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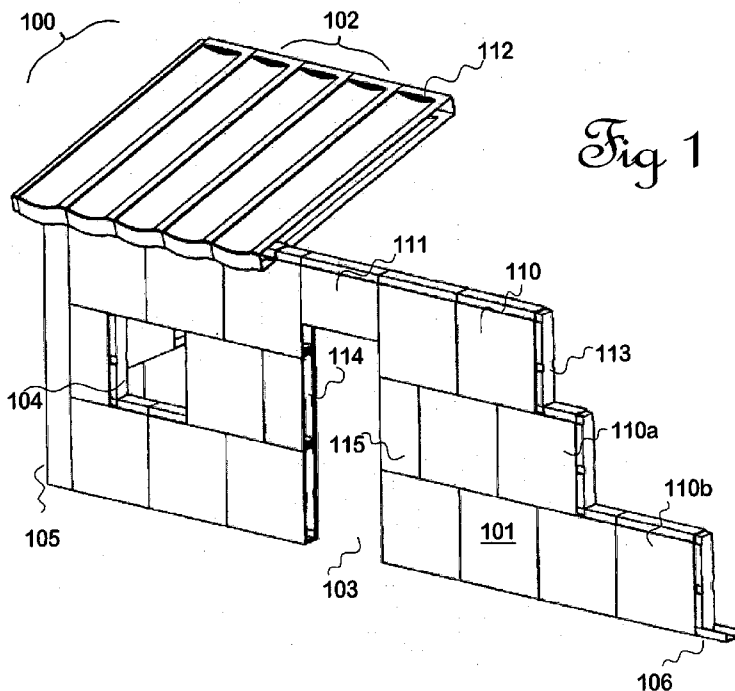
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(54) Title: INTERLOCKING BLOCKS AND TILES FOR BUILDINGS



(57) Abstract: A set of prefabricated, interlocking plastics components for construction of a building of any shape is described. The components are preferably rotationally moulded or extruded as regular shapes (rectangles, triangles or hexagons) from thermoplastics materials. Moulding allows each component to be comprised of more than one region or layer of material, or to include a void. The building can be carried to a site as individual or aggregated components as dictated by the transport facilities available, then erected at the site. Disassembly is facilitated if non-adhesive fasteners are used to secure the tongue and groove joints.

WO 2014/014366 A1

TITLE: INTERLOCKING BLOCKS AND TILES FOR BUILDINGS.**FIELD:**

The invention relates to buildings; to buildings made from a limited range of modular
5 parts, and in particular to buildings made from interlockable modular parts formed from a
plastics material by a rotational moulding process.

BACKGROUND

The inventor has previously described buildings, such as dwellings, made from a plastics
material by a rotational moulding process in a large oven holding a heated mould that is
10 rotated in one axis only, while feeding a flow of a selected type of plastics granule (to set
solid or to set as a foam) into the interior of the mould. Such an oven can produce a round
building several metres in diameter and several metres off the ground, as a single item.

The inventor has previously described unitary parts for buildings made of fused plastics
by rotational moulding techniques but the shapes of the parts were generally dictated by
15 the shape of the rotating oven and retained curved or circular forms, rather than by
following the usual building conventions that seek rectangular or cubic modules, like
bricks, for assembling rectangular buildings of unlimited size. For example, in
WO/2008/133535 the Applicant described “ a bell-shaped product capable of conversion
into a dwelling is made in this manner inside a metal mould, open at one end and slowly
20 rotating about a horizontal axis in an oven”. That is a 2 metre diameter oven.

The prior-art finished structures retained dimensional limits of the rotating ovens. In
WO2010/036130 the present Applicant described a single-axis rotational moulding
apparatus which conveniently forms planar or curved three-dimensional shapes of
plastics, suitable as modules for buildings. An erectable, demountable building made of
25 such modules may be shipped in the disassembled state and then erected by untrained
personnel on a site. The modules may be made of wood or plastics. Preferred modules are
made by rotational moulding and include insulation-filled cavities serving as thermal
insulation. A further oven is used to fabricate large cylinders. After removal the hot
cylinders are flattened into sheets of plastics material for use as flooring.

30 **PROBLEM TO BE SOLVED:**

If the inventor's prior-art process could be modified so that it produced moulded and inter-joinable cubic structures resembling bricks or concrete blocks, a builder could construct a building having dimensions that "escape" the dimensions of the oven.

OBJECT

35 An object of the present application is to provide a quickly, simply and easily constructed building at a site, or at least to provide the public with a useful choice.

SUMMARY OF INVENTION

In a first broad aspect, the invention provides interlockable components comprising a mutually interlockable set for use in building construction wherein each component of the
40 set has an exterior comprised of a fused thermoplastics material and an interior; each component conforming to standardised dimensions at least with respect to a complementary interlocking portion, the set of components including:

rectangular wall panels; the panels being interlockable in two perpendicular axes;
rectangular outer wall panels having a domed external surface; the panels being
45 interlockable in two perpendicular axes;
rectangular outer wall panels having an environmentally resistant external surface; the panels being interlockable in two perpendicular axes.

Preferably any interlockable component for use as part of a set as previously described in this section uses tongue and groove complementary joints having standardised,
50 compatible dimensions along mating edges of the component, said joints comprising the interlocking portions; said joints being capable of being joined together by adhesive or physical fastening means.

In a related aspect, a further range of components compatible with the interlockable component as previously described in this section are selected from a range including:
55 interlockable corner pillars; interlockable rectangular full-height wall panels;
interlockable elongated roof tile panels; window frames; door frames; panels having an integrated window within an aperture; panels having a gap into which a window frame may be inserted; and panels which when interlocked form a gap into which a window may be inserted.

60 In a major aspect, any interlockable component as previously described in this section is comprised of fused together thermoplastics granules having at least a first composition; the component having been melted together within a heated mould.

In a first related aspect, an external layer of the component is entirely comprised of a fused mass formed by heating and melting a first selected composition including a first type of non-foaming type of thermoplastics granule within a heated mould during rotation of the mould; the external layer surrounding a void.

In an option of the first related aspect, a portion of the external layer of the component is comprised of a fused mass formed by heating and melting a second selected composition including a non-foaming type of thermoplastics granule within a heated mould while not fully rotating the mould; the external layer surrounding a void.

In a second related aspect the void within the component is optionally filled with a fused, foamed mass formed by subsequent introduction of a foaming type of thermoplastics granule into the heated mould so that, after moulding, the foamed mass is contained within a non-foamed external mass, together comprising the interlockable component.

