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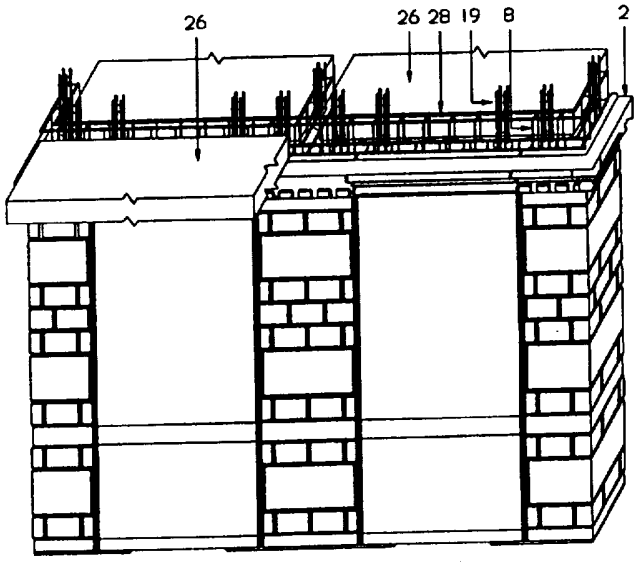

(57) Abstract

Pre-cast concrete panels bodies for construction in building industry and a method of construction of structure using the pre-cast panel bodies is disclosed. The pre-cast concrete panels bodies includes pre-cast beams (3) at an upper edge and at least one bore (6) extending longitudinally from one end to the other. The bore is adapted to receive starter bars (16) reinforcement steel bars (19), wires, pipes or concrete. The upper edges of the panel bodies include cornices (4) casted simultaneously with the casting of the panel body. All the pre-cast concrete panels and pre-cast concrete slabs (26) are interlocked together by the introduction of steel bars (28) through links (8) extending from the pre-cast concrete panels, adding wire mesh (38) and top bars (40) on the pre-cast concrete slab and pouring concrete over the steel bars, wire mesh and top bars to provide a sturdy structure.

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PRE-CAST CONCRETE PANELS FOR CONSTRUCTION OF A BUILDING

The invention relates to set of pre-cast concrete panels for construction of a building and a method of using the same in the building industry.

In building construction, it is often necessary to construct the structural frame work, floor slab and followed by the erection of in-fill panels (normally they are brick walls). Thereafter additional construction work has to be done in the installation of electrical wires, gas and water plumbing connections and external wall furnishing of the building has to be completed. All these require skilled workers and are time consuming and is expensive. The mould formwork set for pre-cast concrete industries in prior art is expensive because a specific mould only can be used for a particular project.

The objectives of this invention are to mitigate these disadvantages by the use of various types of pre-cast concrete panels, adoption of a universal mould formwork set and the adoption of a new system of construction of a building using the pre-cast concrete panels.

According to the first aspect of the invention, the pre-cast concrete wall panels comprise of:-

1. 'I' shape panels (straight line in cross-section width wise) and 'I' shape panels with door or window opening,
2. 'L' shape panels and 'L' shape panels with door or window opening,
3. 'T' shape panels and 'T' shape panels with door or window opening,
4. 'Cross' shape cross-sectional panels and 'Cross' shape cross-sectional panels with door or window opening on one or more sides.

According to a second aspect of the invention, the pre-cast concrete wall panels, include a pre-cast concrete beam and a pre-cast concrete cornice finishing at one edge.

According to a third aspect of the invention, a plurality of steel links extend from the pre-cast concrete beam of the pre-cast concrete panels. An interlocking system of reinforced concrete beams if formed by the insertion of reinforcement steel bars through the links and the pouring in-situ concrete to construction joints formed by pre-cast concrete slabs and pre-cast concrete beams of the pre-cast concrete wall panels.

According to a fourth aspect of the invention, the length of 'I' shape pre-cast concrete wall panel can be adjusted at the construction stage to comply with the architectural and engineering requirements by adjusting the edge formwork of moulding formwork set. The arms of 'L' shape, 'T' shape and 'Cross' shape panels can also be adjusted if necessary, but normally they are constant in single size.

According to a fifth aspect of the invention, the pre-cast concrete slab includes recesses at the central region of the slab panel and pre-cast concrete beams along the perimeter of the slab panel.

According to a sixth aspect of the invention, the sizes of the pre-cast concrete slab panels can be adjusted at the casting stage to comply the architectural and structural requirements.

According to seventh aspect of the invention, the height of the pre-cast beam of the pre-cast concrete slab panel can be adjusted at the casting stage to comply with the structural engineering requirements.

Hollow cores extend longitudinally from one end to the other in the pre-cast wall and in the pre-cast slab panel. The hollow cores are designed to accommodate structural, mechanical and electrical requirement. A reinforced concrete column is formed in a bore by inserting reinforcement steel bars into the hollow core of the pre-cast concrete panel and thereafter in-filled with cast-in-situ concrete.

Walls can be erected and supported by introducing reinforcement steel bars and in-fill cast-in-situ concrete into the cores at both ends of the pre-cast concrete wall panels or by introducing reinforcement steel bars and in-fill cast-in-situ concrete to longitudinal recesses which form core when two pre-cast walls are placed in straight-line alignment to each other.

It would understood that the cores can be provided to 'T' shape, 'L' shape and 'cross' shape pre-cast concrete panels but cores may not be necessary to pre-cast concrete wall panels like 'I' shape (straight in cross section). The 'I' shape pre-cast concrete panel may be provided with longitudinal recesses at the both ends of the panel without any cores in between.

The structural linking of pre-cast concrete wall panels and pre-cast concrete slab panels is carried out by introducing reinforcement steel bars through the links extending from the pre-cast concrete beams of the wall panels, adding wire mesh and top bars to the top surface of pre-cast slab panels and pre-cast beams respectively, then pouring concrete into troughs formed by pre-cast concrete slabs and the pre-cast concrete beams to form construction joints. For single storey building, 'U' shape steel bars are inserted into the cast in-situ concrete columns next to each other from the two linearly aligned adjacent pre-cast concrete wall panels.

In-fill wall panel between corners of pre-cast concrete wall panels or between any two desired points can be obtained by using a single panel or plural number of 'I' shape straight wall panels placed in a linear alignment to each other. The length of any panel can be adjusted at the casting stage by sliding an adapter without altering the moulding formwork set.

The invention will be described in detail by reference to preferred embodiment and system of construction with reference to accompanying drawings in which:-

Fig (1A). Shows a top plan view, Fig. (1B) shows side elevation and Fig (1C) shows section cut through a core (6) of 'I' shape (straight line in cross section) pre-cast concrete wall panel complete with pre-cast concrete beam (2), pre-cast concrete cornice (4) finishing and steel links. (8)

Fig (1D) shows a top plan view of a 'I' shape pre-cast concrete wall panel without any longitudinal cores within.

Fig (2A) & (2B) shows the plan and side view respectively of the 'I' shape panel as stated in Fig (1A), (1B), (1C) & (1D) but with door opening. (10)

Fig (3A) & (3B) shows the plan and side view respectively of the 'I' shape panel as stated in Fig (1A), (1B), (1C) and (1D) but with window opening. (12)

Fig (4A) shows a top view plan, Fig (4B) shows side elevation and Fig (4C) shows section cut through a core of 'L' shape pre-cast concrete wall panel complete with pre-cast concrete beam (2) and pre-cast concrete cornice (4) finishing.

Fig (5A) & (5B) shows the plan and side view respectively of the 'L' shape as stated in Fig (4A), (4B) & (4C) but with door opening. (10) on an extended arm.

Fig (6A) shows a top view plan, Fig (6B) shows side elevation and Fig (6C) shows section cut through a core of 'T' shape pre-cast concrete wall panel complete with pre-cast concrete beam (2) and pre-cast concrete cornice (4) finishing.

Fig (7A) & (7B) shows the plan and side view respectively of the 'T' shape as stated in Fig (6A), (6B) & (6C) but with door opening (10) on an extended arm.

Fig (8A) & (8B) shows the a plan and side view respectively of a 'T' shape as stated in Fig (6A), (6B) & (6C)but with two door openings (10) on two extended arms.

Fig (9A) shows a top view plan, Fig (9B) shows side elevation and Fig (9C) shows section cut through a core of 'Cross' shape pre-cast concrete wall panel complete with pre-cast concrete beam (2) and pre-cast concrete cornice (4) finishing.

Fig (10) shows the section of vertical casting moulding formwork set for casting a pair of pre-cast concrete wall panels as above stated.

Fig (11) shows a perspective cut out view of the vertical casting moulding framework shown in Fig (10)

Fig (11A) shows an enlarged section of an extendable adapter between two spaced apart edge panels.

Fig (11B) shows an adjustable bottom plate for vertical casting moulding framework set. (Fig 10)

Fig (12), (13) & (14) show a cross-sectional view of pre-cast concrete slab panels of varying widths.

Fig (15A) illustrates the first step in constructing a wall using pre-cast concrete walls whereby a ground floor concrete slab is casted and starter bars are placed at pre-determined positions.

Fig (15B) illustrates the second step after Fig 15A whereby concrete kicker is constructed and the level is adjusted to receive the pre-cast concrete wall panels.

Fig (15C) shows a section A-A cut through Fig (15B)

Fig (16) shows a partially completed building wall where pre-cast concrete wall panels show in Figs 1A, 1B, 1C; 4A, 4B, 4C and 6A, 6B, 6C have been erected.

Fig (17A) shows a top plan view of the partially completed building wall shown in Fig 16.

Fig (17B) shows a partially completed building wall with reinforcement steel bars in some of the hollow cores.

Fig (18) shows a sectional view of the connecting joint between two adjacent pre-cast concrete wall panels.

Fig (18A) shows a sectional perspective view of a pre-cast concrete wall panel and pre-cast concrete beams with a cap over a hollow core.

Fig (18B) shows a perspective view of a cap that is designed and configured to be placed over a hollow core.

Fig (19) shows the positioning of the pre-cast floor slabs on the pre-cast concrete beams of the pre-cast concrete panels.

