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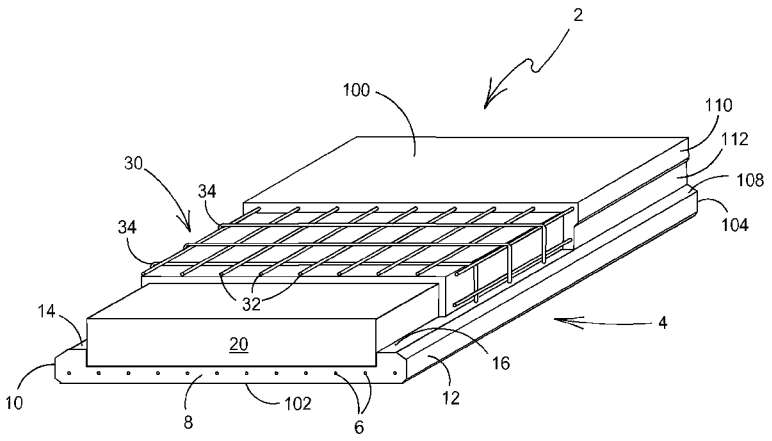

FIGURE 1

(57) **Abstract**: A building unit and method of construction of such a building unit are disclosed. The method requires i) locating a number of longitudinally extending pretensioned bars (6)with respect to a mould, introducing a first amount of a concrete mix into the mould to cover the bars within the mould; ii) providing a number of low density inserts (20) on a surface of the concrete mix; ii) providing reinforcement bars (30) about the number of low density inserts; and iv) introducing a second amount of a concrete mix into the mould about the number of low density inserts (20) and the reinforcement bars (30) to envelop the number of low density inserts (20) and the reinforcement bars (30) in which steps ii) to iv) occur before the setting of the concrete poured in step i).

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Improvements in and relating to a Building Unit

The present invention relates to a building unit, in particular to a building unit having use as a structural floor or roof slab.

It is known to produce concrete slabs for use in the construction of buildings, for example car parks or other structures, in which flooring is required to support significant loads while at the same time there is a requirement that there be wide spaces unobstructed by beams.

In the construction of car parks and similar structures it is known to provide a base slab or slabs (reference to a slab including reference to multiple slabs as appropriate) which are located in situ. The base slab is prestressed, that is pretensioned reinforcement is provided within the cast concrete. Once in place on site, and suitable formwork assembled to define the sides of the building unit, an upper layer of concrete is poured over the base slab, and a screeding operation performed to produce a desired surface finish to the building unit. Such a process has its advantages in that lighter slabs can be transported and assembled in comparison to a finished building unit. However, it also has its own disadvantages in that construction is dependent upon environmental conditions while the concrete added in situ is allowed to set and that the total weight of the building unit still requires regular support by support columns.

According to a first aspect of the present invention a building unit for use in the construction of a floor comprises:

a number of pretensioned rods,

a number of low density inserts located above the rods, and a number of reinforcing bars provided about the number of low density inserts,

the pretensioned bars, low density inserts and reinforcing bars being encased in a unitary concrete casting.

This has as an advantage that a lighter building unit than the described prior art building unit can be manufactured for transport to a site for assembly of a structure.

Preferably the number of reinforcing bars are provided around three sides of the low density insert or inserts.

Preferably, the number of reinforcing bars comprises a framework.

More preferably, the number of reinforcing bars comprise a unitary framework.

Preferably, the number of reinforcing bars are disposed above and to the sides of the insert or inserts.

More preferably, the number of reinforcing bars include a first set of bars extending longitudinally with respect to the base portion, and a second set of bars extending laterally with respect to the base portion.

Preferably, the building unit further comprises a mesh within the concrete cover portion disposed above the reinforcing bars. More preferably, the mesh is also disposed to the sides of a or the framework formed by the reinforcing bars.

Preferably, a number of elements, for example, lifters, are provided in the concrete cover portion.

According to a second aspect of the present invention, a method of manufacture of a building unit according to the first aspect of the invention comprises the steps of:

i) locating a number of longitudinally extending pretensioned bars with respect to a mould, introducing a first amount of a concrete mix into the mould to cover the bars within the mould;

ii) providing a number of low density inserts on a surface of the concrete mix;

iii) providing reinforcement bars about the number of low density inserts; and

iv) introducing a second amount of a concrete mix into the mould about the number of low density inserts and the reinforcement bars to envelop the number of low density inserts and the reinforcement bars

in which steps ii) to iv) occur before the setting of the concrete poured in step i).

This has as an advantage that the casting of the slab can occur within a controlled environment, allowing for reproducibility in the forming of the building unit. Further, the production of a building unit according to this method can be achieved in about half a day. The method thus has as a further advantage that better lead in times for manufacture and supply to site are enabled. In addition as the first part of the concrete mix has not set when the second part of the concrete is poured, there is no dry joint between a base and subsequently formed upper layer of concrete.

This method allows for longer spans to be constructed and thus fewer unit to unit joints need to be catered for.

Preferably, wet concrete is used in step iv). This has an advantage over the use of a semidry mix and is believed to provide a stronger final product. It will be understood that wet concrete may thus be used in both steps i) and iv).

Preferably, lifting elements are located with respect to the reinforcing bars before step iv).

Preferably, a mesh is located with respect to the reinforcing bars before step iv).

Preferably, one or more adjustment elements are located with respect to the reinforcing bars before step iv).

According to a third aspect of the present invention, assembly of a structure comprises bringing together a first plurality of building units produced in accordance with the second aspect of the invention and a first plurality of support columns, locating the first plurality of support columns in a suitable arrangement, locating the first building units with respect to the first support columns and securing the first building units with respect to the first support columns.

Such a structure has as an advantage that fewer down stand beams, or no down stand beams, are required, offering a clearer, or clear, span.

Preferably, the building units are secured to the columns by beams.

More preferably, the building units are secured to the columns by in situ post tensioned reinforced concrete beams.

Preferably, the levels of upper surfaces of adjacent building units are adjusted prior to securing the building units with respect to the support columns.

Preferably, assembly of the structure includes manufacture of a plurality of building units.

Preferably, assembly of the structure further comprises locating a further plurality of support columns in a suitable arrangement, on the beams, locating a further plurality of building units with respect to the further

plurality of support columns, and securing the further plurality of building units with respect to the further plurality of support columns.

The invention will now be described, by way of example only, in relation to the attached Figures, in which

Figure 1 shows a perspective part sectional view of a building unit in accordance with the present invention;

Figure 1a shows a side section through a first embodiment of a building unit in accordance with the present invention;

Figure 2 shows a plan view of the first embodiment of a building unit in accordance with the present invention;

Figure 3 shows a longitudinal section through the building unit of Figure 2;

Figure 4 a section thorough a side edge of the building unit of Figure 2;

Figure 5 shows a detail of Figure 3;

Figure 6 shows a plan view of a building unit of alternative construction in accordance with the present invention;

Figure 7 shows a longitudinal section thorough the building unit of Figure 6;

Figure 8 a section thorough a side edge of the building unit of Figure 6;

Figure 9 shows a detail of Figure 7;

Figure 10 shows a sectional view through side edges of adjacent building units in accordance with the present invention;

Figure 11 shows a side section through a structure constructed utilising building elements in accordance with the present invention;

Figure 12 shows a detail of the structure of Figure 11;

Figure 13 shows a second detail of the structure of Figure 11;

Figure 14 shows a third detail of the structure of Figure 11;

Figure 15 shows a schematic perspective view of a part of the structure of Figure 11;

Figure 16 shows a first sectional view through a side edge of a third embodiment of a building unit in accordance with the present invention;

Figure 17 shows a second sectional view through a side edge of the building unit of Figure 16;

Figure 18 shows a longitudinal section of a fourth embodiment of the present invention;

Figure 19 shows a sectional view through side edges of adjacent building units in accordance with the present invention;

Figure 20 shows a plan view of parts of the building units of Figure 19;

Figure 21 shows a section through part of a structure constructed utilising building units in accordance with the present invention; and

Figure 22 shows a section through part of an alternative structure constructed utilising building units in accordance with the present invention.

Like reference numerals are used to refer to like or corresponding parts.

Referring first to Figure 1, there is shown a perspective part sectional schematic view of a building unit 2 in accordance with the present invention. A plurality of pretensioned rods 6 is shown at the lower part of the building unit. The pretensioned rods 6 extend longitudinally, the ends of the rods 6 indicating a front end and a rear end of the building unit 2 to be formed. In practice, the pretensioned rods are located with respect to

a mould (not shown) such that their respective ends extend beyond the front and rear of the mould. The building of a suitable mould will be within the skill of one skilled in the art and is not discussed further. A first amount of wet concrete is added to the mould, for example by pouring, about the pretensioned rods 6 to encase and cover the pretensioned rods 6, for example to a level indicated by line A-A in Figure 1.

The pretensioned rods 6 extend beyond the front and rear edges of the concrete base portion.

The first amount of concrete may also include or part cover other elements (as described by way of example below).

An insert 20 of density lower than that of concrete is arranged on an upper surface of first amount of concrete. In Figure 1 this is shown as a unitary mass. However the insert 20 may be made up of a number of units. The insert 20 may extend substantially from one end of the concrete to the other. As will be seen it is advantageous that the insert 20 does not extend to each end of the concrete. In an alternative embodiment, the insert 20 comprises a series of inserts with or without spacings between adjacent inserts.