In a second broad aspect the invention provides a method for manufacturing interlockable building components; the method including the steps of:

creating an openable and releasable mould for each distinct shape of component,
heating an oven to a working temperature,

loading each mould with an amount of a thermoplastics material preferably as granules,

placing each mould in the oven while rotating the mould so that all parts of the mould are internally coated with the thermoplastics material,

after a time removing each mould and allowing it to cool,

opening the mould,

and optionally trimming each component so that its dimensions are controlled.

In a third broad aspect the invention provides a interlockable range of components; each component having an exterior comprised of a fused thermoplastics material and an interior; each component conforming to standardised dimensions with respect to a complementary interlocking component, but in contrast to the first broad aspect the components are selected from a range of non-rectangular blocks including a set of components having a triangular outline and a set of components having a hexagonal outline; said blocks being interlockable by tongue and groove joining means provided along each of the edges.

- Preferably the components are held together at the joints with one or more of the
- 95 following fastening means:
- a) Physical fasteners which traverse the joint, thereby holding the components to each other,
 - b) Physical fasteners moulded into the joints, selected from a range including mating lugs and sockets,
 - 100 c) Plastics glues selected from a range including solvent glues, two-part glues such as epoxies, and glues which become active when dried,
 - d) Localised application of heat, thereby locally melting the components on to each other, including heat from a heat gun, from an ultrasonic generator, from an included hot wire, or from a reversibly penetrating hot object.
 - 105 e) Preferably the physical fasteners are capable of being undone, so that after a period of use a fabricated building may be disassembled and removed.

PREFERRED EMBODIMENT

The description of the invention to be provided herein is given purely by way of example
110 and is not to be taken in any way as limiting the scope or extent of the invention.

Throughout this specification unless the text requires otherwise, the word "comprise" and variations such as "comprising" or "comprises" will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. Each document, reference, patent application
115 or patent cited in this text is expressly incorporated herein in their entirety by reference. Reference to cited material or information cited in the text should not be understood as a concession that the material or information was part of the common general knowledge or was known in New Zealand or in any other country.

DRAWINGS

120 Fig 1: shows an oblique perspective view of part of a building illustrating the major components.

Fig 2: shows a different aspect of that part of a building.

Fig 3: (as Figs 3a, 3b and 3c) illustrates an example half-height block. Fig 3d shows a block in cross-section.

125 Fig 4: shows detail of a screwed joint.

Fig 5: shows detail of a roof tile; lateral view.

Fig 6: shows detail of a roof tile; underneath view.

Fig 7: shows detail of a roof tile, from the downward side.

Fig 8: shows detail of a corner pillar from the groove joint side.

130 Fig 9: shows a triangular wall block having two tongue sides and one groove side.

Fig 10: shows part of a polyhedral enclosure suitable for use as a dwelling and made of tiles such as shown in Fig 9.

Fig 11: shows an isometric view of full panel height components.

135 Fig 12a and 12b show in elevation and plan a small building constructed from full panel height components of the types shown in Fig 11.

Fig 12c illustrates the building of Figs 12a and 12b in exploded view.

EXAMPLE 1

Each member of the set of interlockable components for use in the construction of a
140 building is, according to the invention, comprised of fused thermoplastics material.

Preferably all parts are manufactured by forming in a single-axis rotational moulding type process within moulds. Movements other than simple single-axis rotation may be used.

The interlockable components provide a set of rectangular or cubic interlockable wall blocks rather like bricks or concrete blocks, including a set of half-sized blocks, a set of
145 corner pillars, and a set of roof panel tiles that are intended for use in the construction of a building. Each component conforms to a set of mutually standardised dimensions at least with respect to an interlocking or joining portion of each component. It is also convenient for those standardised dimensions to conform with local building practices. It is preferred that all parts in the range can be joined together at compatible interlocked joints. They
150 share a common coupling means or joint mechanism, having consistent dimensions. The parts in the range include half-size and full-size wall blocks, corner pillars and door or window frames, and roof tiles. The parts may be approximately square or may be elongated such as those shown in Figs 11 and 12 - a, b and c. Note that the preferred elongated roof tiles are only partially "cubic" because each tile includes a dished cross-section. The tiles are intended for side-by-side assembly with the channel of each dish
155 directed downwards.

Each member is made by rotational moulding techniques within moulds and hence is comprised of a compatible thermoplastics material. An example fusible plastics material is a polyethylene plastics material; for example ICORENE 3840 made by ICO Polymers, Inc of 6355 Farm Bureau Rd, Allentown, PA 18106, USA. This is a Linear Medium Density Polyethylene plastic material. Various resins with different characteristics may be used, such as alloys based on the same ethylene with varied co-monomer (hexene, butene or octene) raw materials, as is known to those skilled in the art. Such materials are obtainable in both solid-setting and foam-setting versions. Preferred moulding temperatures are between 180 and 280 degrees Celsius. The preferred single-axis rotational moulding process has been described in at least PCT/NZ2008/000096 (WO/2008/133535), in which the present applicant has developed the capabilities of the generic rotational moulding process towards making large, flattened or angled sheets of materials including more than one layer of plastics. A typical component that has been made in this way has a hollow or attenuated centre surrounded by a tough, formed skin which had been in contact with the walls of the mould and is suitable for internal or external exposure. The hollow or attenuated centre may be occupied by thermal insulation which may be comprised of a space or be filled with a less dense, foamy yet rigid fused thermoplastics material made from a foam-generating type of granules. The space may contain a stored liquid. Of course, components made by other processes or made from natural products such as wood may be incorporated with the rotationally moulded components. Optionally each tile is provided with internal insulation means selected from a range including a more foamy plastics material, animal or vegetable fibre, or rock or glass wool.

180 **WALL COMPONENTS**

Figs 1 and 2 show oblique perspective views of part of a building 100, made from components created in a rotational moulding machine. The roof 102 is incomplete, for the purpose of illustration. There is a channel 106 (fig 2) that provides a footing for the wall, which might be formed in concrete or in metal. The walls 101 (and 101A in Fig 2 only) are comprised of an array of interlockable rectangular blocks for example 110, 110a and 110b as detailed below, which are fitted tightly together during assembly by tongue 113 and groove 114 joints (details of which are given below) in order to make a sufficiently large plane surface wall. Fig 1 shows an opening 103 for a door and another opening 104 for a window. The door has a lintel comprised of a half-height block 111. That block has tongues on each side (not shown) . All borders of the door are groove joints, as shown in

Figs 1 and 2. A corner pillar 105 – see also fig 8 - is a length of material fitted with sufficient tongue joints along one side and groove joints along another side to accommodate the joints of several blocks; such as a three-high stack. The corner pillar separates wall 101 from another, end wall 101A in a perpendicular plane. Half-width blocks 115 are used alternately to commence every second course of wall blocks since the usual method of construction, like a brick wall, uses overlapping courses of unit blocks in order to provide strength. This assembly as described does not include internal vertical concrete and iron bar strengthening although holes could be bored through the hollow or attenuated centres and parallel to the outer walls, for insertion of steel or other tensile rods if required by a building code. The wall is seated upon a channel member 106. A roof 102 is comprised of an array of elongated roof units, as detailed below.

