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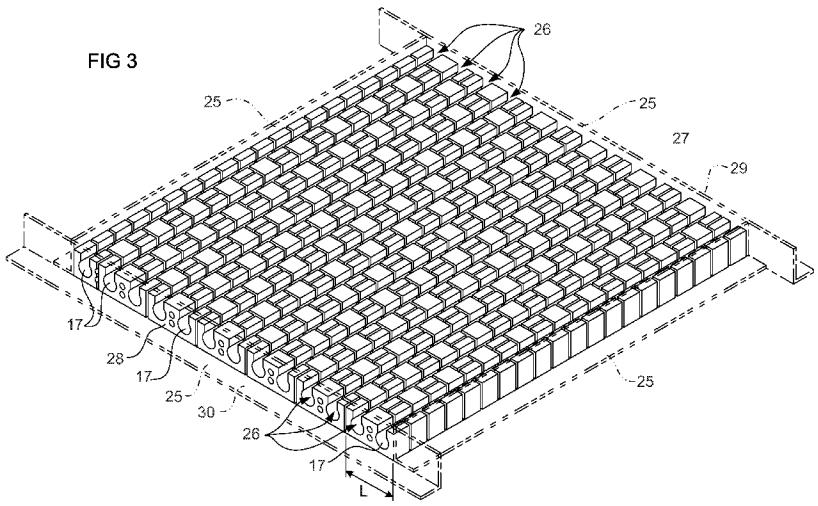
(54) Title: A BRICK PANEL AND METHOD OF FORMING A BRICK PANEL

FIG 3



(57) Abstract: A brick panel (40) including a plurality of bricks (10), each having a front (11) and a rear (2), top and bottom (15,16) and sides (13,14). The bricks (10) are arranged in a grid-like pattern in a plurality of courses and are embedded in a body of cementitious material. The depth to which each brick (10) is embedded is such that the front of each brick either protrudes from the cementitious material or is flush with that material. A plurality of reinforcing bars (41) extend vertically of the panel (40) when erected, and those bars (41) extend through recesses (17) formed in the bricks (10). The recesses (17) are otherwise substantially filled with the cementitious material (10).

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A BRICK PANEL AND METHOD OF FORMING A BRICK PANEL

FIELD OF THE INVENTION

The present invention relates to a brick panel comprising a plurality of bricks formed into a panel and a method of forming such a panel for use in the construction of walls for buildings, such as domestic dwellings.

BACKGROUND OF THE INVENTION

Brick walls typically are constructed on-site by bricklayers, who lay individual bricks in successive brick courses on a bed of mortar laid on the previous course. This can be a slow and tedious process. It can also add significantly to the time and cost of constructing a building and requires skilled labour. The construction of a wall in this manner is also subject to weather conditions, such that during rain or snow, or in extreme heat, construction is normally halted.

An alternative to the laying of individual bricks in brick courses on-site is the provision of bricks formed into a panel. Brick panels for buildings have been attempted before. The benefit of forming bricks into a panel is that a large panel can be fabricated, either on site or remotely in a factory, and then the panel, or more likely a plurality of panels can placed into position to form the walls of a building. Advantageously, the construction of walls in this manner can increase the speed at which a building can be constructed over the speed at which individual bricks can be laid manually.

In one form of panel disclosed in US 6,421,974, brick tiles are formed with a shape which enables connection to a steel backing. When constructing a wall, the steel backing is first secured in place and thereafter the brick tiles are clipped into place on the backing. This system is suitable only where cladding is required, rather than a supporting or structural wall, but does remove the need for the application of mortar and is faster than traditional bricklaying. However, the panel is constructed on-site and thus adverse weather conditions can still interrupt the construction process. Also, because the wall is a cladding only, it is not suitable for many applications.

British patent GB 2,455,284 discloses a brick faced concrete panel. In this panel, half sized bricks are moulded into the front face of a concrete panel. The panel of this

patent is thus effectively a concrete panel with a face formed by a matrix of bricks. The bricks are employed for aesthetic purposes to simulate an actual brick wall, but the bricks make no contribution to the structural integrity of the wall. The method of production involves assembling half bricks in a matrix over a template which is within a mould, pouring sand into gaps between adjacent bricks and pouring concrete into the remaining portion of the gaps and behind the bricks. The sand prevents the concrete from reaching the front of the bricks.

Brick panels have not been developed to a satisfactory commercial form at present and accordingly, they have not attracted widespread use.

The present invention therefore proposes a new and innovative brick panel and a method of producing a brick panel which differs from prior art brick panels and methods and which provides advantages as will be explained herein. In particular, the present invention proposes to provide a brick panel that is more likely to be commercially useful.

SUMMARY OF THE INVENTION

The present invention provides a brick panel including a plurality of bricks each having a front and a rear, a top and a bottom, and a pair of sides, the bricks being arranged in a grid-like pattern of a plurality of courses and being embedded in a body of cementitious material such that a substantial portion of the depth of each brick between the front and the rear is embedded in the cementitious material with the front of each brick either protruding from the cementitious material or being flush with the cementitious material so that the front of the brick remains visible, a plurality of reinforcing bars extending in a direction which is vertical relative to the orientation of the panel when erected, the vertical reinforcing bars extending through channels formed by aligned recesses formed in the bricks between the front and rear of the bricks and each of the recesses formed in the bricks being otherwise substantially filled with cementitious material.

The present invention also provides a method of forming a brick panel, the method including:

assembling formwork to contain liquid cementitious material, the formwork being approximately the dimensions of the panel being formed,

within the formwork , assembling a plurality of bricks each of which has a front and a rear, a top and a bottom, and a pair of sides, generally horizontally and front facing down in a plurality of courses, the bricks being spaced apart between adjacent sides of adjacent bricks in each course and between adjacent courses,

inserting a plurality of reinforcing bars extending in a direction which is vertical relative to the orientation of the panel when erected, the vertical reinforcing bars extending through recesses formed in the bricks between the front and rear of the bricks and which when aligned form channels for receipt of the vertical reinforcing bars, pouring cementitious material into the formwork so that at least a substantial portion of the depth of each brick between the front and the rear is submerged or embedded in the cementitious material with the front of each brick either protruding from the cementitious material or being flush with the cementitious material so that the front of the brick remains visible, and allowing the cementitious material to cure.

A brick panel according to the invention can be made to have the appearance of a brick wall which has been laid in the traditional manner. Thus, the bricks of a brick panel according to the invention can be laid in a regular pattern with the bricks of one row being offset approximately half a brick relative to the bricks the adjacent rows on either side. Likewise, the spacing between the bricks can be of a thickness suitable to have the appearance of a traditional brick wall. Thus the brick panel according to the invention can have the appearance of a traditional brick wall despite being formed as a brick panel. This is very appealing to builders and architects who will recognise the advantages of a brick panel according to the invention in terms of time and cost savings, but who still want to simulate the appearance of a traditional brick wall.

A brick panel according to the invention can include lifting lugs for lifting the panel from its horizontal orientation during forming, to a substantially vertical orientation after the cementitious material has cured for the purpose of transporting the panel from the formation location to a second location, which might be a storage location, or might be an installation location. The lifting lugs can be inserted into the assembly of bricks prior to the pouring of cementitious material, so that the lugs form part of the panel which is embedded in cementitious material. The lugs can extend through the

rear face of the panel, or the side or top edges, or they can be recessed into a recess or depression formed in any of the side edges, the top edges or the rear face. The lugs can have any suitable configuration for lifting the panel.

In a brick panel according to the invention, the bricks can be embedded in the cementitious material to the extent that only the front of the bricks remains visible when the panel is completed. Thus, the bricks can be embedded to beyond the full depth of each brick between the front and rear thereof, so that the rear surface of the brick panel is a cementitious material surface. The thickness of the cementitious material layer which extends beyond the rear of the brick can be in the region of 0mm to 150mm.

