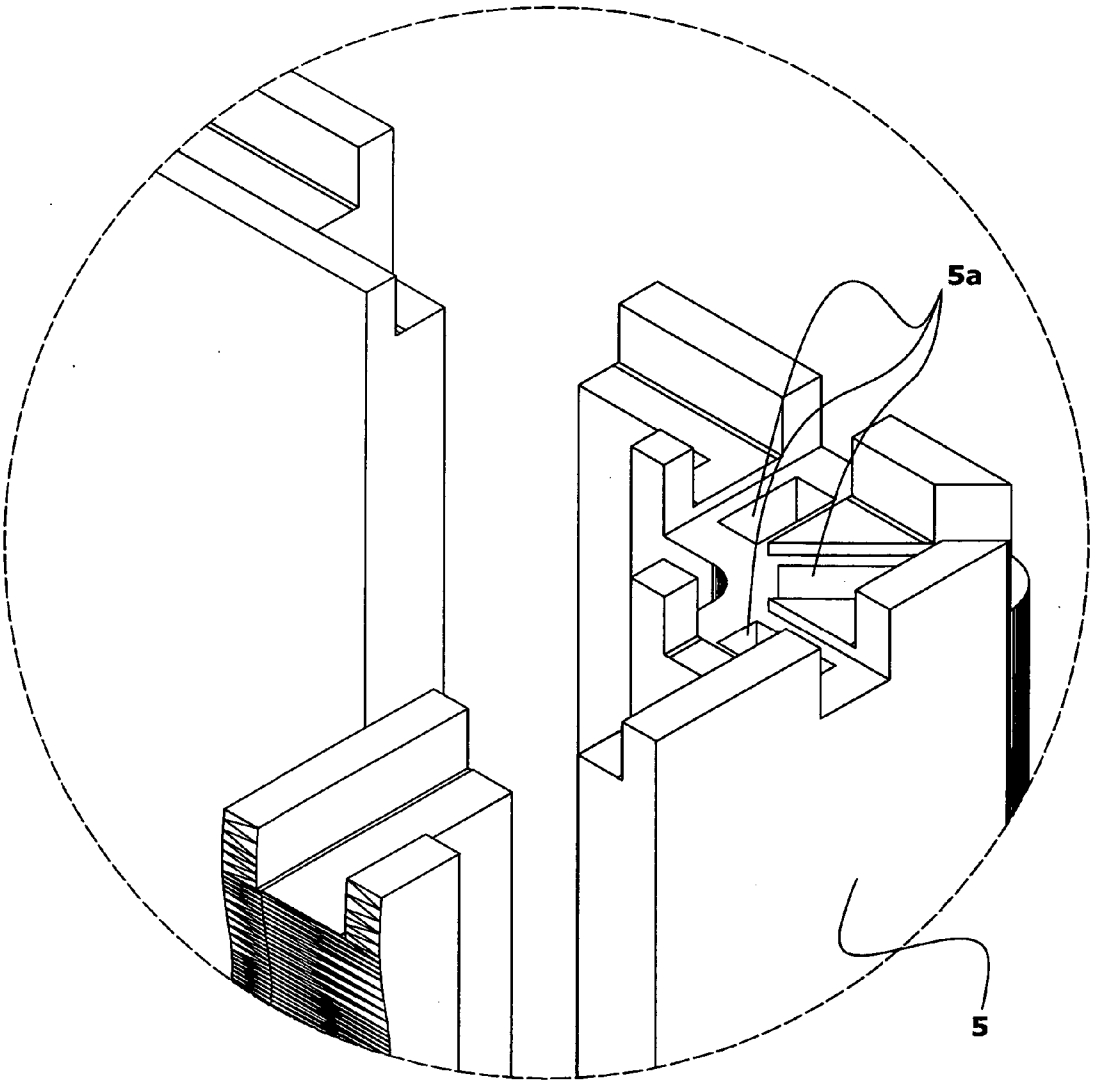


Fig.9

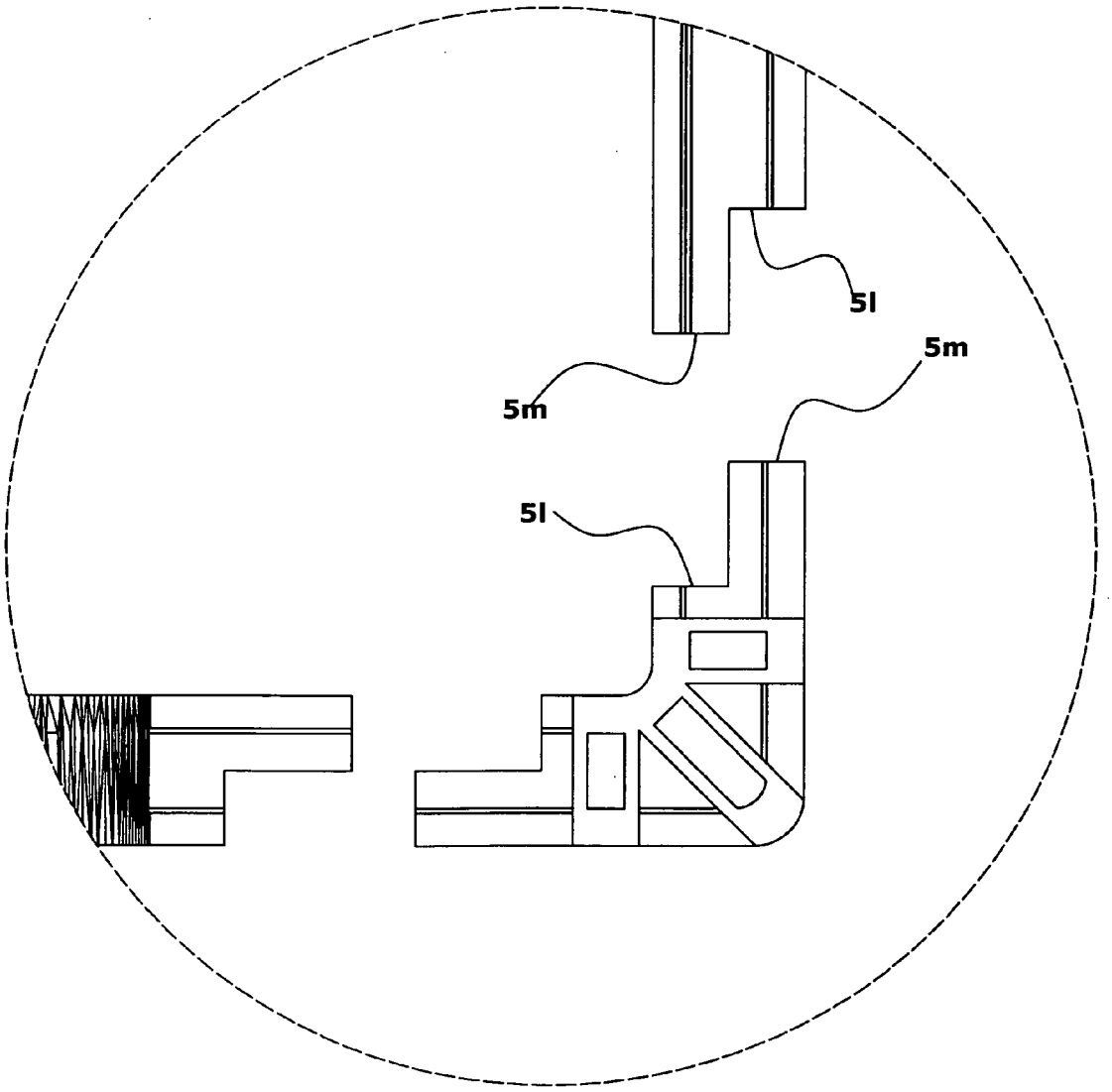


Fig. 10

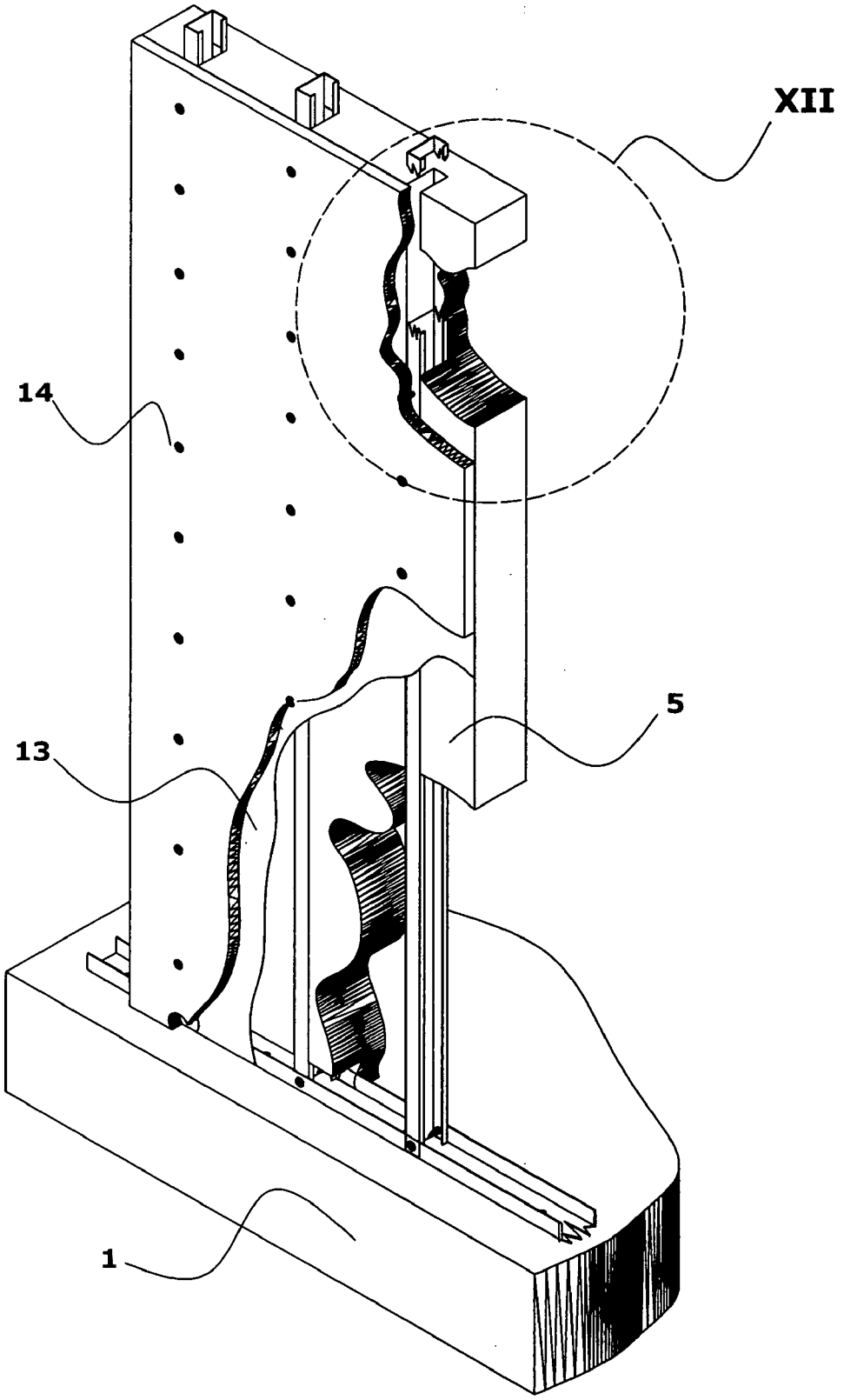


Fig. 11

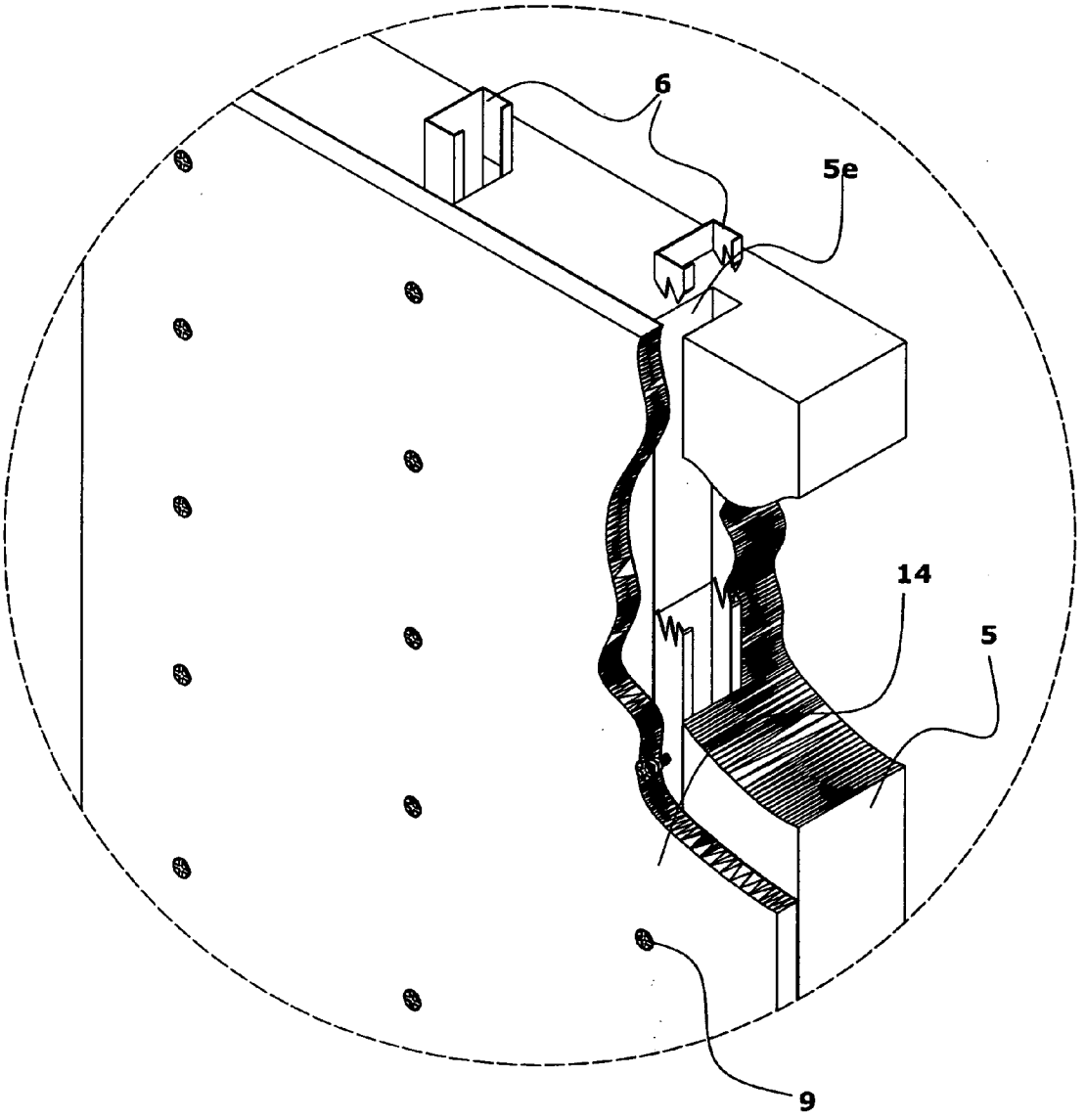


Fig.12

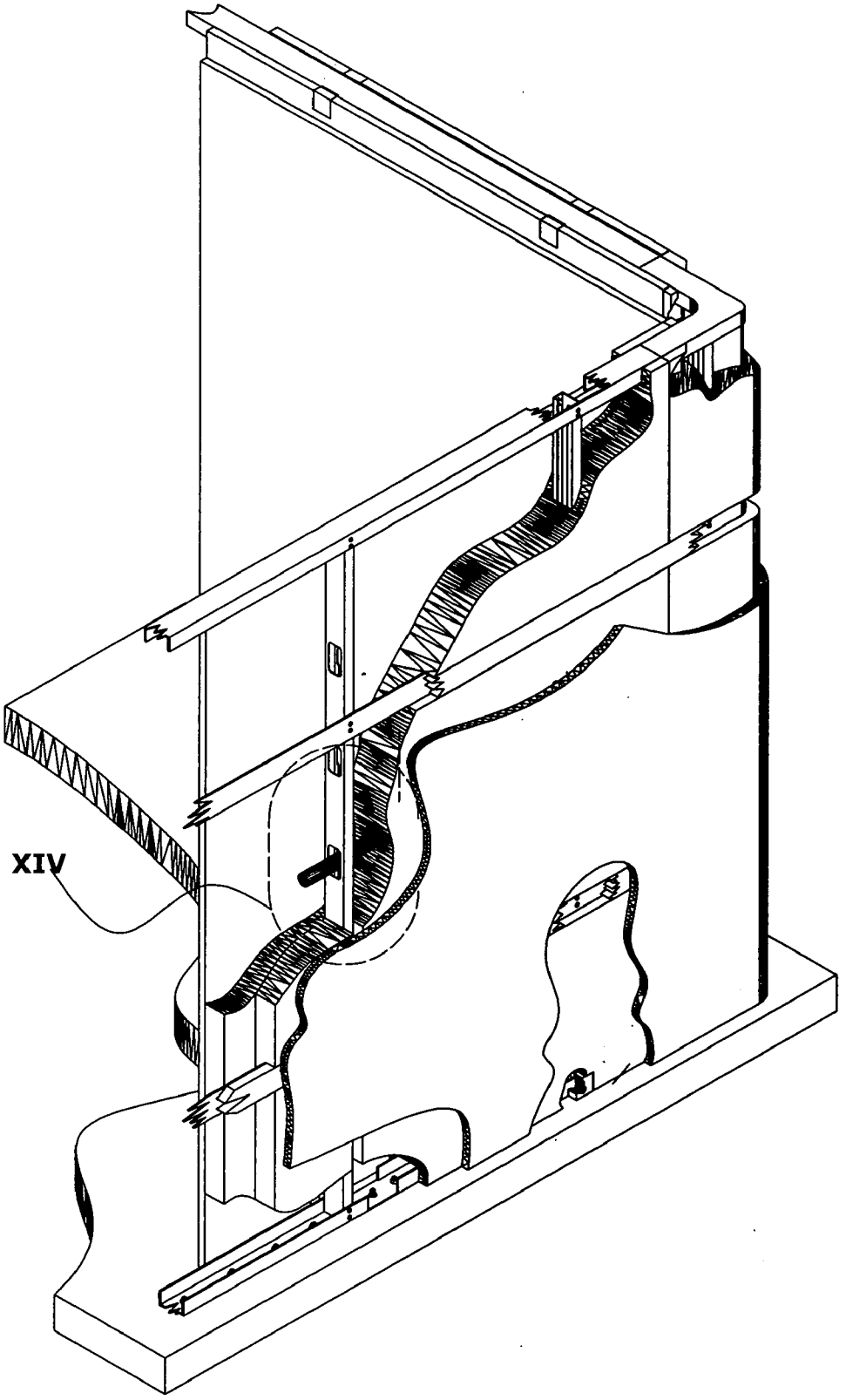


Fig. 13

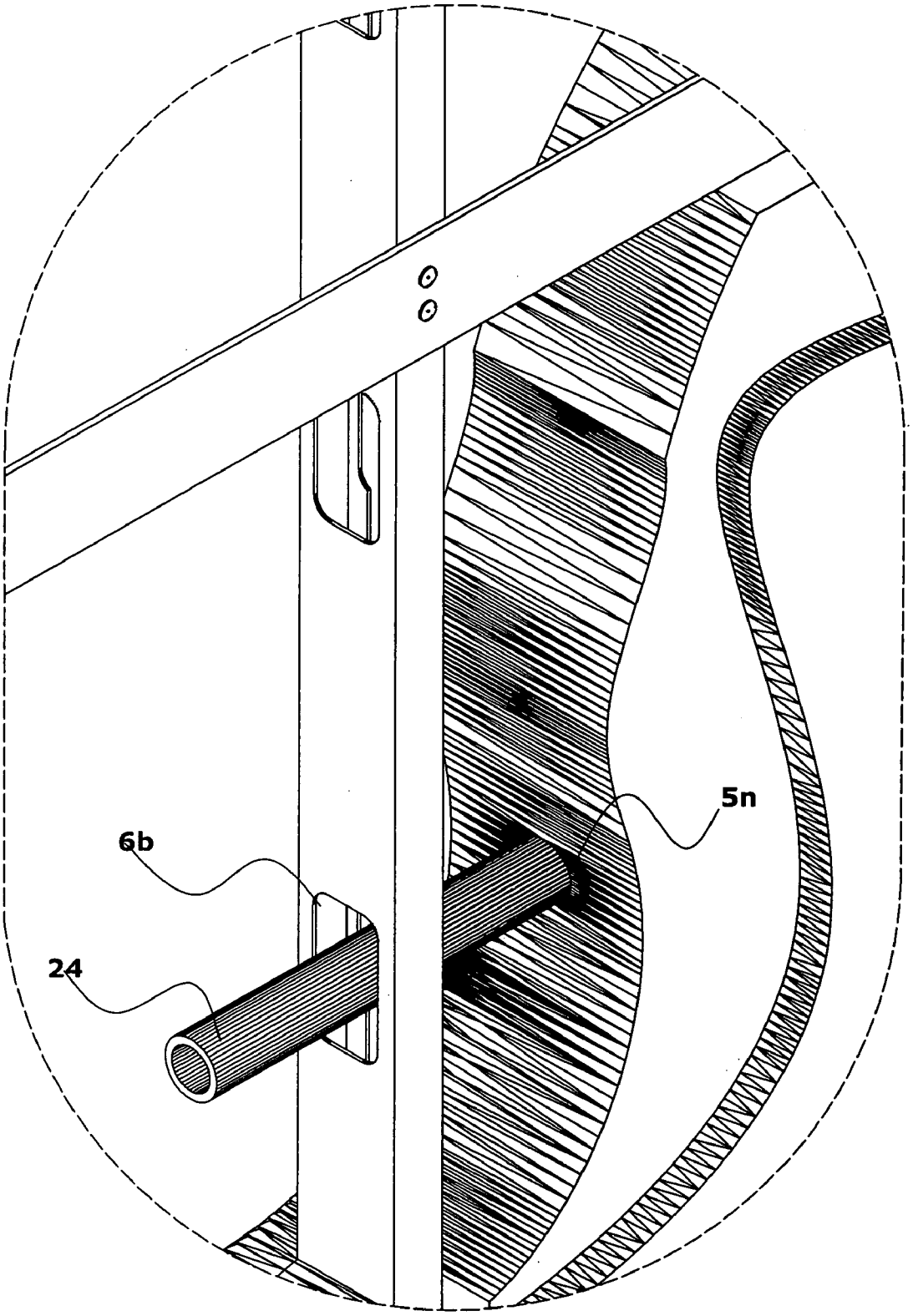


Fig.14

BUILDING UNIT AND METHOD OF CONSTRUCTING BUILDINGS THEREWITH

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from provisional applications No. 60/687,651, filed Jun. 6, 2005, No. 60/687,725, filed Jun. 6, 2005, No. 60/690,902, filed Jun. 16, 2005, No. 60/692,615, filed Jun. 22, 2005, and No. 60/699,348, filed Jul. 15, 2005.

BACKGROUND OF THE INVENTION

[0002] This invention is related to a building unit that includes a panel, a rail, and a stud and to a method of constructing buildings with it. In particular, it relates to an insulating panel having at least one passageway therethrough, where the panel is inserted into a rail and a stud is placed within the passageway.

[0003] A number of inventions have been made for the construction of steel frame buildings using pre-fabricated panels. Generally, a concrete slab is poured that has bolts imbedded in it. Rails are secured by nuts to the bolts and vertical steel studs are screwed to the rails. Another rail is screwed to the top of the studs. Rigid wall panels are then screwed to both sides of the studs and the surfaces are finished off. This process requires skilled workers and is very labor intensive. It is also not compatible with a cheap and simple method of insulating the wall.

SUMMARY OF THE INVENTION

[0004] In this invention, a special insulating panel of foamed plastic is used. The panel is provided with passageways, or channels for forming the passageways, and may also be provided with passageways supported by a tube for carrying utilities. The panels are placed in rails and studs are placed in the passageways, or in the channels that will form passageways, and the studs are attached to the rails. Finally, the wall is covered with a coating or a board to form the finished surface.

[0005] This invention requires no significant modifications to the steel frame designs now being used; most of the same blueprints and steel materials may be used. However, it is much less expensive as skilled workers are not needed and there is less labor involved. Unlike prior construction, in this invention an enclosure is insulated by the panels themselves, so no additional insulation, or work installing insulation, is required.

[0006] The panels also serve as a very accurate alignment tool for the placement of the studs and straps. Channels and passage ways machined on a rigid plastic foam panel may be as precise as ±0.5 mm, using high speed cutting machines. This accuracy makes it possible to build structures with the accuracy of a computer assisted drawing (CAD) design tool, which is practically impossible with any conventional technology available today. Though the term "passageway" is used extensively in the invention body, it is not necessary to have the studs and straps fully surrounded by plastic foam of the panel. The outer surface of the studs and straps may be level with the surface of the panel, then a coating or board may be applied over the panel and studs or straps, although it is not preferred.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] **FIG. 1** is an isometric view, partially cut away, of a certain presently preferred embodiment illustrating a wall building unit according to this invention.

[0008] **FIG. 2** is an enlarged view of the area "II" in **FIG. 1**.

[0009] **FIG. 3** is an enlarged view of the area "III" in **FIG. 1**.

[0010] **FIG. 4** is an enlarged view of the area "IV" in **FIG. 1**.

[0011] **FIG. 5** is an enlarged view of the area "V" in **FIG. 1**.

[0012] **FIG. 6** is an enlarged view of the area "VI" in **FIG. 1**.

[0013] **FIG. 7** is an enlarged view of the area "VII" in **FIG. 1**.

[0014] **FIG. 8** is an isometric view, partially cut away, of a certain presently preferred embodiment of a foamed plastic panels for a wall building unit.

[0015] **FIG. 9** is an enlarged view of area "IX" in **FIG. 8**.

[0016] **FIG. 10** is an enlarged top view of the area "X" in **FIG. 8**.

[0017] **FIG. 11** is an isometric view of another preferred embodiment illustrating a wall building unit according to this invention.

[0018] **FIG. 12** is an enlarged view of area "XII" in **FIG. 11**.

[0019] **FIG. 13** is an isometric view, partially cut away, of yet another certain presently preferred embodiment of a wall building unit according to this invention.

[0020] **FIG. 14** is an enlarged view of area "XIV" in **FIG. 13**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] In FIGS. **1** to **7**, a wall-forming building unit **1** according to this invention includes, inter alia, a base rail **3**, an insulating panel **5**, and a metal stud **6**. Base rail **3** (**FIG. 5**) has two flanges **3***a* that project perpendicularly from flat portion **3***b*. Flat portion **3***b* has a number of apertures **3***c* aligned with bolts **2** that are embedded in concrete foundation **1**. Nuts **4** secure base rail **3** to foundation **1** (**FIG. 5**). Top rail **7** (**FIG. 2**) may be similar to base rail **3**, having two flanges **7***a* projecting perpendicularly from flat portion **7***b*. Screws **9**, or other fasteners, secure studs **6** to base rail **3** and to top rail **7**.

[0022] **FIG. 1** illustrates both the use of passageways that are formed in manufacturing panel **5** and channels that are formed in panel **5**, then later (after joining the crossing steel members, using screws or other means) filled to form passageways. **FIG. 2** shows a vertical passageway **5***a*. into which has been inserted a stud **6**. **FIG. 4** shows a horizontal channel **5***b*. in which has been placed a horizontal metal strap **8**. Strap **8** is later covered with patch **5***c* of the panel material, or other suitable material, to form horizontal passageway **5***d*. Also in **FIG. 4**, stud **6** was placed in the

vertical channel **5***e* and another patch **10***a* was placed over it later to form vertical passageway **5***g*. Where the studs and straps intersect (**FIG. 4**) they are joined together by means of screws **9** or other means, such as bolts, rivets, welding or adhesive.

[**0023**] If passageways are formed in manufacturing panels **5**, instead of channels that are later made into passageways, there are apertures **5***h* in panels **5** at the intersection of the horizontal and vertical passageways (**FIG. 3**). After studs **4** and rails **3** and **7** have been joined together where they intersect, plugs **5***i*, that are preferably level with the surface of panel **5**, are inserted into apertures **5***h*.

[**0024**] Panel **5** may also have one or more horizontal and/or vertical passageways **5***j* that are lined with a tube **24** for holding utilities (**FIGS. 6, 13**, and **14**). Utilities may include hot or cold air, hot or cold water, gas, telephone, cable, electricity, etc. The utility passageways may pass beside studs **6** or may pass though openings **6***b* in studs **6** (**FIG. 14**).

[**0025**] Corner wall **5***k* (**FIG. 7**) may consist of a an L-shaped EPS panel into which one or more vertical studs **6** and **6***a* on which is attached an "L" shaped piece of rail **7***a* at the top and **3***a* at the bottom to which base rail **3** and top rail **7** may be attached. Horizontal straps **8** are attached to corner studs **6** and **6***a* by screws **9** or other means.

[**0026**] If two or more panels are juxtaposed between corner posts, one may be provided with protuberance **5***m* that fits into indentation **51** (**FIG. 10**) of the adjoining panel. The protuberances and the indentations they engage may have various designs, including a ridge in one panel that fits into a channel in the other panel, a column of knobs in one panel that fits into holes in the other panel.

[**0027**] A rigid board **14** such as cementitious board, fiber cement, gypsum, oriented strand board (OSB), foil isolative board, wood board, and plywood, or similar rigid skin material could be laminated using adhesive **13** on a rigid plastic foam **5**, with preformed channels **5***e* , on the surface to create passageways, where cold formed steel members maybe inserted later (**FIGS. 11 and 12**).

[**0028**] The Rail

[**0029**] The rail is an elongated metal piece. It is preferably made of steel for strength, but other metals, such as aluminum or metal alloys, could also be used. A rail may be of any length, but it is preferably at least as long as the edge of one of the panels it will support. For example, a rail may be about 0.5 to about 20 feet long and is preferably about 4 to about 10 feet long. Several rails may be used end-to-end to form a wall, floor, ceiling, or roof.

[**0030**] The rail performs the function of attaching the panel to a supporting structure of the building, such as to a foundation or to walls. To perform that function, the rail preferably has, in cross-section, a flat surface that can be attached to the flat surface of a foundation or wall and at least one flange extending perpendicularly from that flat surface to which the studs may be attached and also for supporting the panel. The flat surface is preferably provided with apertures that are aligned with bolts embedded in the concrete, or that are aligned with bolts in another supporting structure of the building, so that the rails may be easily attached to the supporting structure. While the rail may have, in cross-section, a "T" shape, or an "L" shape with a single flange extending from the flat surface, or another shape, it preferably has a "U" shape, as shown in the drawings, so that the studs are supported on both sides.

[**0031**] The rail, if made of steel, should have a thickness of the metal of about 0.002 to about 0.2 inches. Thinner rails may bend and thicker rails are more costly and usually unnecessary. The flat portion of the rail may be about 2 to about 10 inches wide and is preferably about 3 to about 6 inches wide. If a "U" shaped rail is used, the inside bottom of the "U" should be just wide enough so that the stud it will support fits snugly into the "U." The flanges are preferably provided with apertures into which may be inserted screws, bolts, rivets, or the like to hold the stud to the rail.

[**0032**] The same rails that are used for wall panels may be used for floor, ceiling, or roof panels, but they are mounted with their flanges extending horizontally or diagonally (for a roof or ceiling) instead of vertically. But if the floor, ceiling, or roof panels are sturdier than the wall panels, it may be necessary to use heavier or wider rails.

[**0033**] Studs and Straps

[**0034**] The studs are elongated, linear, and two dimensional in cross-section, so that they resist bending in two directions that are at right angles; they are preferably "C" shaped in cross-section, but may also have other shapes, such as "u," a square, a z , a rectangle, or "T" shaped. The straps, however, are preferably only one dimension in cross-section because two dimensional straps are not needed, though they may be used if desired, and they require additional space.

[**0035**] The studs may have any dimensions, but typically studs will be about 1 to about 20 feet long and about 3 to about 10 inches in width and about 1 to 2 inches in depth. C shaped studs are widely used which also has a flange which is between about 0.25 and about 2 inches wide. The metal may have a thickness of about 0.02 to about 0.2 inches. The straps may have a thickness of about 0.02 to about 0.2 inches and a width of about 1 to about 10 inches. Studs and straps that are commercially available may be used and it is not necessary to design special studs or straps.

[**0036**] The studs and straps are preferably made of metal, such as steel, aluminum, and metal alloys; steel is the preferred metal due to its strength. Other materials, such as wood, may also be used if desired. Studs and straps may be galvanized or painted for rust resistance.

[**0037**] The Corner Posts

[**0038**] The corner posts may be constructed in a variety of ways. Each corner post preferably includes (1) one or more studs for support, (2) an "L" shaped piece of rail mounted perpendicularly to the stud at the top and bottom of the stud, to which the top and bottom rails may be attached, and (3) two rails parallel to the stud and perpendicular to each other to which the metal straps may be attached. In another embodiment, the "L" shaped piece of rail and the rails parallel to the stud may be omitted and the straps and top and bottom rails may be attached directly to the stud.

[**0039**] The Panels

[**0040**] The panels are made from a rigid foamed plastic and, as such, they are heat-insulating, and are usually

electrically insulating as well. Preferably, they are also fire-retardant or fire-resistant; that is, while they may burn at a high enough temperature, they preferably will not spread the flames. This may be accomplished by the addition of flame retardants to the plastic and/or by using a non-flammable gas, such as carbon dioxide, to expand the foam. Examples of plastics that may be used include polystyrene, polyurethane and soy based foams. The preferred plastic is polystyrene, because it is cheap, structurally strong and highly isolative. Particularly useful products are expanded polystyrene ("EPS") and extruded polystyrene ("XPS") which are sold commercially by Owens Corning, Tremco, Dryvit, 3M, and other companies.

[0041] The thickness of the panel will depend upon the amount of insulation that is desired and other factors, such as the size of the studs. As an example, the panels may be about 6 to about 18 inches thick, and a thickness of about 3 to about 24 inches is preferred. The panels are thicker than the studs plus the straps so that the studs and straps are completely enclosed within the thickness of the panels. The panels will normally be thicker than the rails and will have grooves that the flange(s) of the rails fit into so that they cover the rails, as shown in the drawings. Preferably, the panels are also thick enough to completely enclose any utility pipes.

[0042] The panels will normally be rectangular, as that makes for the easiest construction, but other shapes may be used for special designs. The width and length of a rectangular panel will also depend upon design requirements, but panels that are about 1 to about 12 feet wide and about ½ to about 20 feet long may be used; a width of about 0.5 feet to about 10 feet and a length of about 0.5 to about 9 feet are preferred.

[0043] Each panel is provided with at least one primary linear passageway, or channel for forming a primary passageway, into which will be placed a stud. Since the studs are linear (i.e., straight) and will be attached to rails at opposite ends of the panel, the passageways for the studs must have a size and shape that the studs will fit into, must be linear, and must extend all the way through the panel, from one end to the other, except in locations such as windows and doors. Normally, the passageways will be perpendicular to two opposing ends of a rectangular panel. If the panel is to be used as a wall panel, the width of the panel will normally be greater than the distance between two studs, and therefore a panel will usually have at least one vertical passageways It may have, for example, 1 to 10 vertical passageways. These vertical passageways may be any distance apart (less than the width of the panel, of course), but are preferably centered about 5 to about 20 inches apart as vertical studs are commonly on 16" centers.

[0044] The panels may also be provided with one or more secondary linear passageways, or channels for forming secondary passageways, that are perpendicular to the above-described primary passageways. For a wall panel, for example, there may be secondary passageways for holding straps as well as vertical primary passageways for holding studs, as shown in the drawings. Usually, the secondary passageways in a wall panel will be horizontal, but they may also be diagonal if desired. Where the two passageways cross, there may be an opening in the panel that extends to one or both surfaces of the panel so that stud and strap within the passageways can be joined together at that intersection. If a panel has both primary and secondary passageways, there will normally be more primary passageways than secondary passageways. Also, the primary and secondary passageways will not both be centered within the panel, but will be off-set (as shown in the drawings), so that when the studs placed in the primary passageways they pass by the straps placed in the secondary passageways.

[0045] The panels may further have one or more utility passageways for carrying various utilities. The utility passageways are lined with a tube, which may be plastic, metal, or other materials, depending upon what is carried within the tube. Utility passageways may be molded or machined into the panels when they are manufactured and may be provided with connectors at the ends so that they can be connected to the utility passageways of adjoining panels.

[0046] The passageways may be formed either by molding them into the panel when it is made or by machining a channel open to one surface into the panel when it is made, then covering the channel with a patch after a stud or strap has been placed in it. The latter is preferred as it is easier to manufacture a panel with channels than with passageways.

[0047] Assembling the Building

[0048] The building is assembled using the building units of this invention by first attaching the rails to a support. For the lowest floor, the support is usually the foundation, which has bolts embedded in it. The rails are provided with holes that line up with the bolts. They are placed over the bolts and nuts are screwed onto the bolts. The support could also be a higher floor or something that is not a foundation, such as a wall. If floor, ceiling, or roof panels are to be installed, the rails and corner posts are attached to a support in the same way, but horizontally around the building.

[0049] The panels are then placed in and/or over the channels of the rails and are temporarily held in place, if necessary, by means of an adhesive or mechanical clamping. Once the panels are in place, the studs and straps are placed within the passageways or channels and are secured to the rails and corner posts and to each other by screws, bolts, rivets, or other means. If desired, or if channels are used instead of passageways formed during manufacturing, the studs and straps may be inserted into the passageways after the panels have been mounted on the rails.

[0050] A glue or filler may be used to fill any space between the passageways and the studs and/or straps to ensure a tight fit and prevent movement of the panels. The surface of the studs may be coated with some expandable adhesive such as a moisture sensitive adhesive. The walls of the passageways in the panels may be pre-moisturized. When adhesive-coated studs are inserted, the adhesive may expand and create a tight contact between studs and straps and the plastic foam. An example of such an adhesive is "Gorilla" adhesive, which is sold almost in most hardware stores. Patches are then installed in the top of the channels and patches are installed at the intersections of the studs and straps.

[0051] Finally, a board is attached over the panels by adhesive or other means or the panels are coated by spraying polymer modified cement, preferably with the addition of some glass or metal fiber mesh for increased impact resis-

tance. The outermost surface then could be painted or decorated with decorative features such as bricks, stones, or tiles.

What is claimed is:

1. A building unit for a wall, ceiling, floor, or roof comprising

(A) a metal rail having a flat surface and at least one flange extending from said flat surface;

(B) an insulating panel having a front surface and a back surface bounded by opposing edges, made of rigid foamed plastic and having at least one primary linear passageway extending therethrough between and perpendicular to two opposing edges, where at least one of said opposing edges is attachable to said metal rail; and

(C) an elongated linear stud having two ends, where said stud fits into said primary linear passageway, is at least as long as said primary linear passageway, and one end of which can be fixed to said rail.

2. A building unit according to claim 1 wherein said panel is formed with at least one linear channel open to said front surface that extends between two opposing edges, including a patch placed within the outermost portion of said channel, thereby forming said passageway therebeneath.

3. A building unit according to claim 1 including a coating over said facing surface.

4. A building unit according to claim 3 wherein said coating is a polymer-modified cement containing a mesh support.

5. A building unit according to claim 1 wherein a rigid board is attached over at least one surface of said panel.

6. A building unit according to claim 5 wherein said rigid board is selected from the group consisting of cementitious board, fiber cement, gypsum, oriented strand board, foil isolative board, wood board, and plywood

7. A building unit according to claim 1 including a second metal rail having a flat surface and at least one flange extending from said flat surface, where the other end of said stud can be fixed to said second metal rail.

8. A building panel according to claim 1 wherein said foamed plastic is polystyrene.

9. A building unit according to claim 1 including an additional panel, where one of said panels has an edge that has an indention and the other of said panels has an edge that has a protuberance that is insertable into said indentation.

10. A building unit according to claim 1 wherein said panel has at least one passageway that extends between opposing edges that is supported by a tube.

11. A building unit according to claim 1 including at least one secondary linear passageway that intersects at right angles at least one primary linear passageway, where said panel has an opening to a surface for access to the intersection of said primary linear passageway and said secondary linear passageway.

12. A building unit according to claim 11, including an elongated linear metal strap that fits within said secondary linear passageway and is at least as long as said secondary linear passageway.

13. A building unit according to claim 1 including a corner post to which two of said panels at right angles and two of said metal rails at right angles are attachable.

14. A building unit according to claim 13 wherein said corner post has an "L" shaped piece of rail mounted perpendicularly to said corner post at the top and bottom thereof, to which top and bottom rails may be attached, and two rails parallel to said post and perpendicular to each other, to which metal straps may be attached.

15. A method of constructing a wall, ceiling, floor, or roof using a building unit according to claim 1 comprising

(A) securing said metal rail to a support for said building;

(B) attaching an edge said panel to said metal rail;

(C) placing said stud within said passageway; and

(D) attaching said stud to said metal rail.

16. A method according to claim 15 wherein said support is the foundation of said building.

17. A building unit for making a wall comprising

(A) a base linear metal rail and a top linear metal rail, each having a flat surface and two flanges that extend from said flat surface;

(B) at least two rectangular rigid foamed plastic insulating panels, each having

(1) a front surface and a back surface bounded by left and right vertical edges and by top and bottom horizontal edges, where a left vertical edge of one of said panels has at least one indentation and a right vertical edge of the other of said panels has at least one protuberance that fits into said indentation, and where said bottom horizontal edge of said panels is attachable to said base linear metal rail and said top horizontal edge of said panels is attachable to said top linear metal rail;

(2) at least one vertical linear passageway that extends through said panel from one horizontal edge to the other; and

(3) at least one horizontal linear passageway that extends through said panel from one vertical edge to the other vertical edge, where the horizontal linear passageways of said at least two panels are aligned;

(C) an elongated linear metal strap that fits into and extends through a horizontal linear passageway;

(E) an elongated linear metal stud that fits into and extends through a vertical linear passageway and is attachable to said base linear metal rail and to said top linear metal rail, whereby said metal stud intersects said metal strap;

(F) means for attaching said metal stud to said metal strap where they intersect; and

(G) a covering for each surface of said panel.

18. A building panel according to claim 17 wherein said covering is a board that is adhesively attached to a surface of said panel.

19. A building panel according to claim 17 wherein said covering is a coating of a polymer-modified cement containing a mesh support.

20. A building unit for making a wall comprising

(A) two base linear metal rails and two top linear metal rails, each having a flat surface and two flanges that extend from said flat surface;

(B) two rectangular insulating panels made of rigid foamed plastic each having

(1) a front surface and a back surface bounded by left and right vertical edges and by top and bottom horizontal edges, where the bottom horizontal edge of said panels is attachable to said base linear metal rail and the top horizontal edge of said panels is attachable to said top linear metal rail;

(2) at least one vertical linear passageway that extends through said panel from said bottom horizontal edge to said top horizontal edge; and

(3) at least one horizontal linear passageway that extends through said panel from said left vertical edge to said right vertical edge, where said horizontal linear passageways of said at least two panels are aligned;

(C) a vertical corner post having means for attaching at right angles

(1) said two base rails;

(2) said two top rails;

(3) the right edge of one panel; and

(4) the left edge of the other panel;

(D) an elongated linear metal strap that fits into and extends through a horizontal linear passageway;

(E) an elongated linear metal stud that fits into and extends through a vertical linear passageway and is attachable to said base linear metal rail and to said top linear metal rail, whereby said metal stud intersects said metal strap;

(F) means for attaching said metal stud to said metal strap where they intersect; and

(G) a covering for each surface of said panel.

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