Conveniently the insert 20 is formed of polystyrene, which is of relatively low density and easily formed to the desired shape and volume. Polystyrene also has as an advantage that it provides significant weight savings.

A framework 30 of reinforcing rods is located over and to the sides of the insert(s). In the illustrated embodiment, the framework 30 comprises a plurality of longitudinally extending rods 32 and a plurality of laterally extending rods 34, the laterally extending rods 34 being bent at each end to form a plurality of depending rods along each side of the insert 20. The longitudinally extending rods 32 and the plurality of laterally extending rods 34 are secured to one another to form the framework 30 in any suitable way, such as by welding the rods together or tying the bars together.

Conveniently lower ends of the depending reinforcing rods are located in the still wet concrete of the concrete. Further elements may be supported on or from the framework of reinforcing rods.

In an alternative construction (Figure 1a) the framework 30 may comprise first and second separate L-shaped members 32, 34 in which each L-shaped member comprises a plurality of L-shaped lateral rods and a plurality of longitudinal rods, the depending rods of one L-shaped member being located in the still wet concrete to one side of the insert 20, and the depending rods of the other L-shaped member being located in the still wet concrete to the other side of the insert 20, the free limbs of each L-shaped member overlapping above the insert(s). (The longitudinal rods 6 have been omitted from Figure 1a for clarity.)

Other constructions of the framework will be envisaged to fit around the upper surface and sides of the insert(s) to provide reinforcement about the insert(s).

The longitudinal bars of framework 30 may extend beyond the front and rear edges of the concrete.

A second amount of wet concrete is poured into the mould to encase and envelop the insert 20, and the framework 20. The second amount of wet concrete may be prepared separately from the first amount, or may comprise a remainder of the concrete prepared for the first amount. In Figure 1 the concrete is shown in cut away only for the purposes of illustrating the framework 30 within.

In the embodiment of Figure 1a, a mesh 36 of any convenient, suitable material is located over an upper plane of the framework 30 prior to pouring of the second amount of wet concrete. The mesh 36 may extend to one or both sides of the framework 30 and is also enveloped or encased by the concrete.

The concrete may be shaped by the mould when formed to produce a building unit 2 having a desired side structure. Any desired finish may be provided for the upper surface 100 of the concrete. Portions of the framework 30 may extend beyond the concrete to the front and rear of the building unit 2.

The construction of the building unit 2 in this way means that no structural screed is required.

The use of pretensioned rods 6 in combination with the insert(s) and reinforced framework 30 allows for a longer span of building unit in comparison with the described prior art method.

By adding the second amount of concrete while the first amount of concrete is still wet, there is no dry joint between the two.

Details of a building unit in accordance with the present invention will now be discussed in relation to Figures 2 to 5.

A plan view of a building unit in accordance with the invention is shown in Figure 2. For clarity, save where they extend beyond the ends of the building unit the longitudinally extending rods 6 have been omitted. The footprint of first and second inserts 20 are shown in ghost.

Figure 3 shows a section along line 3-3 of Figure 2. The first and second inserts 20 are shown separated by a region of concrete 52.

Figure 4 shows a sectional view of a side edge of a building unit 2 showing an example side profile. The concrete provides a lower surface 102 of the building unit 2 and is provided with a suitable soffit finish. The concrete further provides a substantially vertical lower side surface 104 connected to the lower surface 102 by way of a bevelled surface 106.

A lower generally inclined surface 108 extends from the vertical lower side surface 104. A generally flat upper surface 100 of the building unit 2 is provided, with a generally vertical upper surface 110 extending to each side of the building unit. An intermediate vertical surface 112 extends upward from the lower inclined surface 108 and is connected to the upper vertical surface 110 by an upper inclined surface 114. As can be seen from Figure 4 the lower side surface 104 extends furthest laterally from the insert 20, with the intermediate side surface 112 being closest to the insert 20.

Figure 5 shows a detail of one end of the building unit of Figure 2 showing an example end section.

End surfaces of the building unit 2 are formed with a shoulder or rebate 120 joining the end surface to the upper surface of the building unit. The end surface comprises a major surface 122 generally inclined towards the lower surface 102 of the building unit, the major portion 122 transitioning to the lower surface 102 of the building unit by way of a more steeply angled second bevelled surface 124.

It can also be seen that the end of the building unit 2 has been provided with tethering means, here head anchors 60, by which the building unit may be lifted. The head anchors 60 are located with respect to the framework 30 prior to casting of the concrete. A recess 61 has been formed around a free end of the head anchor.

Further details of another building unit 2 in accordance with the present invention will now be discussed in relation to the Figures 6 to 9. Again, for clarity, the rods have been omitted. The footprint of the first and second inserts 20 are shown in ghost. Figure 6 is similar to Figure 2, and Figure 7 is similar to Figure 3.

Figure 8 is similar to Figure 4 but shows a different example side edge profile.

While generally similar to the side edge profile of Figure 4, it will be seen that the lower inclined surface 108 extends more steeply and forms a greater part of the side surface, with the lower side surface 104 forming a smaller part of the side surface in comparison to the embodiment of Figure 4.

Figure 9 shows a view similar to that of Figure 5, but instead shows a lifting loop 62. As can be seen from Figure 6 four such lifting loops 62 are illustrated two at each end of the building unit 2. A lower part 64 of the loop is secured for example to one of the pretensioned rods 2 or to a lower part of the framework 30, exiting the desired point of the end surface due to the guide element 68 retained within the framework. An upper part 66 of the loop extends from the end of the building unit 2 to allow for lifting of the building unit 2.

Figure 10 shows in side section adjacent edges of adjacent building units 2 showing adjustment elements incorporated within the building units 2. (The framework 30 has been omitted for clarity.) Each building unit 2 has a first plate 70, conveniently of steel, cast into the intermediate surface 112 of the edge of the building unit 2. Plates 70 are also shown partially in ghost in Figure 6 and Figure 7. In practice one end of the plate 70 extends into, and may be supported by, the insert 20 prior to casting of the concrete. Once the concrete has set the concrete cover portion 50 holds the first plate 70 in position. When building units 4 incorporating the first plate 70 are arranged adjacent to one another (as shown in Figure 10), an arrangement of washer plates can be used to level the adjacent building units. A first washer plate 72 is located above one of the first plates 70 and a second washer plate 72' is located. Each of the washer plates 72, 72' is provided with a through bore. A headed bolt 76 is passed through the washer plates 72, 72' and is received by a nut 74 on the side of the washer plates 72, 72' remote from the head of the bolt 76. The nut 74 and bolt 76 can then be tightened such that the washer plates 72, 72' cause, by way of the first plates 70, the alignment of the (upper surfaces of) the adjacent building units 20.

It will be understood that where building units of identical depth are located adjacent to one another the lower surfaces of the adjacent building units will also be brought into alignment.

The use of downstand beams to support the weight of a floor has been a necessity when using building units formed according to the prior art

method described. Due to the lightweight construction of the building units of the present invention downstand beams may be dispensed with. Since downstand beams no longer need be used, the height of the overall structure constructed using building units according to the present invention may be less than an equivalent structure using building units formed according to the described prior art method, by around 300mm per floor level. In addition the use of a material of lower density than concrete in the construction of the building unit reduces the overall weight of the structure.

Figure 11 shows a section through a structure 80 constructed utilising building elements 2 in accordance with the present invention. This structure may be utilised as a car park. Three pre-cast concrete support columns 82, 84, 86 are shown provided at ground level with their associated footings located beneath ground level 88. Above each of the outer end columns 82, 86 are edge beams 92, 96 carrying upstanding thin walls 90. It will be understood that there are further support columns behind and/or in front of those shown in Figure 11 to provide further support for the edge beams 92, 96. The edge beams 92, 96 are in situ formed post tensioned concrete beams. The middle support column 84 supports an intermediate in situ post tensioned reinforced concrete beam 94.

Building units 2 in accordance with the present invention are supported between the outer edge beams 92, 96 and the intermediate in situ post tensioned concrete beam 94. An example section through an edge beam

is shown in Figure 12 showing the engagement of the end section of the building unit 2 with the edge beam 92.

The edge beam 92, 96 includes a reinforcing structure of reinforcement bars 97 (omitted from Figures 11, 12 and 14 for clarity, but shown by way of example in Figure 15).

The inclined surface and rebate key with the concrete cast about the reinforcing structure to support the ends of the building unit adjacent the edge beam. As may be seen from Figure 15 where the reinforcing bars 6 (and/or the bars of the framework 30) extend beyond the ends of the building unit 2, these provide further means by which the building unit 2 may be keyed to the edge beam 92, 96.

An example section through an intermediate beam 94 is shown in Figure 13 showing the engagement of the end sections of building units 2 to each side of the intermediate beam 94 with the intermediate beam 94.

The intermediate beam 94 also includes a reinforcing structure of reinforcement bars (omitted from Figures 1 and 13 for clarity). As with the edge beams 92, 96, any longitudinal bars 6 and portions of the framework 30 extending beyond the edge of the building unit will provide means to key the building unit to the intermediate bar. The inclined surface and rebate at the ends of the building unit 2 also allow the building units 2 to key to the intermediate beam 94.