Benefits are provided by having a rear panel surface of cementitious material, rather than having the rear of the bricks protruding through the cementitious material. These benefits include:

1. obscuring the rear of the bricks as these can be aesthetically unattractive,
2. providing a workable surface for attaching or applying designs, patterns or paint, and
3. allowing for the variation of the thickness of the panel by varying the thickness of the cementitious material behind the rear of the bricks.
4. allows connectors to be embedded into the rear surface of the panel for the connection of services and facilities, such as thermal insulation, wiring, plumbing etc., and for the connection of a pair of panels together in facing relationship, with or without a cavity between them.

For aesthetic reasons, the sides of any bricks that are located at the edge of the brick panel can be free from coverage by cementitious material, as can the sides of any bricks that are located at openings in the panel, such as might be provided for windows and doors.

The expression “cementitious material” is intended to encompass any material suitable for embedding the bricks and includes mortar, grout and cement, geopolymer and bitumous cements and potentially other materials.

Any number of vertical reinforcing bars can be employed. In a panel which has been tested already, vertical reinforcing bars have been employed at centre intervals of 600mm commencing from just inside each vertical edge of the brick panel, although the spacing could be less than this in other panels. For example, the spacing can be at 50mm intervals although 300mm, 400mm and 500mm centres are the most likely after 600mm centres.

Accordingly, for a panel which has a width between opposite side edges of 5030mm, 9 vertical reinforcing bars can be employed. However in different panels, say panels having a width dimension of 1550mm, three vertical reinforcing bars can be employed, while in a panel having a width dimension of 2990mm five vertical reinforcing bars can be employed. The number of vertical reinforcing bars is typically dependent on the strength characteristics required by the panel.

The reinforcing bars can be made of any suitable material, but typically they will be black or galvanised steel such as 500 grade reinforcing steel. The reinforcing bars would typically extend from approximately the top edge of the brick panel to approximately the bottom edge. The bars can be fully embedded within the cementitious material of the panel or they can project from the edges. Projection of the bars through the top edge of the panel can be used to locate panels relative to each other when they are stacked vertically or for lifting panels or for other attachments. The reinforcing bars typically would be circular in cross-section and can include a ribbed profile throughout the length of the bars to ensure secure anchoring within the cementitious material.

In some forms of the invention, the panel can include a plurality of reinforcing bars extending in a direction which is horizontal relative to the orientation of the panel when erected. Like the vertical reinforcing bars, the horizontal reinforcing bars can also be provided in any suitable number. In a panel which has been tested already, with a width discussed above and of a height of about 3000mm, about 14 horizontal reinforcing bars have been provided. These can be provided in any suitable spacing, although in a panel which has been tested already, a cluster of 4 reinforcing bars has been provided at each of the top and bottom of the panel, with the remaining bars

being spaced apart equally between the top and bottom clusters. The cluster of 4 reinforcing bars was spaced at 86mm centres, while the remaining reinforcing bars were spaced apart equally at 344mm centres.

The horizontal reinforcing bars can be laid over or under or tied to the vertical reinforcing bars, although in some forms of the invention the preference is to lay the vertical reinforcing bars first and to lay the horizontal reinforcing bars over the vertical bars. The vertical and horizontal reinforcing bars can be in contact with each other.The horizontal reinforcing bars can extend from one side edge of the panel to the other side edge but the intention is that the bars be fully embedded within the cementitious material of the panel, although like the vertical reinforcing bars, they can project from the side edges. Like the vertical reinforcing bars, the horizontal reinforcing bars typically would be circular in cross-section and can include a ribbed profile throughout the length of the bars to ensure secure anchoring within the cementitious material.

In place of or in addition to horizontal reinforcing bars, other forms of reinforcing could be employed, such as reinforcing mesh. The reinforcing mesh could be normal steel mesh reinforcement used in concrete slabs. This is particularly useful in panels in which the cementitious material extends for some distance behind the rear of the bricks.

In a brick panel according to the invention, the panel preferably has significant or substantially full penetration of cementitious material into the gaps between bricks and into any recesses formed in the bricks. Such recesses include those provided for the insertion of vertical reinforcing bars, as well as those that might be provided for other reasons, such as for the provision of electrical wiring or plumbing conduit in walls in which the brick panels are installed. The bricks of such brick panels might also include cores running between the top and bottom of the bricks, which are included for the purpose of manufacture of individual bricks prior to inclusion of the bricks in the brick panel. Those cores might be provided to regulate heat distribution during drying and firing of the bricks. It is not essential that such cores are completely filled with cementitious material when the bricks are embedded in cementitious material to form the panel. Nevertheless, if those cores can be filled with

cementitious material, the preference is to do so. To assist this vibrating screeds or the like can be used maximise penetration of the cementitious material into the cores.

The bricks used in a brick panel according to the invention can have any suitable shape. Typically, the bricks will have standard sizing, which in Australia is usually 230mm by 110mm by 76mm. While it would be possible to form the bricks so that only some of the bricks of the panel include a recess of the kind required to accept the vertical reinforcing bars, in some forms of the panel, all of the bricks have such a recess, although it will be appreciated that only some of the bricks will be located where a vertical reinforcing bar is to be positioned. Accordingly, before cementitous material is poured to embed the bricks, but after the vertical reinforcing bars have been inserted into the channels formed by the aligned recesses, there will be a number of channels that might be absent a vertical reinforcing bar.

A benefit in having each of the bricks include a recess even though not all of the channels formed by aligned recesses accommodate a reinforcing bar, is that there is a resultant saving in material cost for forming the brick, ie because less material is required to form the brick compared to a solid brick, while there are also savings associated with transport, given that the bricks themselves weigh less than a solid brick, and there are further savings in manufacturing, given that drying and firing times typically will be less due to the reduced brick mass.

In some forms of the invention, bricks manufactured for use in a brick panel according to the invention can include a pair of recesses spaced apart on either side of a central brick portion. Thus, the brick can comprise, when standing on its front, a pair of upstanding side portions and an upstanding central portion. Recesses can be formed between the central portion and each of the upstanding side portions. The recesses can be of any suitable shape, although in some forms of the invention, the recess can include an opening which opens through the rear of the brick and which leads to a part circular recess portion. The opening which extends through the rear of the brick can be formed from facing surfaces of the central and respective side portions and those surfaces can be planar and generally parallel. The opening can be formed by scoring either fully through the rear of the brick into the recess or by scoring only a portion of that distance, prior to drying and firing the brick. In this manner, the scoring

provides a line of weakness for latter removal of the portion of the brick that will form the opening, but by leaving the portion in the brick during drying and firing, the brick structure remains stable where it might otherwise distort.

Alternatively, the opening or openings can be formed during formation of the brick and prior to the brick being dried and fired, where the brick structure is not expected to distort because of the opening. The opening can be formed in this manner in bricks which are formed by pressing or extrusion.

Because the bricks are substantially embedded within cementitious material , the brick mass can be reduced compared to a brick which is laid in a traditional manner. Instead, the portions of the bricks that are left void or open, are filled with cementitious material during the manufacturing process of the panel and thus the panel which is formed is left substantially free of voids or openings even though they are initially formed in the bricks themselves. Thus, the structural integrity of the panel according to the invention is not compromised by the provision of recesses in the bricks which form the panel.

As discussed earlier, the bricks can also include cores which extend through the top and bottom of the bricks, and which assist manufacture of the bricks by facilitating more even drying and firing of the bricks. In bricks which include a pair of upstanding side portions and an upstanding central portion, one or more cores can be provided through the central portion. In some bricks according to the invention, a pair of cores, spaced apart in the direction between the front and rear of the brick, is provided in the central portion of the brick.

A benefit of providing or using a brick which includes recesses formed between a central upstanding portion of the brick and respective side portions of the brick, is that courses of the brick panel can be offset a distance equal to half the length of the brick, in accordance with normal bricklaying principles. This offset arrangement can be employed without affecting the ability to form channels in the panel for accommodating of the vertical reinforcing bars. Thus, by employing a brick of this kind, channels can be formed for the receipt of the vertical reinforcing bars between

the top and bottom of the brick panel even though the brick courses are offset half a brick length.

