

(12) UK Patent Application (19) GB (11) 2 365 454 (13) A

(43) Date of A Publication 20.02.2002

(21) Application No 0018959.7

(22) Date of Filing 02.08.2000

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(51) INT CL⁷
E04C 2/288 , B28B 23/00

(52) UK CL (Edition T)
E1D DCF D1073 D2145 D401 D405 D406 D414 D421
B5A AB17 A1R150 A1R214F A1R314C1D A1R455
A2E12C A20T3

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(58) Field of Search
UK CL (Edition S) **B5A AB12 AB13 AB17 AB19 , E1D**
DCF DLCHW DLCQW DLEHW DLEQWNV
INT CL⁷ B28B , E04C
ON - LINE: EPODOC, PAJ, WPI

(54) Abstract Title
Load bearing GRC panels and building made therefrom

(57) A load bearing panel is made by inserting glass reinforced concrete into a mould to a predetermined thickness, placing a rib template of expanded polystyrene 12 in the mould and covering this with further GRC to form a strengthening rib in the panel. In the construction of a building, corner panels (Fig 8, not shown) are attached to a foundation and wall panels are fixed between the corner panels, e.g. by bolts passing through holes 14 in peripheral ribs. Gable end panels and roof panels all of similar GRC construction are attached above the walls to complete the roof.

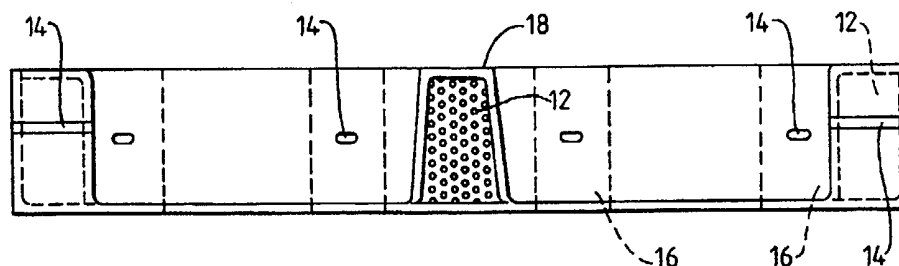


FIG. 2

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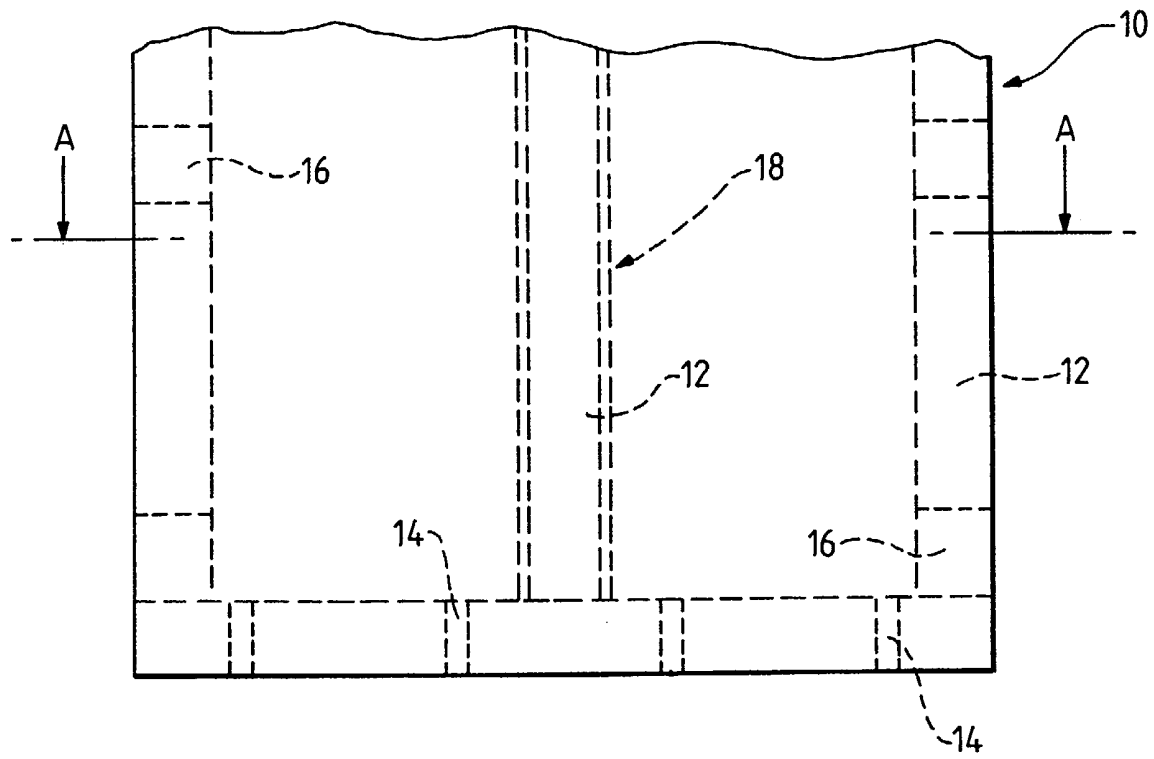