Before the ends are secured in place, upper surfaces of the adjacent building units 2 will preferably be made level in the manner explained with reference to Figure 10.

It will be appreciated that the side sections of adjacent building units form a valley or trough therebetween. In use, this allows access to the first and second plates 70, 72 to allow for relative adjustments of the levels of the adjacent building units prior to fixing of the building elements 2 into position. After alignment, preferably the trough or valley may be infilled with non-shrink concrete 98 (Figure 14).

Further levels or storeys of the structure 80 may be built up by providing further support columns 82', 84', 86' atop the post tensioned concrete beams 92, 94, 96 and providing further beams 92', 94', 96' to support further building units.

Figures 16 and 17 show sectional views of a building unit in accordance with the present invention. While the other building units discussed above could have been symmetrical with each side edge being identical, the building unit shown in Figures 16 and 17 is not symmetrical in this way. Figure 16 shows a side section in a region where adjacent building units are to be secured together, while Figure 17 shows a side section through other regions of the building unit.

A building unit 200 comprises a low density insert 220 is provided encased within a concrete mass 200 in the form of a unitary concrete casting

created according to the method described above. An array of pretensioned rods 206 may be seen beneath the low density insert 220, as in previous embodiments. However, to one side the building unit 200 has been formed with a upper protrusion 202 and to the other with an lower protrusion 204. It will be noted that with the base of the building unit as a reference point, an upper surface 208 of the lower protrusion 204 is lower than a lower surface 206 of the upper protrusion 202.

In the region where the building units are to be secured together the upper protrusion 206 is formed with a recess or well 214. An upper surface 209 of the upper protrusion in this region (that is at the base of the well in this region) is lower than an upper surface 211 of the building unit. The upper protrusion is provided with a cast through bore 210 extending from the base of the well 214 through to the lower surface 206 of the upper protrusion 202. As can be seen from Figure 20, the through bore is conveniently takes the form in section of a slot having a shorter axis and a longer axis, the longer axis being conveniently aligned with the edge of the building unit.

The lower protrusion is formed with a blind bore 212 provided with a thread.

In the region where the building units are to be secured together to each side of the low density insert 220 a framework 230 is provided in the concrete mass 200.

In the remainder of the building unit, that is outside of those regions where the building units are to be secured together a further framework 231 is provided. Additional tubular frameworks 242,244 are supported from the further framework 231 and provide reinforcement to the upper and lower protrusions 202,204.

Turning to Figures 19 and 20 adjacent building units as illustrated in Figures 16 and 17 are shown secured together. A left hand building unit 200 is located in position and a suitably resilient member, for example a compressible mastic seal 340 is provided at or applied to the upper surface 208 of the lower protrusion 204. A right hand building unit 300 is then located adjacent the left hand building unit 200.

A threaded bolt or stud 342 is introduced through the through bore 310 and into the blind bore 312. The threaded bolt or stud 342 is provided with a thread which engages with the thread of the blind bore 312. In the first instance the slotted nature of the through bore will be understood to allow ready engagement of the headed bolt or stud with the blind bore without an exact lateral alignment of the two building units. A washer or plate 312 having an opening is located over the threaded bolt or stud 342 at an upper end of the through bore 210 (Figure 20), the plate 312 extending over the shorter axis of the bore, but not the longer axis.

A nut 344 is then provided on the threaded bolt or stud 342 to engage a thread at an upper end thereof. Conveniently the threaded bolt or

stud 342 is provided with a single thread extending along its length. Rotation of the nut 344 on the headed bolt or stud 342 beyond a certain point will be understood to allow relative displacement of the left and right hand building units 200,300 until the desired arrangement has been obtained.

Once the desired configuration has been obtained, grout or similar material may be introduced into the through bore 210 and about the threaded bolt or stud 342 by way of the portions of the upper end of the through bore 210 not covered by the washer or plate 312.

A mastic joint 346 may also be introduced between the lower protrusion 304 and the adjacent building unit 302.

The ends of the building unit may also adopt a configuration other than that shown for example in Figure 3. Figure 18 shows a longitudinal section through a building unit 400. As in Figure 3, first and second low density inserts 420 are separated by a region of concrete 452. The ends of the building unit 400 are identical and only one will be described. The ends of the building unit comprise an extension 402 extending in line with a lower surface 406 of the building unit.

As may be seen by reference to Figure 21, a support beam 500 is located on top of a column 502. A mastic joint 504 may be provided between the support beam 500 and the column 502. A lower portion of the support beam 500 is provided with a ledge 506. The ledge 506 includes a plurality

of upwardly extending locating means 508, such as a threaded stud. Conveniently such locating means 508 are formed cast into the support beam 500 and are spaced to allow suitable location of building units 400 as will be described.

The building unit 400 of Figure 18 is shown in position on the support beam 500. The building unit extension 402 is conveniently provided with two through bores, one 404 of which is shown in Figure 21. The building unit 400 is positioned such that one of the plurality of locating means 508 extends into each through bore 404 but conveniently does not extend beyond an upper surface 406 of the building unit extension 402. Prior to location of the building unit 400 a strip or layer 520 of neoprene or similar may be provided on an upper surface of the ledge 506, the locating means 508 is always behind the strip or layer 520 of neoprene or similar.

Once located, the through bores 404 and any clearance between the support beam and the end of the extension 402 of the building unit 400 may be filled with grout or similar material 440.

Then, a further strip member 510 may be secured to the support beam 500 by way of any suitable retaining means. The strip member 510 of Figure 21 can be seen to extend into a region above the upper surface 406 of the extension and below a level of an upper surface 411 of the building unit 400. Concrete 450 may then be used to infill between the upper surface 411 of the building unit 400 and the support beam 500. In Figure 21 the support beam 500 is provided with a surface 511

intended to be substantially level with the upper surface 411 of the building unit 400, when the building unit 400 has been correctly positioned.

An alternative construction for the end of a building unit 600 is shown in Figure 22. The building unit 600 is shown with an extension 602. The extension 602 includes a plate 604, an upper surface 610 of which is located flush with an upper surface 606 of the extension 602. The plate 604 together with a plurality of studs 605, typically four, is located by a framework (not shown in Figure 22) and is located during the manufacture of the building unit 600.

The building unit 600 is shown located on a beam 700. The beam 700 is provided with a ledge, a lower surface of the extension 602 resting on an upper surface 702 of the ledge. Conveniently, a layer of grout or similar 740 is introduced between an end face of the extension and a vertical face 710 of the beam 700. The beam 700 is also provided with a plurality of plates 704 extending along the beam 700. The plates 704 are formed flush with the vertical face 710 of the beam and are located by a plurality of studs 705, typically four, located by a framework (not shown in Figure 22) within the beam 700.

Once the building unit 600 has been located in position a further plate 750 is located such that it in part overlies the building unit plate 604 and also contacts one of the beam plates 704. The further plate 750 may then be welded to each of the building unit plate 604 and beam plate 704 to retain

the building unit 600 in position. It will be understood that each of the plates 604, 704, 750 are of a suitable material to allow this to occur.

Conveniently each end of the building unit 600 is provided with two such plates 604 to enable two such connections to be made.

Conveniently concrete 650 may then be used to infill between the upper surface 611 of the building unit 600 and the support beam 700.

Conveniently as illustrated in Figure 22 each of the building unit and the beam may be also provided with a number of cast in loop boxes 660,760. In practice the loop boxes 760 of the beam 700 are arranged in an alternating fashion with the beam plates 704. As may be seen from Figure 22, the loop boxes 760 are arranged slightly higher on the vertical face of the support beam 700 than the beam plates 704. Conveniently the building unit 600 is provided with at least one such loop box 660 disposed in a vertical end face of the building unit 600 above the extension 602. Prior to addition of the wet concrete 650 a pretensioned strand 800 is introduced through the loops of the respective loop boxes 660,760 and suspended therefrom.

The construction of building units of the kind set forth allows for greater spans to be covered while maintaining a lower depth of building unit. By way of example, the span of a building unit is judged to be that part between its ends less any part that is supported (so in Figure 21 that part of the end supported by the ledge does not form part of the span of the

building unit). It has been found that a building unit in accordance with the present invention (for example that disclosed in relation to Figure 2) may have a span of 15.65 metres while having a depth of only 400mm – or a depth to span ratio of 1:39.125.

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CLAIMS

1 A building unit for use in the construction of a floor comprises a number of pretensioned rods, a number of low density inserts located above the rods, and a number of reinforcing bars provided about the number of low density inserts, the pretensioned bars, low density inserts and reinforcing bars being encased in a unitary concrete casting.

2 A building unit according to claim 1, in which the reinforcing bars are provided around three sides of the low density insert or inserts.

3 A building unit according to claim 1 or claim 2, in which the number of reinforcing bars comprise a framework.

4 A building unit according to claim 3, in which the number of reinforcing bars comprise a unitary framework.

5 A building unit according to any of claims 1 to 4, in which the number of reinforcing bars are disposed above and to the sides of the insert or inserts.