The method of forming a brick panel according to the invention enables a panel to be assembled and formed on a horizontal bed and thereafter allows the panel to be lifted from horizontal for storage or transport to an installation site. The brick panel can thus be manufactured in a manufacturing facility remote from the site of installation and a plurality of panels can be transported to the installation site and installed quickly and conveniently, and without the difficulties associated with traditional brick laying methods.

The formwork which is formed to contain liquid cementitious material can take any suitable form and in some forms of the invention, is a metal formwork, against which bricks of the brick panel abut. In most forms of the invention, the formwork will be square or rectangular and will cooperate with a floor on which the bricks are assembled. The floor can be of any suitable material, but for mass production, it is expected that the floor will be a metal floor. The cooperation with the floor is such as to resist leakage of cementitious material past the formwork.

In order to create an even or level surface on the bed on which the bricks are assembled, a foam material can be provided to overly the bed on which the bricks are placed. The foam will form a surface on which the bricks are laid and can compensate for surface irregularities that are present on the bed beneath the foam. For example, in the environment in which a brick panel according to the invention might be manufactured, it is likely that the bed could be contaminated with small particles of brick or cementitious material from earlier panels, which disturb the surface on which the bed of bricks is laid. By covering the bed with a layer of foam, such particles can be absorbed into the foam and thus can be prevented from upsetting the level surface of the front of the brick panel.

The foam can also advantageously press against the surface of the front of the bricks and resist penetration of cementitous material to the front surface. This is an advantage in some forms of the method of the invention as it minimises the amount of cementitous material which might adhere to the front surface of the brick panel and in

testing conducted to date, panels have been prepared with negligible penetration of cementitous material to the front surface. This minimises the need for acid or similar chemical cleaning of the front surface of cementitous material and thus improves the timeframe in which a brick panel can be prepared.

If foam is employed, the foam can be treated with a suitable retardant, which can prevent the foam from adhering to the front of the bricks which are laid on it. Such a retardant can be applied when the foam is laid within the formwork, or it can be applied in advance of this such as within a spray booth.

It will be appreciated that the discussion above in relation to foam could apply to other materials having similar properties to foam, so that the invention is not restricted to foam, but could employ any suitable material.

The method of the invention includes assembling a plurality of bricks in a plurality of courses, with each brick being spaced apart between adjacent sides of adjacent bricks and between adjacent courses. While the gaps between adjacent bricks and adjacent courses can be selected as appropriate, in some forms of the invention, the gap between adjacent sides of adjacent bricks is the same dimension as the gap between adjacent courses. In some forms of the invention, this gap is in the range of between 5mm and 20mm and can be approximately 10mm.

Automatic or manual placement of bricks on the bed can be adopted, and if manual placement is chosen, the bed can include openings to receive mounts for an alignment gauge. Such a gauge provides a surface against which bricks can be moved into abutment with at the correct position on the bed.

Grout tubes or ferrules can be employed in panel edges, normally bottom edges, for cooperating with projections from facing edges of adjacent panels. For example, if the vertical reinforcing bars extend through the top edges of a panel, grout tubes or ferrules in the bottom edge of an adjacent panel can accept the projecting ends of the vertical reinforcing bars. Once accepted, grout can be pumped into the grout tubes or ferrules to cement the projecting ends of the vertical reinforcing bars into the tubes or ferrules.

In some arrangements of the invention, the grout tubes can be fitted through the bottom edge of the panel and extending into the panel from the bottom edge. A pair of grout tubes can be employed towards opposite side edges of the panel. The grout tubes can be positioned within channels formed by aligned recesses of the bricks of the kind that also accept the vertical reinforcement bars and therefore the grout tubes should be of a diameter that neatly fits within the recesses. In testing, grout tubes of approximately 50mm outside diameter have been employed. The grout tubes are typically set at spacings as close as 1.5m but can be positioned in any suitable location to suit design requirements.

The grout tubes can be installed prior to installation of the reinforcing bars so that in respect of the horizontal reinforcing bars, one or more of these sit over the top of the grout tubes when the assembly is assembled within the formwork. The grout tubes preferably are accommodated within channels which do not accommodate vertical reinforcing bars.

It is preferred that the vertical reinforcing bars sit above the surface of the recesses in which they are accommodated, and thus suitable elevation elements can be fitted either into the recesses or to the vertical reinforcing bars, to provide a surface on which the reinforcing bars are supported. These elevation elements can simply support the reinforcing bars, or they can positively locate the reinforcing bars.

Ferrules can be applied prior to applying the cementitous material for the connection of fittings, such as lifters which are used for lifting the panel after the cementitious material has cured.

With the bricks assembled within the formwork and with each of the grout tubes and the reinforcing bars, both vertical and horizontal, installed, the cementitous material can be poured into the formwork to embed the bricks. For this, a suitable viscous grout or other form of cementitous material can be prepared and is poured into the formwork at a velocity suitable to minimise the generation of air pockets and to maximise penetration of the cementitous material to within the spaces between bricks and to within the recesses and any cores of those bricks, and in a manner to avoid

moving any of the bricks in the panel. Screeding can be employed as necessary to ensure full coverage of cementitous material across the brick assembly.

Once the panel has been prepared with the bricks embedded, it can be covered or shifted into a heating facility in order to raise the temperature of the panel and to promote curing. Once cured (in approximately 12 hours), the panel can be removed from within the formwork and lifted, such as via lifters (if provided) to a substantially vertical orientation. The panel can then be cleaned. Cleaning can involve amongst other things, washing the front surface of the bricks to remove any cementitous material or foam material that has adhered to that surface, such as by high pressure water. To resist attachment of material to the surface of the panels, a wax or other suitable coating can be applied to the panel surface.

For a better understanding of the invention and to show how it may be performed, embodiments thereof will now be described, by way of non-limiting example only, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front view of a brick partially formed for use in a brick panel according to the invention.

Figure 2 is a front view of the brick of Figure 1 with portions removed and ready for use in a brick panel according to the invention.

Figure 3 is a perspective view of a plurality of bricks assembled in a form for manufacture of a brick panel according to the invention.

Figure 4 is a schematic illustration of a brick panel according to the invention,

Figure 5 shows substantially the same illustration of Figure 4, but with actual bricks shown.

Figure 6 is a cut-away view of Figure 3 without the formwork and with reinforcing bars illustrated.

Figure 7 illustrates a wall construction which utilises a wall panel according to the invention.

Figure 8 is a view of a portion of the wall of Figure 7

Figure 9 is a cross-sectional view through a brick of the wall of Figure 7.

DETAILED DESCRIPTION OF THE DRAWINGS

With reference to Figure 1, a brick 10 is illustrated which has length, width and height dimensions of approximately 230mm x 110mm x 76mm. This is a standard dimensioned brick for Australian domestic building purposes.

The brick 10 is formed from a suitable clay material and is dried and fired in the normal manner. The brick 10 can be formed by extrusion or pressing. The brick 10 includes a front 11, a rear 12, a pair of sides 13, 14 and a top 15 and a bottom 16 (not visible in Figure 1).

The brick 10 includes a pair of primary cores 17 extending through the top 15 to the bottom 16, and the brick 10 further includes a pair of secondary cores 18 which also extend through the top 15 to the bottom 16. As illustrated, the cores 18 are aligned between the front 11 and the rear 12 and are positioned midway between the cores 17. The cores 17 are spaced from the respective sides 13 and 14 an equal distance.

The brick 10 of Figure 1 includes score lines 19 through the rear 12 and score lines 20 through the top 15. Further score lines are made through the bottom 16 but are not visible in Figure 1. Further, additional score lines extend through the surface of the cores 17 between the top 15 and the bottom 16. Each of the score lines 19 and 20 and the score lines through the cores 17 and through the bottom 16 which are not visible in Figure 1, connect. Those score lines are generated by passing a wire through the brick 10 prior to the brick being dried and fired, and thus a pair of lines of weakness is formed so that the portions 21 and 22 of the brick 10 can be easily punched out or shattered later when the brick 10 has been dried and fired. By doing

this, the brick 10 is conformed to the shape illustrated in Figure 2 and reference will now be made to that figure.