Fig 2 shows the same assembly from a different viewpoint, and identifies wall 101A.

Fig 3 (as Figs 3a, 3b and 3c) provides dimensional details and detailed orthogonal views of an example half-width (800 x 400 mm) block. It should be noted that the dimensions (given here in millimetres) corresponding to a series of standard blocks presenting an exposed surface of 800 x 800 mm are by way of example only, and do not in any way limit the range of sizes to be provided for by the invention. For instance dimensions may be arranged to correspond with the popular 1.2 metre multiples commonly used by builders, although the 800 mm size conforms to a typical door width. The popularity of any one size may in part be dictated by the cost (which may be affected by a rejection rate) of manufacturing individual units. The depth or height of the joints is partially affected by a desired final assembly strength. Preferably the depth of a groove is slightly greater than the height of a tongue.

One preferred style of block is moulded so as to be substantially hollow.

Details of a preferred joint arrangement will now be described. Fig 3 includes example measurements in millimetres for parts 3a and 3b. Fig 3(a) is an edge elevation view of an interlockable block version along one edge, wherein 301 is a groove or recess across the face extending towards a viewer out through the plane of the drawing.

The dimensions given, by way of example only, in this drawing show: An 800 x 400 (usable area) block which has a thinner tongue extending from two adjacent edges by 70 mm. The thickness of the block is 170 mm; the thickness of the tongue is 148 mm, leaving 10-11 mm on each “tongue cover” around the 70 mm deep recesses on the other two adjoining edges. These tongue dimensions are adequate for the material from which the blocks have been constructed – namely a fused thermoplastics material.

225 When in use each recess would receive a tongue 306 of an adjacent block. 300 is a groove
along an edge for receiving a tongue 305 from another block. Blocks may be glued
together although they may also be screwed together for the benefit of easier installation
and easier disassembly (see later). 302 is one face, perhaps an outer face, of the block and
304 is the other, perhaps inner face. (In general both faces will be interchangeable,
230 although it may be preferred that the face intended for exposure to weathering will have
an included dye or pigment, or other additives for extending the life of the block when
exposed to weathering. The inventor's moulding process provides a step for applying a
different thermoplastics mixture to each side.) 303 indicates an indexing groove, which
receives an inwardly protruding tongue of another block. This is mainly useful during
235 assembly as a temporary locating means. Fig 3(b) shows a tongue 306 across the face of
the opposite edge elevation of a block and extending towards a viewer out through the
plane of the drawing.

Fig 3c is a face view of a typical block, showing dimensions, and provision of tongues
along two adjoining edges. 302 is one face of the block. 305 and 306 are two tongues.

240 Fig 3d shows a preferred domed surface 307 on the outer (exposed) surface of a cross-
sectioned wall block. This dome, formed by a dished shape in one face of the mould,
provides for controlled thermal expansion of the dome when heated, such as by sunlight.
If the outer surface is left flat then expansion and contraction are not controlled and the
entire block may bend. Materials thickness may be exaggerated in this section. Other parts
245 are as previously identified. The internal void may be filled or partially filled with a
foamed, fused thermoplastics mass.

ROOF (TILE) COMPONENTS

Figs 5, 6 and 7 show a single one of the array of roof tiles 112 that form the partially
250 completed roof 102 of the building in Fig 1. Fig 5 is a longitudinal section, showing the
hollow interior 506 of the roof tile which is adapted for side-to-side joining of an array of
such tiles and fastening as described elsewhere in this section. Each of these tiles is
intended to span over half a roof from the ridge along the middle and so the length of the
selected tile determines the size of the room below. However these tiles can be joined end
255 to end; preferably in a waterproof manner and supported on intermediate purlins parallel
to the ridge. Fig 7 shows details of a tile coupling arrangement 502, 505 to be optionally
provided on ends of tiles. Conventional flashing along the ridge of the roof is useful,

depending on the environment. Each tile includes a transverse groove 503 (see Figs 5 and 6) intended to be placed over and attached to the top course of the wall blocks, near the lower end 505 of the tile 112. The angle of this transverse groove, which is formed obliquely into the underside of the tile, partially determines the angle of the tiles from a vertical plane – since as shown in Fig 1 this groove sits over the top of the wall. Fastening as described elsewhere in this section is intended to be used to fix the tiles down to the wall, and at free surface 501, to another array of tiles. The surface facing the sky, 502, is dished inward, partly for strength and partly to assist in water collection. (No gutter arrangement is shown here) The underneath surface shown in fig 6 is dished outward, up from the plane of the drawing. The space underneath the tiles may, during construction, be packed loosely with a fibre such as animal hair or wool that is held in place with (for example) wire netting in order to increase the thermal insulation of the roof.

270 **CORNERS**

An example of a corner pillar 105 is shown in Figs 1 and 2 at 105, and in detail in Fig 8. This example is shown from one side – the “groove” side 114. This drawing shows the essentially hollow nature of the corner pillar which structure can be achieved with rotational moulding, thereby providing a relatively light pillar. The opening 114 might be strengthened for transport with inserted blocks although, once assembled, the edges are held apart from each other by the assembled tongues of the wall tiles (see Fig 3a, 3b or 3c) that are fixed within. The protruding blocks such as 113 are the “tongue” elements intended to mate with corresponding grooves of each of three courses of wall blocks such as 110 in Fig 1.

280 **FASTENERS**

The components are held together with one or more of the following preferred fastening means:

- a. Physical fasteners which traverse the joint, thereby holding the components to each other. This option allows deconstruction after the building has been used in one place, in anticipation of it being needed elsewhere. Fig 4 shows an example of physical fasteners, namely screws 401 and 402 in a section across a joint between blocks 110 and 110a.
- b. Physical fasteners may be moulded into the joints, selected from a range including mating snap-in lugs and sockets. For disassembly, apertures that allow a tool to be inserted and then press back the lugs might be provided (not shown).