6 A building unit according to claim 5, in which the number of reinforcing bars include a first set of bars extending longitudinally with respect to the base portion, and a second set of bars extending laterally with respect to the base portion.

7 A building unit according to any of claims 1 to 6, in which the building unit further comprises a mesh within the concrete cover portion disposed above the reinforcing bars.

8 A building unit according to claim 7, in which the mesh is also disposed to the sides of a or the framework formed by the reinforcing bars.

9 A building unit according to claim 8 in which a number of elements, for example, lifters, are provided in the concrete cover portion.

10 A method of manufacture of a building unit according to any of claims 1 to 9, comprises the steps of:

i) locating a number of longitudinally extending pretensioned bars with respect to a mould, introducing a first amount of a concrete mix into the mould to cover the bars within the mould;

ii) providing a number of low density inserts on a surface of the concrete mix;

iii) introducing reinforcement bars about the number of low density inserts; and

iv) pouring a second amount of a concrete mix into the mould about the number of low density inserts and the reinforcement bars to envelop the number of low density inserts and the reinforcement bars

in which steps ii) to iv) occur before the setting of the concrete poured in step i).

11 A method according to claim 10 in which wet concrete is used in step iv).

12 A method according to claim 10 or 11, in which lifting elements are located with respect to the reinforcing bars before step iv).

13 A method according to any of claims 10 to 12, in which a mesh is located with respect to the reinforcing bars before step iv).

14 A method according to any of claims 10 to 13, in which one or more adjustment elements are located with respect to the reinforcing bars before step iv).

15 A method of assembly of a structure comprising bringing together a first plurality of building units in accordance with any of claims 1 to 10 and a first plurality of support columns, locating the first plurality of support columns in a suitable arrangement, locating the first building units with respect to the first support columns and securing the first building units with respect to the first support columns.

16 A method according to claim 15, in which the building units are secured to the columns by beams.

17 A method according to claim 16, in which the building units are secured to the columns by in situ post tensioned reinforced concrete beams.

18 A method according to any of claims 15 to 17 in which the levels of upper surfaces of adjacent building units are adjusted, prior to securing the building units with respect to the support columns.

19 A method according to any of claims 15 to 18, in which assembly of the structure includes manufacture of a plurality of building units.

20 A method according to any of claims 15 to 19, in which assembly of the structure further comprises locating a further plurality of support columns in a suitable arrangement, on the beams, locating a further plurality of building units with respect to the further plurality of support columns, and securing the further plurality of building units with respect to the further plurality of support columns.

21 A building unit substantially as described herein with reference to and as illustrated in the accompanying drawings.

22 A method of manufacture of a building unit substantially as described herein with reference to and as illustrated in the accompanying drawings.

23 A method of assembly of a structure substantially as described herein with reference to and as illustrated in the accompanying drawings.