In Figure 2, the portions 21 and 22 have been removed from the brick 10, but otherwise the brick 10 remains as described in relation to Figure 1. However, with the portions 21 and 22 removed, access to the cores 17 is facilitated through the rear 12 of the brick 10. The cores 17 thus form open recesses such that access through the rear 12 of the brick 10 facilitates insertion of reinforcing bars during manufacture of a brick panel according to the invention.

With reference now to Figure 3, this shows a formwork 25 in phantom outline which is formed into a rectangle, and within which has been assembled a plurality of bricks 10. The bricks 10 are laid in horizontal courses which are offset from each other horizontally half the length L of a brick. By this arrangement, the front of the brick panel, which is face down in Figure 3, will simulate the look of a standard brick wall in which one course of bricks is offset half the length of a brick of the immediately adjacent upper and lower courses of bricks.

It is evident in Figure 3, that a plurality of channels 26 is formed between what will be the top edge 27 of an installed brick panel according to the invention, and the bottom edge 28. In each case, both the top and bottom edges 27 and 28 are in abutting engagement with the portions 29 and 30 of the formwork 25. The channels 26 are formed by the alignment of a plurality recesses formed by the open cores 17.

The channels 26 which are formed in the assembly of Figure 3 are formed to accommodate several different items of a brick panel, but predominately, they are employed for the accommodation of reinforcing bars which extend vertically in a brick panel according to the invention which has been installed.

Figure 4 is a schematic illustration of a brick panel 40 according to the invention, while Figure 5 shows substantially the same illustration but with actual bricks shown. Figure 6 is a cut-away view of Figure 3 without the formwork 25 and with reinforcing bars illustrated.

Referring to Figures 4 to 6, these show a plurality of vertical reinforcing bars 41. The reinforcing bars 41 are placed adjacent each of the sides 46 and 47 of the panel 40, and at 600mm spacing across the width of the panel 40. In the panel 40, the width of the panel between the sides 46 and 47 is equivalent to 21 bricks of 230mm length, each being spaced apart from an adjacent brick by a gap of 10mm. The total width of the panel 40 between the sides 46 and 47 is thus 5030mm.

Also illustrated in Figure 4 is the provision of a pair of grout tubes 42 which extend into the panel 40 through the bottom 49. Opposite the grout tubes 42 is a pair of lifting anchors 43, which extend through the top 48. The lifting anchors 43 provide an anchor which is attachable to a lifting crane for lifting the brick panel 40 once formed for relocation of the panel to either a storage site or to a transport vehicle or to the installation site. The upper end of the lifting anchors 43 do not extend past the top 48 of the panel 40 but rather are accessed through a recess in the top 48 .

Figures 4 to 6 further show a plurality of horizontal reinforcing bars 45. It can be seen in Figures 4 and 6 that a cluster of 5 reinforcing bars 45 is provided in close proximity to each of the top 48 and bottom 49 of the panel 40, while in Figure 5 a cluster of 4 reinforcing bars 45 is provided in close proximity to each of the top 48 and bottom 49 of the panel 40. Between those clusters of bars 45, further horizontal bars 45 are provided equally spaced apart. The horizontal reinforcing bars 45 are positioned in gaps between adjacent courses of bricks. The clusters are provided to increase the strength of the panel 40 at the top and bottom edges 48 and 49 for lifting and transportation.

It will be evident that all of the reinforcing bars 41 and 45 terminate inside the outer edges of the panel 40. Moreover, it will be evident that the respective bars 41 and 45 have intersecting paths and in the panel 40 illustrated, the bars 45 are positioned to overlie the bars 41. The bars 45 also overlie the pair of grout tubes 42.

While it would be acceptable to lay the bars 41 against the surface of the cores 17, in the brick panel 40, supports are provided to elevate the bars 45 within the cores 17 so that the bars 41 are positioned approximately at the midpoint or centre of the cores 17. This places the reinforcing bars 41 at approximately the midpoint of the panel 40

between the front and rear faces thereof so that the reinforcement provided by the bars 41 is approximately equal on either side of the bars and cover to the reinforcement is maximised.

Once the bricks 10, reinforcing bars 41 and 45, and the grout tubes 42 have all been laid within the formwork 25, cementitious material can be poured into the formwork 25. The cementitious material should be poured at a rate at which the likelihood of air bubbles forming is minimised, and once poured, the exposed surface of the cementitious material should be screeded from time to time as the cementitious material sets. As the cementitious material settles, additional cementitious material can be added to ensure the volume of cementitious material is sufficient. The volume of cementitious material should be sufficient to cover the rear 12 of the bricks. Once the cementitious material has set, the panel can be heated in order to cure the cementitious material. The temperature of heating can be in the region of 40°C, and time taken to cure is approximately 12 hours.

As explained earlier, the bricks can be laid on a foam sheet to accommodate any irregularities on the bed surface. This also assists to minimise or prevent passage of cementitous material into contact with the front surface of the bricks.

The cementitous material mixture which can be used with the panel according to the invention can be of any suitable composition, although in a panel which has been tested already, the following compositions have been successfully employed: 30% cement, 42% sand A (see below) and 28% sand B (see below). Water cement ratio 0.7.

Particle size mm	Sand A	Sand B
4.75	100	100
2.36	99	100
1.18	96	100
0.6	87	100
0.3	22	37
0.15	4.5	0.5
0.075	2	0.1
Silt & Clay	25	0

With this mixture the following cement characteristics can be achieved:

Strength	> 32MPa
12hr Strength	10 – 20 MPa
Shrinkage	500 – 1800 Microstrain
Spread	700-800mm
Max Ag Size	4mm

Other additions include plasticiser to promote flow of the cementitious material, and fly ash and/or magnesia. Other additions could be made.

Figure 7 illustrates a wall construction which utilises a wall panel according to the invention. Figure 8 is a view of a portion of the wall of Figure 7, while Figure 9 is a cross-sectional view through a brick of the wall of Figure 7.

In Figures 7 to 9, the wall 50 includes a wall panel 51 constructed in accordance with the invention and comprising a plurality of bricks 52 embedded in a body of grout 53 and reinforced by a bar 54.

The wall panel 51 further includes a plurality of connectors 55 which are embedded in the grout 53 as shown in Figure 9. The connectors 55 extend rearwardly of the wall panel 51 for connection to an internal concrete wall panel 56.

An insulation layer is attached to the surface of the panel 56 facing the wall panel 51. The layer 57 can be any suitable insulation layer, such as an insulation foam with a silver lining, or an insulating paper material.

An air gap is provided between the insulation layer 57 and the facing surface of the wall panel 51. The air cavity 58 assists to insulate the wall 50 and provides a space for wires and other utilities to extend through the wall 50. The bottom end of the wall 51 is supported on a flashing/termite barrier, which rests on a recess formed in a concrete slab 59. A dowel 60 is embedded in the slab 59 and is received within grout tubes or ferrules which are embedded in the wall panel 51 and which were illustrated in Figure 4 by reference numeral 42. By that mechanism, the bottom end of the wall

panel 51 can be securely anchored to the slab 59. Other connectors can be employed to secure the wall panel 51 to the slab 59 in addition to the dowels 60 or as an alternative form of connection.

The opposite end of the wall panel 51 engages with the roof structure 61. The roof structure 61 comprises an eave 62, roof bearers 63 and a roof cladding 64, which can be a tiling arrangement or a corrugated iron arrangement etc., and bearers 65. To the underside of the bearers 65 is applied plaster board 66 and a cornice 67.

With reference to Figure 9, the perpendicular orientated reinforcing bar 54 is of a 12mm diameter, while the perpendicular bar 68 is of a 7.6mm diameter. Clearly the reinforcing bar can be of any suitable diameter as required.