Fig (20) shows a perspective view of partially completed building where reinforcement steel bars are introduced through the links extending from the pre-cast concrete beam of pre-cast concrete panels shown in Fig (19).

Fig (20A) is a perspective view of an assembly of pre-cast concrete floor slabs positioned over a plurality of pre-cast concrete wall panels.

Fig (21A) is a sectional view showing in detail the positioning two adjacent pre-cast concrete floor slabs.

Fig (21B) shows two numbers of pre-cast concrete slab panels laid on the pre-cast concrete beams of a pre-cast concrete wall panel.

Fig (22) shows a perspective view of the assembly of wire mesh and top bars on the pre-cast concrete floor slab before pouring the concrete.

Fig (22A) shows a perspective view of an assembly shown in Fig 22.

Fig (23) shows a perspective view of two adjacent linearly aligned pre-cast concrete walls being locked in position in single storey building.

Fig (24A) shows top view plan of pre-cast concrete panels combination by using two numbers of 'L' shape and one number of 'I' shape whereby the length of 'I' shape panel can be adjusted at the casting stage to comply with architectural and structural requirements.

Fig (24B) shows a side elevation view of combination of panels shown in Fig (24A)

Fig (25A) shows the top view plan of pre-cast concrete panels combination by using two numbers of 'L' shape, two numbers of 'I' shape and one number of 'T' shape panel whereby the length of 'I' shape can be adjusted at the casting stage to comply with architectural and structural requirements in Fig 24A.

Fig (25B) shows a side elevation view of combination of panels shown in Fig (25A).

Fig (26A) shows top view plan of pre-cast concrete panels combination by using one number of 'cross' shape, one number of 'T' shape, one number of 'L' shape and two numbers of 'I' shape panel whereby the length of 'I' shape can be adjusted at the pre-casting stage.

Fig (26B) shows a side elevation view of combination of panels shown in Fig (26A)

Fig (27A) shows a top plan view of pre-cast concrete panels combination by one number of 'L' shape, one number of 'L' shape with door opening one number of 'I' shape panel.

Fig (27B) shows a side elevation view of combination pre-cast concrete panels shown in Fig (27A)

Fig (28A) and Fig (28B) to Fig (32A) and Fig (32B) shows various combinations of pre-cast concrete wall panels by using same method of combination as described from Fig24A, 24B to 27A & 27B.

Fig (33A) shows a top plan view of pre-cast concrete wall panels combination by using two numbers of 'cross' shape pre-cast concrete panels and one number of 'I' shape pre-cast concrete panel with a recess at both sides of the panel and without cores in between.

Fig (33B) shows a side view of the elevation combination of pre-cast concrete wall panels shown in Fig (33A)

Fig (33C) shows section A-A view cut through the 'I' shape pre-cast concrete panel in the combination shown in Figs (33A) and (33B).

Fig (34A), (34B) and (34C) show a same combination as Figs (33A), (33B) and (33C) but with one core in the 'cross' shape panel.

Various modular pre-cast concrete panels will now be described. A first pre-cast concrete panel is a planar wall with 'I' shape with or without pre-cast concrete beam (2) and pre-cast concrete cornices (4) at the top edge (Fig 1A, 1B and 1C). The wall includes a plurality of evenly spaced apart cores (6) extending from the top edge to the bottom edge of the wall and steel links (8). The length (x) of the pre-cast concrete wall panel can be varied according to the structural design and architectural requirements of the building.

A second pre-cast concrete panel is a planer wall with 'I' shape as described in Fig 1A & 1B) but with a door opening (10) (See Figs 2A & 2B). A third pre-cast concrete panel is a 'I' shaped planar wall as described in Fig 1A, 1B & 1C) but with a window opening (12) (See Figs 3A & 3B). A fourth pre-cast concrete panel is a 'L' shaped panel (See Figs 4A, 4B & 4C). Each arm of 'L' shape panel includes a longitudinal core (6). The external sides (14) can be plain or patterned. The upper edges can include pre-cast concrete beam (2) and cornices (4) or be without the pre-cast concrete beam or cornice.

A fifth pre-cast concrete panel is 'L' shape unit as described in Fig 4A, 4B & 4C) but with one arm extended (see Figs 5A & 5B). The extended arm can include a door opening (10) or alternatively include window opening (12). A sixth pre-cast concrete panel is a 'T' shape unit with pre-cast concrete beam and pre-cast cornice as described in Fig 1A, 1B & 1C (see Figs 6A, 6B & 6C). A seventh pre-cast concrete panel is another 'T' shape unit where the middle arm in perpendicular relation to the other arm is extended and includes a door opening (10) or alternatively a window opening (12) as described in Fig 1A,1B and 1C. A eighth pre-cast concrete panel is a 'T' shape wall structure with two door openings (12) (see Fig 8A & 8B). A ninth pre-cast concrete panel 'cross' sectional columnar unit, with at least one bore (6) in the panel (see Figs 9A, 9B & 9C). All the concrete panels described above may optionally include steel links (8) secured to the reinforcement steel bars (3) in the concrete beam (2) of the concrete

wall panels. Further all the panels described above can be casted with or without pre-cast concrete beams and cornices.

It will be appreciated that the individual dimensions of the various parameters such as height, length and thickness of the panel, shapes and designs of the window opening or door opening, patterns on the side wall can be different depending on architectural requirements. The combination selected from the above described pre-cast concrete panels will form any design and any size of a building the except some length of the 'I' shaped panel will have to adjusted at the casting stage. Pre-cast concrete panel of other cross-sectional types can be envisaged for other requirements. Such pre-cast concrete panels would be within the scope of this invention.

The mould (100) comprises of a twin set of mould formworks. Each set of mould formwork comprises of a pair of horizontally placed but spaced apart guide plates (102) and a pair of side panel plates (104). The vertical length of the concrete wall panel to be casted can be varied by adjusting the height of the bottom guide plate (102) upward and downward utilising conventional means known to the art (see Fig 11B). In the preferred embodiment, the bottom guide plate (102) is raised or lowered by means of slot and bolt means (see Fig 11B).

The mould (100) includes a means to vary the length of the yet to be casted concrete wall panels. The means include a pair of vertical adapter(106) extending from the top of bottom guide plate to under-side of top guide plate (102). A pair of shafts (108) are introduced through the holes (110) in the horizontal guide plates (102), top and bottom. A plurality of extendable arms (112) are arranged spaced apart between the shaft and the vertical adapter(106). The extendable arms (112) extend from one vertical adapter to the other, whereby the distance apart between the vertical adapters can be varied over a pre-determined range. Collapsible cylindrical tubes (114) are introduced into the holes in the horizontal guide plates. After the wire mesh was placed in position, concrete is introduced into the mould by pouring the concrete across the inverted V shape ledge (116). The concrete is introduced into both sides of the inverted V shaped ledge (116) until the moulds are field with concrete.

It will be appreciated that concrete beam (2) and various designs such as cornices (4) and patterns (14) can be incorporated onto the side panels (104) of the mould. An example of a pattern incorporated into the side panels is shown in Fig 6B and 6C. The cornices (4) and the patterned sides (14) can be provided on one side or on both sides.

Fig 12, 13 and 14 shown pre-cast concrete slabs of different lengths. Each pre-cast concrete slab is a rectangular slab, with a concrete beam around the perimeter. The concrete beam can include a hollow core if necessary. The perimeter edge further includes pre-cast concrete beam (34). The heights of the concrete beam and the corresponding depth of the recess can be adjusted at casting stage in accordance with architectural and engineering requirements.

In constructing a building, the pre-cast concrete panels as stated above will be erected, supported and interlocked together by the following methods.

Step 1. Cast the ground floor concrete (13) and extend the starter bars (16) out at the predetermined column position (15). Fig (15A)

Step 2. Constructed the concrete kicker (18) and adjust the level to receive the pre-cast concrete wall panels and cast-in-situ columns Figs(15B)(15C).

Step 3. Lift up the pre-cast concrete wall panels and erect to the respective positions. Figure 16.

Step 4. Insert the reinforcement steel bars (19) to the respective cores at column positions, and complete with the in fill concrete. Figs(17A)(17B).

Step 5. Seal up the gaps in between linearly aligned adjacent pre-cast concrete wall panels by fitting in P.V.C gasket (20) introducing sealant compound (22) then introducing in-fill concrete. Figure(18). Unused hollow cores in the pre-cast concrete wall panels are covered by inserting P.V.C caps (24) before pouring the concrete into the mould. Figs(18A)(18B).

Step 6. Lift up the pre-cast concrete slab (26) and lay on the pre-cast concrete beams (2) of pre-cast concrete wall panels. Fig (19)

Step 7. Insert the reinforcement steel bars (28) through the links (8) extending from the pre-cast concrete beam(2) of the pre-cast concrete walls. Figure(20) and Fig (20A)

Step 8. Add the wire mesh (38) to the top of the pre-cast concrete floor slabs and top bars (40) to the top of pre-cast concrete beams. Figure(22) and Figure (22A)

Step 9. Pour the concrete to the assembly in Fig (22A). All the pre-cast concrete walls, pre-cast concrete beams and pre-cast concrete slabs will be inter-linked and interlocked together to produce a unified overall structure.

Step10. Repeat the steps 3 to 9 for the next floor.

For single storey, the pre-cast concrete wall panels will be inter-linked and interlocked together by inserting U shape steel bars (42) after pouring the concrete to column positioned next to each other from two linearly aligned adjacent pre-cast concrete wall panels. Figure (23).

One edge of a concrete slab is connected to the edge of another adjacent concrete slab by placing the two concrete slabs adjacent to each other and inter-linking pre-cast concrete beam of the pre-cast concrete slab by steel bars (33). Any crevice or gap at the joint of the two concrete slabs is sealed with a suitable sealant (32) (See Fig 21A).