- c. Plastics glues selected from a range including solvent glues, two-part glues such as epoxies, and glues which become effective when dried,
- d. Localised application of heat, thereby locally melting the components on to each other, including heat from a heat gun, from an ultrasonic generator, from an included hot wire, or from a reversibly penetrating hot object.
- e. Rope, twine, or plant fibre, or rawhide may be used to bind the structure together. Holes for passing the bindings through the tiles to be bound together are not shown. Such holes may be made during assembly.

The physical fasteners as opposed to adhesives allow for the disassembly of a fabricated building, so that it can be rearranged into another configuration or taken apart and transported to another site.

This invention also provides roof tile components as shown in Fig 5, 6 and 7.

EXAMPLE 2

The previous description assumed rectangular components. If the components are instead triangular blocks, and in particular can be joined together securely yet allowing the surface plane of any one triangular block differs from that of adjoining triangular blocks, it is easy to fabricate polyhedral dwellings as popularised by the architect Buckminster Fuller. They have no distinct roof assemblies. The groove side is placed to face downward in order to facilitate drainage. Fig 9 shows a face view of an example triangular block 900 having two tongue edges 901, 902 and one groove edge 903. About half of the triangular blocks will require one tongue edge and two groove edges. Fig 10 shows a portion of a polyhedral assembly made from triangular blocks 900. The groove aspects of two of the blocks can be seen at 1001, which also show the appreciable thickness of each individual triangular block.

EXAMPLE 3

Example 1 assumed that rectangular components would interlock both horizontally and vertically, like bricks or concrete blocks, to form a desired vertical wall height. The preferred manufacturing process allows many of the components could instead be manufactured as full-panel-height pieces each having the same height as the finished wall. Even as full-height (for instance 2.4 metres in length) the hollow or foam-centered components are not too heavy to carry and to place in position. See Fig 11, which in an “exploded view” depicts two full height wall panel components (120) aligned to interlock

with the corner column (105). A finishing full height component (130) is provided for use where a narrower wall section is desired, for example as a frame for a door or a window.

325 Immediately after extrusion each component may be laid on to a moving flat conveyor belt in order that it can set solid without distortion.

As an illustrative example, a small worker's accommodation built from such full panel height components is shown in Fig 12a (elevation view), 12b (plan view), and 12c as exploded view of components 600. Fig 12c includes: floor panels 122, cutout wall panels

330 121 for use in framing a window, a window lintel 123, a door lintel 111, and two door frame components 130.

METHOD

The principles of this component manufacturing method have been described previously by the inventor, but some modifications, and the shapes of the moulds are novel. An

335 example method for manufacture of interlockable components according to the invention includes the steps of:

- a. making an openable and releasable mould which can conduct heat into the interior for each distinct shape of component, and which maintains access for the introduction of granules into the interior of the mould when being rotated during use;
- 340 b. heating an oven to a working temperature – which is related to a softening temperature for the selected thermoplastic material, typically between 180 and 280 degrees Celsius;
- c. placing each mould in the oven and heating it to a selected temperature;
- 345 d. introducing a first granular non-foaming thermoplastics material while rotating the mould for a time so that all parts of the mould become internally coated with fused thermoplastics material;
- e. optionally then introducing a foam-generating inner thermoplastics material while continuing to rotate the mould so that an inner void within the mould become
- 350 internally coated with the thermoplastics material;
- f. after a time removing each mould and allowing it to cool;
- g. opening the mould;
- h. and optionally trimming at least the mating joint surfaces of each component once moulded and cooled using a cutting tool – such as a saw or an end mill along with

355 a holding vice or jig - so that its dimensions become fully controlled regardless of shrinkage or sagging.

Many of the components described here could not be made in a two-axis, closed mould. The temperature is best set by experience. Too low a temperature will lead to extended fusion times, and too high a temperature causes decomposition of the plastic. The
360 readings are dependent on transducer placement. Of course the temperature also depends on the selected plastics material.

The variation at the step (e) provides each component with improved thermal insulation and extra mechanical strength without much increase in weight.

Another variation at the step (d) includes (d1) placing a first variation of a non-foaming granular mixture on a first face of a tile or the like, fusing it in place while agitating or
365 only partially rotating the mould, and then (step d2) rotating the mould through 180 degrees, introducing a second non-foaming granular mixture into the mould, and then commencing single-axis rotation of the mould, so that the second mixture tends to coat the remainder of the inner surface of the mould. That modification causes the outer
370 surface of the mould to have a different composition, such as one including a pigment (for example titanium dioxide for white, iron oxide for red, or carbon for black.

It will be appreciated that these components are easily stacked for transport, such as on pallets or in containers. The blocks might be made by injection moulding or other methods, rather than rotational moulding.

375 Some of the components, especially the elongated ones shown in Figs 11 and 12 might be made economically by plastics extrusion techniques. In this variation, an extruded box section including the groove joint along two adjacent edges and the tongue joint along one edge is made. Post-processing includes the steps of cutting out squares at for example 800 mm spacings along the box section, inserting and gluing into place a separately made
380 tongue section so that the completed block bears a tongue joint component along two adjacent edges.

VARIATIONS

Doors and windows themselves have not been described, but may be made from plastics or wood or glass, and may be replaced by simple curtains in some circumstances.

385 The channel 106 that provides a footing for the wall may be made from a metal
Exposed surfaces may be painted, for example with white paint for thermal resistance.

In order to reduce the total consumption of plastics, a stone aggregate may be mixed with the thermoplastics material for moulding at least some of the components.

390 Optionally at least some of the components are comprised of a material based on concrete rather than a thermoplastics material.

The blocks might be made by injection moulding rather than rotational moulding.

The blocks might be made by extruding a box section including the groove joint along two adjacent edges and the tongue joint along one edge, and after cutting squares at for example 800 mm spacings along the box section, inserting and gluing into place a
395 separate tongue section so that the completed block bears a tongue joint component along two adjacent edges.

The plane surfaces of the wall blocks previously described in this section may be replaced by curved surfaces; preferably curved in more than one plane at one time, so that increased strength per unit of weight is provided. Apart from the domed walls previously
400 described in this section, one version of this would appear like corrugations with a pitch of perhaps 50 mm.

RESULTS AND ADVANTAGES

This invention provides prefabricated components for buildings, so that a building can be carried to a site as individual or aggregated components as dictated by the transport
405 facilities available, then erected at the site. Optionally, the parts for the building are temporarily attached, but are not fused together permanently, so that the building can be taken down when no longer required, and used again elsewhere.

The inventor believes that these buildings may be of particular use as housing for disaster relief or for providing shelter to homeless persons.

410 Finally it will be understood that the scope of this invention as described and/or illustrated herein is not limited to the specified embodiments.