The invention described herein is susceptible to variations, modifications and/or additions other than those specifically described and it is to be understood that the invention includes all such variations, modifications and/or additions which fall within the spirit and scope of the present disclosure.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A brick panel including a plurality of bricks each having a front and a rear, a top and a bottom, and a pair of sides, the bricks being arranged in a grid-like pattern of a plurality of courses and being embedded in a body of cementitious material such that a substantial portion of the depth of each brick between the front and the rear is embedded in the cementitious material with the front of each brick either protruding from the cementitious material or being flush with the cementitious material so that the front of the brick remains visible, a plurality of reinforcing bars extending in a direction which is vertical relative to the orientation of the panel when erected, the vertical reinforcing bars extending through recesses formed in the bricks between the front and rear of the bricks and each of the recesses formed in the bricks being otherwise substantially filled with cementitious material.

2. A brick panel according to claim 1, including lifting lugs for lifting the panel.

3. A brick panel according to claim 2, the lifting lugs being substantially embedded within the brick panel and extending to a top edge of the brick panel.

4. A brick panel according to claim 3, a pair of recesses being formed in the top edge to allow access to the lifting lugs.

5. A brick panel according to any one of claims 1 to 4, the bricks being embedded such that the rear of the bricks is covered by cementitious material .

6. A brick panel according to claim 5, the thickness of the cementitious material behind the rear of the bricks is about 0mm to 150mm.

7. A brick panel according to any one of claims 1 to 6, the vertical reinforcing bars being spaced apart at about 600mm centres.

8. A brick panel according to any one of claims 1 to 7, the vertical reinforcing bars being completely enclosed within the brick panel.

9. A brick panel according to any one of claims 1 to 8, further including a plurality of reinforcing bars extending in a direction which is horizontal relative to the orientation of the panel when erected.

10. A brick panel according to claim 9, the horizontal reinforcing bars comprising an upper group of bars adjacent to an upper edge of the brick panel, a lower group of bars adjacent to a lower edge of the brick panel, and an intermediate group of bars between the upper and lower group of bars, the upper and lower groups of bars being spaced apart closer than the intermediate group of bars.

11. A brick panel according to claim 10, the horizontal reinforcing bars of the upper and lower groups of bars being spaced at about 86mm centres, and the intermediate reinforcing bars being spaced apart at about 344mm centres.

12. A brick panel according to any one of claims 1 to 11, the bricks of the panel having a pair of recesses spaced apart on either side of a central brick portion to define a pair of upstanding side portions and an upstanding central portion, each of the recesses being open through the rear of the brick.

13. A brick panel according to claim 12, each of the recesses including an opening which opens through the rear of the brick and which leads to a part circular recess portion.

14. A method of forming a brick panel, the method including:

forming a formwork to contain liquid cementitious material , the formwork being approximately the dimensions of the panel being formed,

within the formwork , assembling a plurality of bricks each of which has a front and a rear, a top and a bottom, and a pair of sides, generally horizontally and front facing down in a plurality of courses, the bricks being spaced apart between adjacent sides of adjacent bricks in each course and between adjacent courses,

inserting a plurality of reinforcing bars extending in a direction which is vertical relative to the orientation of the panel when erected, the vertical reinforcing bars extending through recesses formed in the bricks between the front and rear of the bricks and which when aligned form channels for receipt off the vertical reinforcing

bars, pouring cementitious material into the formwork so that at least a substantial portion of the depth of each brick between the front and the rear is submerged in the cementitious material with the front of each brick either protruding from the cementitious material or being flush with the cementitious material so that the front of the brick remains visible, and allowing the cementitious material to cure.

15. A method according to claim 14, the method including laying a foam layer over a bed on which bricks are laid and laying the bricks on the foam layer.

16. A method according to claim 14 or 15, the method including inserting a plurality of reinforcing bars extending in a direction which is horizontal relative to the orientation of the panel when erected.