FIG. 1

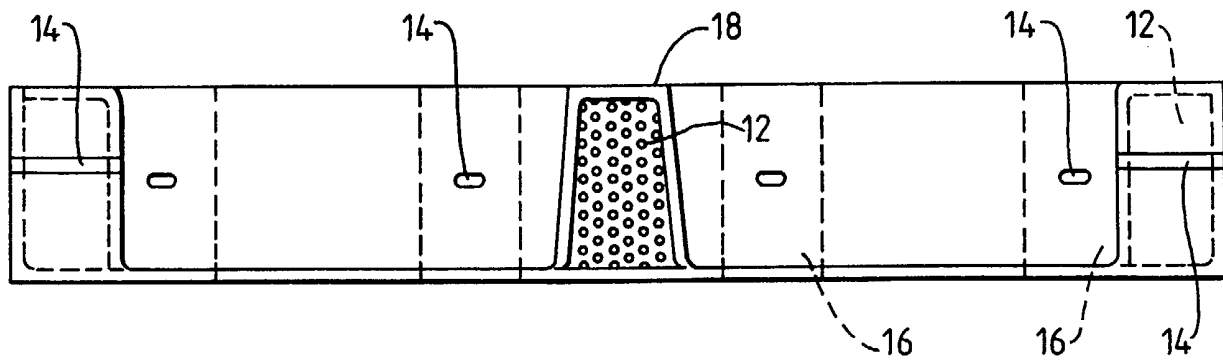


FIG. 2

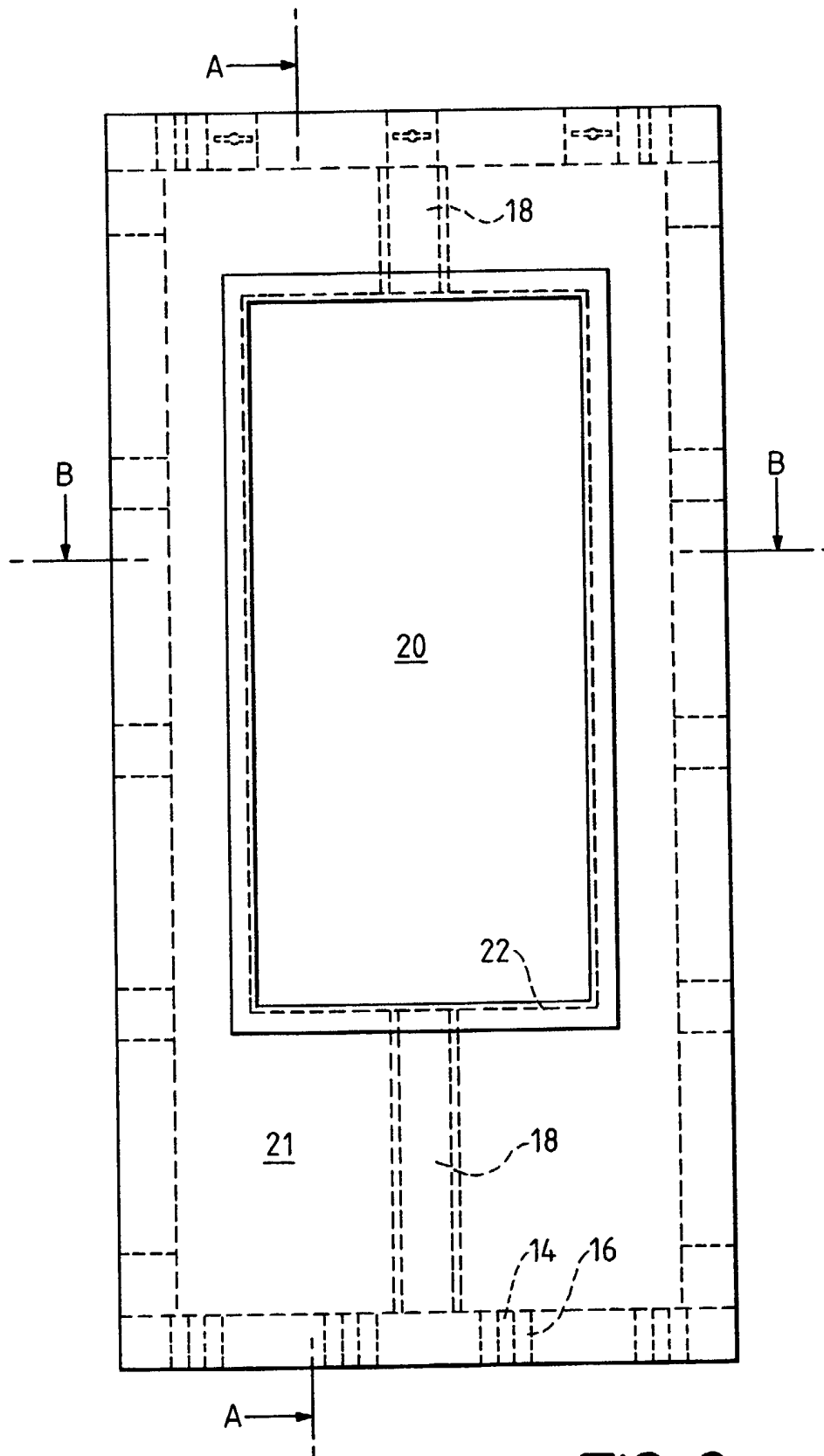


FIG. 3

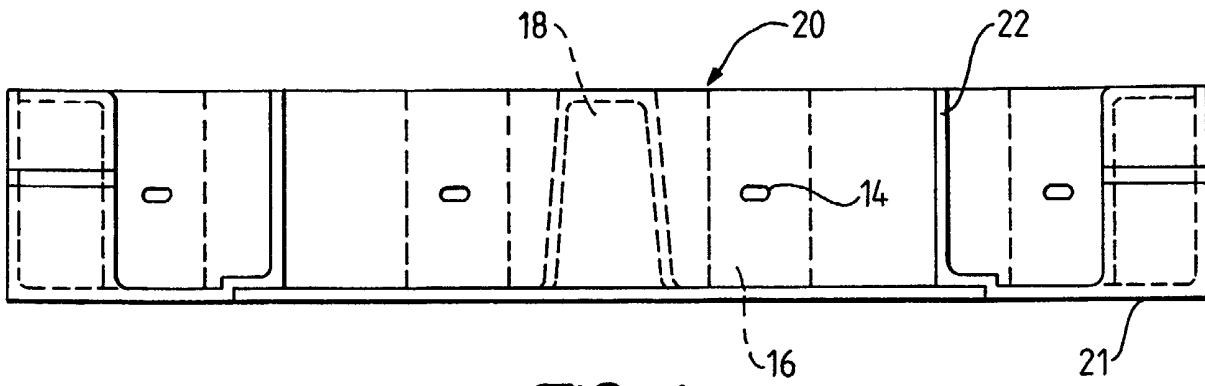


FIG. 4

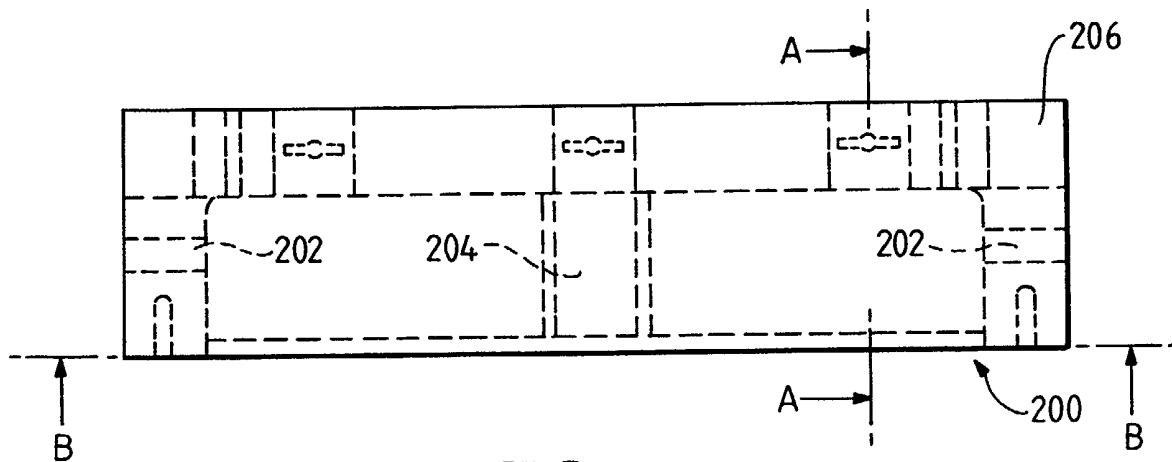


FIG. 4A

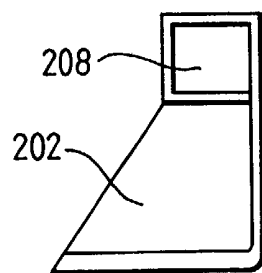


FIG. 4B

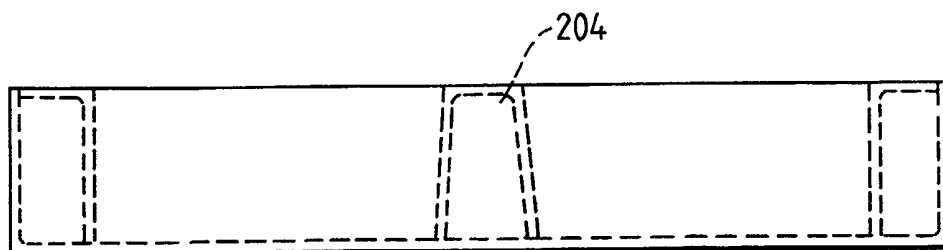


FIG. 4C

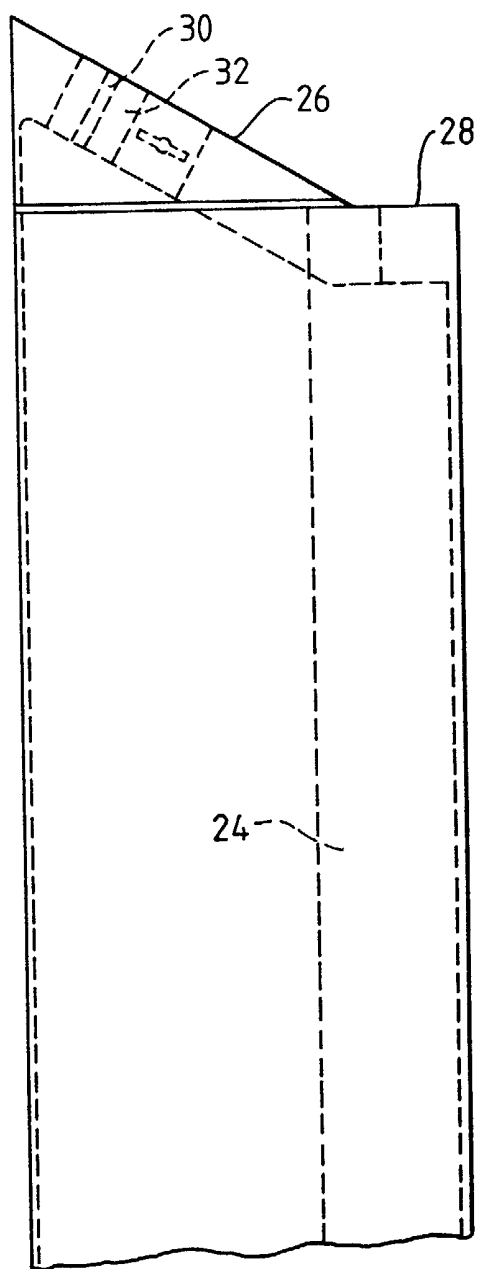


FIG. 5

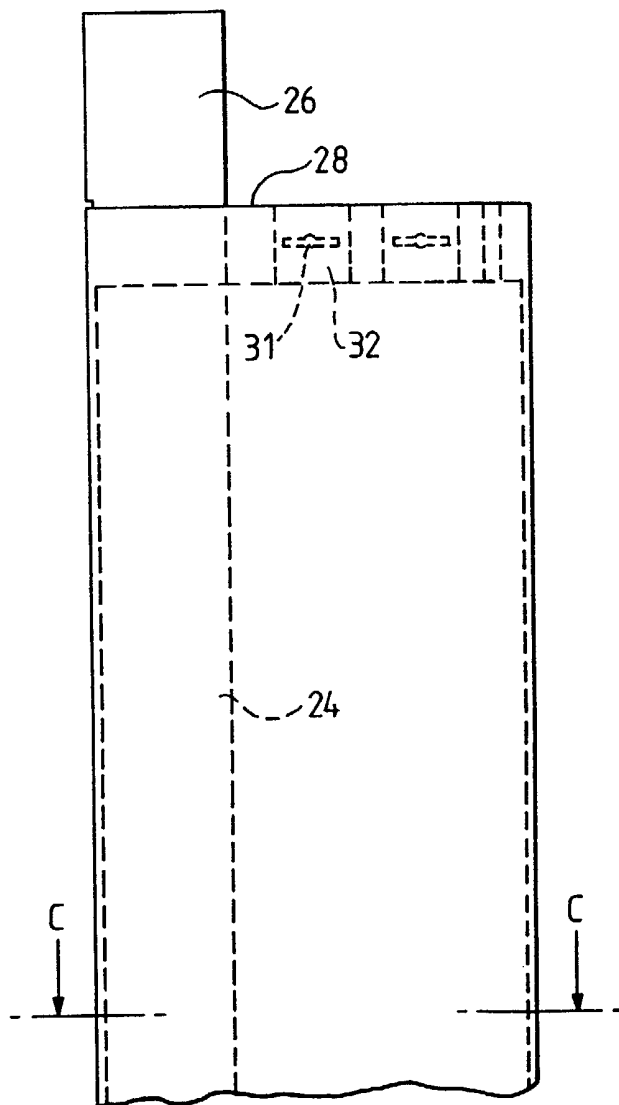


FIG. 6

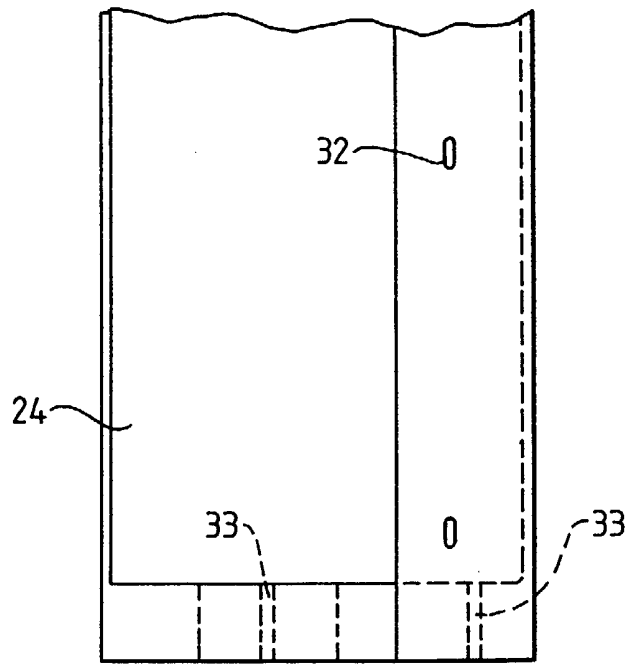


FIG. 7

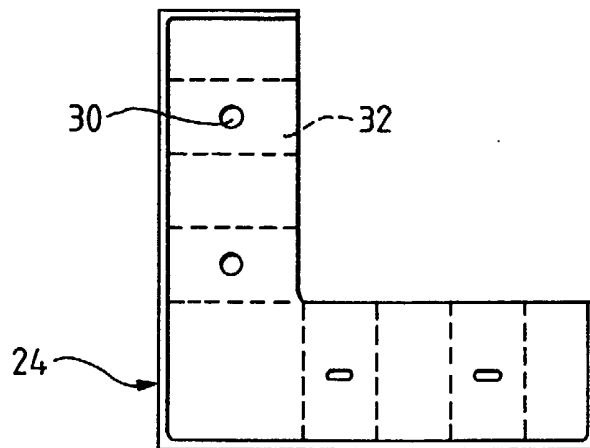
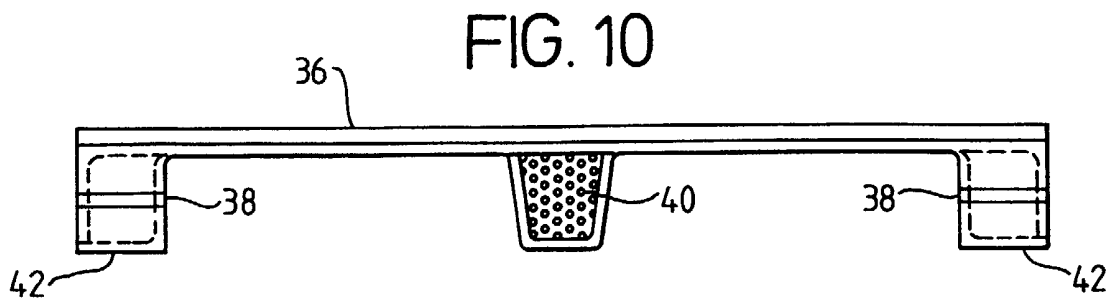
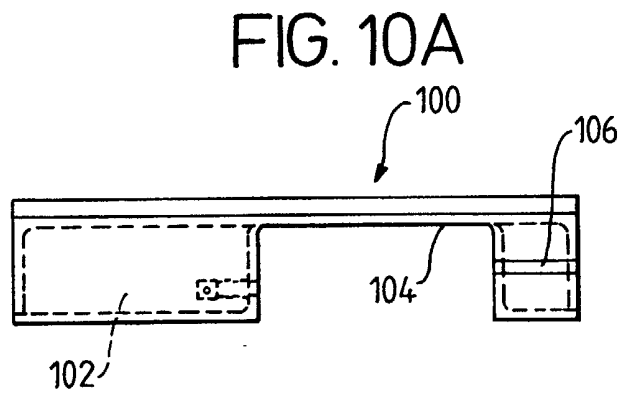
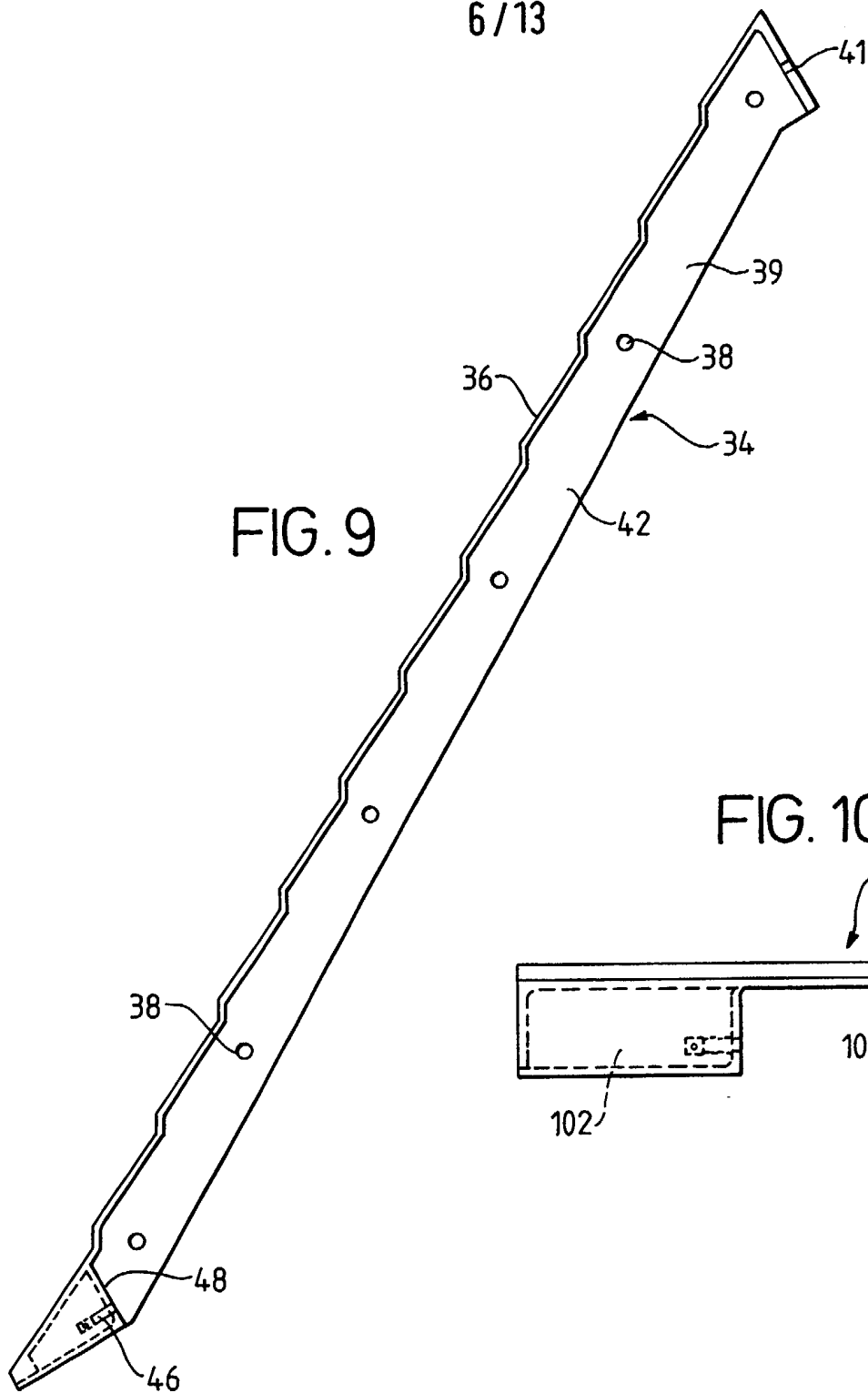


