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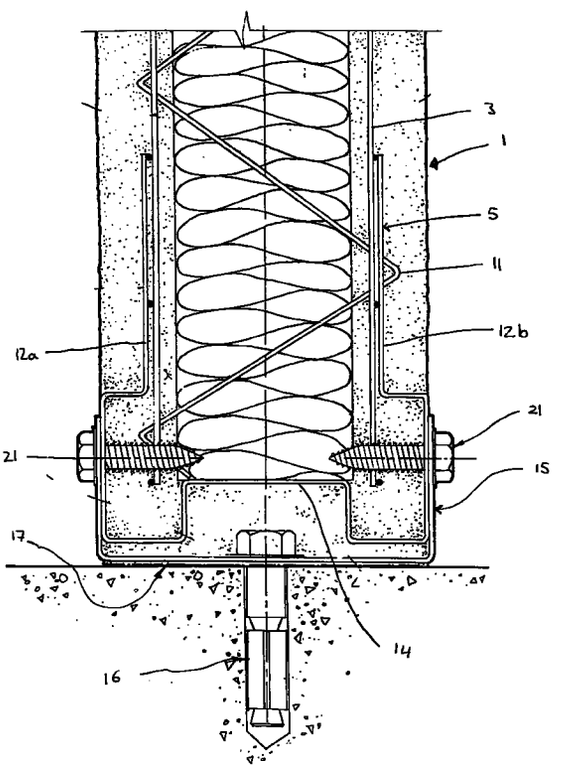
(54) A structural panel

(57) A structural panel (1) for a prefabricated building comprising an insulating panel core (2) reinforced by a warren truss type lattice structure (3,4). The structural panel is provided with a tongue and groove construction (9,10) to permit adjoining panels to be joined to one another. The panel core is mounted on a fastening (5) at each of the lower corners of the panel core. The fastening has vertical arms (12a,b) which are adapted to grip the surface of the panel core. A lower edge of the panel core sits on a raised section (14) between the arms (12a,b). The panel core and the fastening are then encapsulated in concrete. The lattice structure protrudes from the surface plane of the panel core to provide the concrete with structural re-inforcement.

FIG. 2



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Description

[0001] The invention relates to an insulated structural panel suitable for use in a prefabricated building system.

[0002] Building regulations now require the standard of building insulation to be progressively increased due to environmental considerations. New buildings also have to rated according to their thermal efficiency, which enables purchasers to choose the building with the lowest heating costs. The calculation of thermal efficiency must take account of cold-bridging, i.e. parts of a wall where there is a local reduction in the thermal efficiency between the inner and outer faces such as occur in a masonry wall in the mortar joints.

[0003] Many types of pre-insulated structural panels are known and these are establishing themselves as the preferred method of providing the necessary insulation. These include concrete blocks (440mm x 215mm) having either an insulation board bonded to one side or having the insulation placed centrally within the block. These systems however suffer from cold bridging through the mortar at every joint, which results in cold bridges distributed across the face of the wall thereby reducing the thermal efficiency. Being more conventional building systems, i.e. a wet construction, work cannot progress in bad weather and at cold temperatures, shrinkage cracking occurs and consequently, the buildings can take a long time to erect.

[0004] Other known systems use interlocking permanent formwork blocks that are filled with concrete. These systems reduce the cold bridging problems known with other systems but still require large volumes of insitu concrete to be prepared on site and thus cannot be used in cold or wet conditions. This inevitably also leads to long erecting times.

[0005] Prefabricated building systems have been used to try to overcome these problems. Attempts at using concrete panels suffered from poor thermal efficiency and interstitial condensations caused rotting and corrosion of the supporting structure. The thermal efficiency of such panels has retrospectively been improved by the use of insulating panels. Concrete has been abandoned in favour of timber framed structures, which have the problem of cold bridging associated with the known panels and are also subject to interstitial condensation, thereby causing the timber frames to rot unless all joints are sealed and moist air extracted from the buildings. This increases the cost of the building so that timber framed buildings are generally more expensive than the traditional cavity wall construction.

[0006] Finally, it is also known to create insulated prefabricated panels by sandwiching a core of insulating material, e.g. polystyrene, between two concrete panels, whereby the two concrete panels are tied together during casting using glass fibre connecting rods. This process is complex and the resulting panels are expensive. These sandwich panels are also very heavy (360 kg/m^2), which leads to high transport costs, and they require heavy lifting equipment and heavy duty foundations on site.

[0007] The present invention seeks to provide a structural panel which avoids cold-bridging problems, has high thermal efficiency, and that is cheap to produce and enables buildings to be erected quickly and cheaply.

[0008] According to a first aspect of the invention there is provided structural panel for a prefabricated building including a panel core of having a plurality of filler of insulating material reinforced by a lattice structure, which lattice structure comprises two spaced lattice side members and a plurality of interstitial elements connected to the said spaced lattice side members, each of which interstitial lattice elements is disposed between two neighbouring filler elements so that the interstitial lattice elements and filler elements alternate along the panel, wherein substantially the whole of the lattice structure is filled with said insulating material, characterised in that each interstitial lattice element comprises at least in part a substantially continuous structure and in that the panel core is pre-cast in concrete.

[0009] Preferably, each interstitial lattice element has a continuous structure from an upper edge to a lower edge of the panel. Preferably, the interstitial lattice elements are joined to the lattice members adjacent to the apices of the interstitial lattice members. Preferably, at least part of the interstitial lattice structure protrudes from the surface plane at the panel core, thereby providing the concrete with structural re-inforcement.

[0010] The panel of the invention has a high thermal efficiency, avoids the problems of cold bridging associated with known pre-cast panels and is cheap to produce, transport and permits rapid erection of buildings without suffering from damaging interstitial condensation. The panel of the invention is surprisingly very robust and strong. In a preferred embodiment the lattice structure advantageously re-inforces the concrete, thereby further increasing the strength of the panel. The panel has very good fire resistance because the insulating material is encapsulated within the concrete. Furthermore any interstitial condensation will form only on the concrete surface, which will not cause the degradation known in the prior art due to sagging insulation and corrosion.

[0011] The invention also provides for a wall fastening for the panel core, said fastening, when in the installed position, comprising a substantially vertical structure on each face of the panel core adapted to engage said panel core and a substantially horizontal connecting piece joining said vertical structures, said horizontal connecting piece having a supporting plane and a raised section above said plane extending in the longitudinal plane of the panel core along the fastening to support the panel core.

[0012] The wall fastening allows a very rapid and

secure erection of the panel and ensures that the panel retains its resilience during erection.

[0013] Preferably, the panel core and a part of the fastening are encapsulated in concrete such that a lower face of the horizontal member is substantially free of concrete. This may be mounted in a substantially U-shaped fastening, the U-shaped fastening being secured to a base, the panel being secured to the U-shaped fastening, thereby supporting the panel in an upright position. Preferably, the substantially vertical structure includes openings to enable holes to be drilled through the panel.

[0014] Embodiments of the invention will now be described by way of example only in greater detail with reference to the drawings in which:

Figure 1 shows a structural panel partially cut away with the fastening means;
Figure 2 shows a cross section of a structural panel with fastening means;
Figure 3 shows a perspective view of the fastening means in a bracket;
Figure 4 schematically shows a part of a building having a window opening constructed from panels made according to the invention.

[0015] Figure 1 shows a generally rectangular structural panel 1 comprising a core of polystyrene insulating material 2, which is reinforced by a steel wire lattice, thereby defining a panel care 6. The vertical members of the steel lattice 3 consist of first wire elements in spaced parallel relationship which are joined to respective adjacent elements by means of a plurality at spaced parallel members 4 perpendicular to the first wire elements, which in normal usage will be substantially horizontal, thereby forming a cage like structure on the surface of the insulating material 2. The panel core 6 is supported at each of its two lower corners by a fastening 5, which is described in greater detail hereinafter. The panel core 6 and the fastenings 5 are encapsulated on their exterior sides in concrete 7. The structural panel 1 so formed is then mounted in two substantially U-shaped brackets 8 which have been previously secured to, e.g., building foundations. The respective opposite vertical edges of the structural panel 1 are provided with a tongue 9 and a groove 10.

[0016] Figure 2 shows a cross-sectional lower end view of the structural panel 1 with the fastening 5 in the installed position. The panel core 6 again comprises the insulating material 2 and steel lattice 3 and further comprises a member 11 passing back and forth through the insulating material 2, thereby forming a warren truss type structure, whereby the individual apices of the member 11 protrude beyond the surface plane of the steel lattice 3. The tie elements 4 are not visible. The panel core 6 is held in a fastening 5 having substantially vertical resilient arms 12a and 12b on opposite sides of the panel care 6 which arms engage with the steel lattice 3 and may be fastened to the lattice by means of Hartco clips or the like. At approximately one third the length of the vertical arms 12a and 12b the arms extend substantially horizontally outwardly towards the outer surface of the structural panel 1. A substantially horizontal connecting piece 13 joins the lower portion of the arms 12a and 12b to one another, which connecting piece has a raised central plateau 14, on which the panel core 6 rests. The core 6 and the fastening 5 are encapsulated in concrete such that the lower face of the horizontal connecting piece 13 is substantially free of concrete. The structural panel 1 thus formed is mounted in a substantially U-shaped bracket 15 having a cement mortar bed in the space between the upper surface at the bracket and the lower surface of the structural panel 1. The U-shaped bracket 15 is screwed to the structural panel by screws on each side of the panel, said screws 21 reaching into the insulating material 2. The U-shaped bracket is anchored to the floor by means of an anchor 16. A damp proof course 17 is provided between the lower surface of the U-shaped bracket 15 and the parts of the panel not held in the bracket and the floor or surface on which the panel is mounted.

[0017] From figures 1 and 2 it can be seen that the panel core may comprise a series of vertical warren trusses having horizontal tie members joining each truss to its respective adjacent trusses, wherein the space between trusses is filled with stripe of polystyrene insulating material. The panel core may have various thicknesses depending on the amount of insulation required for the particular building. A typical panel is between 76mm and 150mm thick, up to 1500mm wide and 3000mm tall, i.e. each panel can be one storey high. It is also possible to increase the strength of the panel by increasing the diameter of the wire used to form the lattice. Although the insulating material is typically polystyrene, other materials such as mineral wool, phenolic foam or polyurethane may be used depending on the precise application. As the panel is relatively thin in comparison with a conventional structure, the floor space available in the building is increased.

[0018] The panel cores 6 are encapsulated in concrete using split moulds to enable the correct thickness of concrete to be laid out for the lower face and to be screed before adding the panel. The concrete used should preferably be a fine aggregate concrete with a compressive strength in the range of 10 to 60 N/mm^2, be free flowing and contain a waterproofing additive to improve resistance to environmental degradation. The concrete layer is typically 12-25mm thick. It would also be possible to produce a lightweight panel by using a lightweight aggregate such as FIBO expanded clay or Perlite. Such a lightweight panel is man handleable on site.

[0019] Fire tests according TO BS 476 have shown that the panel has the following properties: stability (66 mins); integrity (50 mins); insulation (50 mins). The panel tested by 3.00m x 3.1 m high x 100mm thick,

22mm concrete thickness, load strength 6KN/m run. Surface spread of flame: Class 1.

[0020] Thermal efficiency tests on panels having 22mm of concrete and a 150mm core panel with polystyrene as insulating material have given thermal resistance of 4.911 m^3K/W (U-value = 0.20 W/m^2K). For a similar panel with a 76mm core panel when combined with a brickwork skin and a 50mm uninsulated cavity, thermal resistance is 2.232 m^2K/W (U-value = 0.45 W/m^2K).

[0021] Figure 3 shows a perspective view of the fastening 5 in the U-shaped bracket 15 having too substantially vertical arms 12a,b and connecting piece 13 having a raised central plateau 14. Each of the arms 12a,b has three rectangular openings 18,19,20. The two vertical openings 18,19 being situated above the horizontal opening 20. The openings serve to allow the screws 21 to be screwed into the panel. The U-shaped bracket 15 has an opening 22 an its horizontal section to receive the anchor 16.

[0022] In an alternative embodiment, it is possible to dispense with the fastening 5. In this case the structural panel 1 is mounted in two U-shaped channels which together extend over substantially the entire length of the lower edge of the panel. The U-shaped, channel is anchored to the floor by means of an anchor. A mortar cement bed would be placed between the upper surface of the channel and the lower surface of the structural panel. A damp proof course is provided between the lower surface of the channel and the floor.

[0023] Figure 4 shows a schematic representation of a part of a building having a window opening constructed using panels made according to the invention. The walls of the building are constructed of storey high panels 41. The storey high panels adjacent to a window opening 42 43 have a small rectangular portion missing from the upper edge facing the opening, which is adapted to receive a lintel 44 using tongue and groove or notches. A spandrel panel 45 forms the lower edge of the opening and spans the gap between the panels 42,43. The lintel 44 is made in the same manner as the structural panel 1 but may have added re-inforcement in the form of steel rods or the like to increase its strength. The lintel may of course be used with conventional building systems. The thicker panels of the invention may be used as floor panels.

[0024] The panels 41-45 may be finished by rendering to seal the wall against water ingress, possibly with further insulation between the render and the wall or may provide the internal skin of a traditional cavity wall construction, the cavity of which could itself be filled with insulating material.

[0025] Although the interstitial lattice elements are described as zig-zag, they could have a serpentine or triangular wave structure or similar.

Claims

1. A structural panel (1) for a prefabricated building including a panel core of having a plurality of filler elements (2) of insulating material reinforced by a lattice structure, which lattice structure comprises two spaced lattice side members (3,4) and a plurality of interstitial elements (11) connected to the said spaced lattice side members, each of which interstitial lattice elements is disposed between two neighbouring filler elements (2) so that the interstitial lattice elements and filler elements alternate along the panel, wherein substantially the whole of the lattice structure is filled with said insulating material, characterised in that
each interstitial lattice element (11) comprises at least in part a substantially continuous structure and in that the panel core is pre-cast in concrete.

2. A structural panel according to Claim 1, characterised in that each interstitial lattice element (11) has a continuous structure from an upper edge to a lower edge of the panel.

3. A structural panel according to Claim 1 or Claim 2, characterised in that the interstitial lattice elements (11) are joined to the lattice members (3,4) adjacent to the apices of the interstitial lattice members.

4. A structural panel according to any one of Claims 1 to 3, characterised in that at least part of the interstitial lattice element (11) protrudes from the surface plane of the panel core, thereby providing the concrete with structural re-inforcement.

5. A structural panel according to any one of claims 1 to 4, characterised in that the concrete is lightweight concrete.

6. A structural panel according to any one of Claims 1 to 5, characterised in that a tongue (9) and a groove (10) are provided on opposite edges of said panel, said tongue and said groove being adapted to engage a corresponding tongue or groove, respectively, on an adjacent panel.

7. A wall construction comprising in particular a panel according to any one of claims 1 to 6, including a fastening (5) adapted to receive a panel core as defined in Claim 1, said fastening (5), when in the installed position, comprising a substantially vertical structure (12a,b) on each face of the panel core adapted to engage said panel core and a substantially horizontal connecting piece (13) joining said vertical structures, said horizontal connecting piece having a supporting plane and a raised section (14) above said plane extending in the longitudinal plane of the panel core along the fastening to support the

panel core.

8. A wall construction according to Claim 7, characterised in that the panel core (6) and a part of the fastening (5) are encapsulated in concrete such that a lower face of the horizontal member (13) is substantially free of concrete.

9. A wall construction according to Claim 1 or 7, characterised in that the encapsulated panel and fastening, when dependent on Claim 7, are mounted in a substantially U-shaped fastening (15), the U-shaped fastening (8) being secured to a base, the panel being secured to the U-shaped fastening, thereby supporting the panel in an upright position.

10. A wall construction according to Claim 7, characterised in that the substantially vertical structure includes openings (18,19,20) to enable holes to be drilled through the panel.

11. A panel according to Claim 1, characterised in that the panel is a lintel.

12. A building made from a plurality of panels according to Claim 1.

FIG. 1

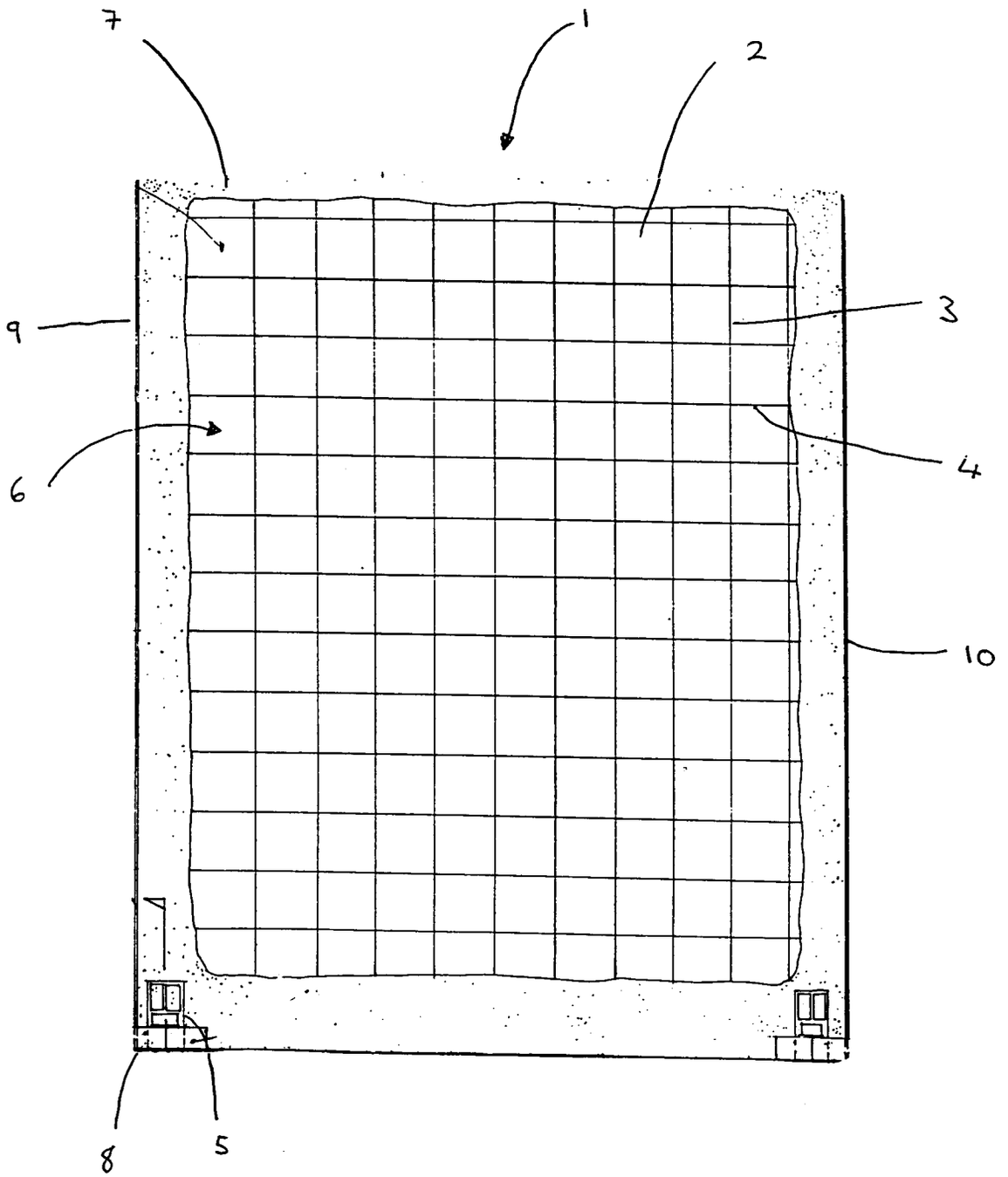
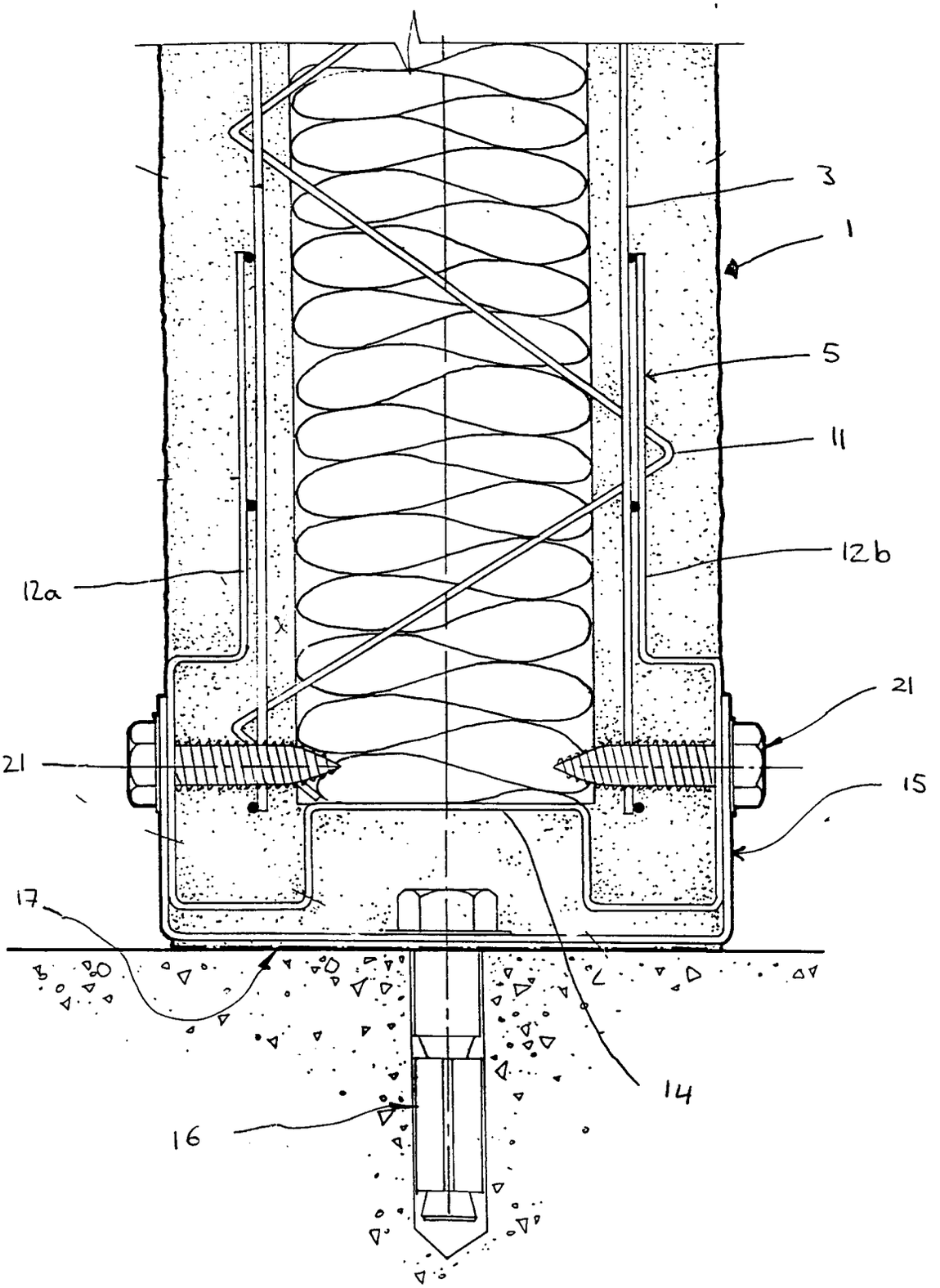


FIG. 2



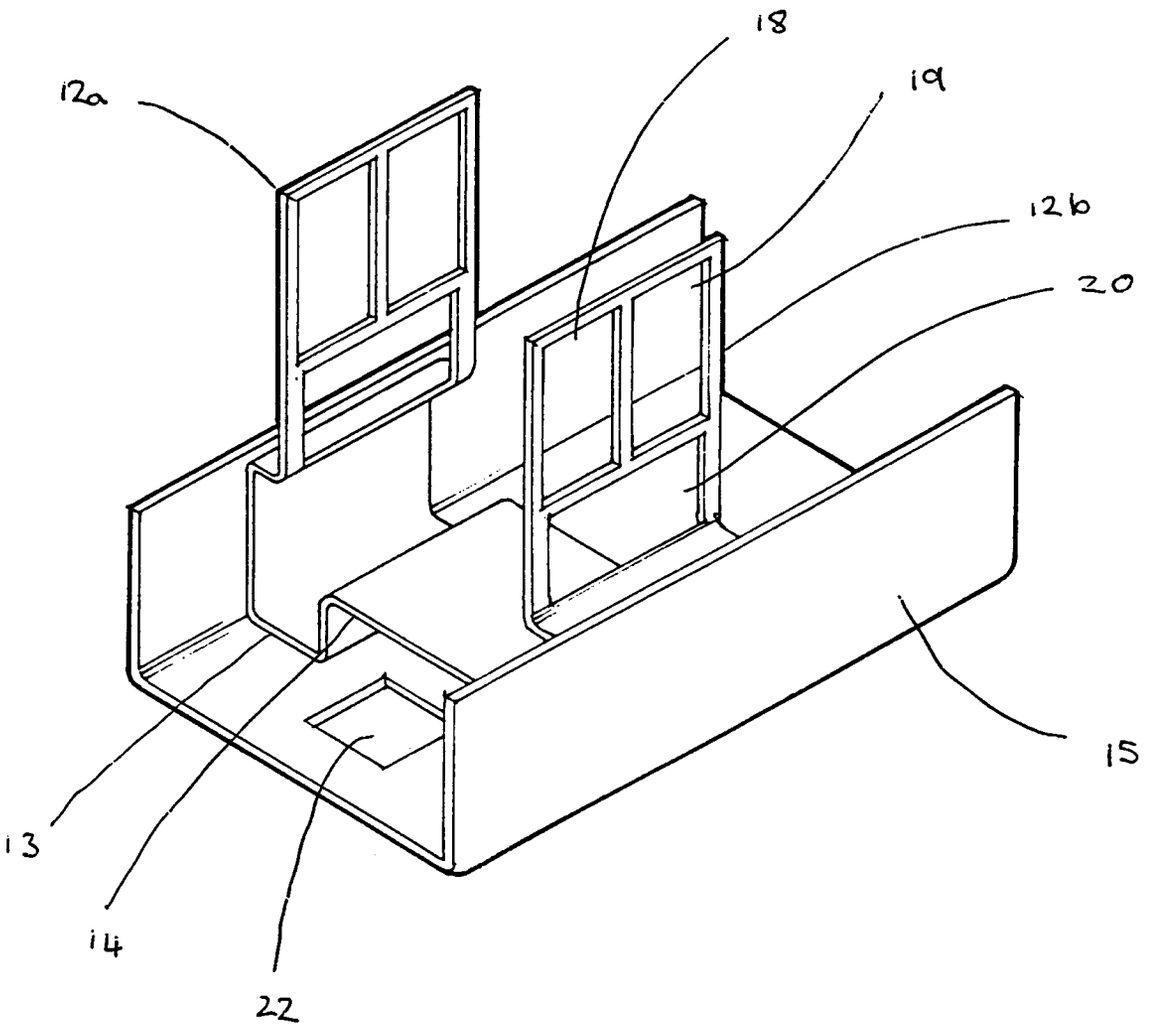


FIG. 3

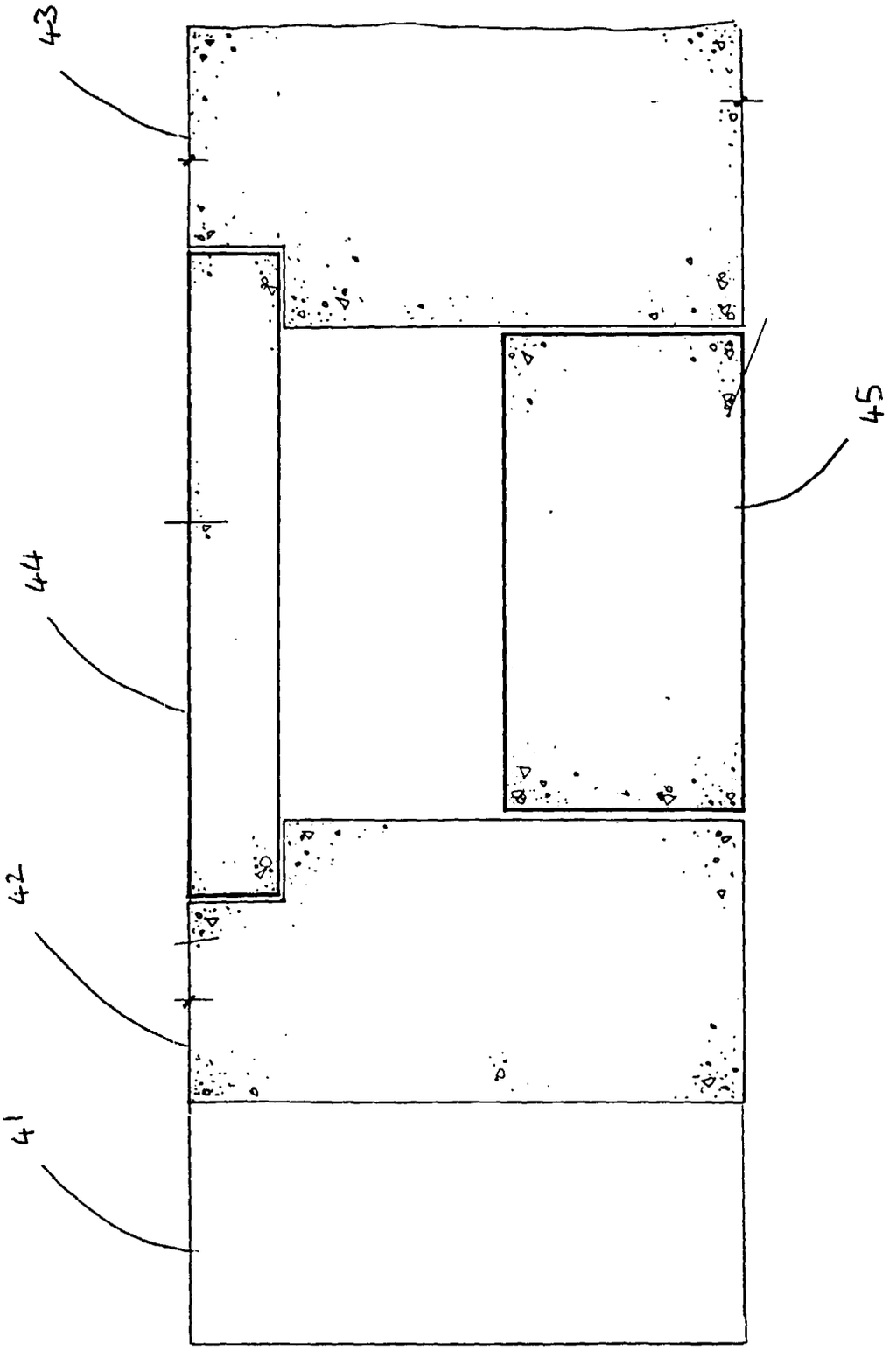


FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 98 20 0702

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	DE 28 43 324 A (C.B.B.S.) 7 June 1979 * page 13, line 7 - page 17, line 6; figures 1-4 *	1-5	E04C2/04 E04C2/288
Y	GB 598 690 A (MALTHOUSE) * page 3, line 11 - line 81; figures 1-4 *	1-5	
A	US 4 117 639 A (STEENSON ET AL.) 3 October 1978 * figures 1,3 *	6,7,12	
A	US 3 979 863 A (HURLEY ET AL.) 14 September 1976 * figure 1 *	1,11,12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 August 1998	Mysliwetz, W

CATEGORY OF CITED DOCUMENTS

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