24 A building unit according to any of claims 1 to 9 having a depth and a span and a depth to span ratio of 1:39.125.

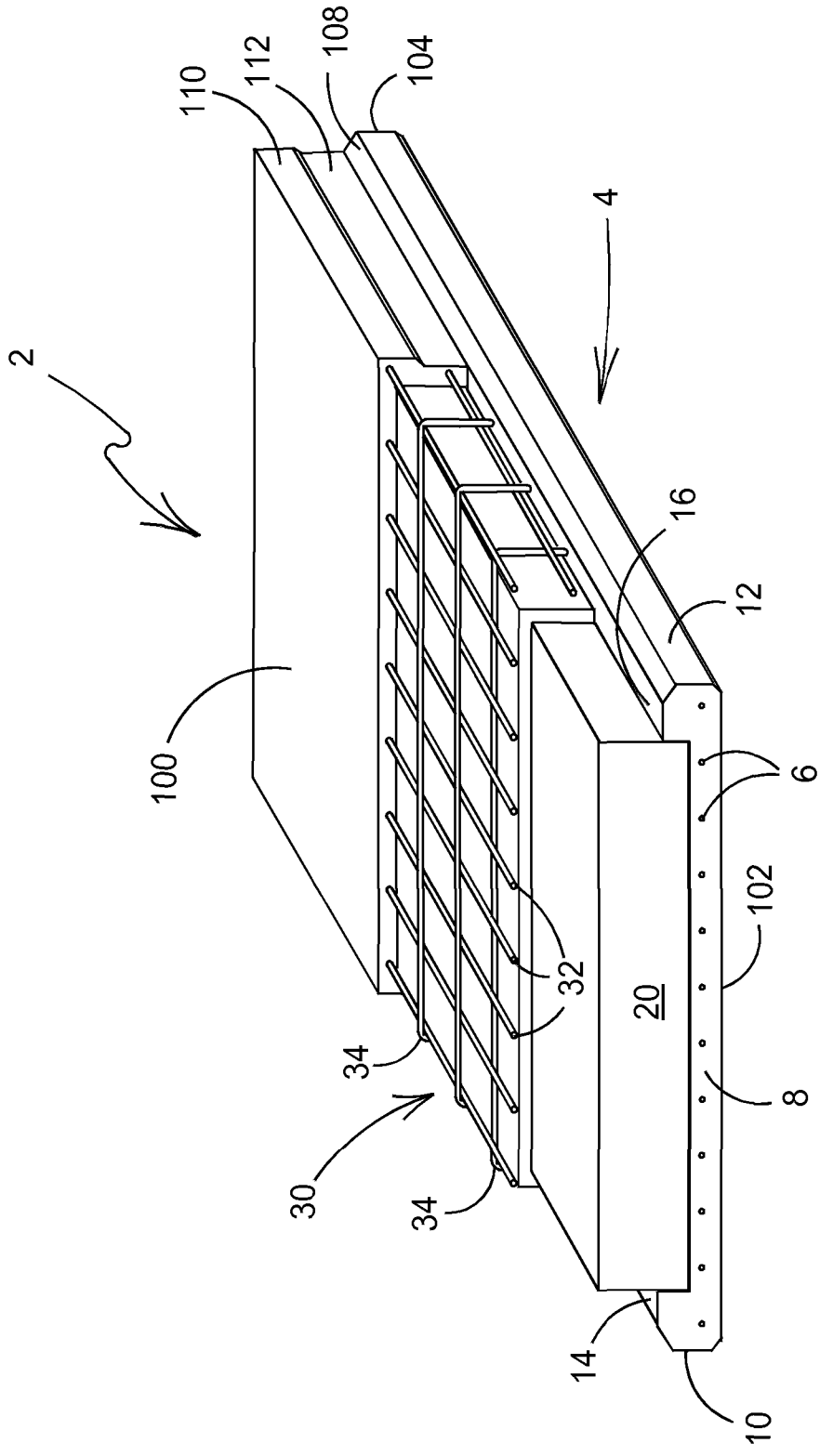


FIGURE 1

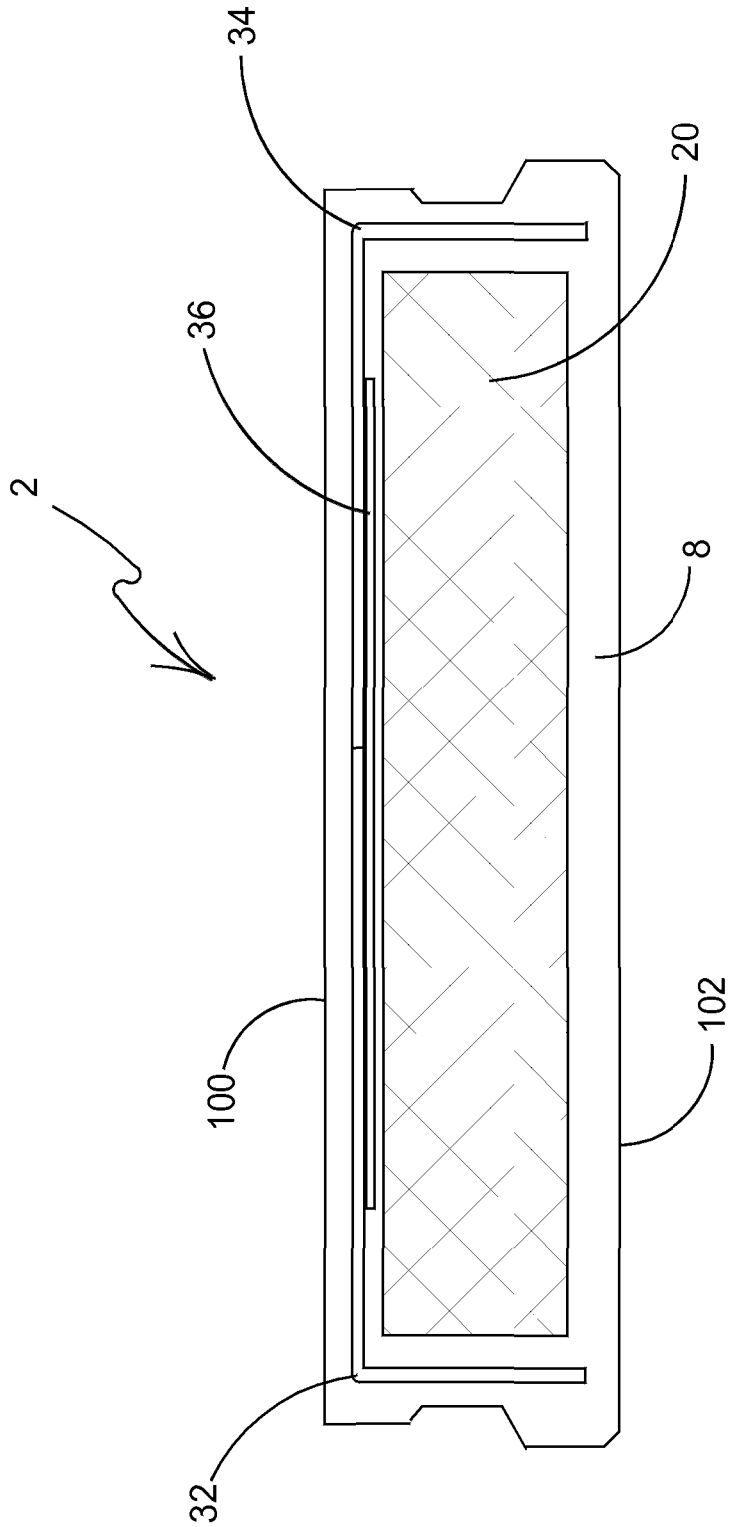


FIGURE 1A

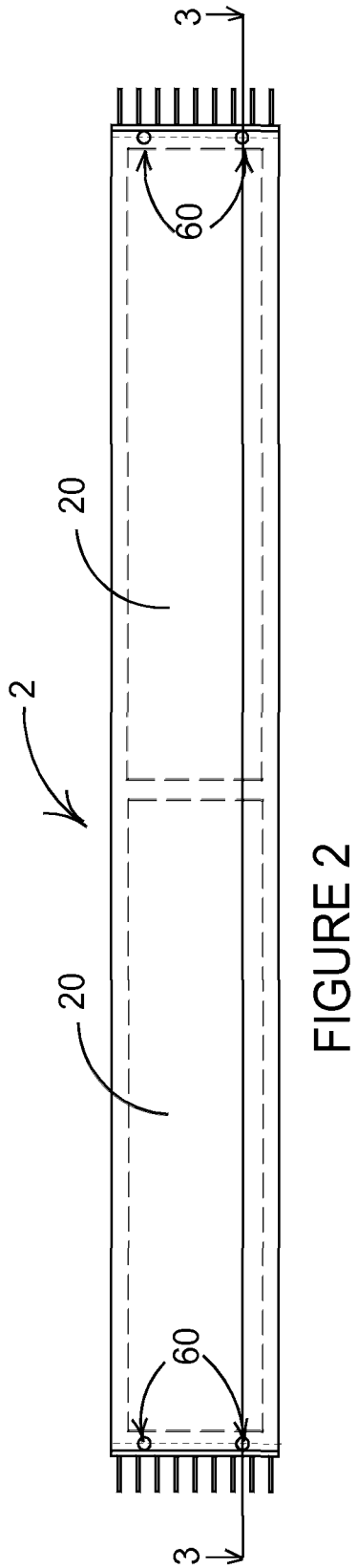


FIGURE 2

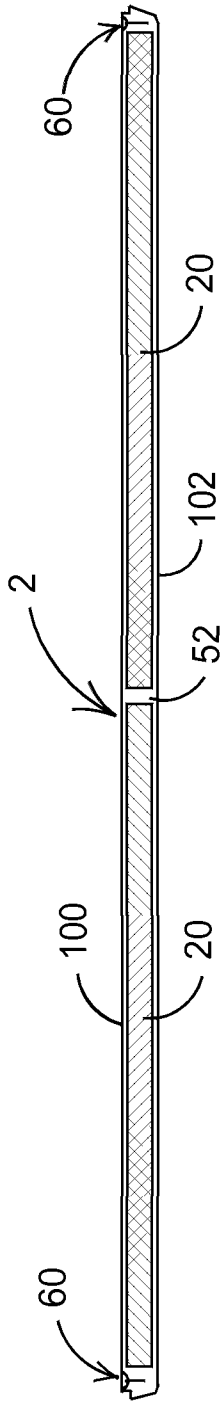
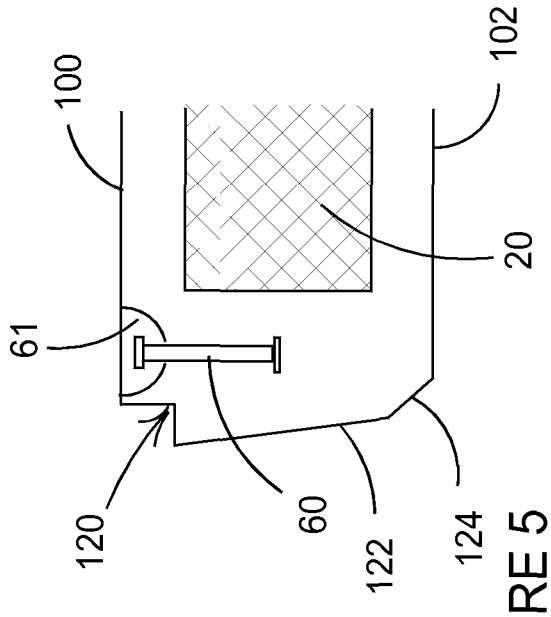


FIGURE 3



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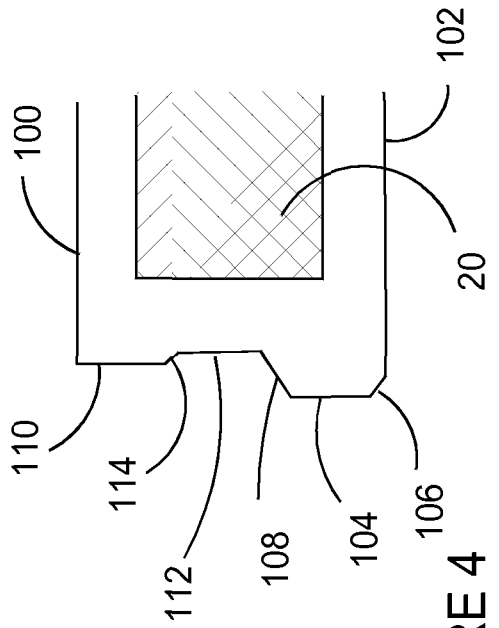

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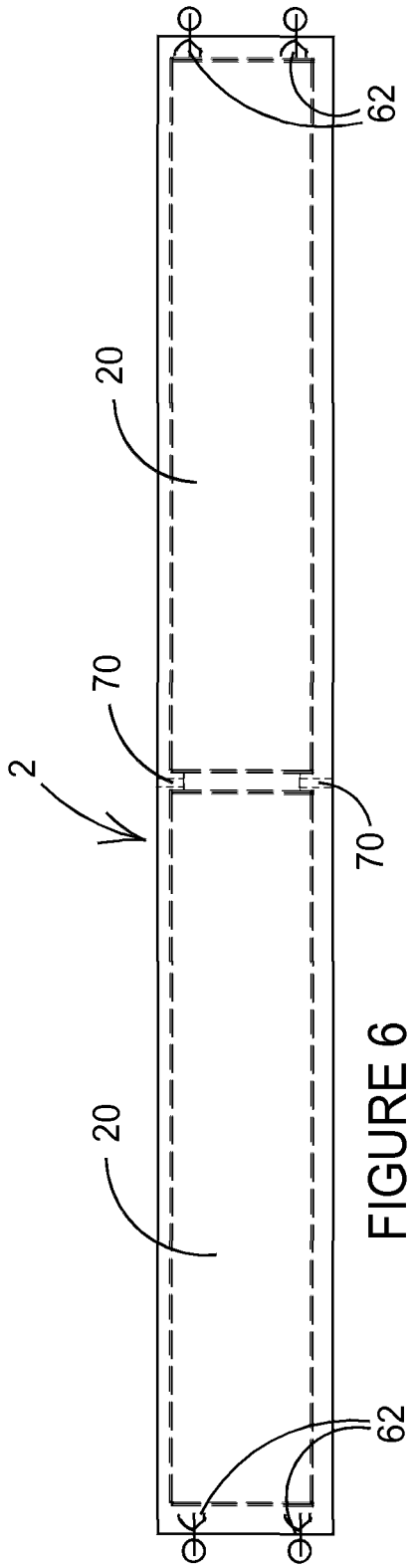

FIGURE 6

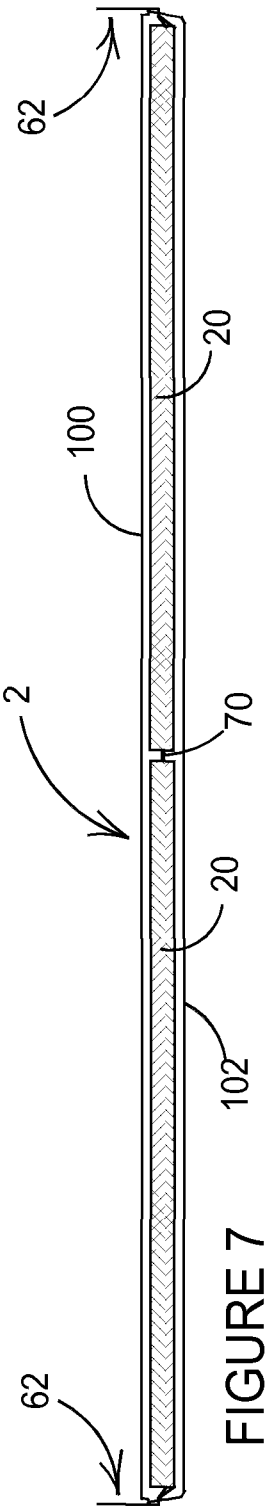

FIGURE 7

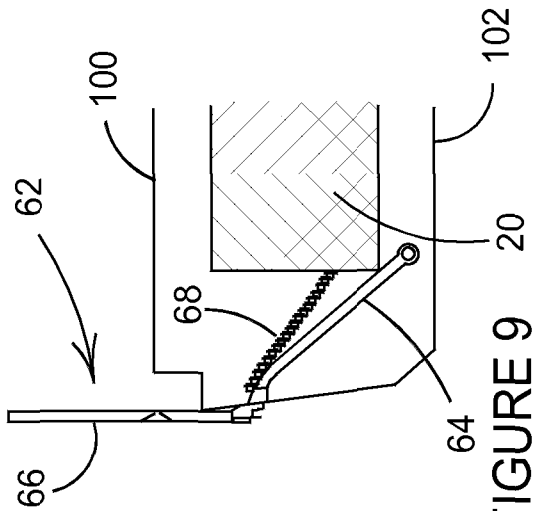

FIGURE 9

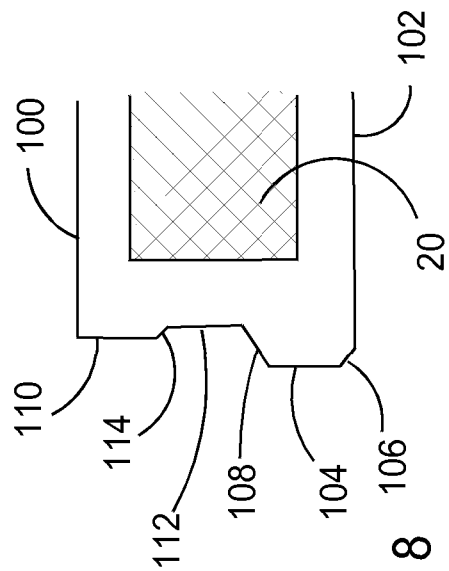

FIGURE 8

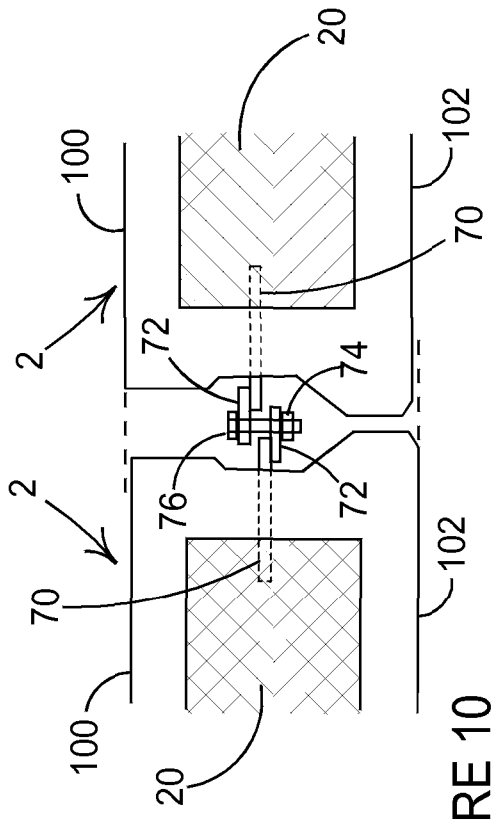

FIGURE 10

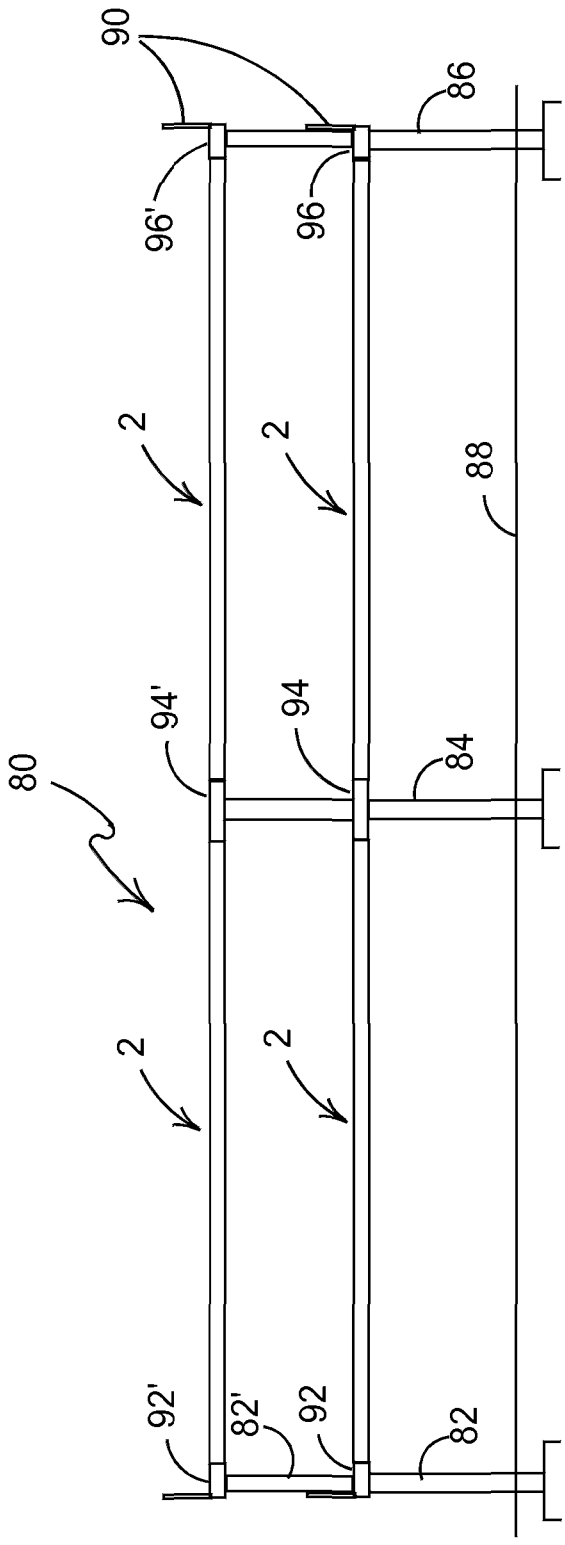

FIGURE 11

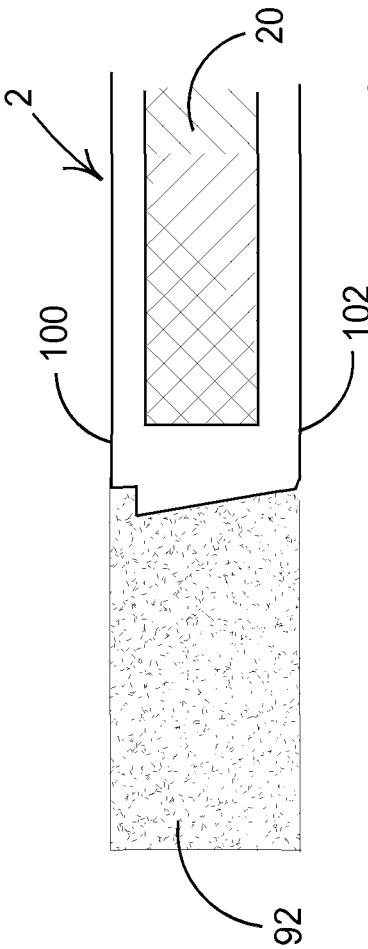

FIGURE 12

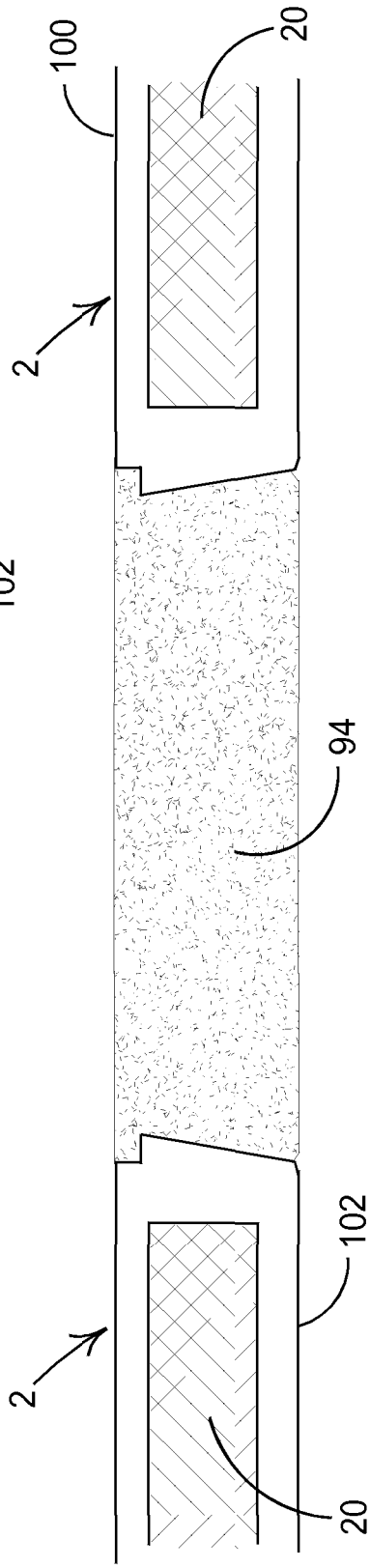

FIGURE 13

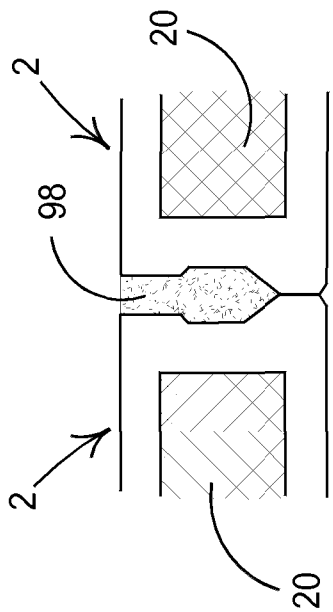

FIGURE 14

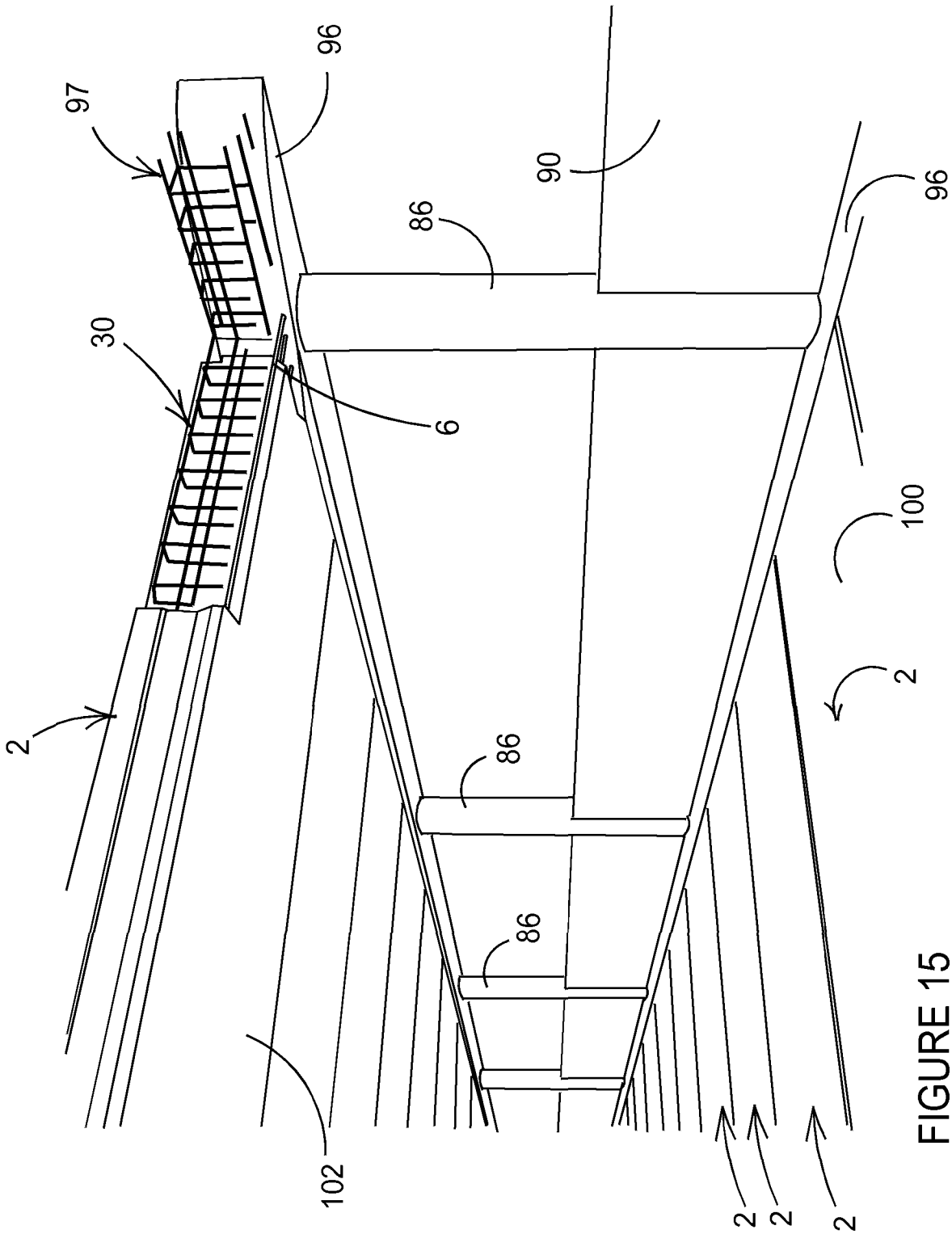

FIGURE 15

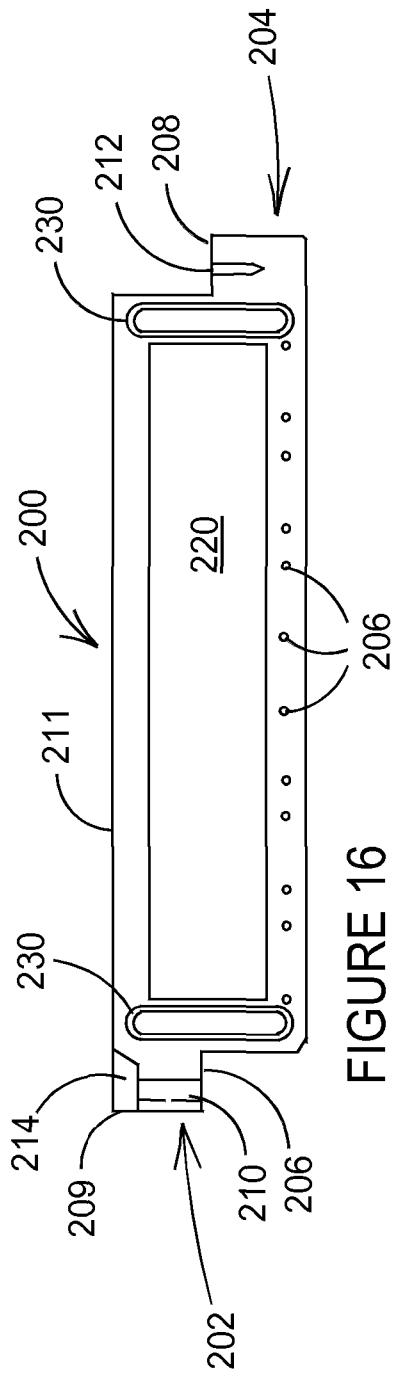

FIGURE 16

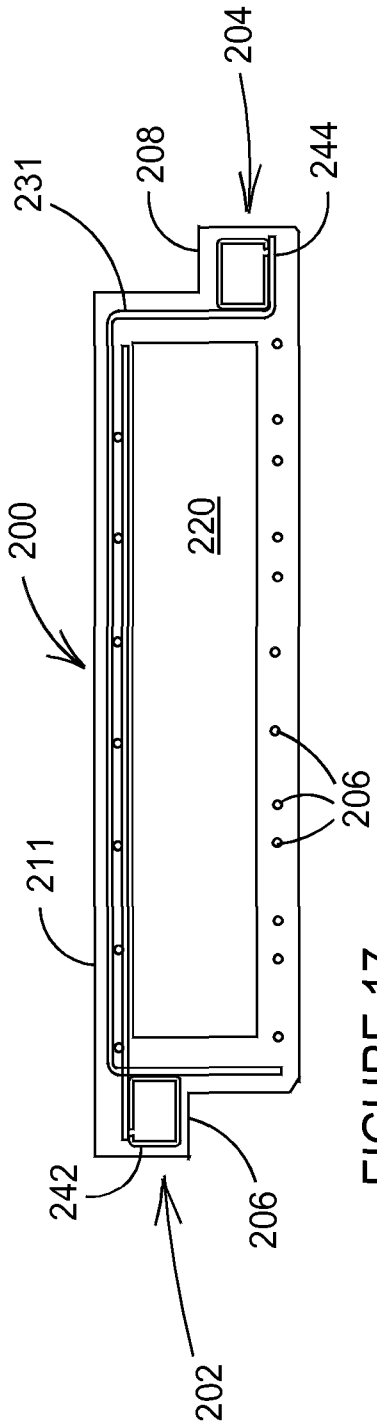

FIGURE 17

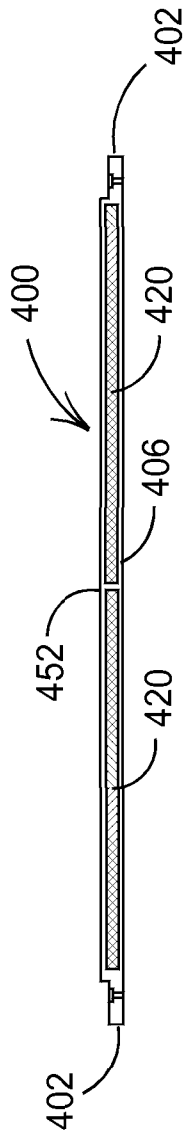

FIGURE 18

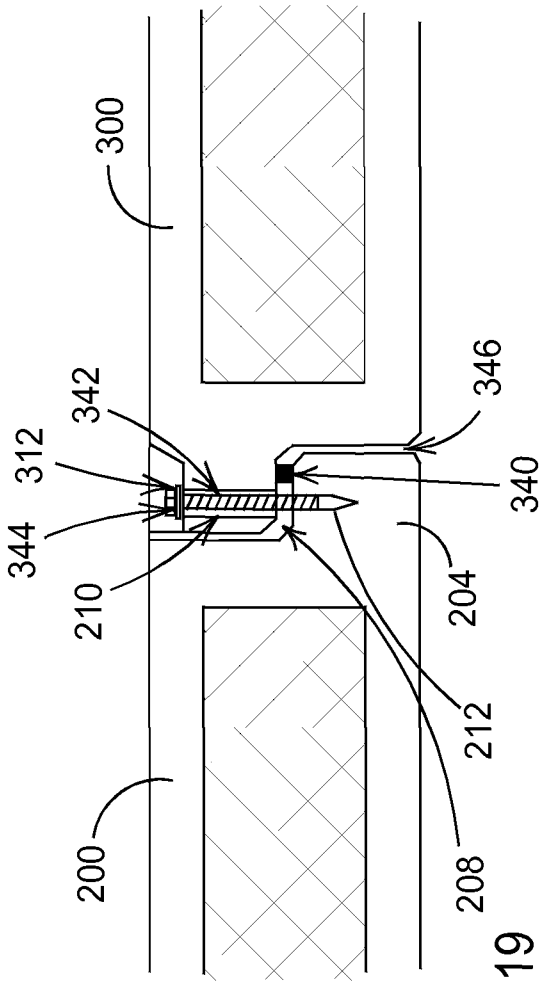

FIGURE 19

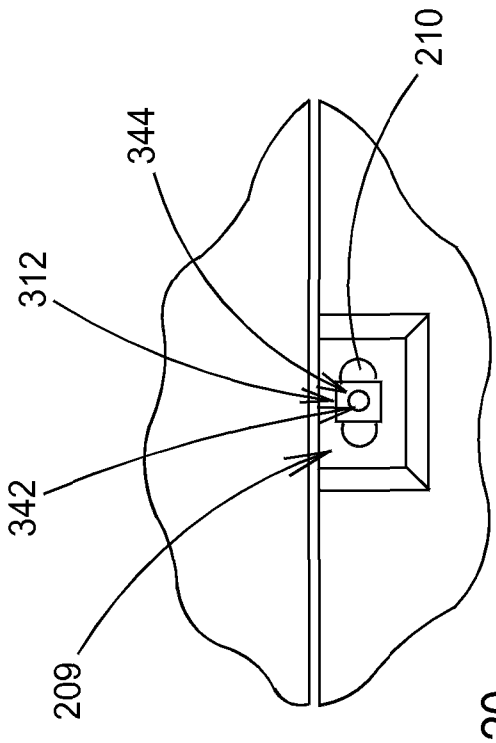

FIGURE 20

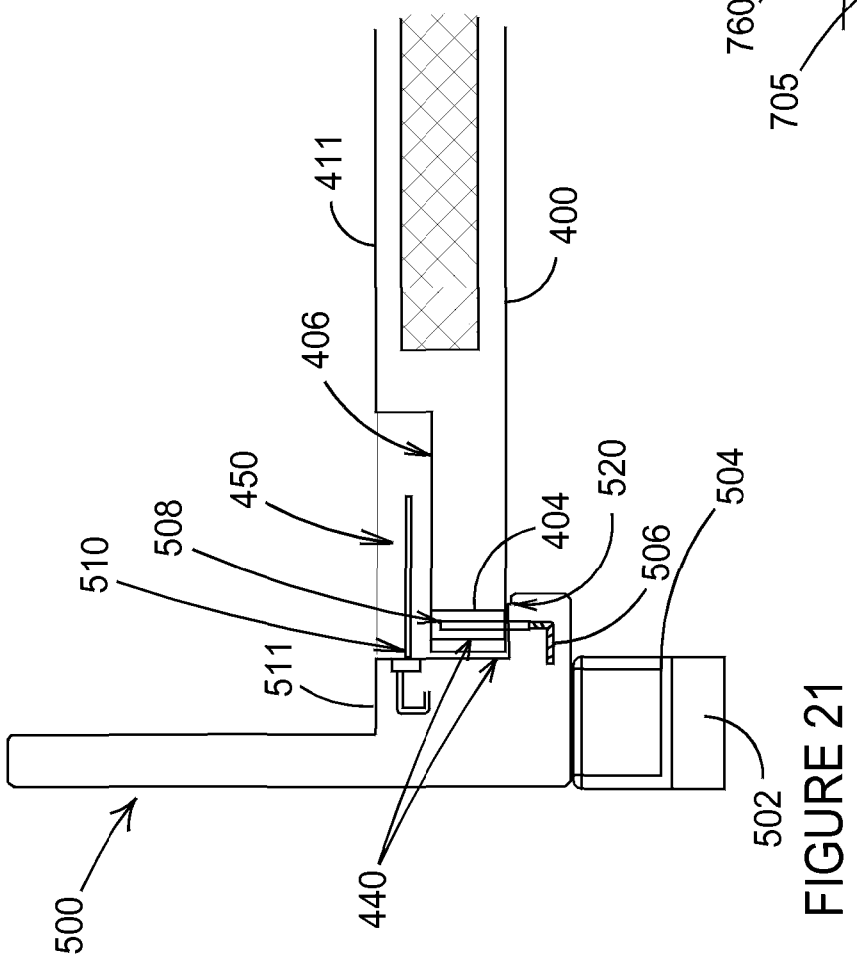

FIGURE 21

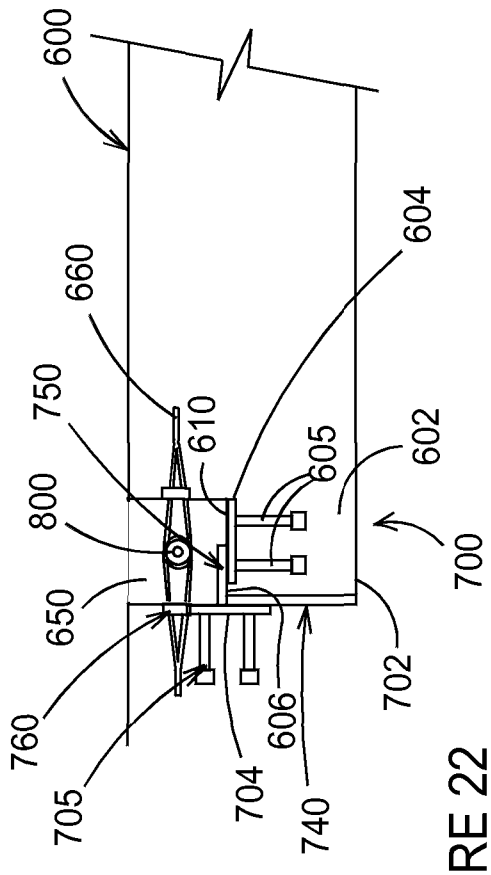

FIGURE 22

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/052463

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04B5/04 E04B5/43 E04B5/02 B28B19/00 B28B23/02
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04B B28B

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 141 946 A (RAUENHORST GERALD A) 27 February 1979 (1979-02-27) figures	1-19,24
X	WO 2011/008783 A1 (21ST CENTURY STRUCTURES LLC; GALLIONE JOSEPH [US]; WEHRLI RICHARD [US]) 20 January 2011 (2011-01-20) paragraph [0053]; figure 8	1,7-9, 15-20,24
X	WO 2010/056691 A1 (SKIDMORE OWINGS & MERRILL LLP; SARKISIAN MARK P [US]; HARTMAN CRAIG W) 20 May 2010 (2010-05-20) figure 5a	1-9, 15-20,24
X	WO 92/06253 A1 (BREUNING JOERGEN ILLNER [DK]) 16 April 1992 (1992-04-16) figure 9	1-9, 15-20,24

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[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
12 December 2012	07/01/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Demeester, Jan

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/052463

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 2 949 657 A (HAROLD ANSON) 23 August 1960 (1960-08-23) figure 6	9,12
A	US 2 962 839 A (CARLSON CARL R) 6 December 1960 (1960-12-06) figures 1, 3, 5	14,18

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2012/052463

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

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

2. ☒ Claims Nos.: 21-23
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

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

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

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

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

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

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 21-23

No meaning full search possible for claims 21-23: The nature of the subject-matter is so that claims comprising references to the description and/or the drawings are not necessary (see Art. 17(2)(a)(ii) and Rule 6.2(a) PCT).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2012/052463

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4141946 A	27-02-1979	NONE	
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		JP H06502896 A	31-03-1994
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