FIG. 8



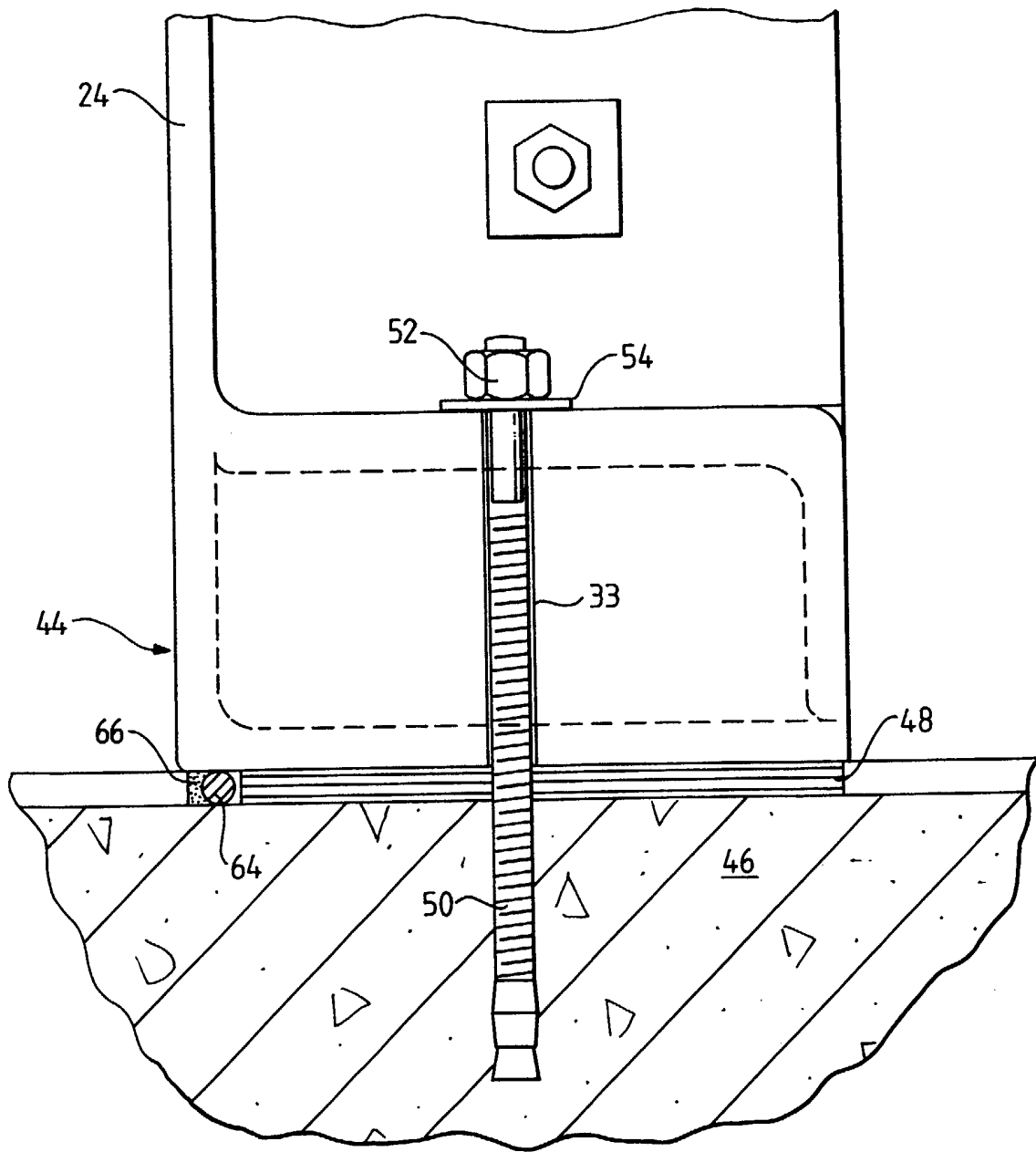


FIG. 11

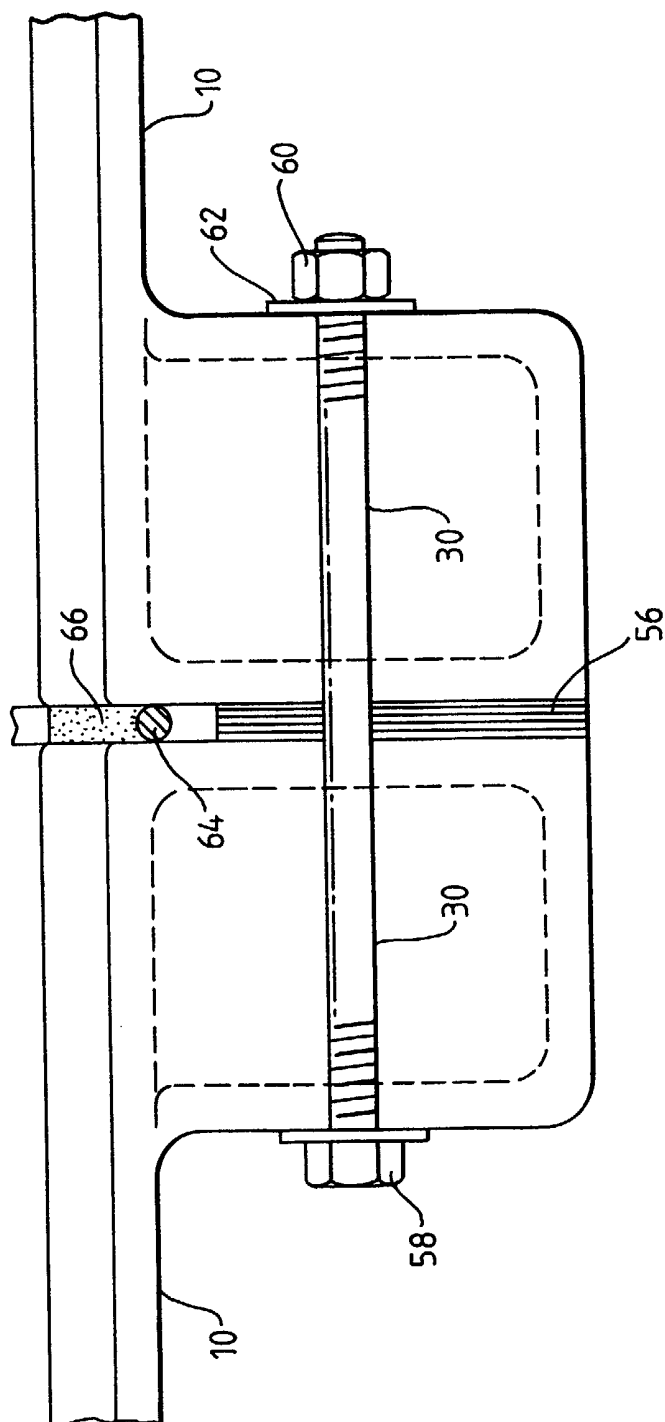


FIG. 12

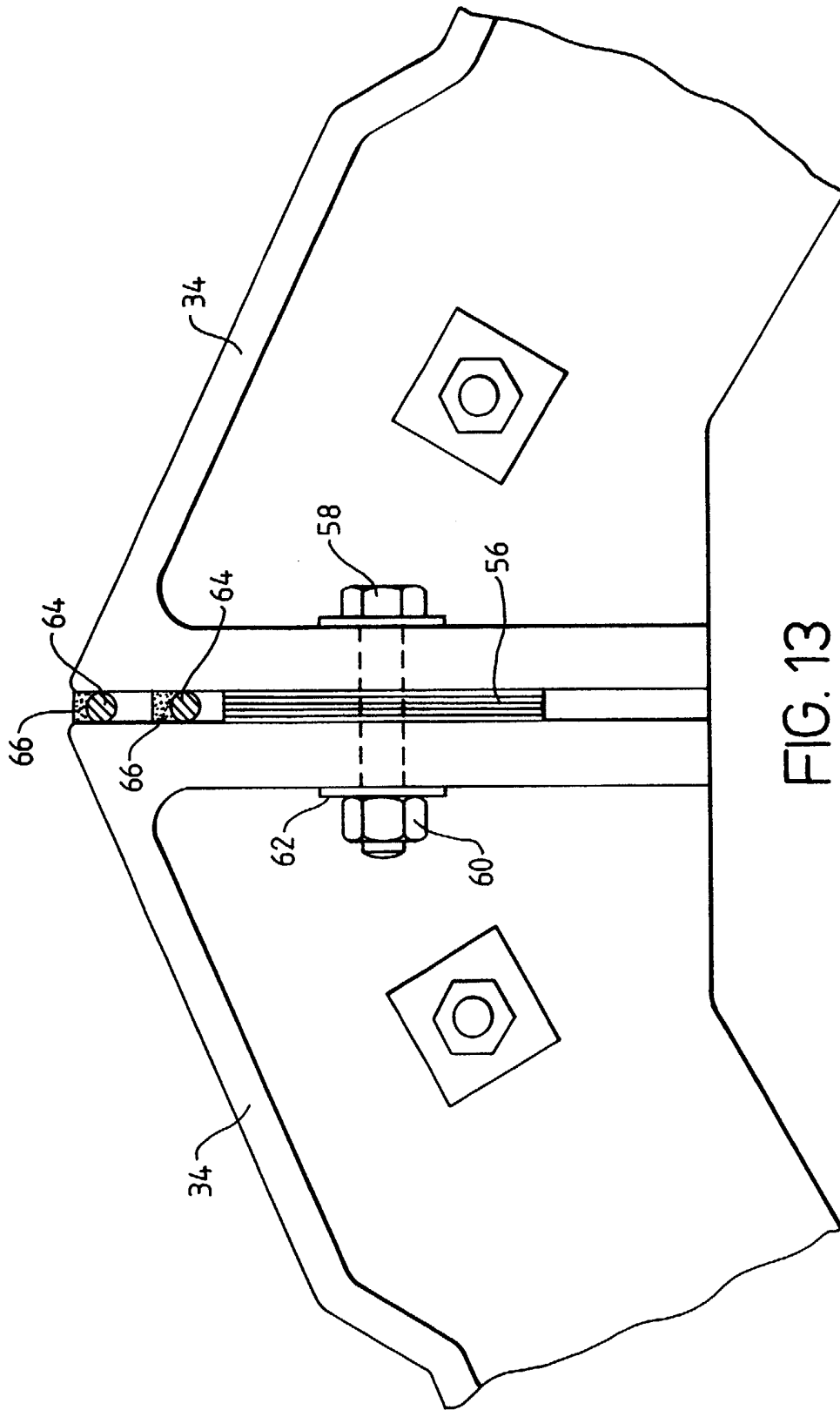
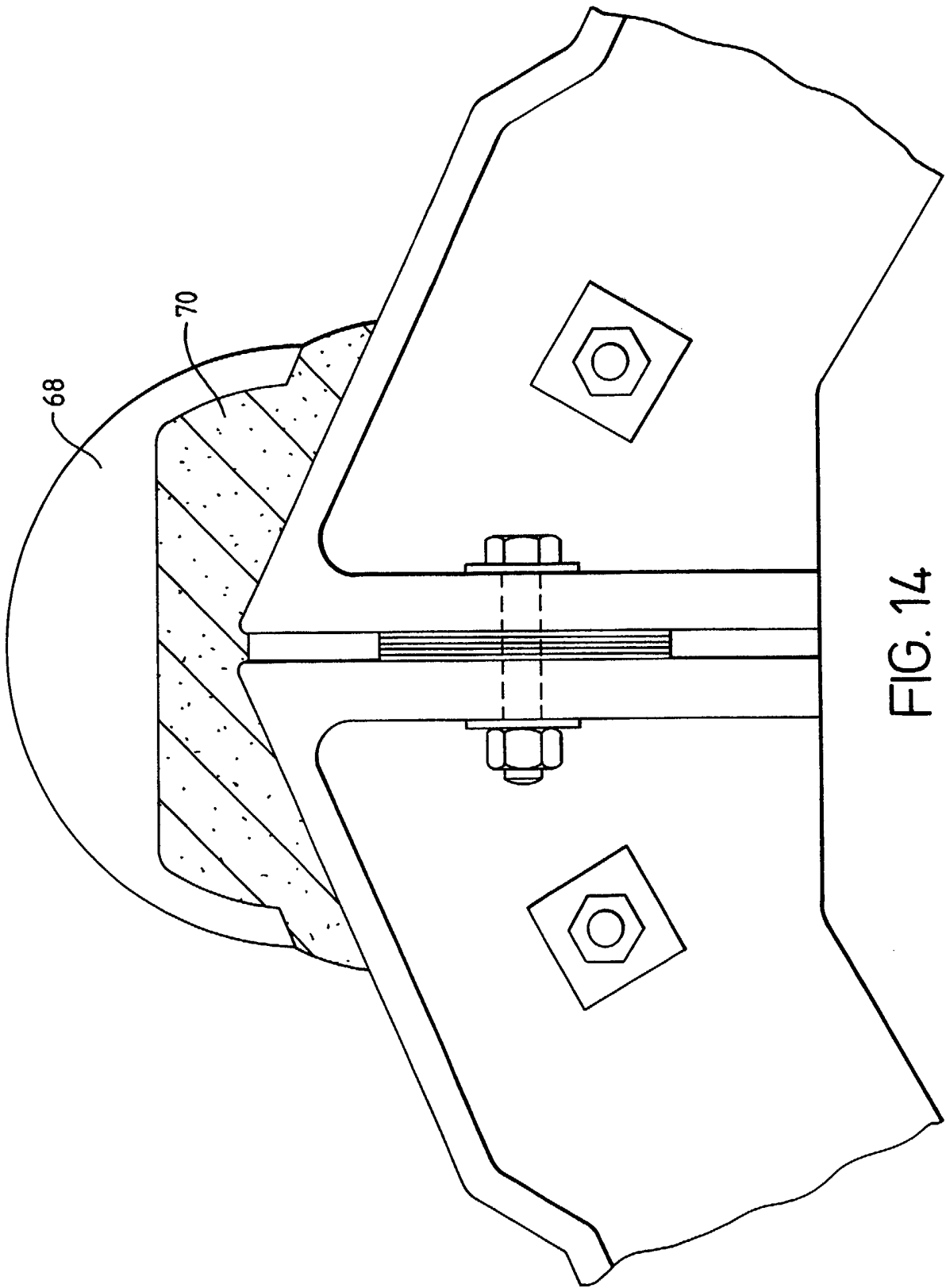


FIG. 13



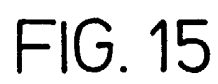


FIG. 15

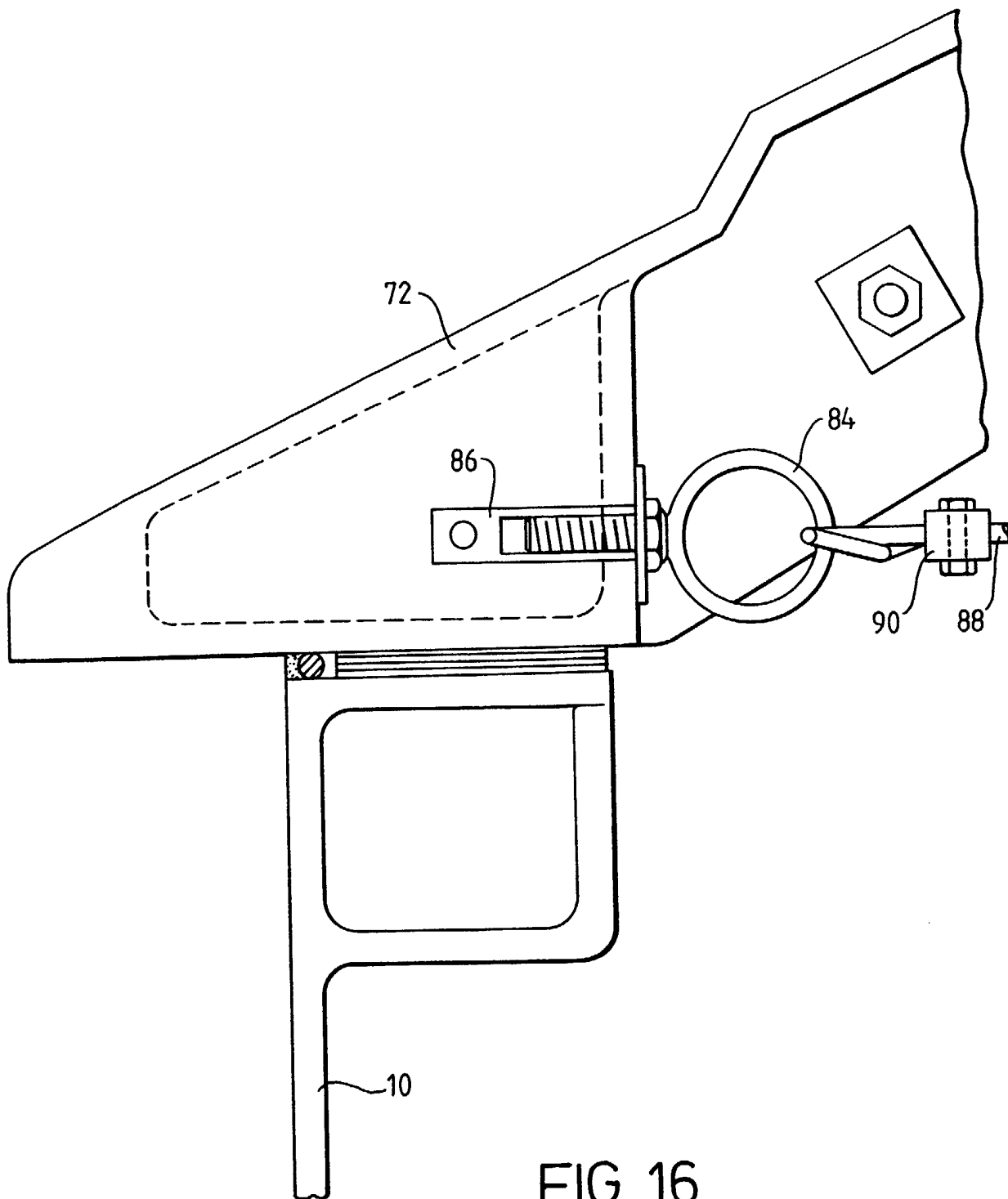


FIG. 16

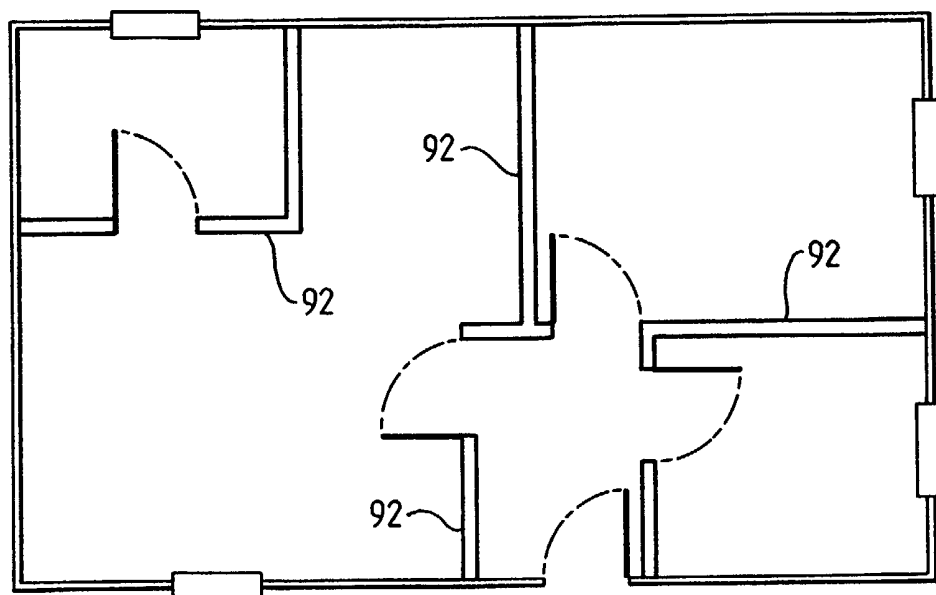


FIG. 17

- 1 -

PREFABRICATED BUILDING

This invention relates to prefabricated buildings or houses.

Currently, prefabricated houses are made of steel
5 reinforced concrete panels and wooden roofs supporting
conventional tiles or bitumen felt. The concrete and roof
members are the load bearing components of the building
and the materials of these components are susceptible to
rot caused by damp and damage due to insect infestations.
10 The appearance of a building made from these materials
degrades rapidly when exposed to weather making them
unattractive as dwellings or office space.

Presently there is a need for cheap, permanent
buildings that can be erected quickly and easily. This is
15 especially prevalent in the third world. The buildings are
required at a high standard of accommodation with good
sanitary facilities.

In an embodiment of the first aspect of the present
invention there is provided a method for making a load
20 bearing panel for use as a building component, the method
comprising; a) inserting a panel material into a mould for
the panel to a predetermined thickness; b) placing at
least one rib template into the mould; c) forming the
panel material to a predetermined thickness over the rib
25 template to form a strengthening rib in the panel; d)
allowing the panel to cure; and e) removing the panel from
the mould.

In an embodiment of a second aspect of the present
invention there is provided a method for constructing a
30 building on a foundation, the building comprising a
plurality of load bearing preformed panels, the panels
being shaped for use as corner members, wall and roof
panels; the method comprising: a) attaching a plurality of
corner panels to the foundation; b) attaching a wall panel
35 to each end of each corner member thereby forming a corner

section; c) determining whether the wall panels of each corner section are perpendicular to each other; d) attaching further wall panels to each corner section thereby forming a wall of the building; e) attaching each
5 wall to the foundation; f) attaching gable end wall panels to opposite ends of the building; g) attaching roof panels between the two gable end panels to form a roof; h) attaching the roof panels to the walls of the building.

In an embodiment of a third aspect of the present
10 invention there is provided a load bearing panel for a building, the panel comprising; a facia on the front of the panel, a peripheral strengthening rib extending around the periphery of the panel, and means for attaching each panel to adjacent panels to form a load bearing structure.

15 In an embodiment of a fourth aspect of the present invention there is provided a building constructed of load bearing panels embodying the third aspect of the present invention.

A panel embodying the invention provides a load
20 bearing glass reinforced concrete (GRC) panel suitable for load bearing walls and roofs of a building. A method embodying the invention also provides a method for manufacturing a load bearing GRC wall or roof panel. A further method embodying the invention provides a means of
25 constructing a building or house using GRC panels as the major load bearing structures of the building. A building embodying the invention provides a structure that is resistant to extremes of weather and longer lasting than current prefabricated buildings by a large factor. A
30 building can be erected using GRC panels embodying the invention that meets current United Kingdom building regulations.

Embodiments of the invention will now be described,
by way of example only, and with reference to the
35 accompanying drawings in which:

Figure 1 shows a portion of a load bearing glass reinforced concrete (GRC) wall panel embodying the invention.

5 Figure 2 shows a cutaway view of the wall panel shown in figure 1 along line AA.

Figure 3 shows a window panel embodying the invention.

Figure 4 shows a cutaway view of the window panel in figure 3 along line BB.

10 Figure 4A shows a doorway lintel embodying the invention.

Figures 4B and 4C are cutaway views of the lintel shown in figure 4A along lines AA and BB in figure 4A respectively.

15 Figure 5 shows a side view of the top portion of a corner member embodying the invention.

Figure 6 shows a front view of the corner member of figure 5.

20 Figure 7 shows a bottom portion of the corner member of figure 5.

Figure 8 shows a cutaway view of the corner member of figure 5.

Figure 9 shows a longitudinal cutaway view of a roof panel embodying the invention.

25 Figure 10 shows a transverse cutaway view of a roof panel embodying the invention.

Figure 10A is a cutaway view of a gable-end roof panel.

30 Figure 11 shows a cutaway view of the base portion of a corner member of figure 6 and the attachment arrangement to the foundation.

Figure 12 shows a cutaway view of a join between the two wall panels of figure 1.

35 Figure 13 shows a cutaway view of an attachment arrangement between two roof panels shown in figure 9.

Figure 14 shows a cutaway view as of figure 13 with the ridge of the roof sealed by a ridge tile.

Figure 15 shows an attachment arrangement for attaching a roof section of figure 9 to a wall panel of figure 1.

Figure 16 is a cutaway view of a roof tie attachment
5 for the roof panel of figure 9.

Figure 17 is a top view of a typical arrangement of interior dividing walls in a building embodying the invention.

Glass reinforced concrete (herein referred to as GRC)
10 is well known in the building industry for its lightweight properties. GRC has been used in cladding and sound proofing panels since the late 1960's. The panels can be made into elaborate designs and placed on the facias of buildings to improve their aesthetic appearance. The main
15 structure of these buildings is generally steel or brick. Typically, known cladding panels consist of 48.75% sand, 48.75% cement and 2.5% chopped glass fibre.

The manufacture of GRC panels is well known. The GRC mix can be sprayed into a suitable mould in layers at a
20 rate of approximately 22 Kg per minute. After each layer is complete, the GRC mix is compacted into the mould to ensure the panel takes the shape of the mould. Other layers are sprayed and compacted until the desired thickness of panel is achieved and the panel is allowed to
25 dry. Once dry the panel is turned out of the mould and it is inspected for faults. If the panel is suitable for its purpose, it will then be shipped to its destination.

GRC is known for its rot and insect resistant properties. Preferably polymers are added to the GRC mix
30 which prevent algae or slime forming in the exterior of the panels, and degradation of the panel strength due to natural UV radiation when the building is exposed to weather. Such polymers are well known in the trade and used in cement manufacture. GRC also has excellent fire
35 retardation properties.

The panel of figures 1 is manufactured in a glass fibre mould, such moulds can be used to manufacture over

30,000 panels before requiring replacement. The wet GRC mix is sprayed into the mould in layers to a depth of roughly 1.5 cm. Preformed lightweight templates 12 are places in the mould along each edge of the panel and as a centrally vertical block. The template blocks are sprayed with GRC to form a rib and the panel allowed to dry in the mould. Suitable lightweight materials that could be used for the rib templates include expanded polystyrene foam.

The holes extending through the ribs formed around the periphery of the panel provide means for the panel to be anchored to the floor, foundation, roof and adjacent panels. The anchorage techniques are described below. Slotted holes 14 are formed in the rib around the panel by suitable mould parts at the edges of the panel. These holes allow bolts to fit through the holes of the finished panel. The surround 16 of the holes 14 is made of solid GRC sprayed around a suitable mould part. Preferably, the surround 16 should extend 50mm from the through holes and the polystyrene rib template should have a cross section profile of 180mm by 100mm. This would be appropriate to a panel with dimensions of 120cm width, 240cm height and 19cm thick. The height of the panel will be dependent on its final position in the building, for example the gable end wall panel is higher than other walls panels because it supports the pitched roof.

The ribs stiffen and strengthen the panels such that the walls of a building embodying the invention have sufficient strength to support a roof made of similar GRC panels described below. The wall panels are designed to withstand twice the weight of the roof. Such a load may occur if snow accumulates on the roof.

Referring to figure 2, the central rib 18 of GRC runs the length of the panel such that the central rib will be vertical once the panel is installed in the building. This single vertical rib arrangement with a peripheral rib has been found to provide the stiffness required whilst keeping the manufacture of the panels at minimum cost and

complexity. Other rib arrangements could be used, such as two diagonally crossing ribs.

The GRC used to manufacture all the panels embodying the invention has a constituency of 47.5% sand, 47.5% cement and 5% chopped glass fibre. The amount of polymers needed to prevent degradation of the panels is typically 0.002% of the GRC mix by volume. A litre of liquid polymer has been found to be sufficient for the volume of GRC mix necessary to manufacture the panels for one building.

This construction and mixture for GRC has been found to provide the best properties for load bearing panels. The ribs are an essential element of the panel and provide rigidity and strength to the panel without unduly adding to the weight of the panels.

Referring to figure 3, the opening 20 for a window is made substantially in the centre of the panel. The central rib 18 runs vertically from the top of the opening to the top of the panel and from the bottom of the opening to the bottom of the panel. The section of the panel 22 that forms the opening 20 for the window is made from 1.5cm thick GRC extending at right angles from the facia of the panel preferably for 200mm from the face of the panel 21. Preferably the opening has dimensions that allow a standard window size to fit the opening.

The strength of the window panel is degraded by the opening 20. Subsequently the side ribs of the window panel bear more of the load than the equivalent side ribs on a wall panel. Preferably a window frame that is capable of taking a significant load should be installed in the opening to help prevent overloading of the side ribs.

Referring to figure 4, holes 14 at the edges of the panel are made in a similar way as described for the wall panel above.

Referring to figure 4A, a doorway is constructed by installing a lintel 200 between two wall panels. The lintel 200 is bolted in position at the top of each wall panel. The holes 202 correspond with similar holes at the

top of each wall panel. A nut and bolt arrangement passing through the holes 202 secures the lintel to the adjacent wall panel. The door and doorframe (not shown) are positioned in the resulting doorway and secured in position in a conventional manner. A central rib 204, side ribs 206 and holes 202 are constructed in the manner described for the wall panel and the ribs bear a portion of the load of the building.

Alternatively, two upright doorway pillars made from GRC (not shown) can be positioned in the doorway secured to adjacent wall panels with the lintel secured on top of the uprights to form an opening for the doorframe. The doorway pillars are designed to bear part of the load of the building.

Referring to figure 4B and 4C, the lintel has a central rib 204 to strengthen the lintel and a transverse rib 208 to stiffen the lintel and prevent sagging of the lintel.

It has been found that the strength of a wall consisting of seven panels will not be adversely affected if three of the seven panels have openings (i.e. are window panels or doorways). The openings should ideally be one doorway and two window panels, and each panel with an opening should have a wall panel on either side of it.

Each wall section of a building is attached perpendicularly to the adjacent wall section by a corner section. The corner section is also made of GRC using the methods described above. Referring to figure 5, the angled portion 26 of the corner member accommodates the soffit of the gable end of the pitched roof (not shown) and the flat portion 28 accommodates the soffit of the gutter end of the roof. The soffit of the gable end of the roof are attached using the holes 30 in the corner member 24. The surrounds to the holes 32 are solid GRC as described for the wall section. Referring to figure 6, hole 31 extends horizontally from inside the panel to the interior surface of the panel and is surrounded by solid GRC. Hole 31

accommodates a threaded socket portion of an anchoring means used to attach a roof panel to a corner member. Similar anchoring points are embedded in the top portion of wall panels embodying the invention. Referring to
5 figure 7 the vertical through holes 33 allow for means to anchor a corner member 24 to the building foundation (not shown).

Referring to figure 8, the rigidity of the corner member is enhanced by its shape and dimensions, and ribs
10 are not necessary to strengthen it. Each surface of the corner member meets its adjacent surface at right angles to form a rigid structure. In this example the facias of the corner members are 60cm wide.

The gable end wall panels are made in a similar way
15 to the other wall panels except that the top of the panel is extended and angled in order to support the pitched roof. Windows and doors can be fitted in the gable end wall panels if required.

The roof panels are made in the same method as
20 previously described for the wall panels. Referring to figures 9 and 10, the outside surface 36 of the roof panel is stepped to give an aesthetic appearance similar to conventionally tiled roofs. Through holes 38 in the longitudinal edges 39 of the panel 34 allow an adjacent
25 roof panel to be anchored to the panel 34; the through holes correspond with those on other panels allowing attachment means to be passed through each set of holes in each panel. The central rib 40 and peripheral rib 42 shown in figure 10 are made in the same way as the ribs in the
30 wall panel. Through hole 44 at the top of the roof section allows the panel to be anchored to another panel, forming the apex or ridge of a roof.

Fixing 46 on the inside of the facia 48 of the roof panel allow the bottom of the roof panel to be secured to
35 a wall panel. Preferably fixing 46 is a threaded socket cast into the GRC during manufacture of the roof panels. The fixings 46 are standard articles available

commercially. They are stainless steel threaded fixings similar to those often used in the marine trade. The fixings are placed in the panel mould before the GRC mix in predetermined positions. The GRC is then sprayed over
5 the fixing such that an opening to the fixing is not filled by the GRC mix and remains free.

Referring to figure 10A, the gable end roof panel 100 has a box section 102 that extends over the gable end wall to form the gable end of the roof. A groove 104 receives
10 the top of the gable end wall panel. Holes 106 allow for attachment means to pass through the roof panel and the gable end wall to anchor the roof panel 100 to the gable end wall.

A method for constructing a building using the panels
15 can be performed with ten unskilled labourers who can build a one story building with a floor area of 34.6 square metres in less than two days. An example of such a building consists of a total of 44 panels, each panel with an average weight of 110 Kg (the lightest weighing 20 Kg,
20 the heaviest weighing 172 Kg). The building is arranged in a 'flat pack' kit form and two building kits can be fitted into a container for shipment.

The building is constructed on a foundation of concrete or other suitable material. The depth and type of
25 the foundation is dependent on the soil properties and surrounding geographic conditions. A survey prior to digging of the foundation allows the builders to assess the necessary foundation requirements. Typically, a foundation of 225 mm concrete or cement layed on a
30 hardcore base is sufficient for most locations. The foundation should have a bearing capacity of 100kNm⁻².

The cement foundation is floated smooth and checks are carried out to ensure the foundation is flat. A building template is laid onto the concrete foundation;
35 the template marks out the eventual outline of the building. Preferably the template is made from thin aluminium sheet that can be rolled up for storage. Holes

in the template mark where holes are to be drilled in the concrete foundation. This type of template can be repeatedly used to mark out many buildings of the same proportion.

5 Alternatively an aluminium 'U' channel building template can be supplied with the kit and is inserted into the foundation before it is allowed to dry. The template should be checked at all stages of installation to ensure it is level. The panels fit into the channel during
10 assembly of the building.

The area of the foundation base should extend beyond the size of the building to be built thereon and typical approximate building and foundation dimensions are shown in the table below.

15

Building size	Length	Width	Foundation size	Length	Width
34.6 m ²	7.2 m	4.8 m	35.5 m ²	7.3 m	4.9 m
46.1 m ²	9.6 m	4.8 m	47.3 m ²	9.7 m	4.9 m
57.6 m ²	12.0 m	4.8 m	58 m ²	12.1 m	4.9 m

20

It is not necessary to damp proof the foundation unless local building regulations stipulate a damp proof course for a building embodying the present invention. Liquid DPCs can be used to treat the foundation if
25 necessary.

The building kit is packed in such a manner that the components of the building can be taken from the container in the order in which they are required for construction. Each panel can be coded to ensure its correct placement in
30 the building. Colours or symbols could be used to code the panels.

The first construction step once the foundation is complete is to erect the corner members. This is achieved

by placing the base of a corner member at the appropriate location on the template.

Referring to figure 11 in which a base portion 44 of a corner member 24 and the attachment arrangement to the foundation 46 are shown. A suitable drill is used to drill
5 holes roughly 15cm into the foundation such that they correspond to the holes 30 in the base of the corner member. The holes can be pre-drilled in the foundation before the panels are erected, or alternatively, holes are
10 drilled once the panels are in position using the panel holes as a guide to the drill bit.

The template 48 can act as a shim and form part of the sealing means that prevents water and air from penetrating into the completed building from outside.
15 Preferably the template is removed from the foundation before the panels are installed. A suitable expansion bolt 50 is inserted into each hole in the foundation through a corresponding hole in the corner member. A nut 52 and washer 54 are inserted over the threaded section of the
20 bolt and tightened to expand the bolt inside the foundation 46. Once expanded in the foundation, the bolt provides a secure means to anchor the corner member to the foundation. The nuts should not be fully tightened down at this stage since fine adjustment of the position of the
25 corner members might be required later on in the construction process. Preferably all four corner members are erected before any other parts of the building.

The next stage involves erecting a wall panel, one on each arm of each corner member, to form a corner section
30 of the building. Each wall panel is married up to the appropriate corner member and held loosely in position whilst a shim is placed between the wall panel and the corner member. The building template acts as a shim between the wall panels and the foundation. The shim acts
35 as a sealant once the wall is securely fastened to the corner member and is preferably made from zinc plate or polystyrene. The wall panel is loosely anchored to the

corner member using a nut and bolt arrangement at each of the through holes on the vertical edge section of the wall and corner panels. The orientation of the wall panel is measured to ensure it is vertical.

5 Referring to figure 12, the shim 56 is placed between the two panels and a bolt 58 is passed through the holes 30 in the panels. A nut 60 and washer 62 are tightened onto the threaded portion of the bolt to secure the panels together. Similar attachments means are used between the
10 wall panels and the corner members.

A measuring rod supplied with the kit is placed from the end of one wall panel furthest from the corner member to the same end of the other wall panel attached to the same corner member. The rod exactly measures the distance
15 between the ends of each panel when they are attached to a corner member and perpendicular to one another. If the rod does not exactly correlate with the distance between the ends of each panel, then the positions of the walls should be adjusted until it does to ensure the corner section
20 prescribes a right angle. Once the corner section is positioned correctly the wall panels are securely fastened to the corner member.

Subsequent wall panels can now be attached to the corner wall panels. At every stage a shim should be placed
25 between adjacent wall panels before they are secured in position. Each panel should also be checked to ensure it is orientated vertically at every stage.

In an embodiment of the present invention the panels are made to a 2% manufacturing tolerance. The shims placed
30 between the panels can be made from deformable material such as polystyrene to take up any defects within the tolerances between adjoining panels.

Once all the wall panels are secured to each other and checked to be vertical, holes are drilled into the
35 foundation using the through holes at the base of the wall panels as a guide. Expanding bolts are inserted in to the holes in the foundation and the panels are secured to the

foundation as described previously. The joints between each panel and the panels and foundation are further sealed using an appropriate material 64 (such as polyethylene or rubber) and putty sealant 66 (such as mastic (RTM)).

It has been found that constructing the corner members on the foundation and then attaching the walls to the corner members provides a more accurate means to constructing the building. There are many fewer alignment problems associated with the building if this method is followed.

With the walls securely in place, the roof can be erected. A roof template is supplied with the kit and should be erected on level ground to the side of the house and preferably at a gable end of the house. The roof template is an angled sub-frame having the same profile as the roof on which preferably two roof panels can be placed. The sub-frame is angled such that each roof panel can be attached to the adjacent panel at the apex or ridge of the roof to form a roof section of the correct profile whilst being supported by the roof template. The template can be made from a wooden or metal frame.

Referring to figure 13, a shim 56 is placed between adjacent roof panels 34 at their junction and the panels are bolted together with a nut and bolt arrangement. Preferably each shim is made with parallel slots that correlate to the position of the holes between adjacent panels. This arrangement helps with positioning the shim between the panels with untightened bolts inserted through the holes of both panels. The shim is preferably 10mm thick and extends from the back or interior of the panel to substantially near the front of the panel, leaving a large enough gap to insert a sealant.

It is preferable to doubly seal the join at the apex of the roof with two sealant rods 64 and putty 66. Alternatively, a ridge tile 68 can be placed along the roof apex or ridge to seal the joint as shown in figure

14. The ridge tile can be made of GRC and is secured in position with a suitable adhesive 70 such as mortar.

Preferably, the roof section is then placed on the top of the walls of the building before other adjacent roof sections are attached. More preferably, the gable end roof section furthest from the roof template is installed first and subsequent roof section are then installed individually. The last roof section to be installed is the opposite gable end roof section nearest the roof template area.

The roof sections are lifted into position using a suitable lifting means such as a crane or pulley arrangement on a moveable 'A' frame. The roof section is lifted off the roof template, positioned on the wall and secured to the wall panels.

In figure 15 an attachment arrangement for attaching a roof section 72 to a wall panel 10 is shown. Threaded fixings 46 in the roof section are aligned with the appropriate fixing 47 on the wall panel. A metal plate 74 is placed between the wall and roof section to brace the roof to the wall. Holes 76 in the plate are preformed to correspond with the positions of the fixings 46 in the roof and wall fixings 47. If necessary, a spacer 78 is placed on either the wall or roof section to provide a flat surface to engage the plate 74 between the roof and wall. Threaded bolts 80 pass through the holes in the plate into the threaded fixings 46, 47 and are tightened to secure the roof to the wall. Preferably washers 82 are placed between the bolts and the plate. The metal plate 74 has sufficient strength to prevent the roof from sliding or lifting off the wall in adverse weather. Preferably the plate is made from 10mm thick aluminium.

It is preferred that roof or wall ties 88 are installed to prevent the roof from spreading. This is shown in figure 16, in which an attachment 84 for a roof tie is a dedicated fixing 86 in the roof panel. In another embodiment, the attachment is incorporated into a bolt 80

as shown in figure 15 that is also used to brace the roof to the wall. The tie 88 extends across the building to an attachment on the opposite wall. The tie is tensioned and secured at both ends to maintain the tension. It can be
5 secured using a nut and bolt arrangement 90 as shown in figure 16. Preferably one tie should be used to brace every roof section of the building.

With the shell of the building complete, the interior walls and fixtures and fittings can be put in place.
10 Typical arrangements are shown in shown in figure 17. Interior walls 92 are arranged to provide living or working spaces such as kitchens, bedrooms, and bathrooms or offices. A ceiling (not shown) can be placed on the interior walls to provide a loft space between the ceiling
15 and the roof. Preferably the roof ties (88 in figure 16) should be out of view from the living quarters. Alternatively a mezzanine area could be made in the ceiling space to increase the usable living or working spaces. The interior walls do not provide any structural
20 strength to the building and can be made using standard building systems, for example, plasterboard on a stud partition wall.

A cavity between the panel and interior walls fixed to the panel provides space for insulation and/or fire
25 retardation materials to be installed if necessary. Ceiling insulation can be laid in conventional ways on top of ceiling panels.

To further increase usable living or working areas several buildings can be built alongside one another with
30 a short connecting corridor between each building. The material for corridors would be GRC panels manufactured in the same way as described herein. Such blocks of buildings could provide sufficient facilities for small hospitals or community centres, for example.

35 The method provides a low cost means to make and manufacture panels for housing. The labour needed to make the panels and erect the buildings are not required to be

skilled or trained over long periods. The panels can be
manufactured close to the construction site using local
labour to further reduce costs and provide employment. The
buildings are quick and easy to erect and large amounts of
5 people can be rehoused in a relatively short time in
permanent buildings. Alternatively, facilities for
hospitals or other working areas can be erected quickly
and local to requirements.

Further embodiments of the invention will be apparent
10 to a skilled person. These may include using resilient
clips to anchor the panels together and to the foundation.
Other ways of constructing a building comprising panels
embodying the invention may also be realised.

CLAIMS

1. A method for making a load bearing panel for use as a building component, the method comprising;
 - a) inserting a panel material into a mould for the panel to a predetermined thickness;
 - b) placing at least one rib template into the mould;
 - c) forming the panel material to a predetermined thickness over the rib template to form a strengthening rib in the panel;
 - d) allowing the panel to cure; and
 - e) removing the panel from the mould.
2. A method according to claim 1, wherein the panel is made from a composite material.
3. A method according to claim 2, wherein the composite material is glass reinforced concrete having the constituents of 47.5% sand, 47.5% cement, 5% chopped glass fibre, and anti-degradation polymers.
4. A method according to claims 1, 2 or 3, wherein the templates comprise lightweight material, and the strengthening ribs are formed around the periphery of the panel and/or along a longitudinal axis of the panel.
5. A method according to claim 4, wherein the templates are expanded polystyrene foam.
6. A method according to claim 4 or 5, wherein the panel has an opening and the longitudinal strengthening rib extends across the portion of the panel above and below the opening.

7. A method for constructing a building on a foundation, the building comprising a plurality of load bearing preformed panels, the panels being shaped for use as corner members, wall and roof panels; the method comprising:
- 5 a) attaching a plurality of corner panels to the foundation;
- b) attaching a wall panel to each end of each corner member thereby forming a corner section;
- 10 c) determining whether the wall panels of each corner section are perpendicular to each other;
- d) attaching further wall panels to each corner section thereby forming a wall of the building;
- e) attaching each wall to the foundation;
- 15 f) attaching gable end wall panels to opposite ends of the building;
- g) attaching roof panels between the two gable end panels to form a roof;
- h) attaching the roof panels to the walls of the building.
- 20
8. A method according to claim 7, wherein the load bearing panels are made from a composite material.
9. wherein the composite material is glass reinforced concrete having the constituents of 47.5% sand, 47.5% cement, 5% chopped glass fibre, and anti-degradation polymers;
- 25
10. A method according to any of claims 7 to 9, wherein the wall and roof panels each having strengthening ribs.
11. A method according to any of claims 7 to 10, wherein the foundation has a load bearing capacity of at least 100kN per square metre.
- 30

12. A method according to any of claims 7 to 11, wherein the corner members and wall panels are attached to the foundation by means of a plurality of bolts, each bolt being fitted into a hole in the foundation through one of a plurality of preformed holes in each of the corner members and wall panels.
13. A method according to any of claims 7 to 12, wherein each corner member, roof panel and wall panel is attached to an adjacent panel by means of a nut and bolt.
14. A method according to any of claims 7 to 13, further comprising:
- i) inserting a shim in a join between each pair of adjacent panels; and
 - j) sealing each join.
15. A method according to claim 14, wherein the shim is a metal plate extending along the length of the join.
16. A method according to claim 14, wherein the joins are sealed with a waterproof putty.
17. A method according to any of claims 7 to 16, further comprising:
- k) attaching a tie between each pair of opposing roof panels whereby the tie prevents the roof panels from spreading.
18. A method according to any of claims 7 to 17, in which the building panels are coded and the building is constructed in an order determined by the code.

19. A load bearing panel for a building, the panel comprising; a facia on the front of the panel, a peripheral strengthening rib extending around the periphery of the panel, and means for attaching each panel to adjacent panels to form a load bearing structure.
20. A load bearing panel according to claim 19, further comprising a longitudinal strengthening rib,
21. A load bearing panel according to claim 19 or 20, wherein the strengthening ribs are lightweight templates covered in panel material.
22. A load bearing panel according to claim 19, 20 or 21, the panel further comprising; holes extending through the periphery of the panel and parallel to the facia of the panel for accommodating attachment means between adjacent panels, the holes being surrounded by a thickness of panel material.
23. A load bearing panel according to any of claims 19 to 22, wherein the panel is made from composite material.
24. A load bearing panel according to claim 23 wherein the composite material is glass reinforced concrete having constituents of 47.5% sand, 47.5% cement, 5% chopped glass fibre, and anti-degradation polymers.
25. A load bearing panel according to any of claims 19 to 24, wherein the panel has an opening, and the at least one longitudinal strengthening rib extends from the opening to the periphery of the panel.
26. A load bearing panel according to claim 25, wherein the opening accommodates a window or door of the building.

27. A load bearing panel according to claims 25 or 26, comprising a lintel member for disposal between wall panels thereby forming a doorway.
- 5 28. A load bearing panel according to claim 27, further comprising a pillar member, wherein the pillar is attached to a wall panel, and in combination with another pillar, supports the lintel thereby forming a doorway.
- 10 29. A load bearing panel according to any of claims 19 to 28 wherein the facia is substantially flat, and the strengthening ribs extend from the back of the panel.
30. A building constructed of load bearing panels according to any preceding claims.
- 15 31. A method for making a load bearing panel as substantially herein described with reference to accompanying drawings 1 to 10A.
32. A method for constructing a building on a foundation as substantially herein described with reference to accompanying drawings 11 to 17.
- 20 33. A load bearing panel as substantially herein described with reference to accompanying drawings 1 to 10A.
34. A building as substantially herein described with reference to accompanying drawings 1 to 17.



Application No: GB 0018959.7
Claims searched: 1 - 6

Examiner: J D Cantrell
Date of search: 20 February 2001

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.S): B5A: AB17, AB19, AB12, AB13 E1D: DCF, DLCHW, DLCQW, DLEQWNV, DLEHW

Int CI (Ed.7): B28B, E04C

Other: ON - LINE: EPODOC, PAJ, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 1324681 FYPOL	1,2
X	GB 1128214 BARNSELEY	1,4,5
X	EP 0063923 A FYPOL	1,2

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Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.