I CLAIM:

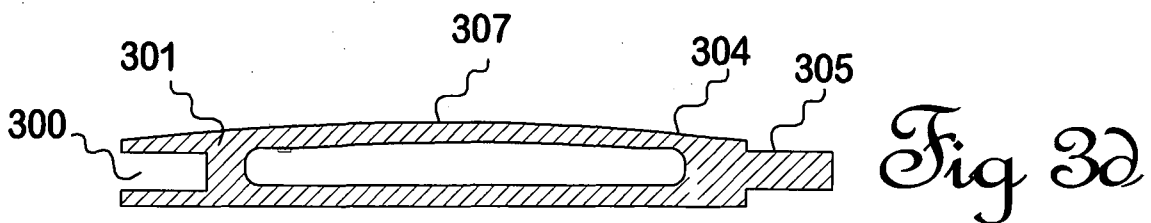
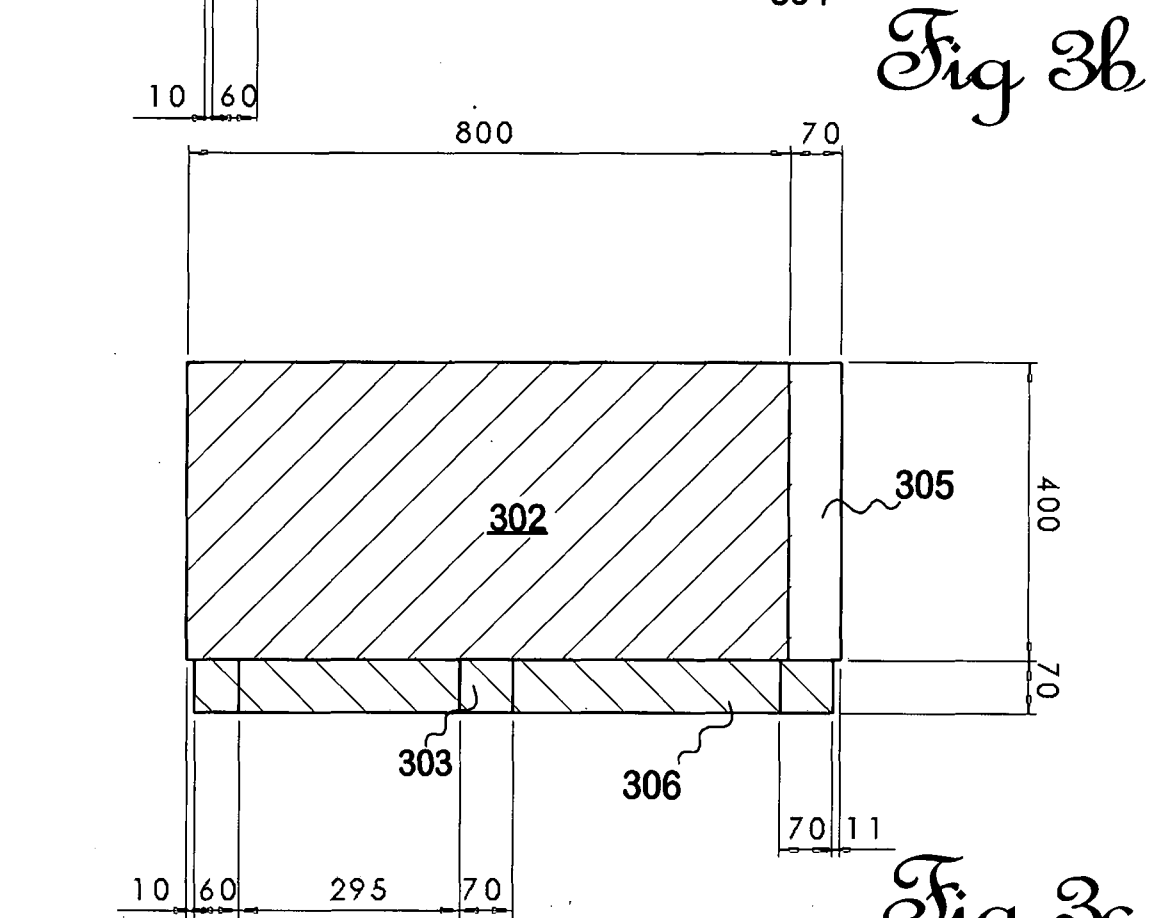
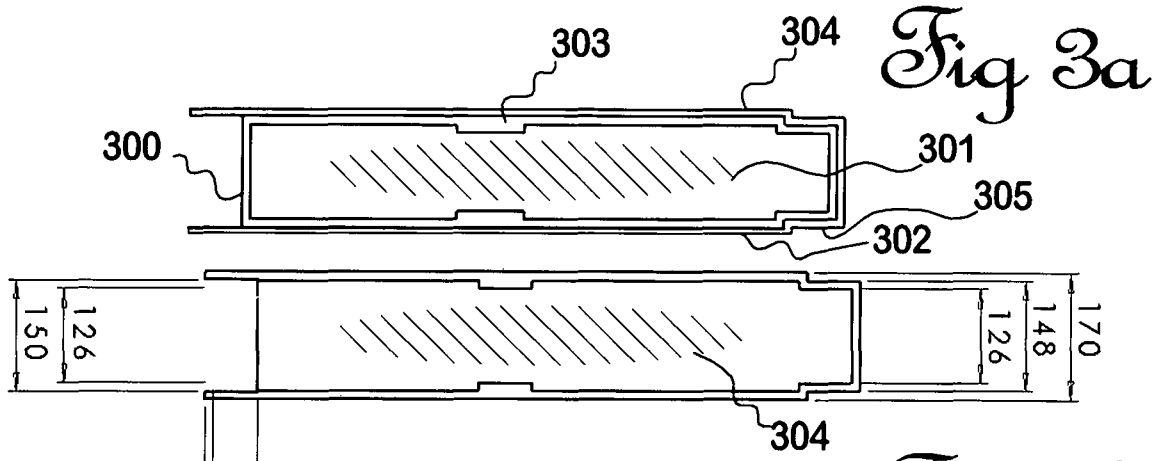
- 415 1) Interlockable components comprising a mutually interlockable set for use in building construction characterised in that each component of the set has an exterior comprised of a fused thermoplastics material and an interior; each component conforming to standardised dimensions at least with respect to a complementary interlocking portion, the set of components including:
- 420 a) rectangular wall panels; the panels being interlockable in two perpendicular axes;
- b) rectangular outer wall panels having a domed external surface; the panels being interlockable in two perpendicular axes;
- c) rectangular outer wall panels having an environmentally resistant external surface; the panels being interlockable in two perpendicular axes.
- 425 2) An interlockable component for use as part of a set as claimed in claim 1, characterised in that tongue and groove complementary joints having standardised, compatible dimensions are provided along mating edges of the component, said joints comprising the interlocking portions; said joints being capable of being joined together by adhesive or physical fastening means.
- 430 3) A further range of components compatible with the interlockable component claimed in claim 2; characterised in that the components are selected from a range including: interlockable corner pillars; interlockable rectangular full-height wall panels; interlockable elongated roof tile panels; window frames; door frames; panels having an integrated window within an aperture; panels having a gap into which a window
- 435 frame may be inserted; and panels which when interlocked form a gap into which a window may be inserted;
- 4) An interlockable component as claimed in claim 2 or in claim 3; characterised in that the component is comprised of fused together thermoplastics granules having at least a first composition; the component having been melted together within a heated mould.
- 440 5) An interlockable component as claimed in claim 4; characterised in that an external layer of the component is entirely comprised of a fused mass formed by heating and melting a first selected composition including a first type of non-foaming type of thermoplastics granule within a heated mould during rotation of the mould; the external layer surrounding a void.
- 445 6) An interlockable component as claimed in claim 4; characterised in that a portion of the external layer of the component is comprised of a fused mass formed by heating