17. A building including a brick panel according to any one of claims 1 to 13.

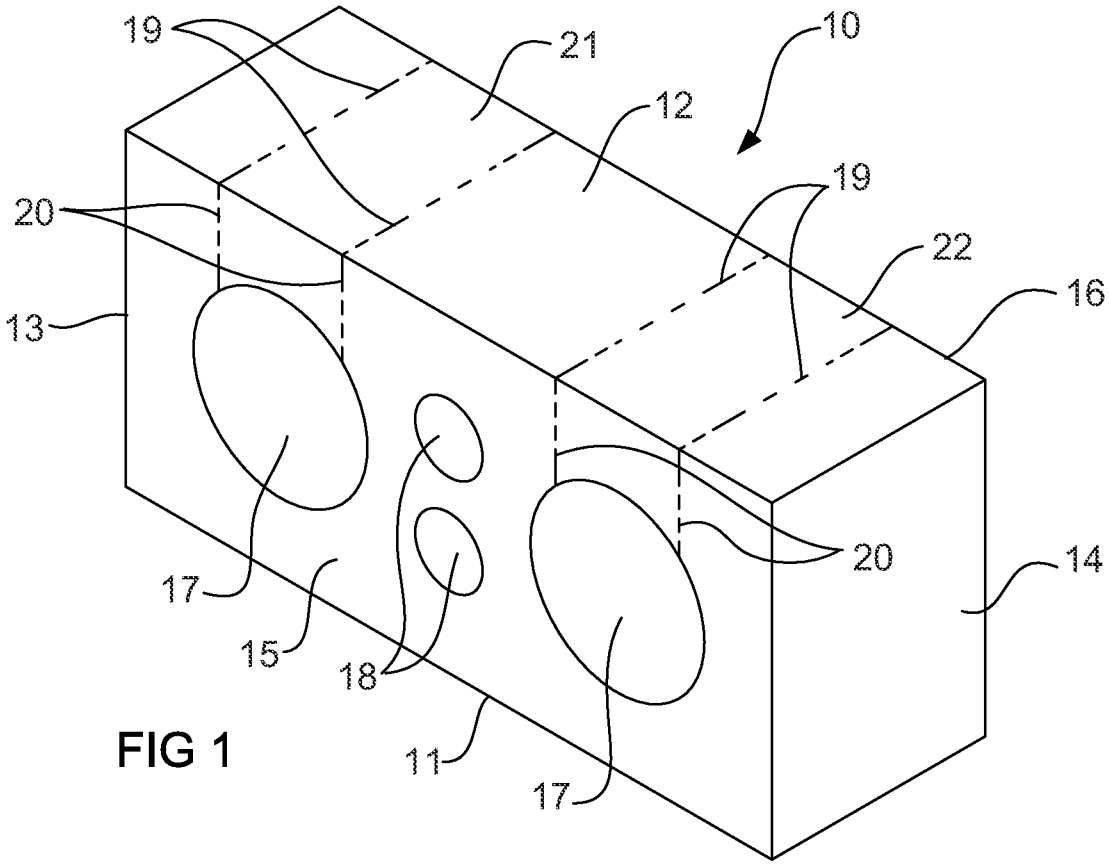

FIG 1

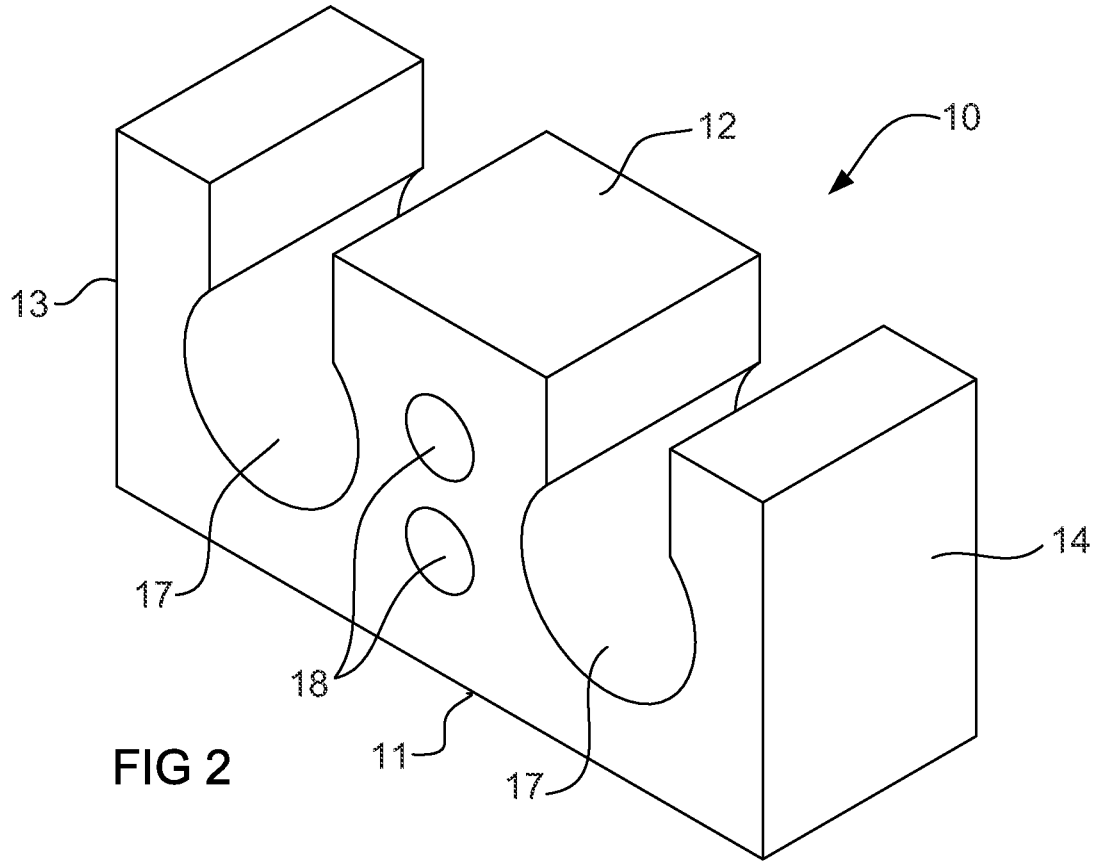

FIG 2

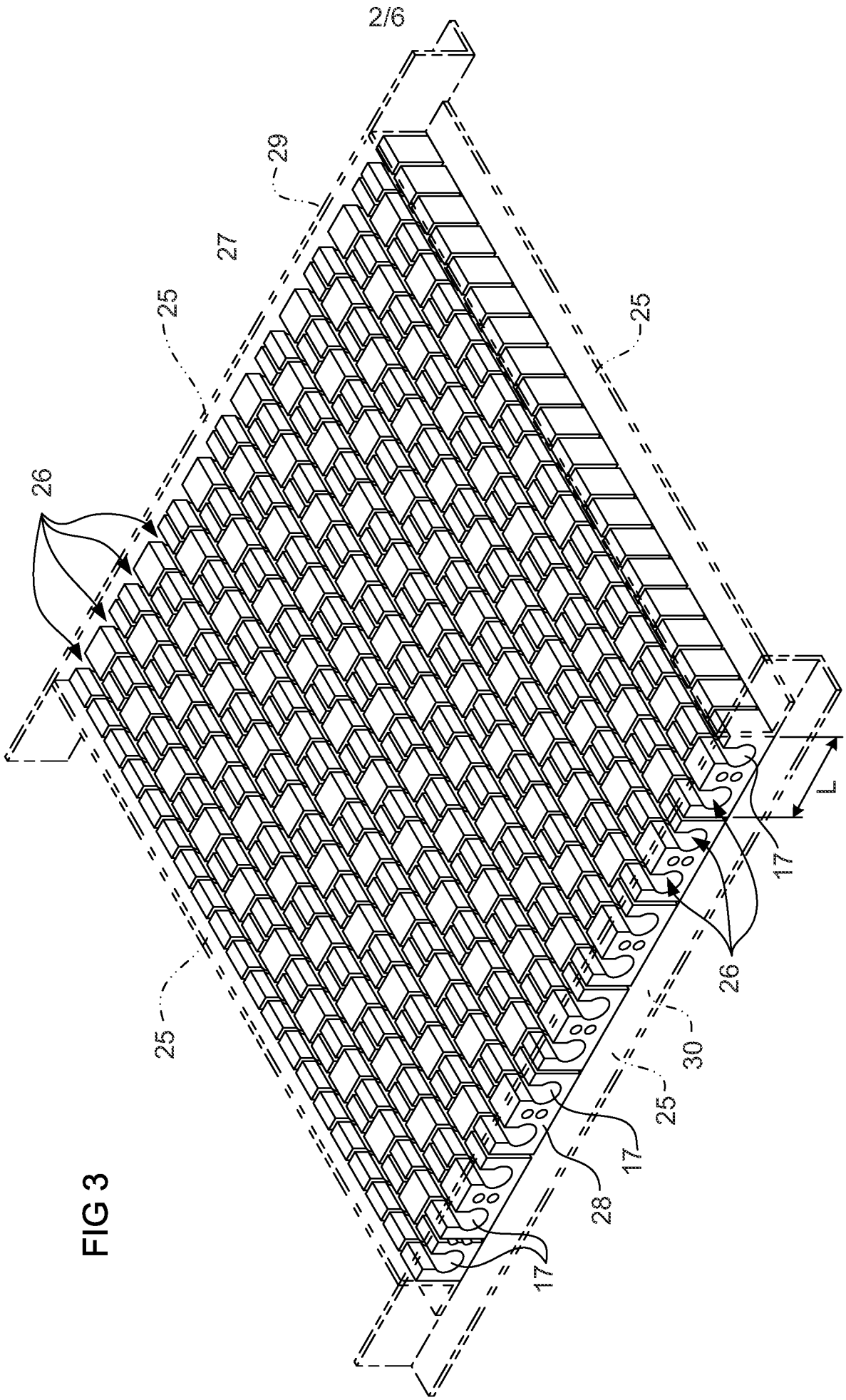

FIG 3

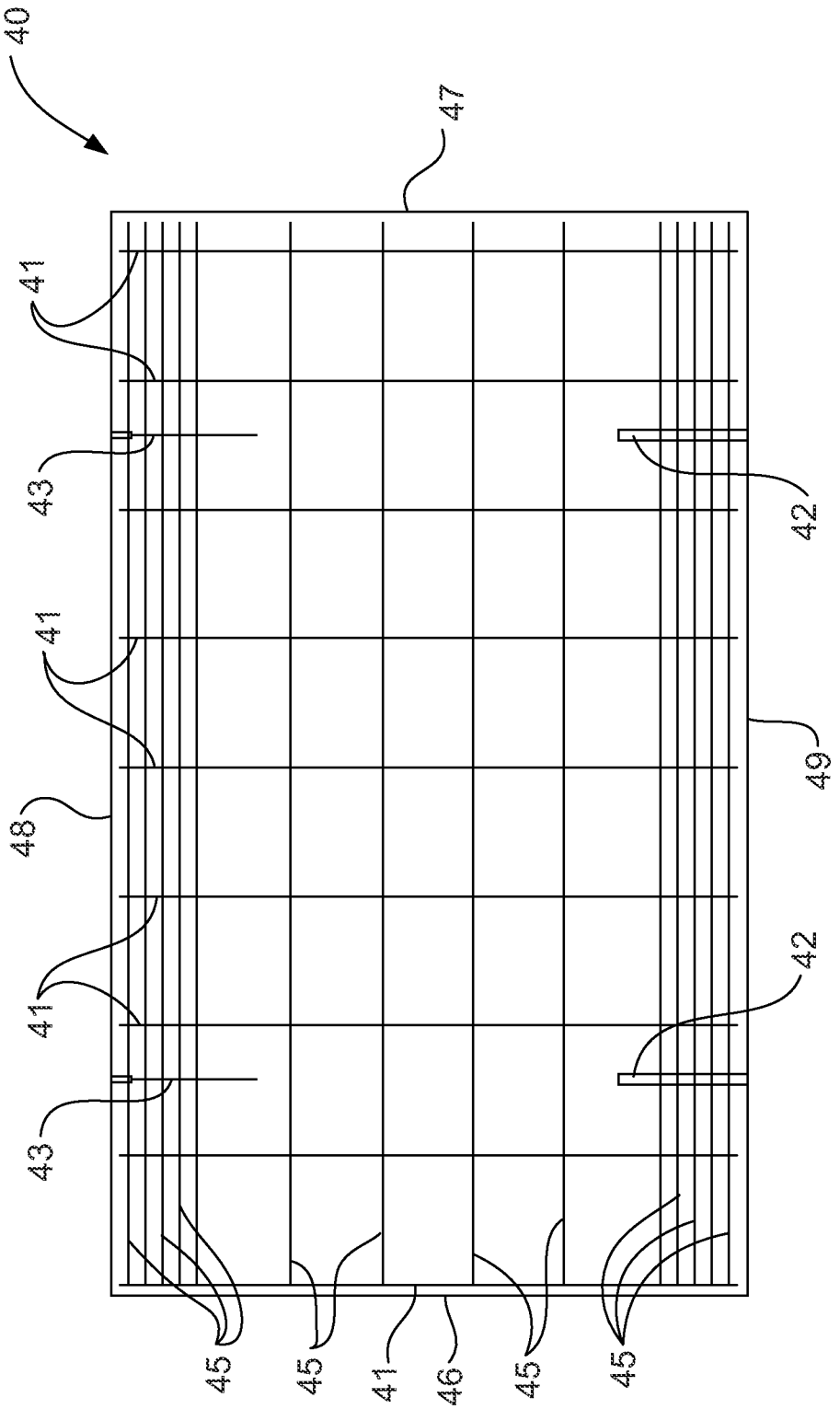

FIG 4

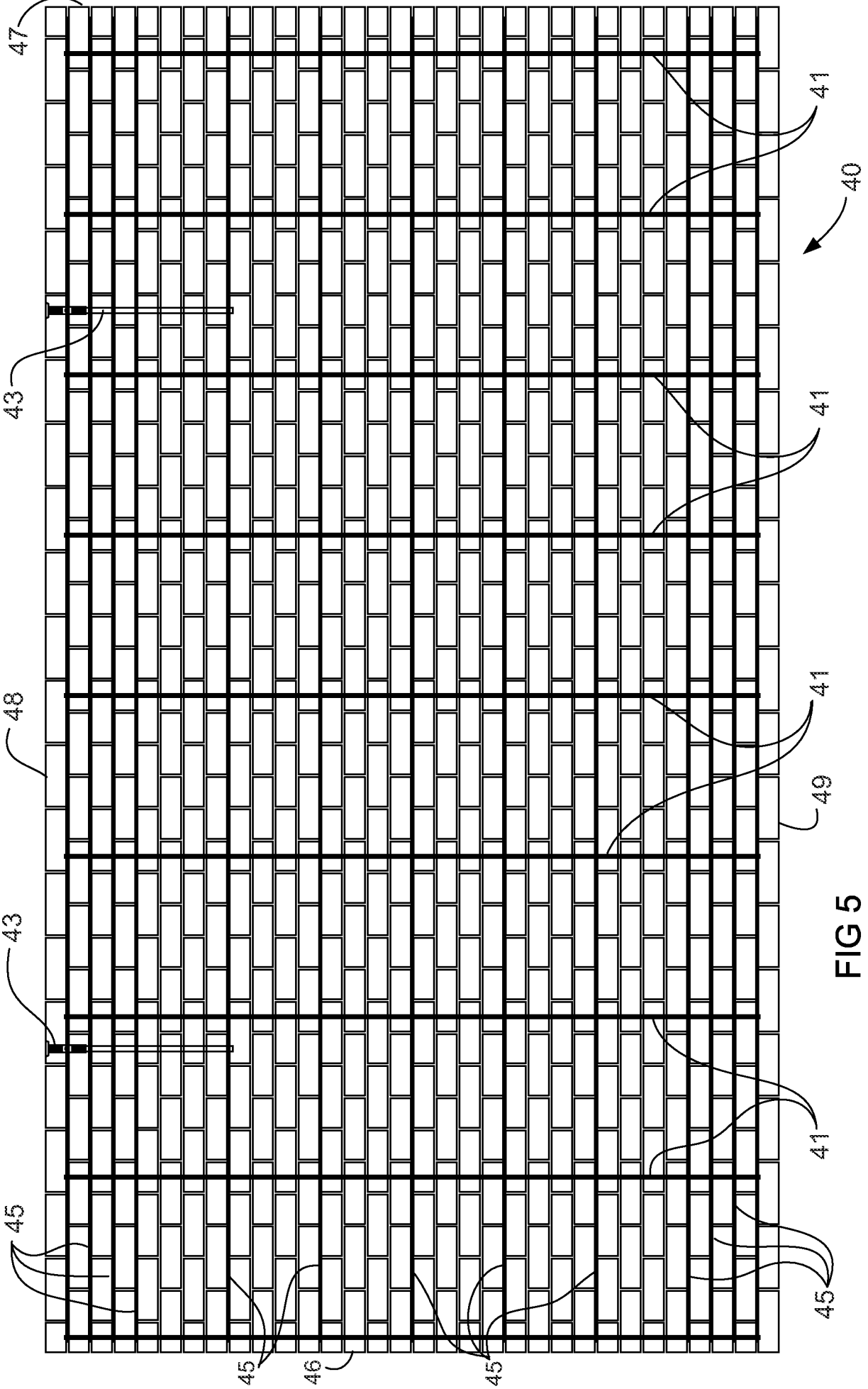

FIG 5

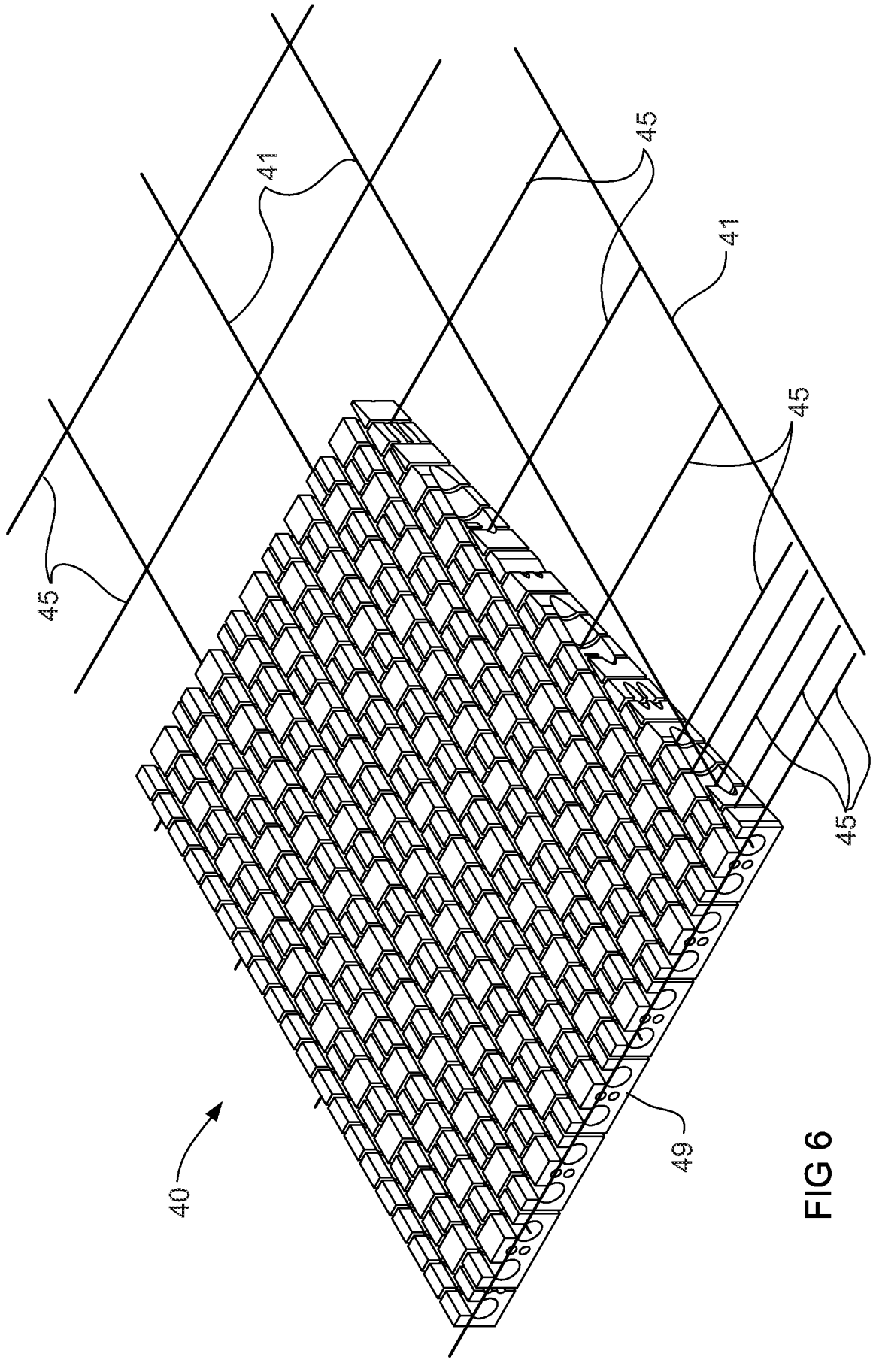

FIG 6

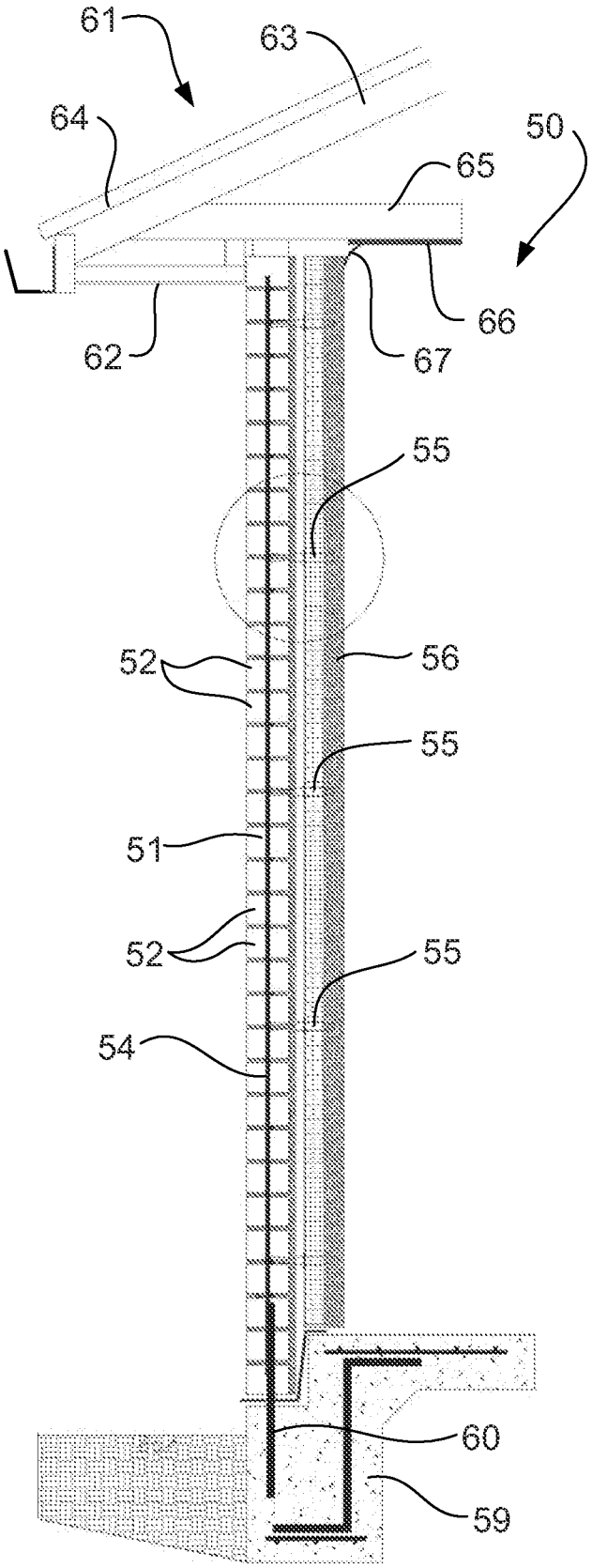

FIG 7

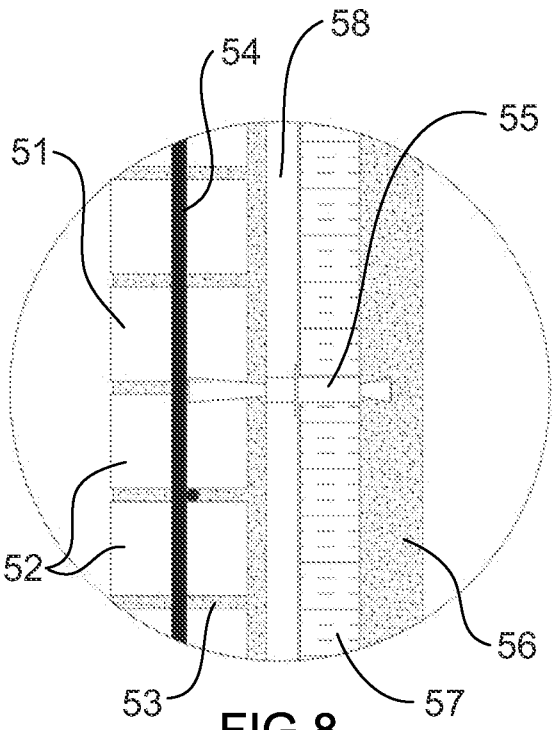

FIG 8

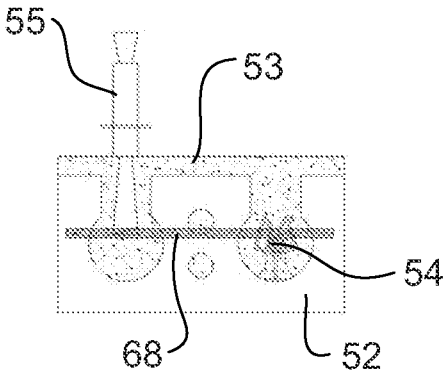

FIG 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2011/000037

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

E04C 2/06 (2006.01)

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)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI & EPODOC: IPC E04B1, E04B2, E04G21, B28B, B29C, E04C2, F16S1 Key Words (prefabricated, brick, block, panel, wall, reinforce, rod, bar and like terms)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2443806 A (POUNDFIELD PRODUCTS LIMITED) 21 May 2008 See figures 2-5, page 9 line 18-page 10 line 16, page 2 line 30 - page 3 line 23	1, 7-11, 14-17
X	US 4429499 A (KATO) 7 February 1984 See figure 1, column 2 lines 27-62	1-4,7, 8, 17
X	US 3248836 A (MONK et al) 3 May 1966 See figures 1, 12, 16-19, 21, 23-24, 26 column 5 lines 51-67	1, 2, 5-8, 12, 13, 17
X	US 3162982 A (MONK, Jr) 29 December 1964 See figures 2-5, column 1line 40-column 3 line 58	1, 5-8, 12, 17

[X] Further documents are listed in the continuation of Box C [X] 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 another 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	Date of mailing of the international search report
23 May 2011	1 - JUN 2011
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **SWAYAM CHINTAMANI** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2202

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2011/000037

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2001/0045551 A1 (SUTTER) 29 November 2001 See abstract, figures 1-4, paragraphs [0020]-[0029]	1-8, 17
A	GB 1149741 A (BRANDESTINI) 23 April 1969 See figures 1, 2, page 1 lines 18-75, page 2 lines 17-22	1, 5-8,12,13, 17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2011/000037

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	2443806	NONE					
US	4429499	DE	3110413	JP	57017314U	JP	57017315U
		JP	57017316U				
US	3248836	NONE					
US	3162982	NONE					
US	2001045551	US	6557830				
GB	1149741	BE	680416	CH	423167	NL	6605975

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX