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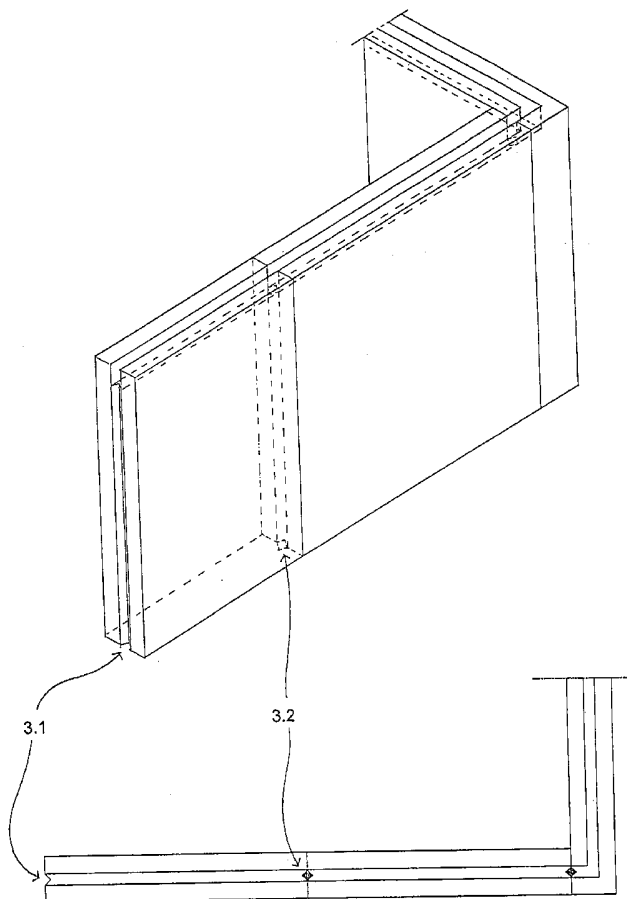
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[Continued on next page]

(54) Title: FULL WALL ELEMENT OF CEMENT STABILISED WOOD WOOL



(57) Abstract: Construction elements for walls comprising cement-bound wood wool with chases arranged in the upper edge and along the sides. The construction elements are manufactured of a mixture of wood wool and cement with a weight ratio between wood wool and cement of 1:1.88 and 1:1.92, which is cast in steel moulds. The finished elements have a density of 200-300 kg/m³. A construction system for small buildings comprises the above-described construction elements, which are laterally joined with vertical, concrete columns moulded on site as well as a horizontal ring beam which is cast on site in the upper edge of the element. The elements are placed on the bedding with aid of a guiding rail made by perforated plate and are attached using plaster. The rafters are anchored in a capping piece by aid of angle steel.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

FULL WALL ELEMENT OF CEMENT STABILISED WOOD WOOL

Technical field

The present invention refers on one hand to a production method for wall
5 elements of floor-to-floor height, which elements are cast from a mix of cement
stabilised wood wool, and on the other hand to a construction system for putting
together these elements to supporting outer walls.

Background of the invention

10 Cement stabilised wood wool today only exists in the form of so-called wood
wool building slabs. This material, which is produced out of wood wool, cement
and water, has been existing in Europe since the 1920s. The slabs are typically 500
or 600 mm wide and 2000 or 2400 mm long. The thickness varies between 20 and
15 wall isolation, sound absorbing ceiling and self-supporting ceiling insulation.

The material is characterised by good heat insulation capability and high
thermal capacity. It possesses a great capability to store moisture and because of its
open structure it can also rapidly absorb and release moisture. The wood wool
building slab is not affected by rot and has a documented high resistance to mildew.
20 Plastered wood wool building slabs have remained on frontages exposed to rain in
over 50 years and also been buried in the ground for 30 years, without being
affected. Further, the material possesses high fire resistance. The wood wool
building slab does not emit any formaldehyde and negligible amounts of volatile
organic compounds (VOC).

25 The present method of manufacturing wood wool building slabs is limited to
a maximum thickness of 150 mm and a maximum width of 600 mm. This precludes
manufacturing of wall elements in one single piece. Putting together wood wool
building slabs into full wall elements is, in view of industrial engineering, relatively
costly.

30

Summary of the invention

The present invention refers to a method for producing construction elements
with the aid of wood wool, cement and water comprising the following steps:

- arranging moulds for casting of the elements;
- 35 - taking wood wool and wetting it;
- stabilising the water content of the wood wool to 25%;
- mixing the stabilised wood wool with dry cement in a ratio by weight
of 1:1.88 to 1:1.92;
- pouring the mix into the mould;

- letting the mix cure.

It also refers to a construction element for walls, comprising cement bound wood wool, characterised in that the element is produced according to the method as mentioned above.

5 The present invention further refers to a method for producing buildings comprising the following steps;

- attaching a construction element, as mentioned above, to the bedding with the aid of plaster;
- joining said elements sideways by casting a concrete column in the
10 vertical cavities formed by means of chases provided in the sides of the elements;
- casting a capping piece of concrete in chases on the upper side of the element, the capping piece can be used to attach rafters.

15 Brief description of the drawings

Fig 1 shows an example of a section of a steel mould (1.1) for casting a full wall element of cement bound wood wool. At the sides of the mould are triangular strips (1.2) arranged to produce the V-shaped chase at the ends of the element, according to fig 3.

20 Fig 2 shows an example of casting a full wall element in section. Two lifting straps (2.1), which are anchored to a round timber (2.2), are cast into the element. In the upper side of the mould is a tin plate (2.3) arranged to produce the rectangular chase, according to fig 4.

Fig 3 shows how the V-shaped chases (3.1) in the element ends forms a
25 rectangular cavity (3.2) intended for an in-site cast concrete column which joins together the elements.

Fig 4 shows the rectangular chase (4.1) in the upper side of the wall elements, as well as how the wall elements are temporarily joined together by U-shaped tin plates (4.2).

30 Fig 5 shows an example of a completed full wall element with cut-out window openings in perspective, as well as how the elements are applied to the foundation.

Fig 6 shows a guiding rail of perforated panel (6.1.) attached to the concrete slab.

35 Fig 7 shows an example of how a wood wool element (7.1) is glued to the bedding using a cement-based plaster (7.2).

Fig 8 shows a joining of wood wool elements using concrete columns moulded on place (8.1). A dowel made of reinforcing iron is anchored in the foundation into the element joint (8.2).

Fig 9 shows how the capping piece is cast (9.1) into the upper side of the element as well as reinforced with reinforcing steel (9.2).

Fig 10 shows an example of securing devices (10.1) for windows and doors.

Fig 11 shows an example of securing a rafter into the capping piece by means of angle fittings (11.1) being attached to annular beam as well as the rafter. The underside of the rafter is protected by moisture barrier (11.2).

Fig 12 shows electric conduits and boxes (12.1) which have been milled into the masonry and thereafter repaired with plaster (12.2) before the surface layer is applied.

Fig 13 shows a section of a wall of wood wool elements, which has been surface treated using outside (13.1) and inside (13.2) reinforced plaster, as well as the wind-sealed plaster sludge on the crown of the wall (13.3).

Fig 14 shows a U-shaped beam (14.1) which is applied between two wall elements. The upper edge of the elements is notched (14.2) for placement of the beam.

Detailed description of preferred embodiments

The invention refers on one hand to a production method for manufacturing outer wall elements of cement stabilised wood wool, i.e. full wall elements, and on the other hand of a construction system for putting together these elements to supporting outer walls. The thickness of the elements is selected based on desired heat insulation and supporting capability. The technique is primarily directed to walls that are not subjected to big vertical loads, e.g. outer walls in small buildings.

25 Method of production

The wood wool elements are manufactured by casting a wood wool mass (a mixture of wood wool, cement and water) in steel moulds. The manufacturing of the wood wool mass is done in such a way that the wood wool mass, which is manufactured by spruce wood in a special plane, is moistened and thereby mixed with cement. In this connection, the mixing proportions between the cement and the moistened wood wool are significant for the elasticity of the mass upon casting: if too much cement is used, the mass of wood wool and cement does not become elastic enough, thus increasing the density. If, on the other hand, too little cement is used, the resistance might be too low. The mixing of the wood wool mass, as well as the filling of the moulds, differ from the manufacturing of the wood wool building slabs, which has a maximum thickness of 150 mm. Full wall elements, according to an embodiment of the present invention, are produced using a weight ratio between wet wood wool and dry cement of 1:1.9 (for conventional wood wool building slabs the mixing proportions are 1:2.0). This mixing ratio of 1:1.90 has been proven to

manage a casting height of 400 mm without collapsing and becoming too compact, and the density can be varied from 200 kg/m³ to 300 kg/m³. Tests have shown that a mixing ratio of 1:1.88 can give rise to problems with the surface strength of the material. At mixing proportions of 1:1.92 some densities becomes too dense and collapses. Tests have also shown that there may arise problems at the lower mixing ratio getting all the wood wool covered with cement. It is important to get all wood wool covered with cement because the cement produces resistance against fire and microbial growth on the finished product. According to one embodiment of the invention, the moulds are 6 m long, 2.4 m high and 400 mm deep (inside measures), however, the measures can be adapted to the desired size of the wall elements. An adjustable tin plate having a cross section of 100 x 160 mm, is arranged adjacent of the upper end of the moulds, to create a chase in the upper edge of the elements. In a similar way, batters with triangular cross sections are arranged at both ends of the mould to create V-shaped chases in the sides of the elements. Lifting straps are cast in each side of the element to enable handling after curing and during assembly. In order to achieve the desired density, the wood wool mass is continuously weighted during the filling of the moulds. The wood wool mass is subsequently spread evenly over the surface of the lying mould, in order for an even density to be achieved. When all wood wool mass is distributed, the moulds are slightly over-filled. The mass is compacted by stacking the moulds on top of each other, the underside of the upper mould forming a lid for the mould lying below. On the top-most mould is placed a mould lid and on top of that concrete weights, weighing approximately 1.000 kg/m². Stripping is possible after 24 hours. Subsequently, the elements are raised and put to dry. The window openings, if any, are normally cut out after the elements are cured, but the elements can be moulded with holes for windows. Doors and large window sections are arranged between two wall elements. The upper edge of the wall elements is notched for storage to U-shaped beams according to fig 14. On both sides of the window- and door openings, mounting plates are arranged to support the fastening. In this mounting plate windows and doors can be attached using frame screw. The full wall elements can be delivered to the construction site as soon as they are cured to sufficient strength and dried out to the desired density. The ready-to-deliver elements hold a density of 200-300 kg/m³ (the exact density can vary between different buildings, primarily depending on desired heat insulation).

35

Building system

For small houses, the walls of wood wool element are manufactured by way that the prefabricated elements are put directly on the foundation, normally on an edge beam. The elements are attached to the bedding by way of putting them in a

string of plaster at the inside of the wall. When the elements are placed next to each other, a vertical cavity having a quadratic cross section with the side 70 mm, is formed through the V-shaped chases, see fig 3. The elements are temporarily kept in place by stamp and are mutually stabilised in the upper edge using U-shaped tin
5 plates. The elements are laterally joined together by moulding concrete columns into the vertical cavities. Apart from joining the elements together, the concrete columns have the purpose of providing the wall with sufficient vertical load bearing capacity for elements with low density and for elements having a thickness down to 150 mm. Subsequently a concrete beam (as a capping piece/annular beam) with the
10 height of 160 mm and the width of 100 mm, is moulded in the chase of the upper side of the elements. This beam is reinforced together with the concrete columns. The capping piece can also be made as a higher beam if it is necessary to distribute loads over large window sections. The rafters are anchored in the capping piece with aid of angle irons, alternatively moulded into the capping piece or attached by
15 screws. The windows and doors are mounted, using ordinary frame screw and plug, into mounting plates, according to fig 10.

For inner surface treatment is used either plaster or gypsum wallboard. Plaster is preferably armed using welded armouring net made of galvanised, alternatively stainless, steel wire. The armouring reinforcement is placed in the
20 outer plaster layer. On top of the element junctions an armouring net is placed also in the coarse stuff. In this way, a double armouring is produced over the element joints. In case gypsum wallboard is used, these are glued to the wall with gypsum plaster. The joints between the boards are filled by putting a string of gypsum plaster between the wood wool elements and the gypsum boards along the entire
25 joint.

On the outside the surface treatment consists of plaster, which is armoured in the same way as the inside plaster, or any other type of facade material. The crown of the wall and the window openings are sealed against the wind using plaster sludge. If a not airtight facade material, such as wood panel or facade bricks is used,
30 the outside of the brick work has to be air-tightened by sludging.

Electric wires are inserted into the masonry by milling groves (as for e.g. light concrete walls). Small load fixings to the wall, e.g. of paintings, is done in the plaster layer (alternatively the gypsum board) using plastic plugs, metal expansion anchors or rubber expansion anchors. In case of heavier load fixings, typically
35 kitchen cupboards or wall-hanged book shelves, sheet metal profiles placed in slit/slotted groves in the wall, are used. As an alternative, screw plug or injection plaster can be used.

Further details of the construction system are apparent from the description of the figures below as well as from the patent claims.

In a further embodiment of the invention, the production method according to the present invention, moulds, according to fig 1, are used to cast full wall elements of cement-bound wood wool, according to fig 2. The elements are cast with chases in the side of the elements, according to fig 3, to enable a lateral joining
5 of the elements. The elements are manufactured with a chase at the upper edge, in accordance with fig 4, to enable casting of capping pieces/annular beam. The window openings are cut out from the finished elements, see fig 5.

In the construction system according to the present invention, wood wool elements are placed on the bedding, in accordance with fig 6, towards a guiding rail
10 made of perforated sheet metal according to fig 7, in a string of plaster. The elements are joined, in accordance with fig 8, by means of concrete columns cast in the joints between the elements. A capping piece is cast in concrete on top of the wall, according to fig 9, in such a way that it is reinforced together with the concrete columns. Windows and doors are attached with aid of frame screws in mounting
15 rails of tin plate in accordance with fig 10. The rafters are mounted in the capping piece, according to fig 11.

The electric wires are inserted in the masonry, according to fig 12. Inside and outside plaster is arranged in accordance with fig 13. The plaster is to be reinforced with welded reinforcement net with galvanised, alternatively stainless, steel wire.
20

Example

In still a further embodiment, a method for producing full wall construction elements comprises the steps of:

- 25 - providing wool wool; Wood wool having the following characteristics is preferred: spruce wood strips each having an approximate thickness of 0.3 mm, a width of 2.5 mm and a length of 300 mm;
- subjecting the wood wool for a water bath, thereby wetting the wood wool;
- 30 - subjecting the wet wood wool to rolling between rubber rolls thereby causing the wood wool to assume a uniform water content. Preferred water content is 24-26%, and more preferred 25% (by weight), when mixing with the dry cement;
- weighing the wood wool before and after the water bath;
- putting a measured amount of the wood wool from the rubber rolls in a
35 container for mixing with dry cement. The amount of wood wool can, e.g., be measured using load measuring cells (Siemens, Germany);
- adding dry cement to the mixing container. The amount of dry cement is preferably 1.88-1.92 times the amount of wood wool with uniform water content, measured as weight ratio. Preferably is some kind of

dispensing device used, e.g. from Thomal, to achieve a suitable dose of cement. The cement is preferably Standard Portland. A ratio of wood wool to cement of 1:1.90 or in the interval of 1:1.895 to 1:1.905, have shown to provide good properties to the finished elements;

- 5 - mixing the mix. During tests a Van Elten device (Dutch) has been used. Mixing was continued under 40-60 seconds;
- pouring the mix into moulds. The production can be performed at temperatures above zero. Tests were performed indoors in a hall.

CLAIMS

1. A method for producing construction elements with the aid of wood wool, cement and water comprising the following steps:
 - 5 - arranging moulds for casting of said elements;
 - taking wood wool and wetting it;
 - stabilising the water content of the wood wool to 24-26%;
 - mixing the stabilised wood wool with dry cement in a ratio by weight of 1:1.88 to 1:1.92;
 - 10 - pouring the mix into the mould;
 - letting the mix cure.
2. The method of claim 1, further comprising the steps of:
 - filling the mould when it is laying down;
 - 15 - overfilling the mould to some extent;
 - placing a number of moulds on top of each other;
 - arranging a cover on top of the topmost mould;
 - arranging concrete weights on top of said cover weighing approximately 1.000 kg/m³.
 - 20
3. The method of claim 1, where said weight ratio of wood wool to cement is between 1:1.895 and 1:1.905.
4. The method of claim 3, where said weight ratio of wood wool to cement is
25 1:1.90.
5. A mould for producing construction elements of cement bound wood wool, **characterised in** that said mould has as size suitable for producing storage high wall elements.
30
6. The mould of claim 5, **characterised in** that said mould has a size of approximately 6 x 2.4 x 0.4 m.
7. The mould of claim 5, **characterised in** that said mould is provided with a
35 strip having a triangular cross section, which is arranged in one or both ends of the mould to create V-shaped chases in the construction elements, cast with the aid of said mould.
8. The mould of claim 7, **characterised in** that an adjustable mould is arranged

in the upper edge of the mould in order to create a chase in the upper edge of the construction element.

9. A construction element for walls, comprising cement bound wood wool,
5 **characterised in** that said element is produced according to the method described in any of the claims 1-4.
10. A construction element for walls, comprising cement-bound wood wool,
where said element is produced from a homogeneous mix of wood wool, water and
10 cement, **characterised in** that said element, as a finished product, has a density of 200-300 kg/m³.
11. The construction element according to claim 10, **characterised in** that a V-
shaped chase has been arranged in the side of said element such that when two
15 elements are placed next to each other, a vertical cavity is formed between the two elements.
12. The construction element according to claim 11, **characterised in** that a U-
shaped groove is arranged at the top of the element, useable as support for a
20 concrete beam.
13. The construction element according to claim 12, **characterised in** that said element has a thickness of 150-400 mm.
- 25 14. The construction element according to claim 13, **characterised in** that said element has a height or a width of approximately 2.4 x 6.0 m.
15. The construction element according to claim 14, **characterised in** that one or more window or door openings have been arranged in said element, and in that one
30 or more fixing devices are arranged on both sides of said opening(s).
16. A method for producing buildings comprising the following steps;
- attaching a construction element according to claim 9 or 10 to the bedding with the aid of plaster;
 - 35 - joining said elements sideways by casting a concrete column in the vertical cavities formed by means of chases provided in the sides of the elements;
 - casting a capping piece of concrete in chases on the upper side of the element, said capping piece can be used to attach rafters.

17. The method of claim 16 further comprising the steps of
- sealing said element with plaster.

- 5 18. The method of claim 11 further comprising the step of
- providing double layers of reinforcing nets in the surface plaster over the joint between two elements.

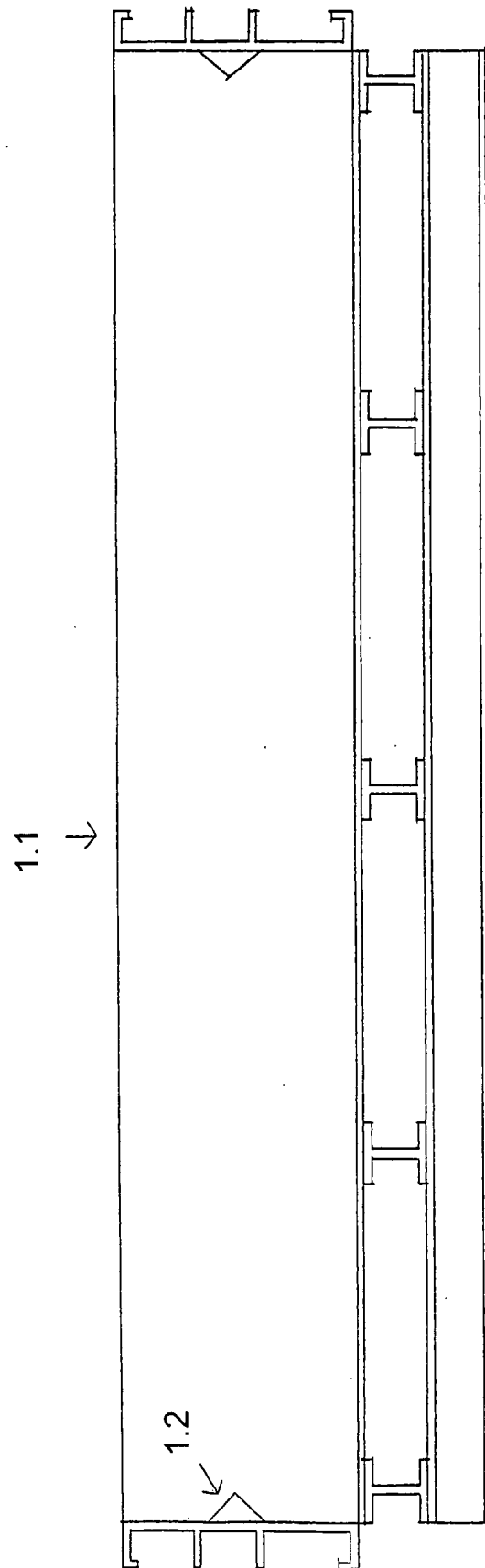


Fig. 1

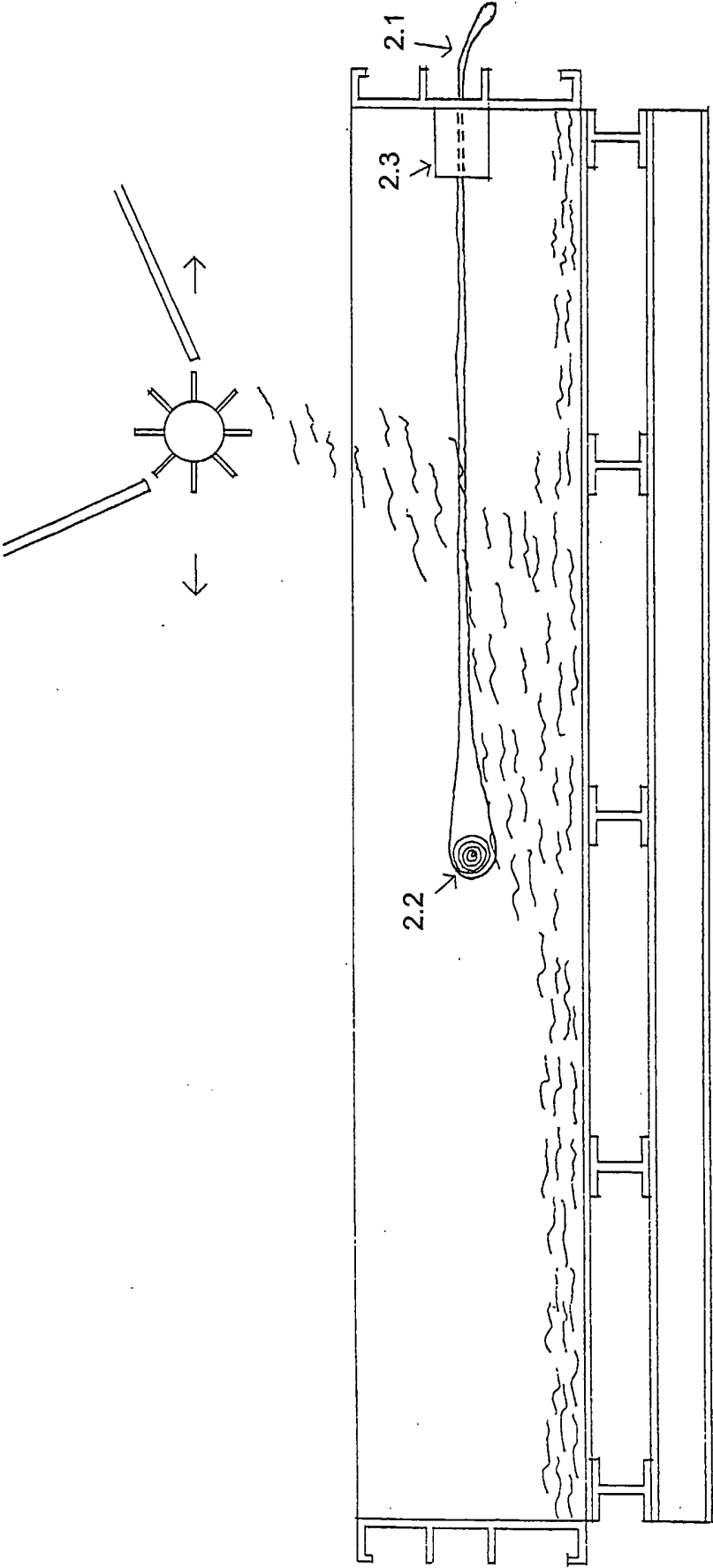


Fig. 2

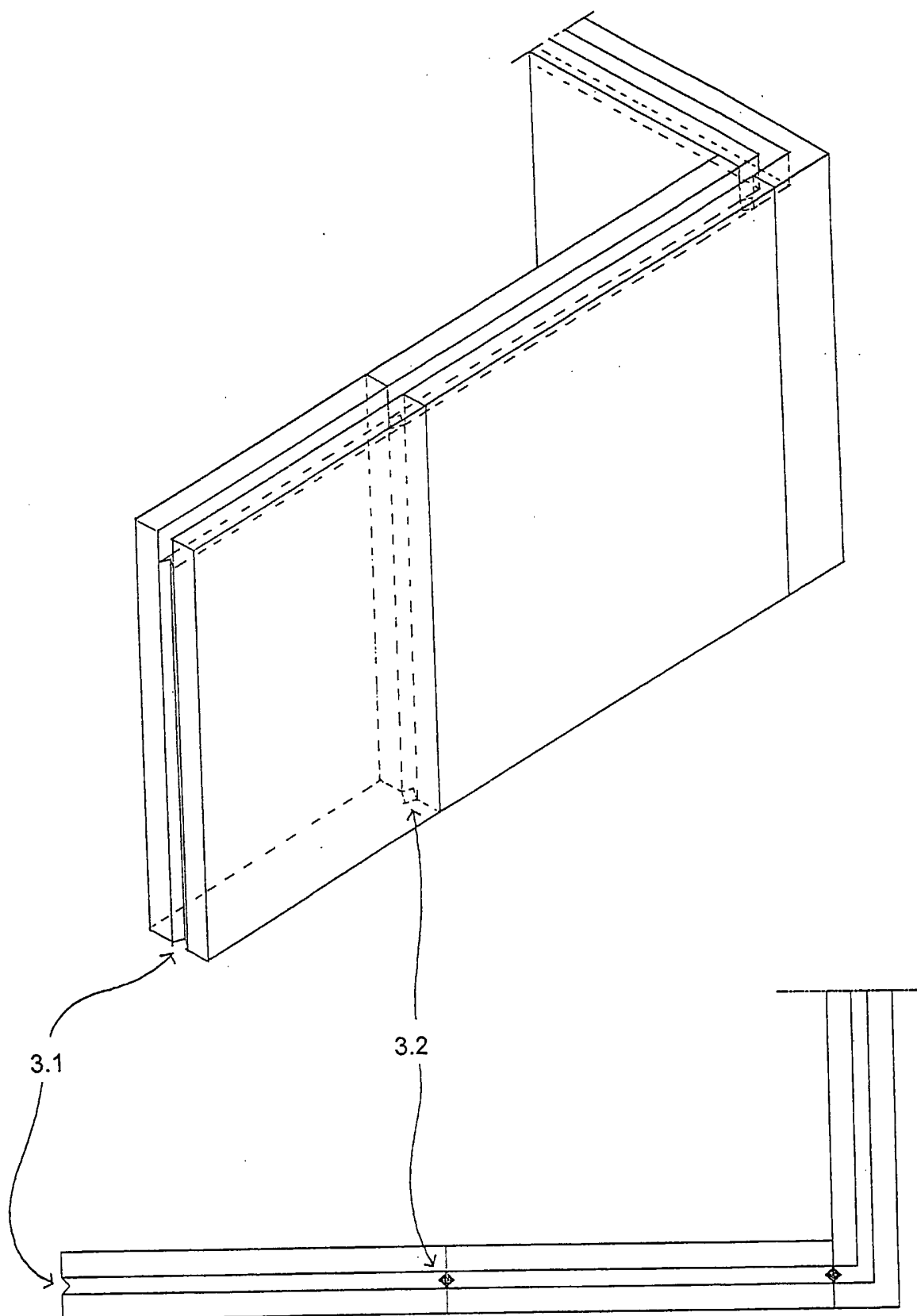


Fig. 3

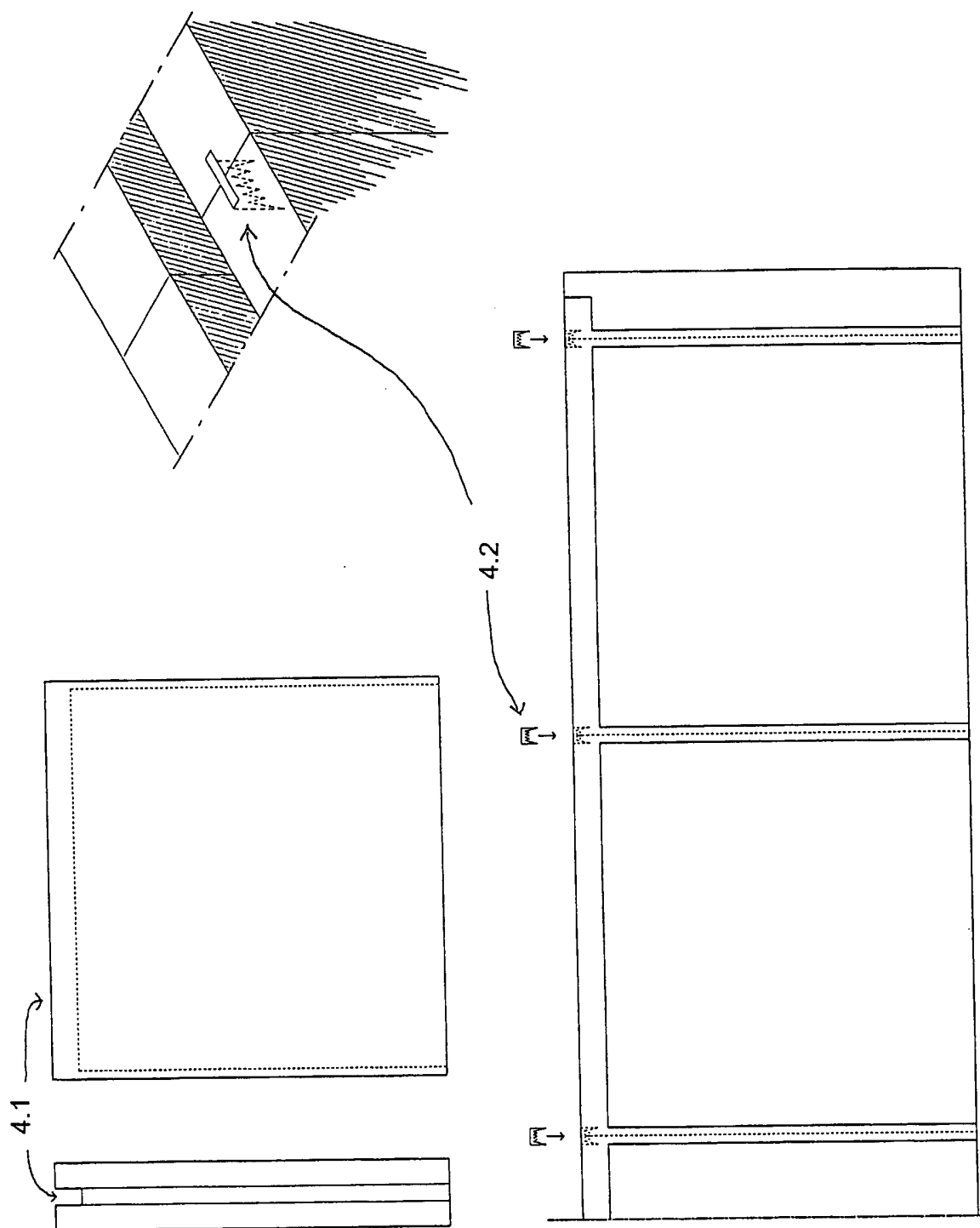


Fig. 4

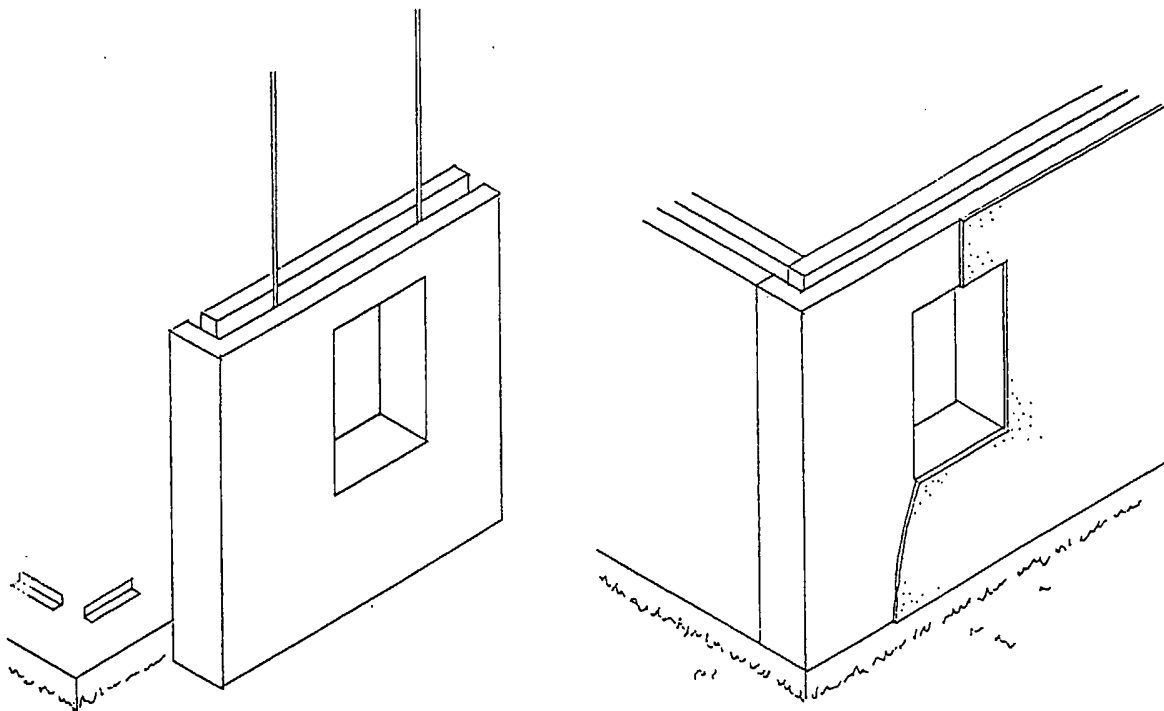


Fig. 5

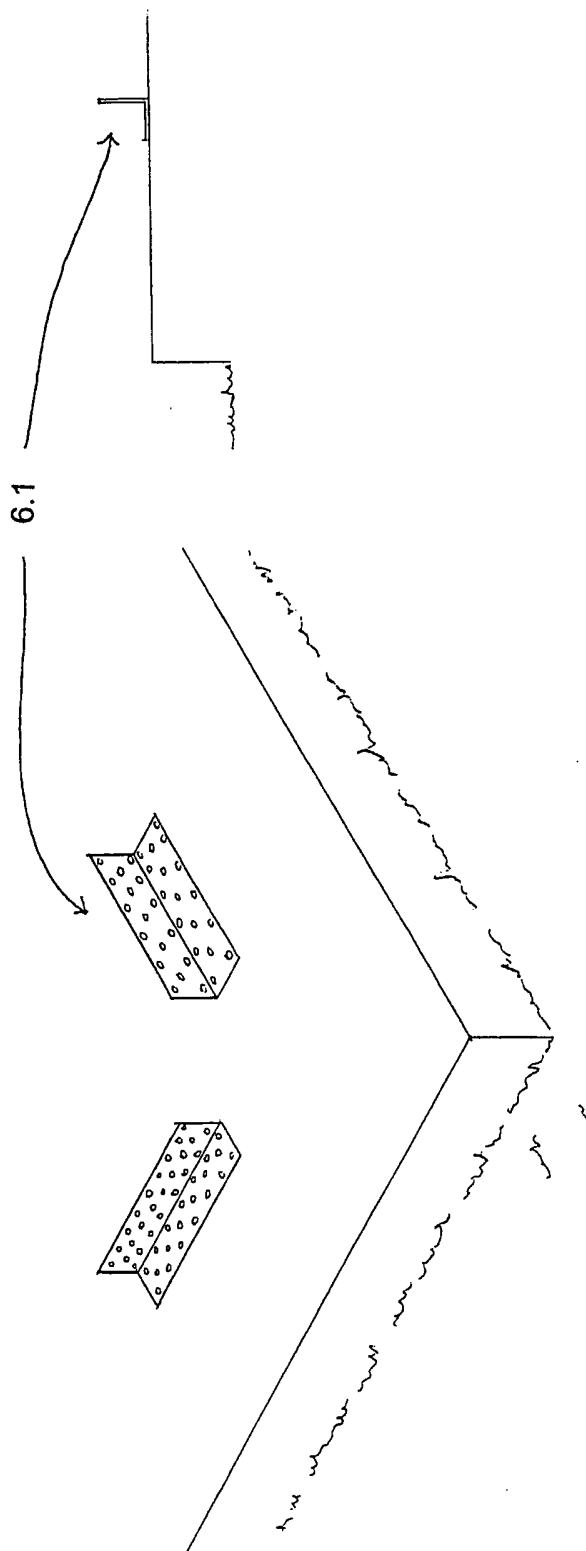


Fig. 6

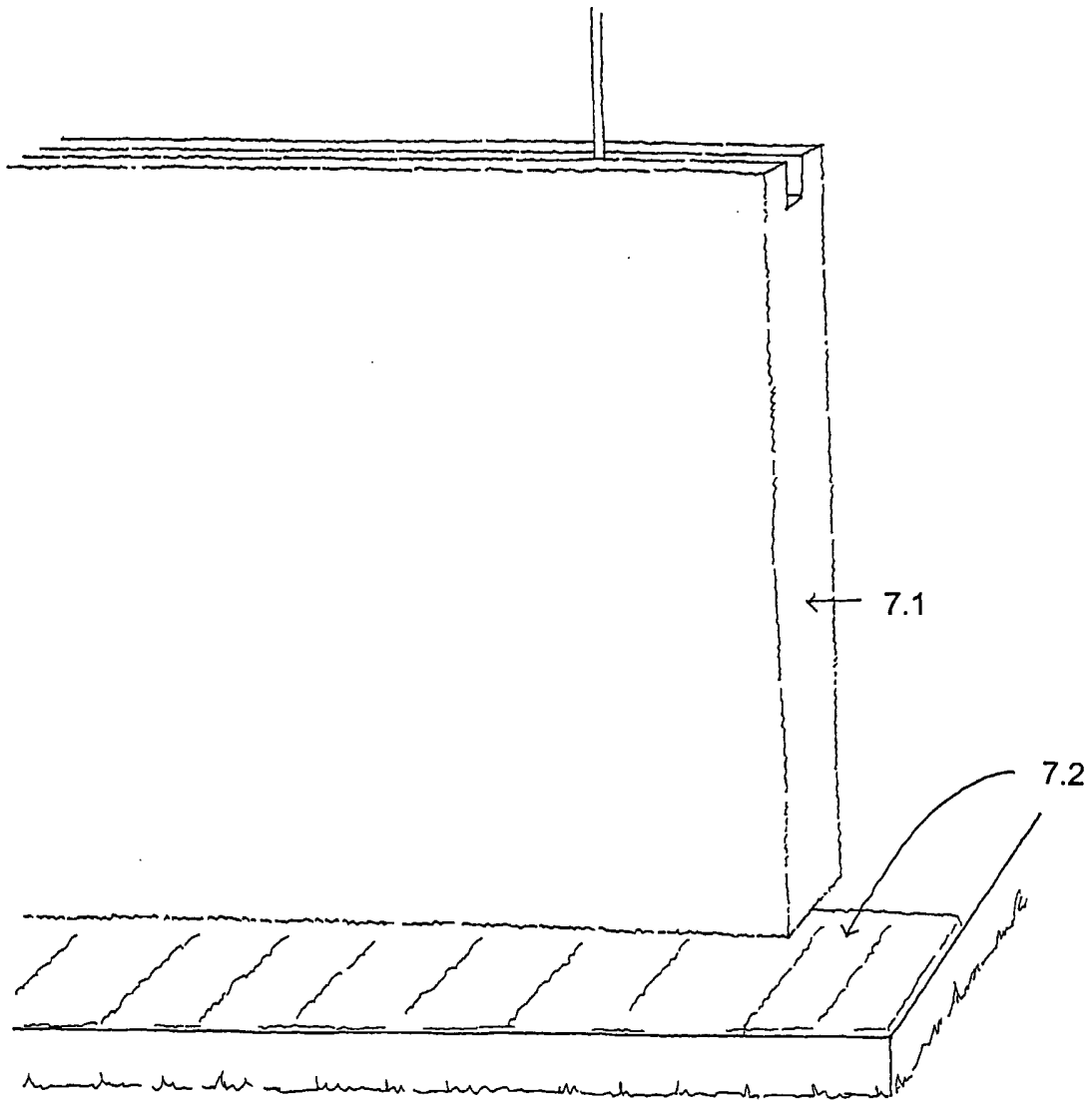
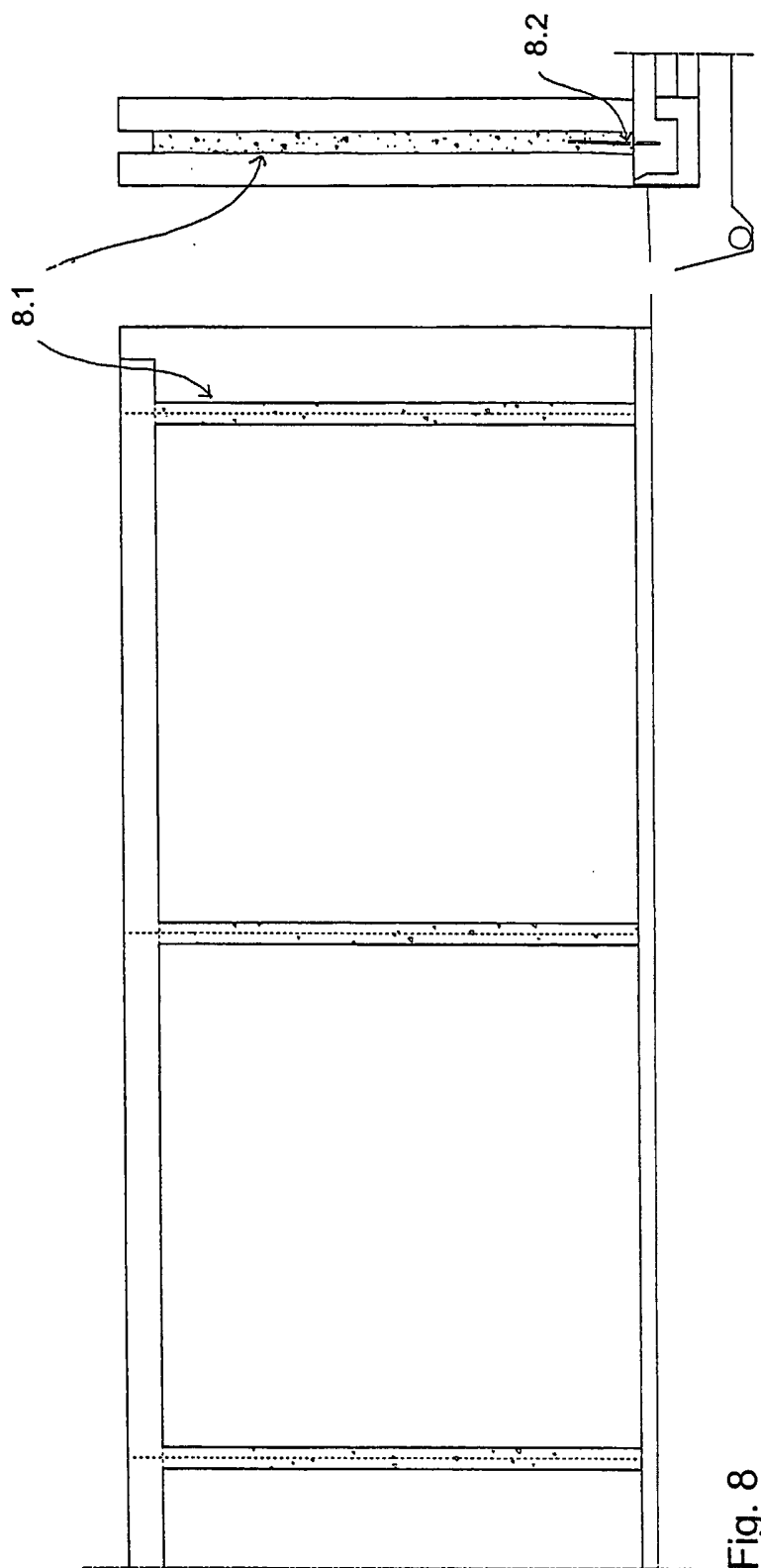


Fig. 7



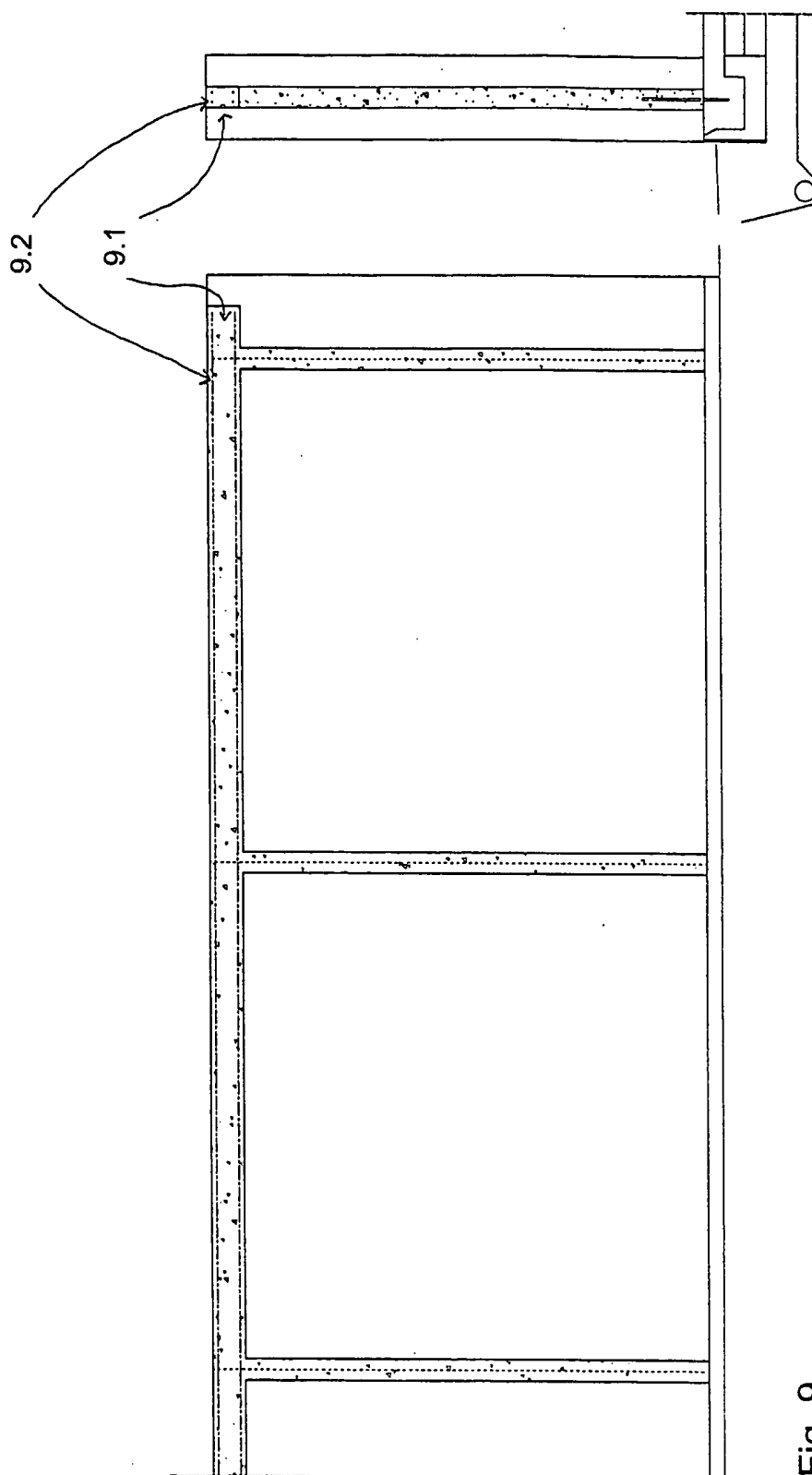


Fig. 9

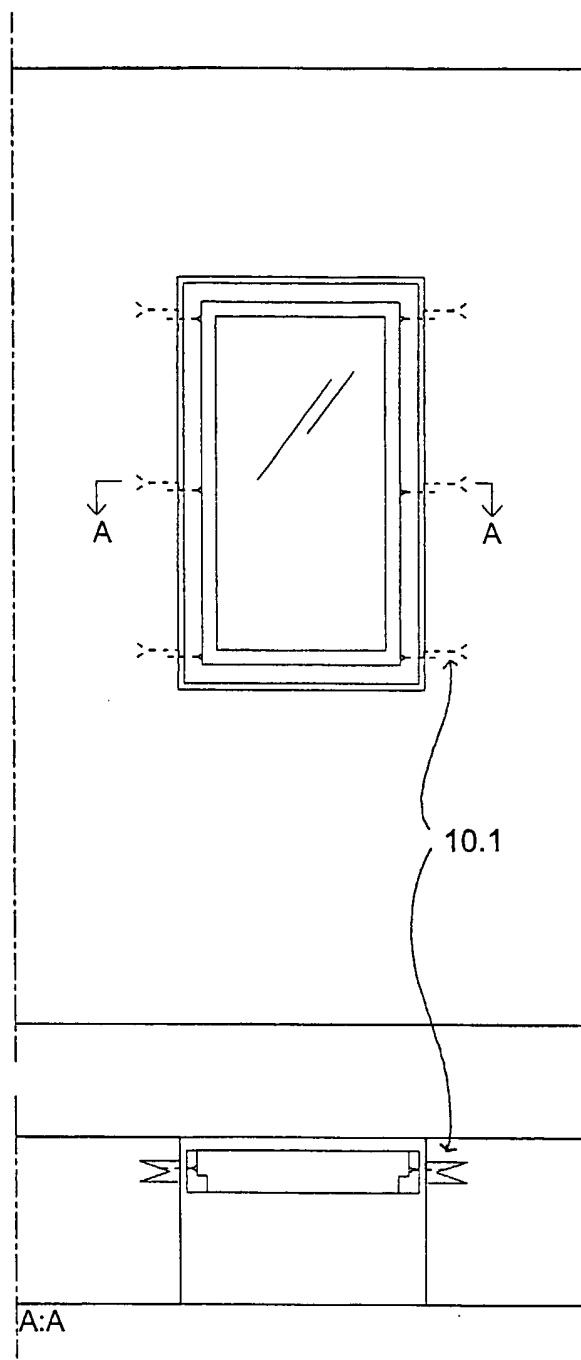


Fig. 10

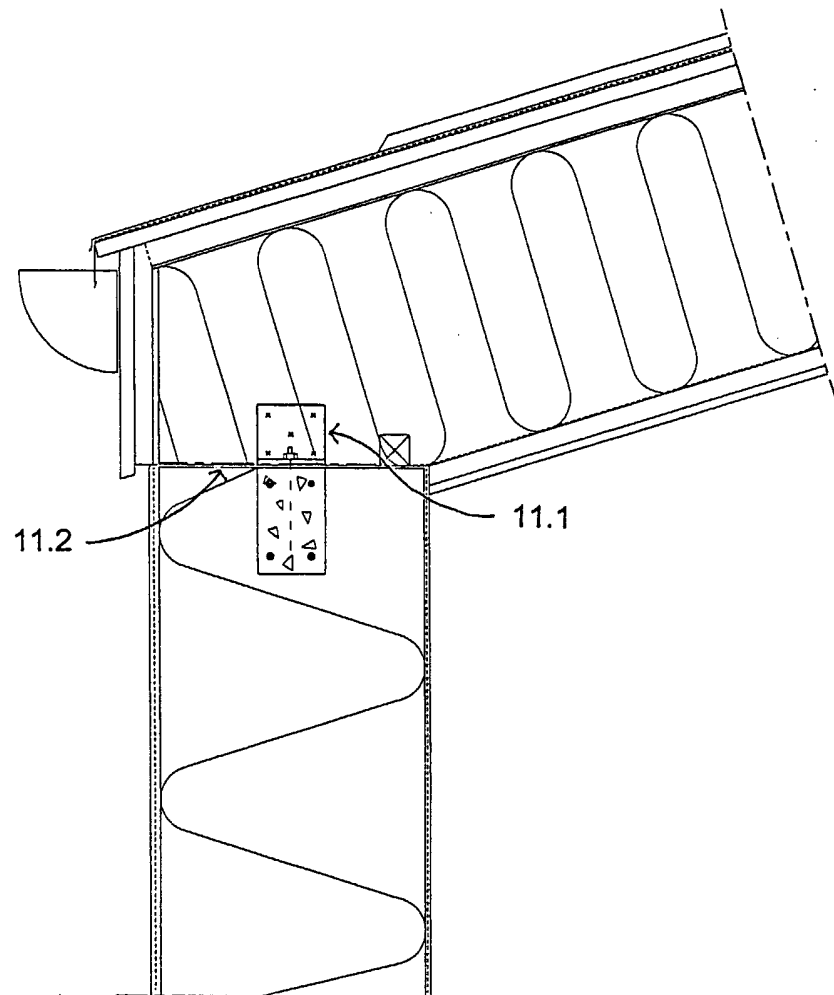


Fig. 11

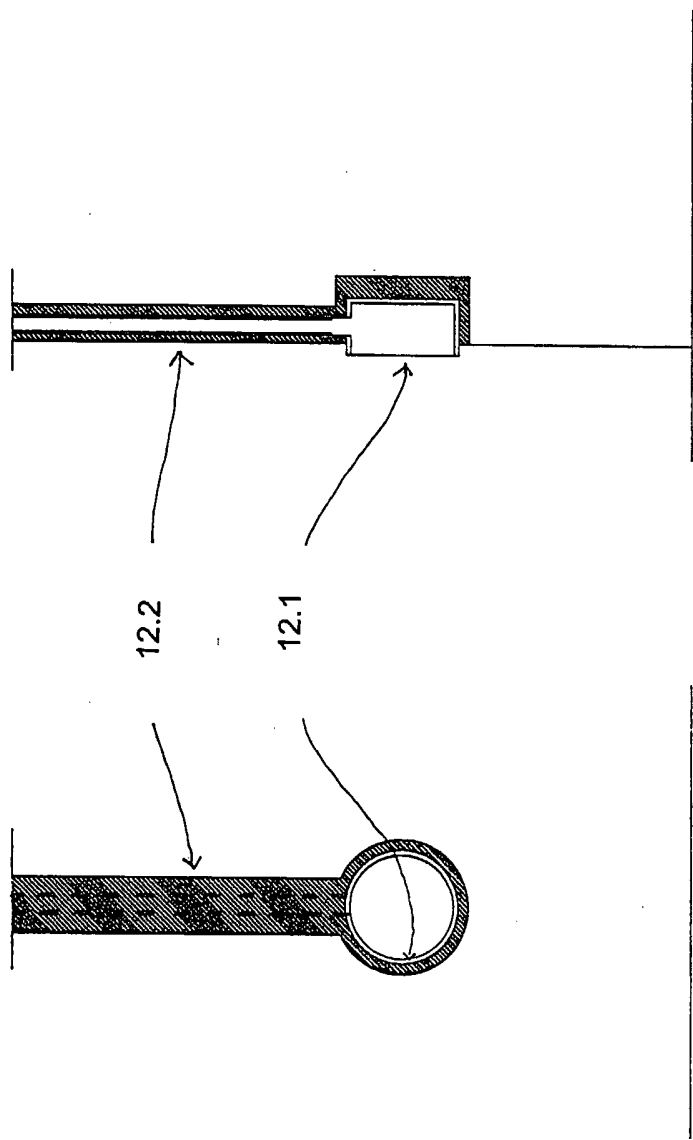


Fig. 12

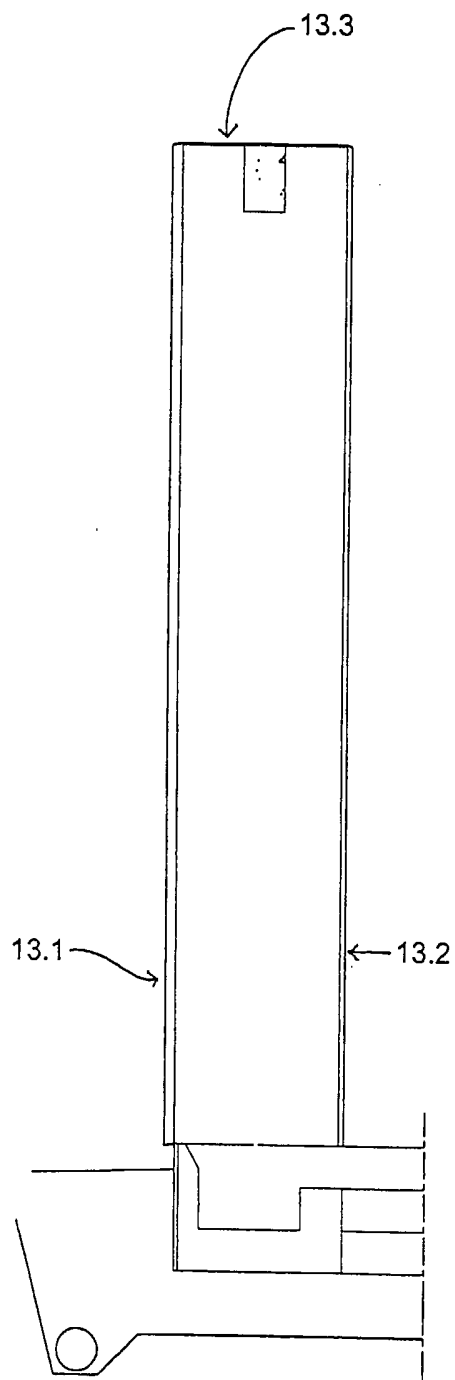


Fig. 13

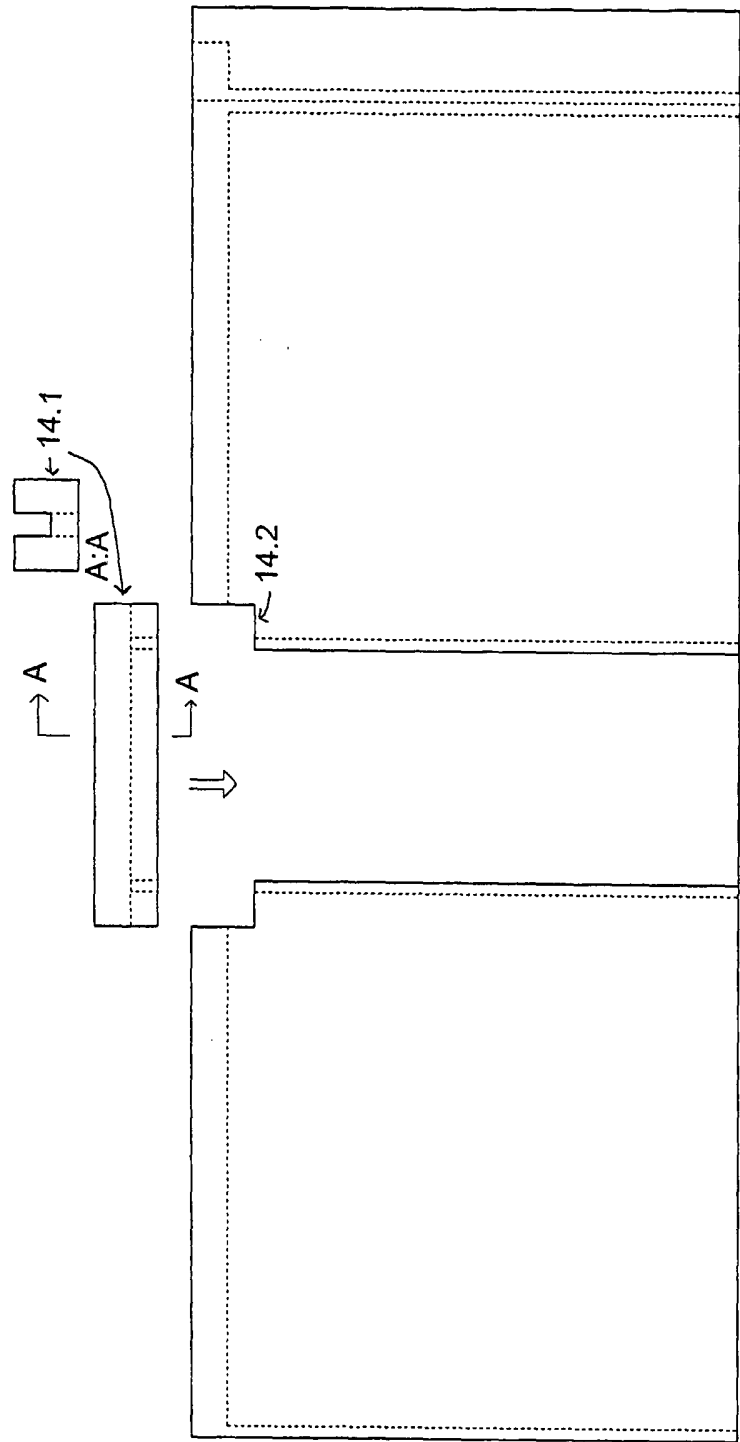


Fig. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2005/001195

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E04B 1/16, E04C 2/26

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)

IPC7: E04B, E04C

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

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2346626 A (SCHAL INTERNATIONAL MANAGEMENT LIMITED), 16 August 2000 (16.08.2000), figures 1,2, abstract	5,6
A	--	1-4,7-18
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A	--	1-4,7-18
A	GB 628335 A (JOHN HEYNY), 26 August 1949 (26.08.1949), whole document	1-18
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

11 November 2005

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	GB 453906 A (ALEXANDER SINGER), 21 Sept 1936 (21.09.1936), whole document --	1-18
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				NL	77698	C	00/00/0000
				US	2569157	A	25/09/1951