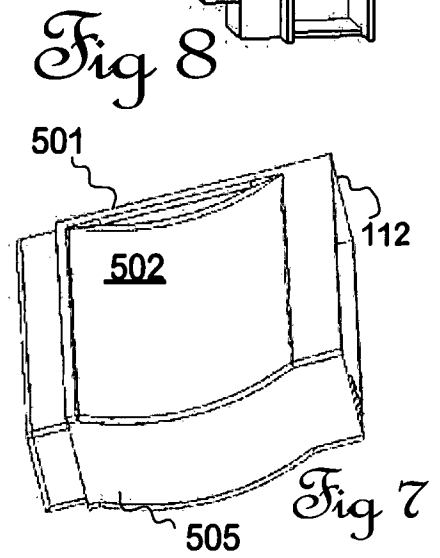
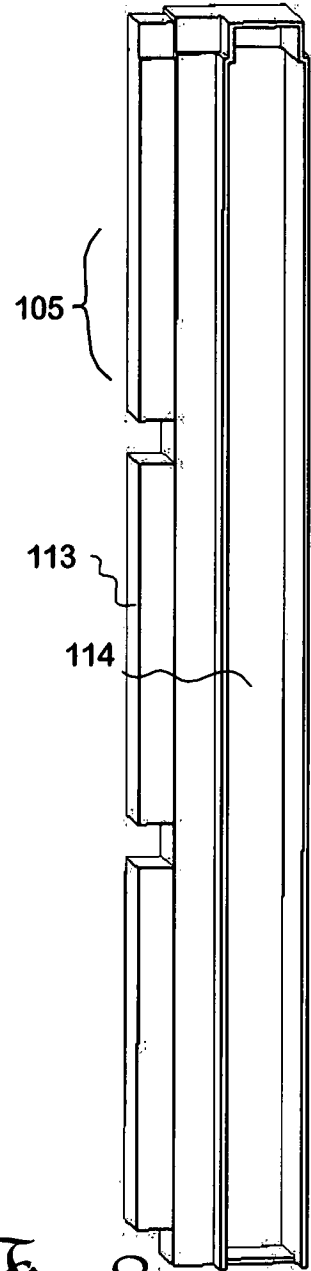
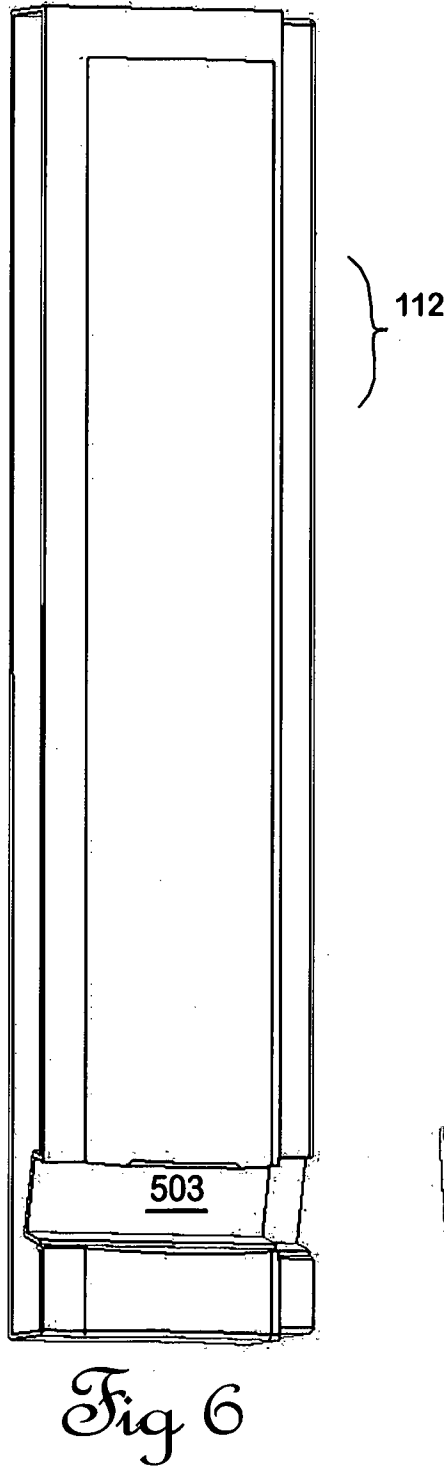
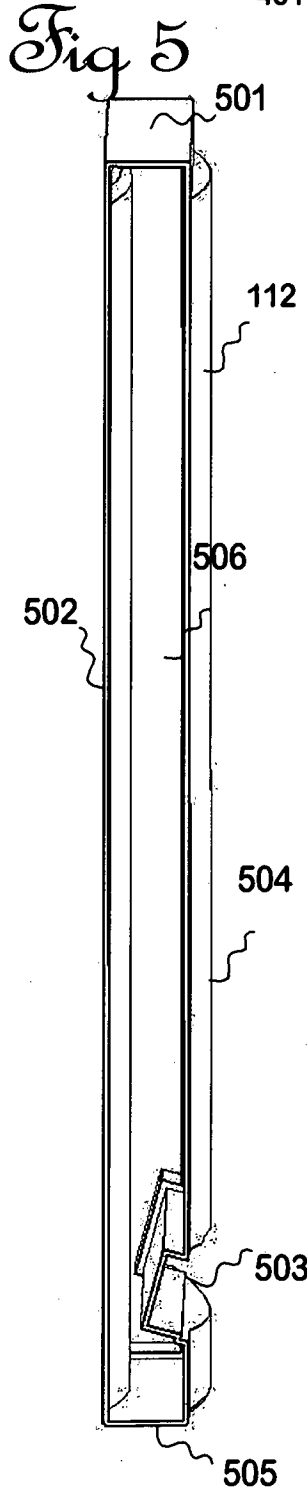
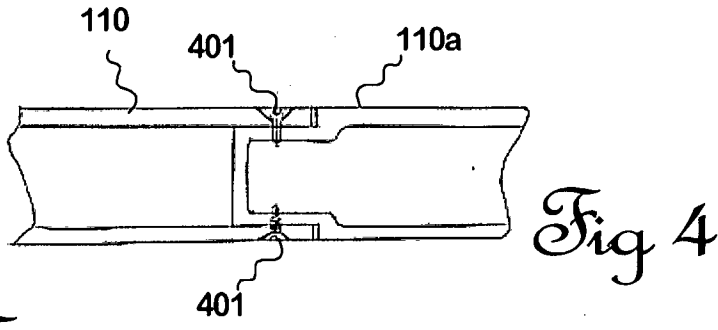
and melting a second selected composition including a non-foaming type of thermoplastics granule within a heated mould while not fully rotating the mould; the external layer surrounding a void.

- 450 7) An interlockable component as claimed in claim 5 or in claim 6; characterised in that the void within the component is filled with a fused, foamed mass formed by subsequent introduction of a foaming type of thermoplastics granule into the heated mould so that, after moulding, the foamed mass is contained within a non-foamed external mass, together comprising the interlockable component.
- 455 8) A method for manufacturing interlockable building components; the method including the steps of:
- a) creating an openable and releasable mould for each distinct shape of component,
 - b) heating an oven to a working temperature,
 - c) loading each mould with an amount of a thermoplastics material preferably as
460 granules,
 - d) placing each mould in the oven while rotating the mould so that all parts of the mould are internally coated with the thermoplastics material,
 - e) after a time removing each mould and allowing it to cool,
 - f) opening the mould,
 - 465 g) and optionally trimming each component so that its dimensions are controlled.
- 9) An interlockable range of components; each component having an exterior comprised of a fused thermoplastics material and an interior; each component conforming to standardised dimensions with respect to a complementary interlocking component, characterised in that the components are selected from a range of non-rectangular
470 blocks including a set of components having a triangular outline and a set of components having a hexagonal outline; said blocks being interlockable by tongue and groove joining means provided along each of the edges.

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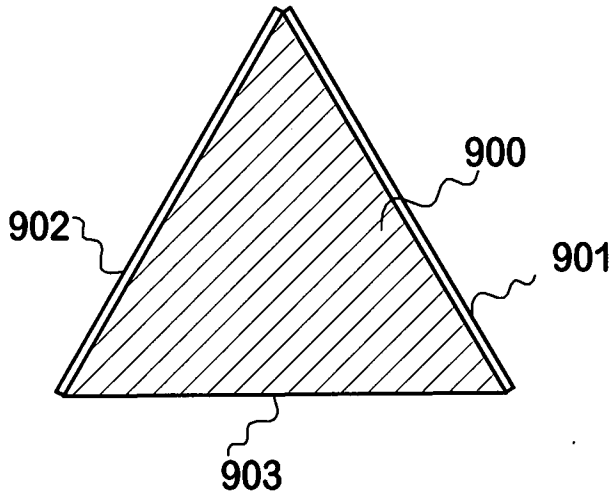


Fig 9

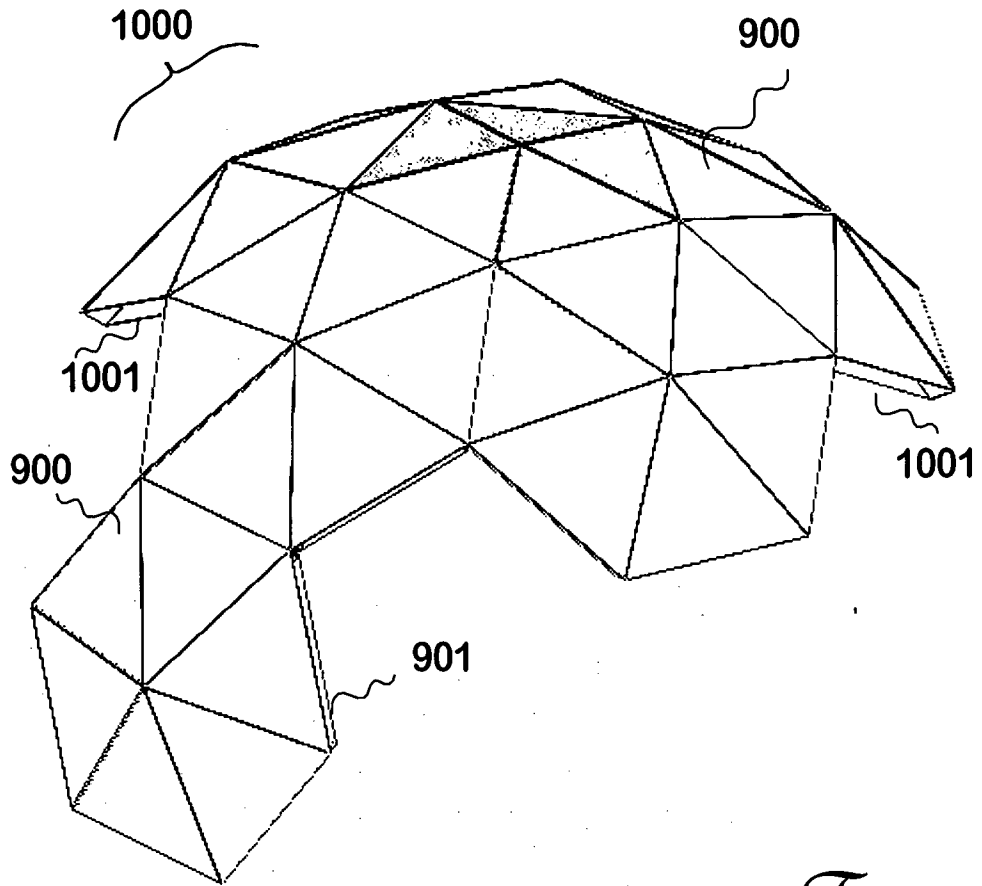


Fig 10

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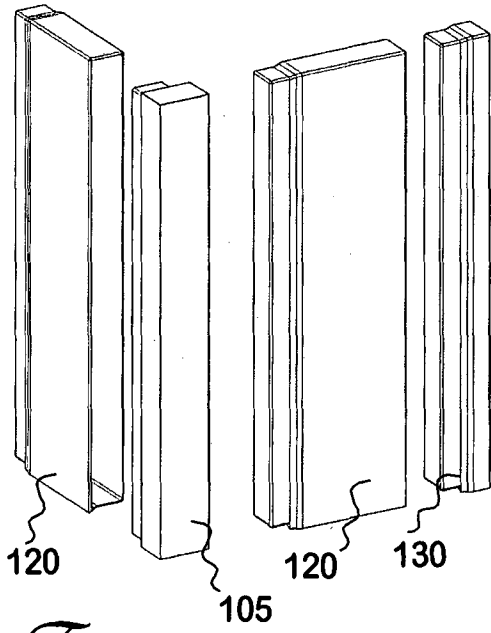


Fig 11

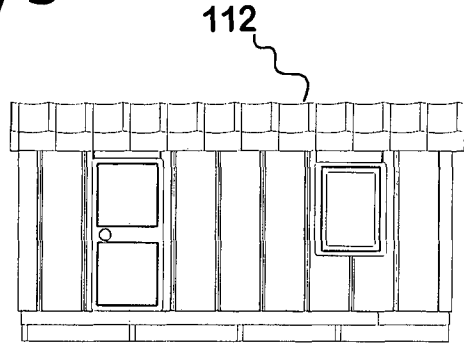


Fig 12a

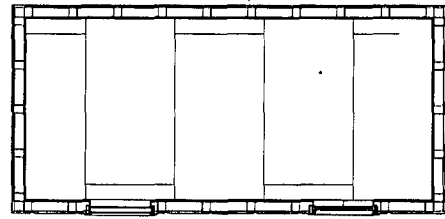


Fig 12b

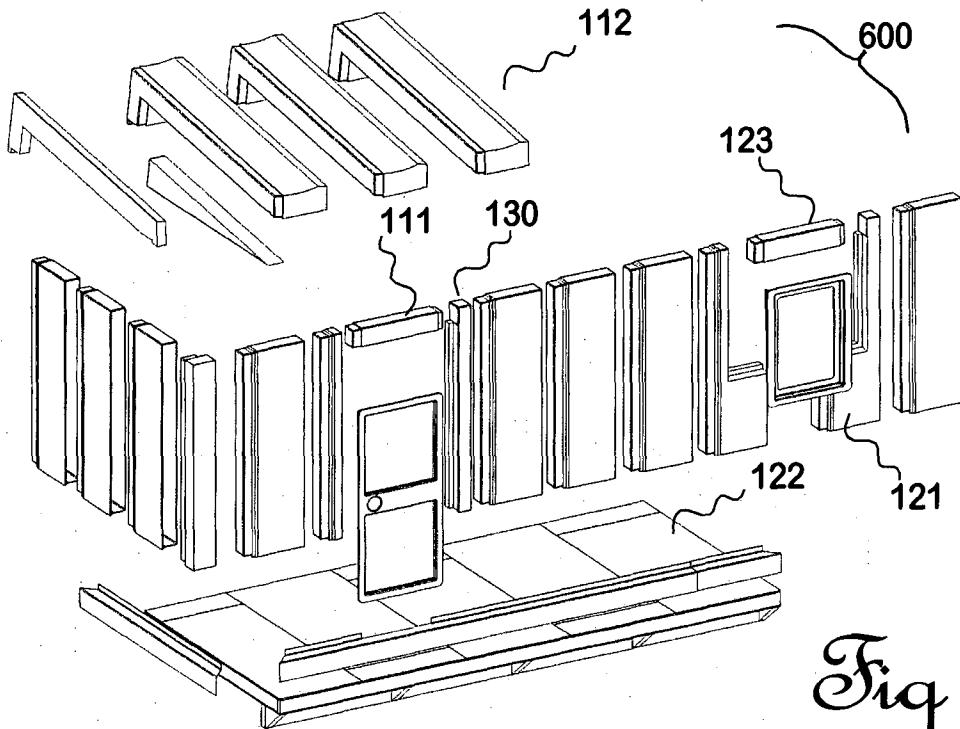


Fig 12c

A. CLASSIFICATION OF SUBJECT MATTER**E04B 1/61(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E04B 1/61; E04B 2/00; E04C 1/4/2; E04C 1/42; E04C 1/00; E04B 5/46; E04B 1/02

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: interlockable component, block, thermoplastic material, rectangular wall panel, and domed external surface

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5904019 A (KOOIJ et al.) 18 May 1999 See column 2, line 28 - column 4, line 64 and figures 1a,3a-3c.	1-3
Y		9
A		4-6, 8
Y	US 5367846 A (VONROENN, JR., KENNETH F.) 29 November 1994 See column 6, lines 15-35 and figures 6-7.	9
A	KR 10-2009-0124644 A (HONG et al.) 03 December 2009 See paragraphs [0052]-[0056] and figures 2-8.	1-6,8-9
A	US 5588271 A (PITCHFORD, PETER R.) 31 December 1996 See column 3, line 62 - column 4, line 65 and figures 1,6.	1-6,8-9
A	US 5033245 A (KLINE, JAMES R.) 23 July 1991 See column 4, line 17 - column 5, line 15 and figures 1,3.	1-6,8-9



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family


Date of the actual completion of the international search

22 October 2013 (22.10.2013)

Date of mailing of the international search report

01 November 2013 (01.11.2013)

Name and mailing address of the ISA/KR


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INTERNATIONAL SEARCH REPORTInternational application No.
PCT/NZ2013/000127**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: 7
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/NZ2013/000127

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5904019 A	18/05/1999	CN 1208802 A EP 0898028 A2 EP 0898028 A3 EP 0898028 B1 JP 04364324 B2 JP 11-131634 A	24/02/1999 24/02/1999 23/02/2000 09/11/2005 18/11/2009 18/05/1999
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KR 10-2009-0124644 A	03/12/2009	None	
US 05588271 A	31/12/1996	WO 93-15286 A1	05/08/1993
US 5033245 A	23/07/1991	EP 0438110 A1 EP 0438110 B1 EP 0452879 A1 EP 0452879 B1 JP 05-098730 A JP 05-222801 A US 05033245 A US 05038542 A	24/07/1991 06/04/1994 23/10/1991 29/06/1994 20/04/1993 31/08/1993 23/07/1991 13/08/1991