Where a reinforced concrete beam is to be constructed between two adjacent concrete slabs, or where a wall is to be erected from one storey to another, than the each concrete slab (26) is placed on the concrete beam (2) of a concrete wall panel. One side of a concrete slab is placed spaced apart from the side of an adjacent concrete slab. A trough is formed by the side edges of the concrete slabs and the top surface of the concrete wall panel. Additional steel bars (28) are placed in the trough and secured to the steel links (8) to form a steel cage. Concrete is poured into the trough so formed and allowed to set to form a reinforced concrete beam. If desired additional concrete wall can be erected above this reinforced concrete beam by placing a concrete wall panel over the reinforced concrete. (See Fig. 22)

The advantage of this invention is that the various shapes of pre-cast concrete panels can be assembled, concrete columns are constructed by the introduction of reinforcement steel bars and concrete into the desired cores, cast in-situ reinforcement concrete beams are constructed on top of pre-cast concrete walls and adjacent concrete slab panels, and all reinforcement steel bars can be inter-linked to form a rigid and sturdy building structure. The system provides great flexibility in constructing various types of buildings by the judicious selection of the appropriate types of pre-cast concrete panels. The length of 'I' shaped concrete panels can be varied according to architectural requirements and the length adjusted by adjusting the universal moulding formwork set. The Figures (24) to Figure (32) showing the plans and elevations for the various type of combination from pre-cast concrete wall panels to form the different designs according to architectural requirements. The specific design of the surface of the wall panel cornices, door frames, window frames and other structures can be easily formed or modified prior to the casting. Furthermore, it is easy to handle the casting and construction and quality is under control at casting plants instead of depending on inconsistent human factor. There is no plastering and no ceiling because the wall and ceiling furnishings can be formed during the process of casting through the moulding formwork set.

The gap between linearly aligned concrete wall panels provides for Fig (18) for central to central alignment/adjustment and also serves the purpose of expansion join for structural requirement. It will be understood that the gap can also be used as the cast in-situ column by introducing steel bars and concrete into a core formed by two adjacently placed concrete wall panels.

CLAIMS

1. Pre-cast concrete panel for the construction in building industry characterised in that each pre-cast concrete panel consists of concrete panel body with pre-cast concrete beam at an upper edge, and at least one bore (6) extending longitudinally from one end to the other, wherein said bore is adapted to receive starter bars (16), reinforcement steel bars (19) wires, pipes or concrete.

2. Pre-cast concrete panel for construction in building industry as claimed in Claim 1 wherein the upper edges of the pre-cast concrete panel body includes cornices casted simultaneously with the casting of the concrete panel body.

3. Per cast concrete panel for construction in building industry as claimed in Claim 1 wherein the pre-cast concrete panel body includes door opening (10) or window opening (12) on the planar surface.

4. Pre-cast concrete panel of construction in building industry as claimed in Claim 1 wherein the pre-cast concrete panel body includes cornices, patterns, impressions, abutments (14) all casted simultaneously with the casting of the concrete panel body.

5. Pre-cast concrete panel for construction of building industry as claimed in any of the Claims 1 to 4 characterised in that the pre-cast concrete panel body includes a longitudinal recess extending from one end to the other end, on at least one terminal end of the pre-cast concrete wall panel body.

6. Pre-cast concrete panel for construction in building industry characterised in that pre-cast concrete panel consists of a rectangular pre-cast concrete slab comprising of pre-cast concrete beam (34) along the perimeter of the slab and a recess at central region of the concrete slab.

7. A system of constructing structures using pre-cast concrete panel characterised in that the pre-cast concrete panel are selected from one or more of the following:-

a) 'I' shaped panel in cross section and 'I' shaped panel with door or window opening.

b) 'L' shaped panel and 'L' shaped panel with door or window opening

c) 'T' shaped panel and 'T' shaped panel with door or window opening

d) 'cross' cross-sectional shaped panel and 'cross' cross-sectional panel with door or window opening

and wherein the panels consist of concrete panel body, with or without pre-cast concrete beam at an upper edge, and at least one bore extending longitudinally from one end to the other, the said bore is adapted to received starter bards (16) reinforcement steel bars (19), wires, pipes or concrete.

8. A system of constructing structures using pre-cast concrete panel body which is supported by at least two cast in situ columns at both ends of the panel body.

9. A system of constructing structures using pre-cast concrete panel as claimed in any of the claims 1 to 6 wherein a plurality of adjacently disposed bores of the panel are in-filled with reinforcement steel bars and concrete to form cast in-situ columns and wherein the columns so formed, as a substitution of a single big column.

10. A system of constructing structures incorporating a pre-cast concrete wall panels characterised in that longitudinal recess extending from one end to the other end of one pre-cast concrete wall panel is aligned apposite to a corresponding recess in another panel in linear alignment with the former.

11. A system of constructing structures incorporating pre-cast concrete panel as claimed in Claims 1 to 5 and pre-cast concrete slab as claimed in Claim 6 wherein all the pre-cast concrete panel and pre-cast concrete slabs are interlocked together by the introduction of steel bars through he links extending from the pre-cast concrete beam of the pre-cast concrete panel, adding wire mesh and top bars on the pre-cast concrete slab and pouring concrete over the steel bars, wire mesh and top bars.

12. A method of constructing structures consisting of pre-cast concrete panel characterised in that the method consists one or more of the following steps:-

a) casting a ground floor concrete with starter steel bars at pre determined positions

b) constructing concrete kicker at pre determined positions

c) positioning pre-cast concrete panel over the casted concrete kicker and starter steel bars

d) introducing steel reinforcement bars into selected bores of the pre-cast concrete panel

e) introducing concrete into the bores selected in step (d) above

f) positioning pre-cast concrete slab over the pre-cast concrete panel.

g) inserting steel bars through steel links extended from pre-cast concrete beam of the pre-cast concrete panel

h) introducing wire mesh on top of the pre-cast concrete slab and introducing top steel bars over the steel bars introduced in step (g) above and across two adjacent pre-cast concrete slabs.

i) introducing concrete to cover the wire mesh and top bars

13. A method of constructing structures consisting of pre-cast concrete panel as claimed in Claim 12 consisting the further step of introducing 'U' shaped steel bars linking two adjacent bores in the re cast concrete panel and thereafter introducing concrete into the bores.

14. A method of constructing structures consisting of pre-cast concrete panel as claimed in claim 12 wherein the pre-cast concrete panel between two fixed positions include 'I' shaped panels in cross-section and/or 'I' shaped panels with door or window opening and wherein the 'I' shaped panels can be of different lengths and are casted from the same formwork mould.

15. A system of constructing structures incorporating pre-cast concrete panels characterised in that reinforced concrete beams comprise of a first part consisting of pre-cast concrete beams at an upper edge of the pre-cast concrete panel and a second part consisting of cast in situ concrete beams and wherein the first and second part are inter-linked to form a solitary concrete beam structure.

16. A system of constructing structures incorporating pre-cast concrete panels as claimed in Claim 15 above where the reinforced concrete beams further include a third part consisting of pre-cast concrete beam of a pre-cast concrete slab wherein the first, second and third parts are inter-linked to form a solitary concrete beam structure.

17. A structure consisting of pre-cast concrete panel consisting of panels according to any of the claims 1 to 6.

18. A structure consisting of pre-cast concrete panel constructed according to any of the claims 7 to 14.

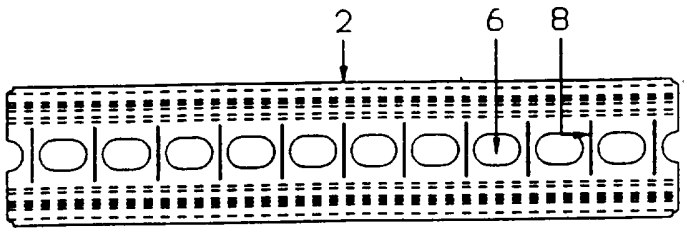


FIGURE 1A

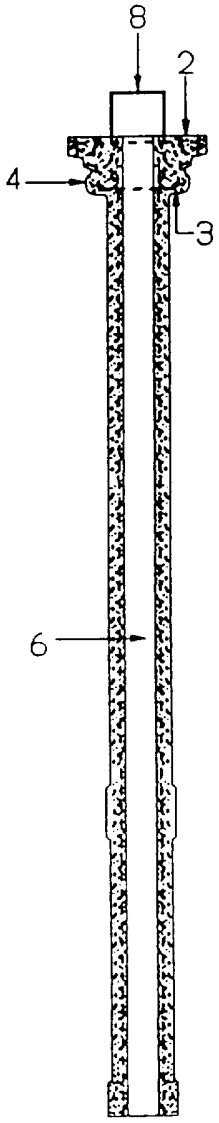


FIGURE 1C

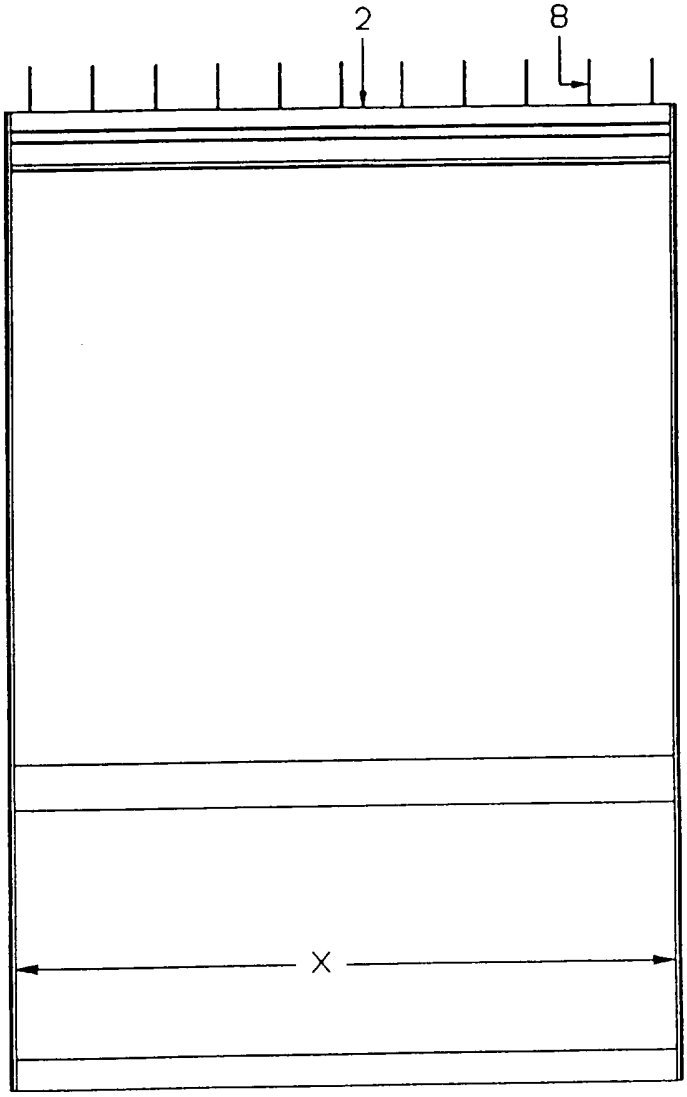


FIGURE 1B

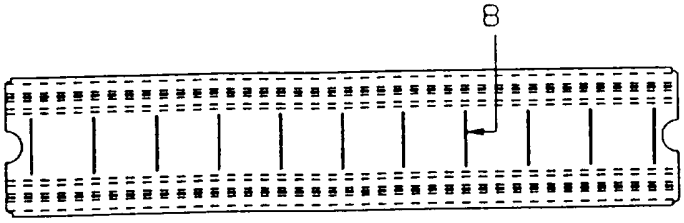


FIGURE 1D

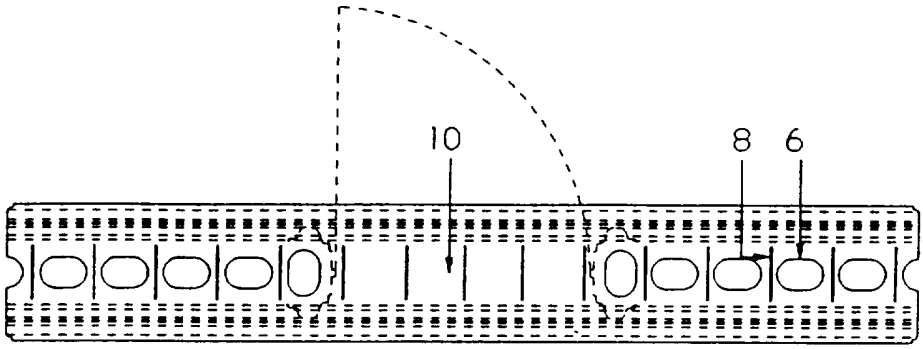


FIGURE 2A

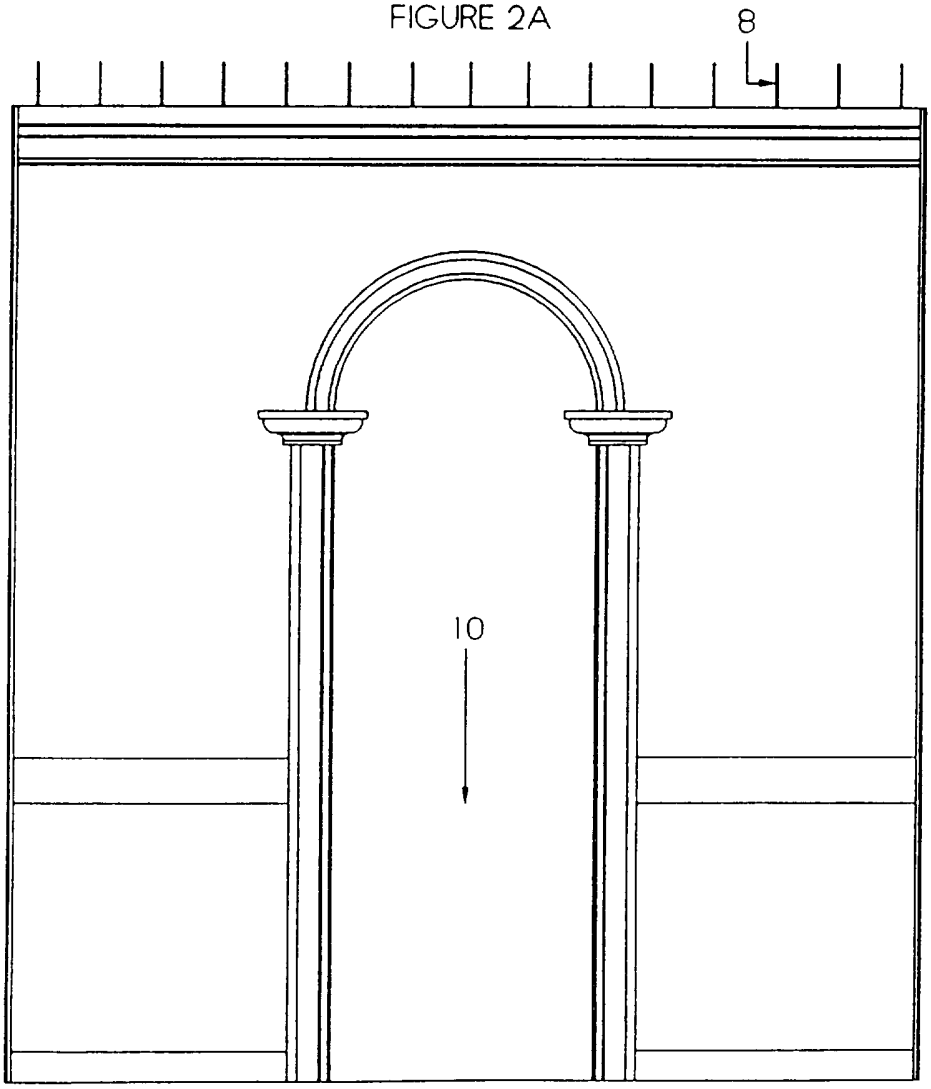


FIGURE 2B

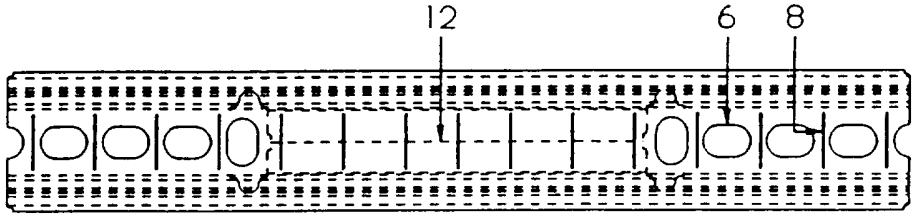


FIGURE 3A

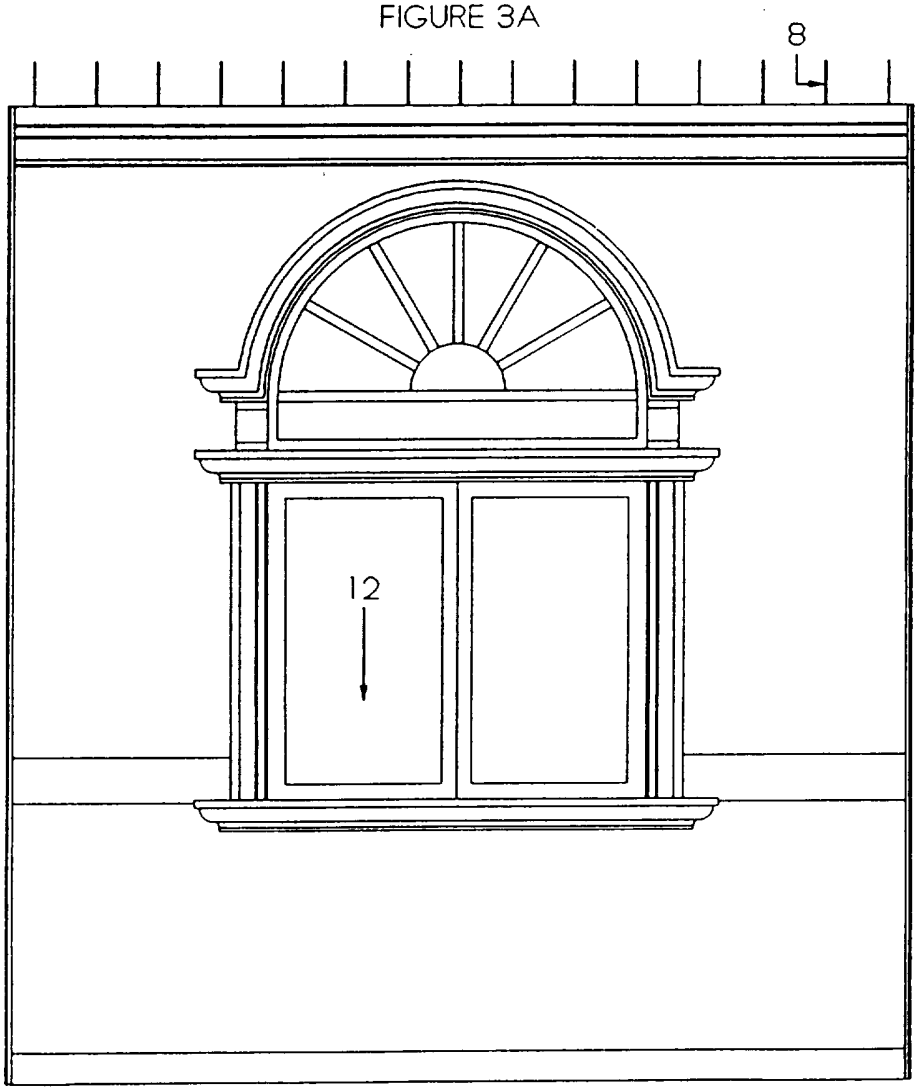


FIGURE 3B

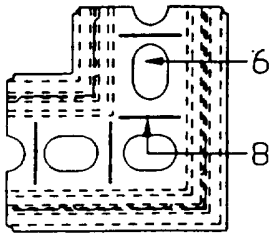


FIGURE 4A

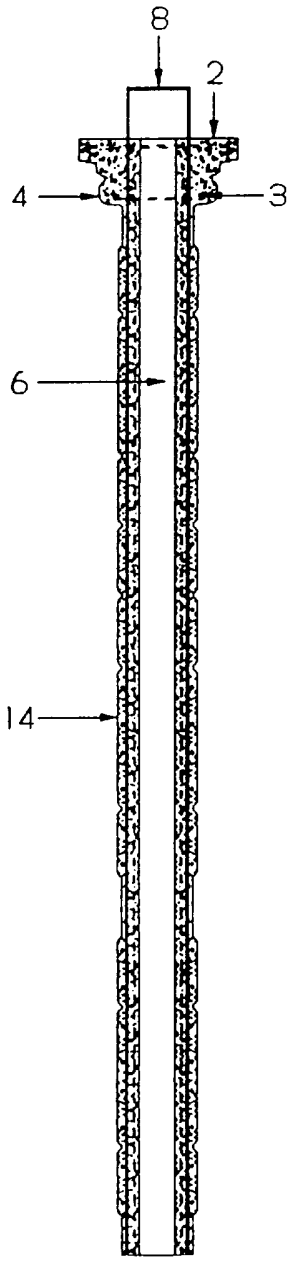


FIGURE 4C

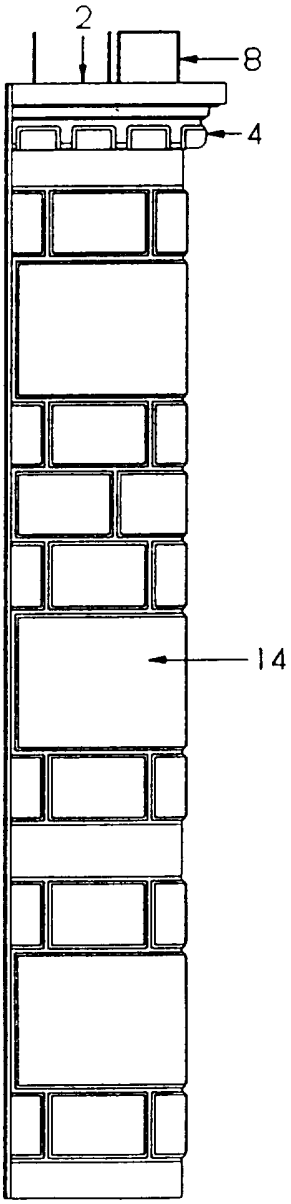


FIGURE 4B

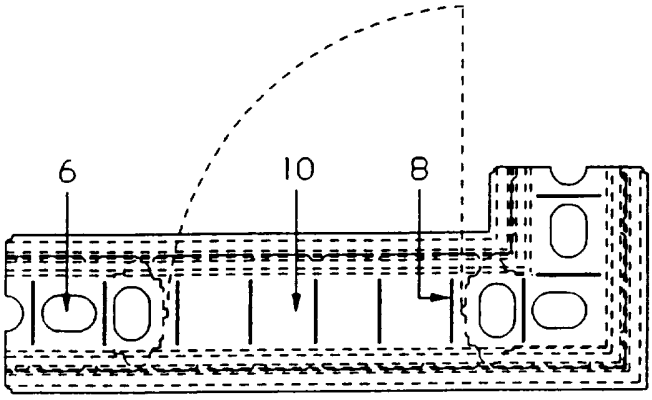


FIGURE 5A

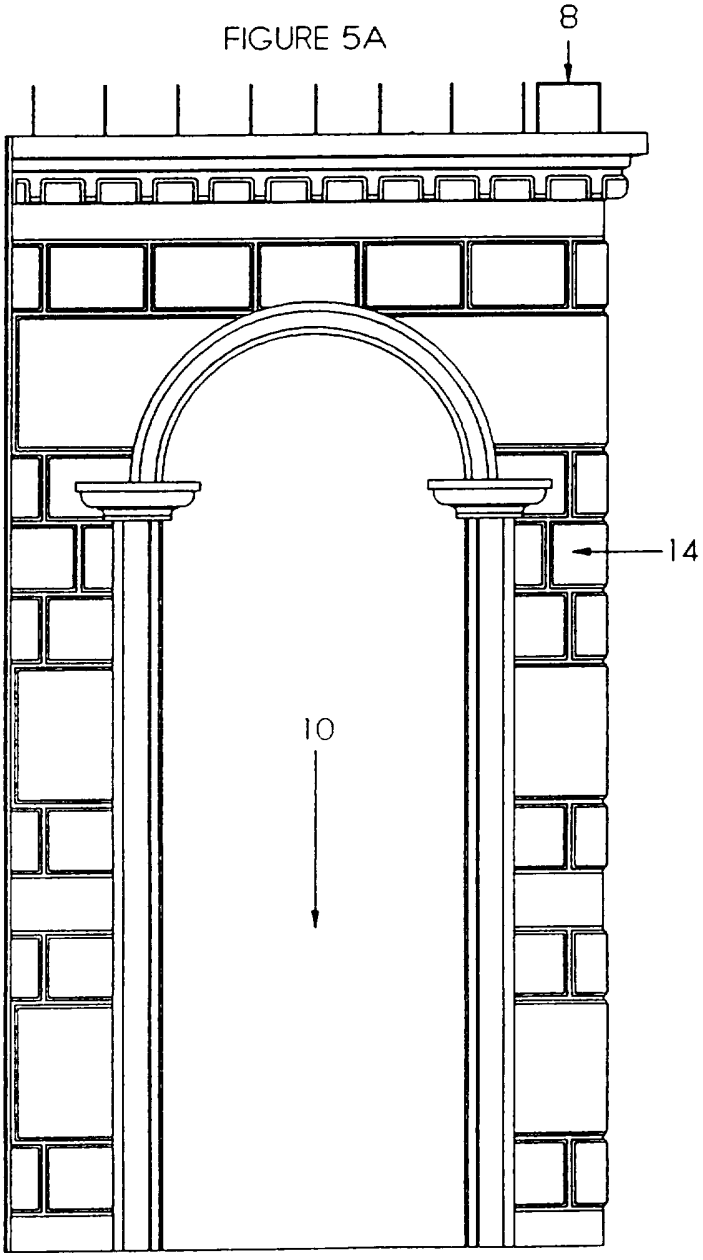


FIGURE 5B

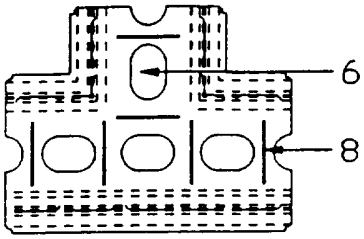


FIGURE 6A

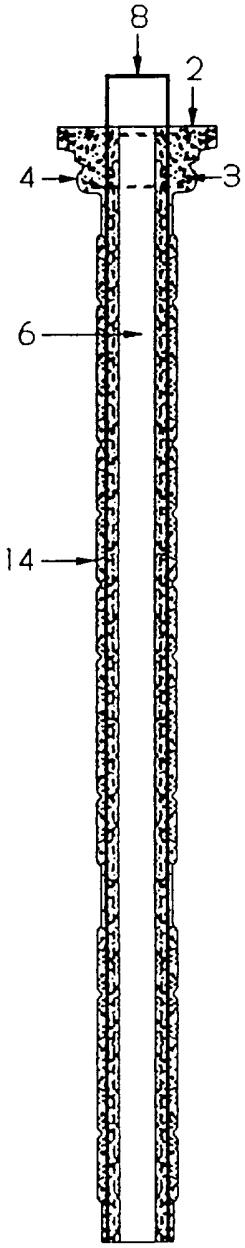


FIGURE 6C

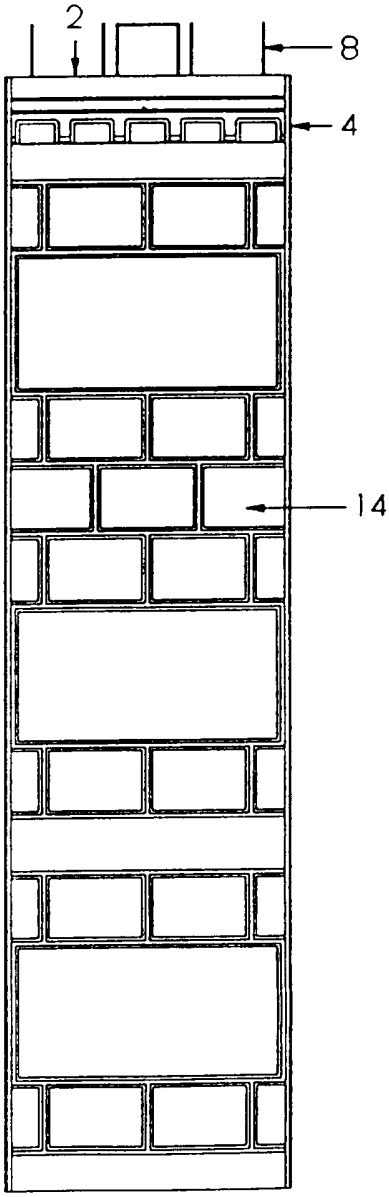


FIGURE 6B

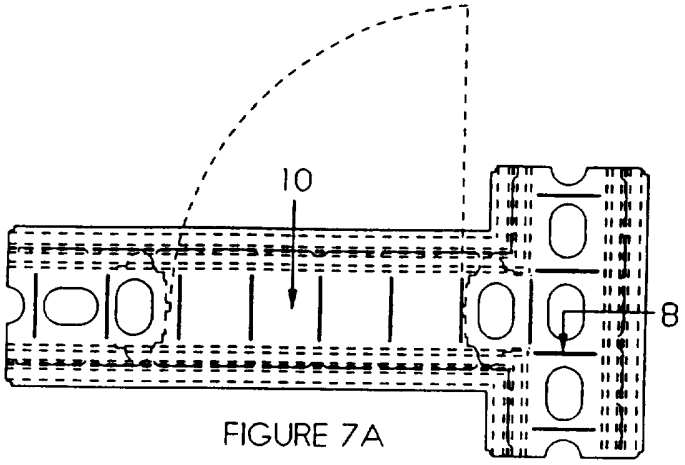


FIGURE 7A

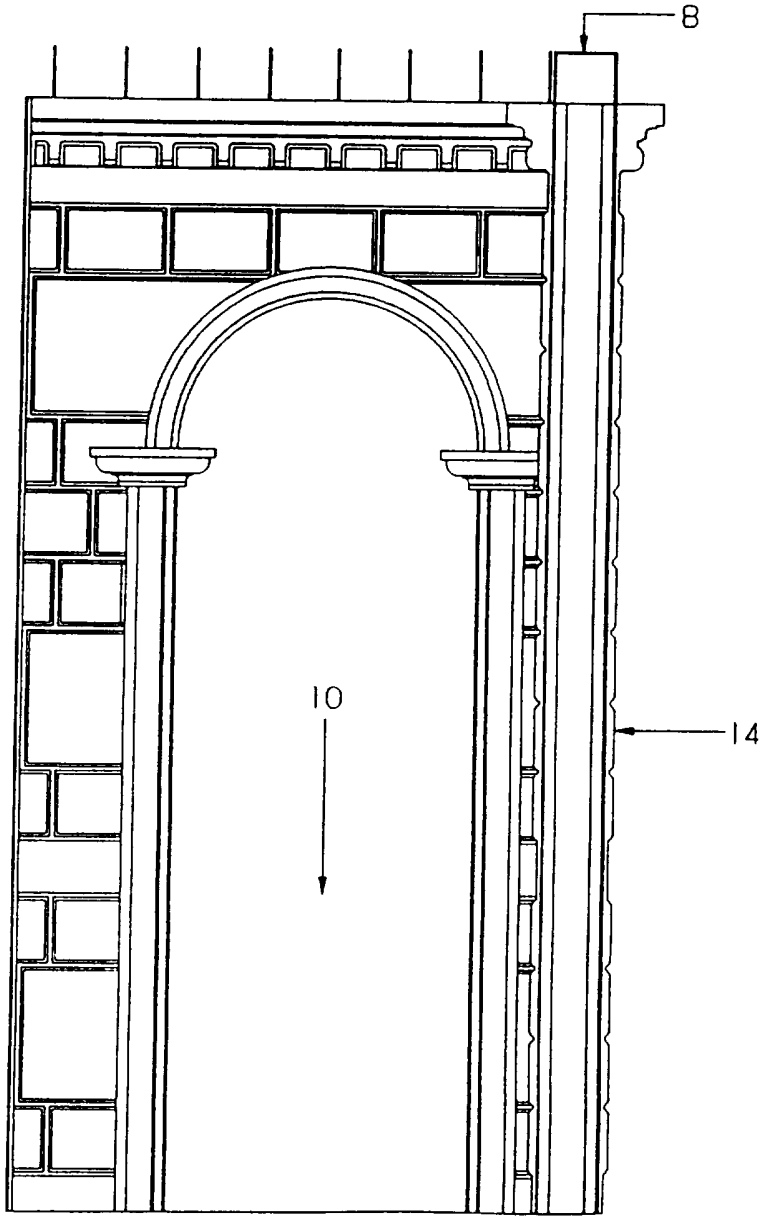


FIGURE 7B

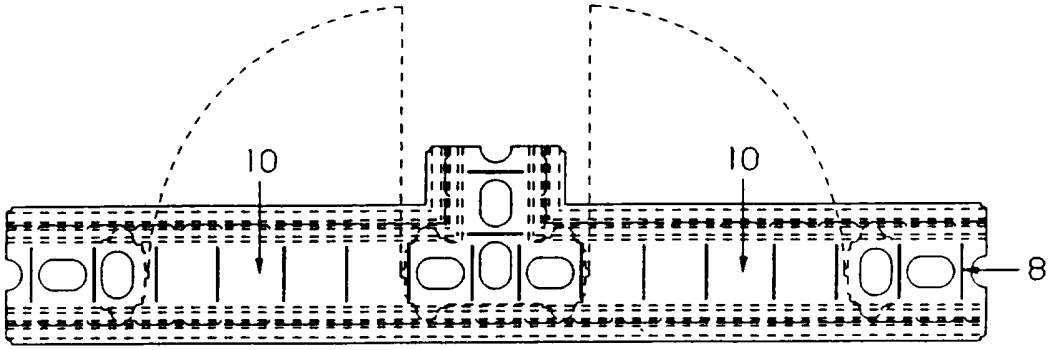


FIGURE 8A

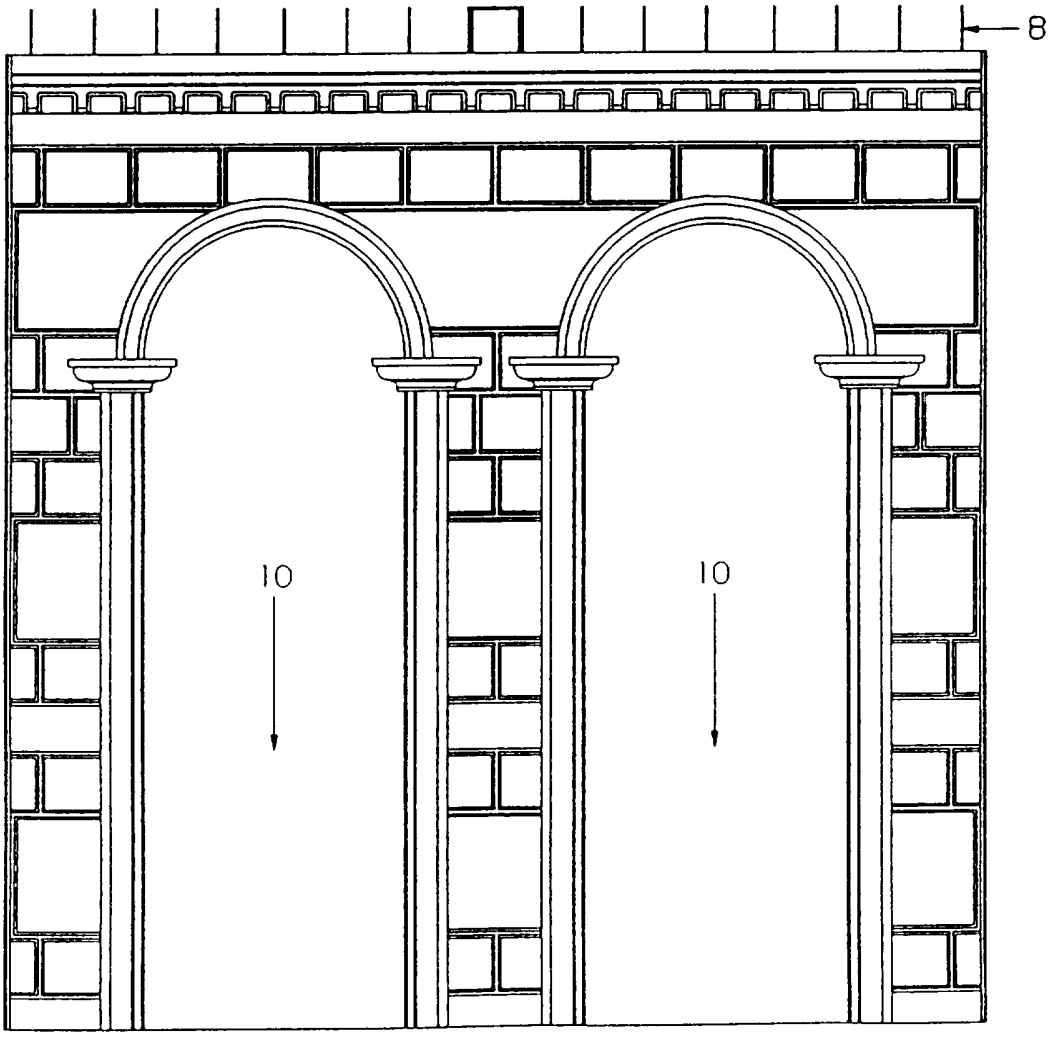


FIGURE 8B

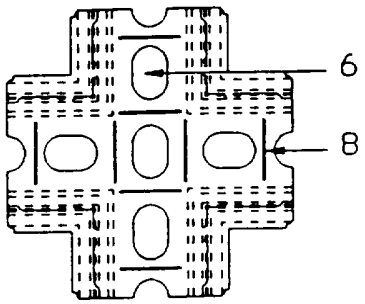


FIGURE 9A

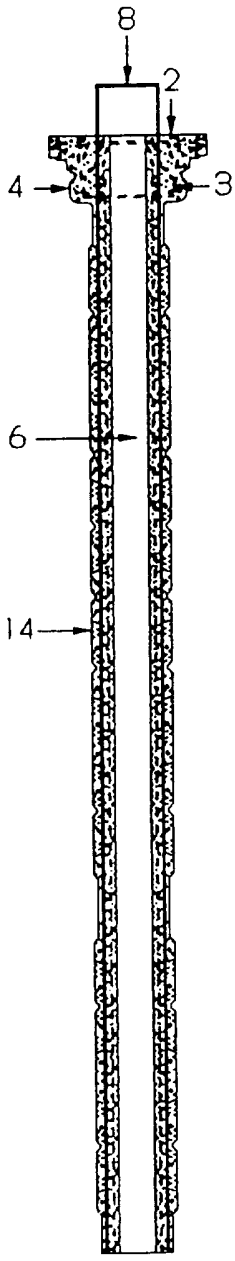


FIGURE 9C

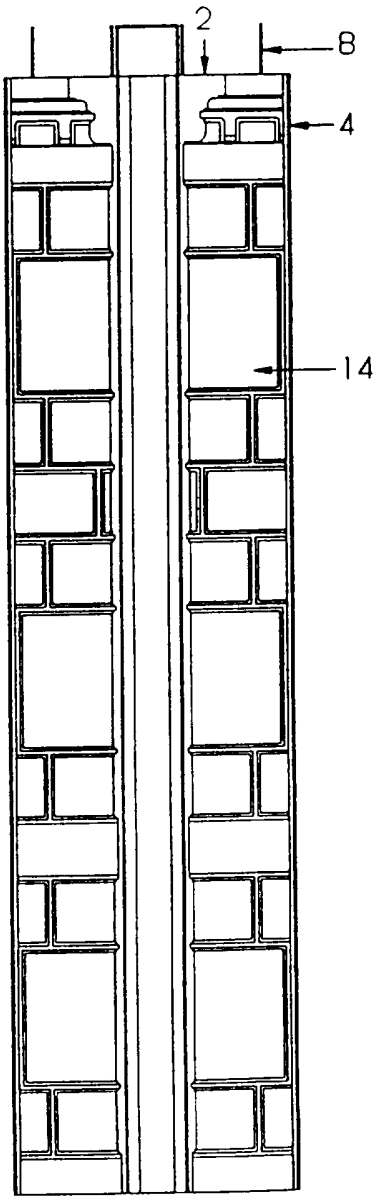


FIGURE 9B

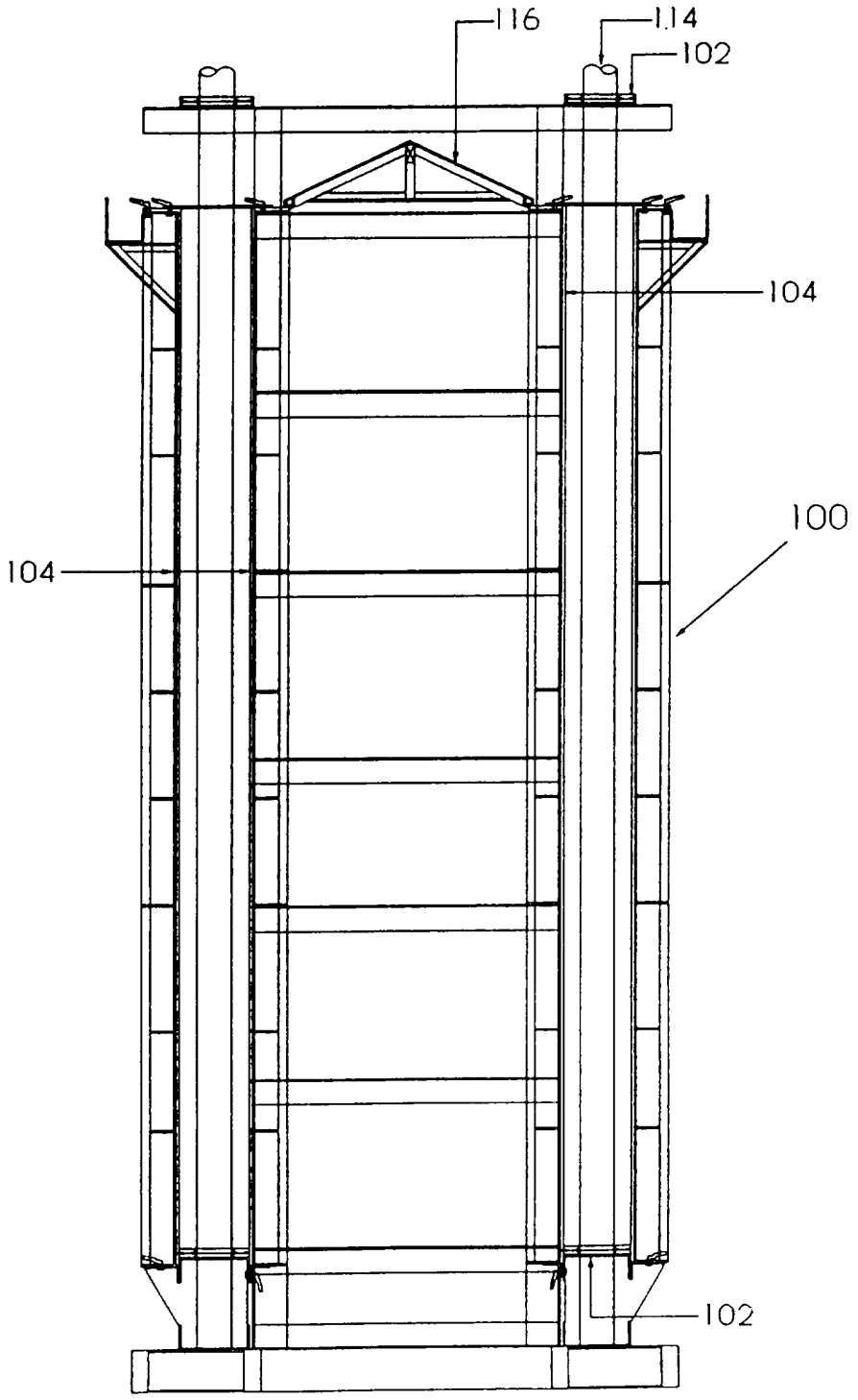


FIGURE 10

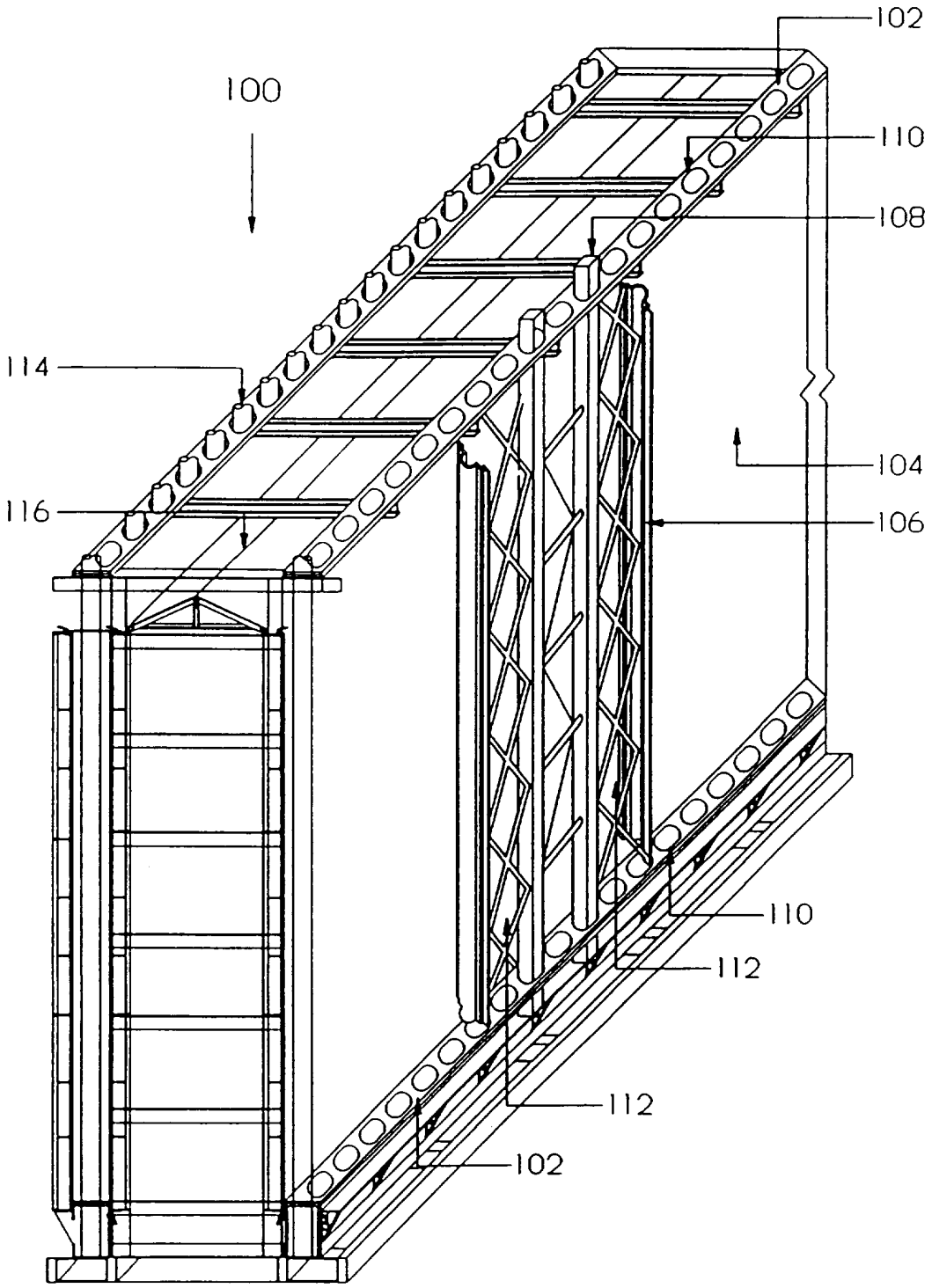


FIGURE 11

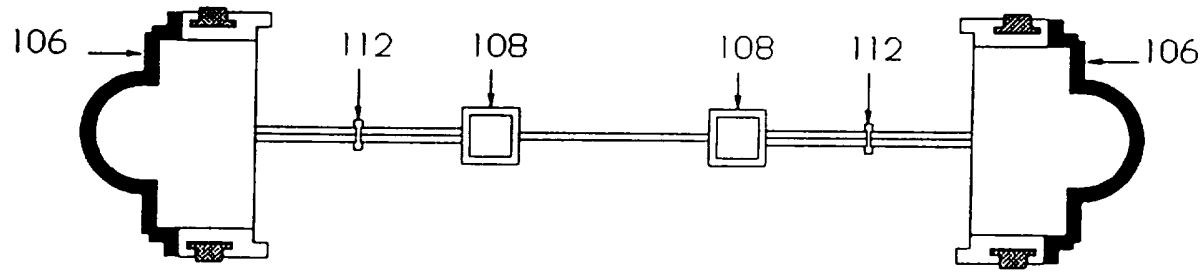


FIGURE 11A

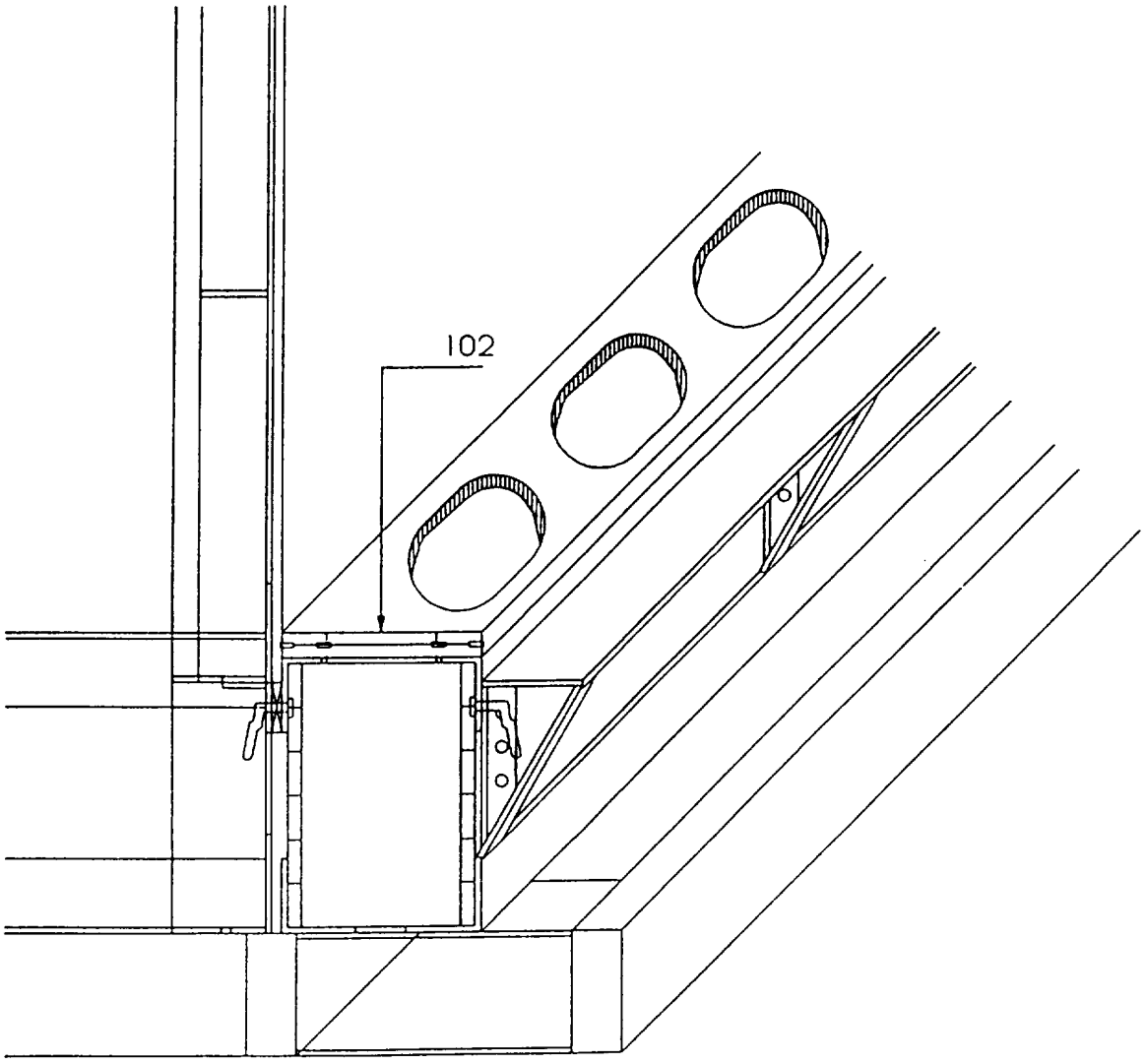


FIGURE 11B

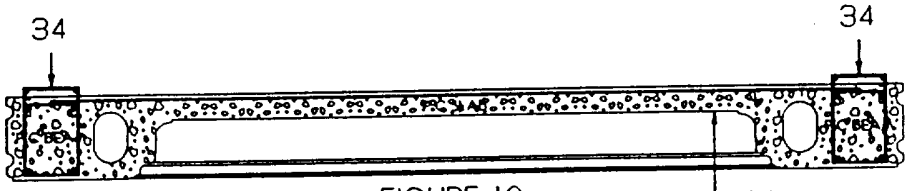


FIGURE 12

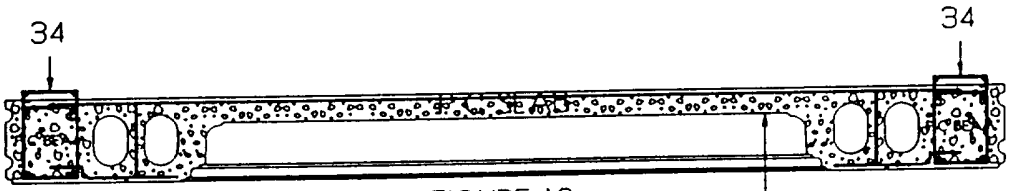


FIGURE 13

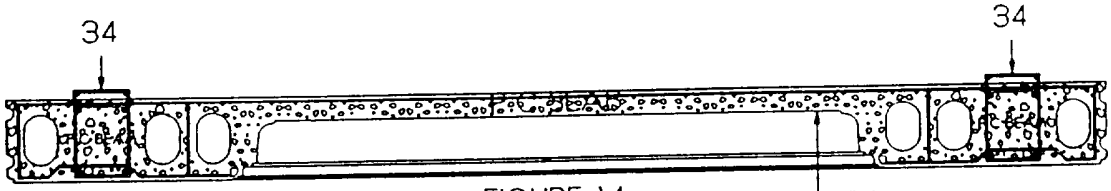


FIGURE 14

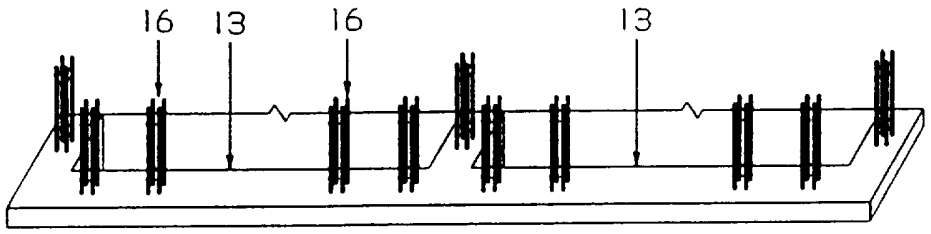


FIGURE 15 A

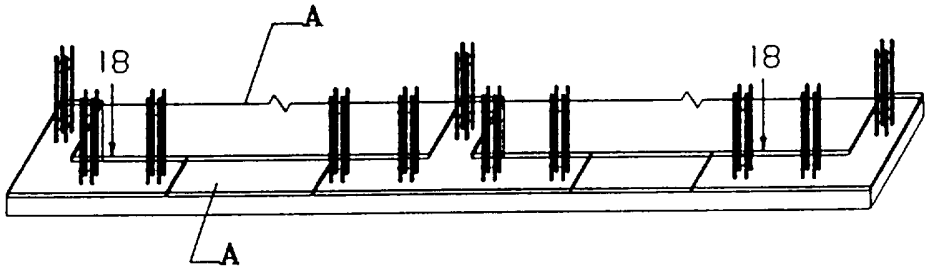
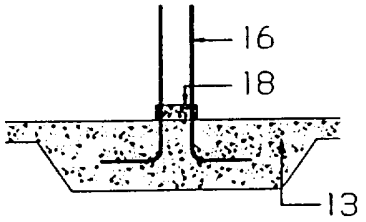


FIGURE 15 B



(SECTION A-A)
FIGURE 15 C

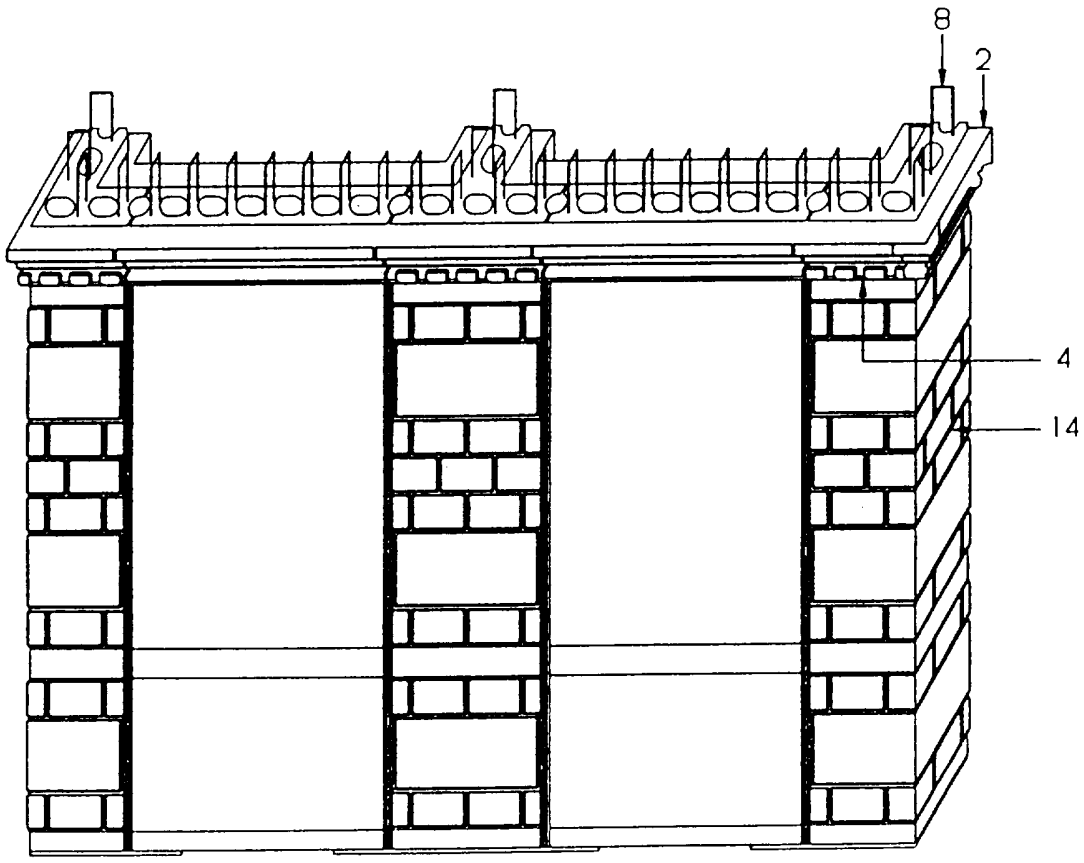


FIGURE 16

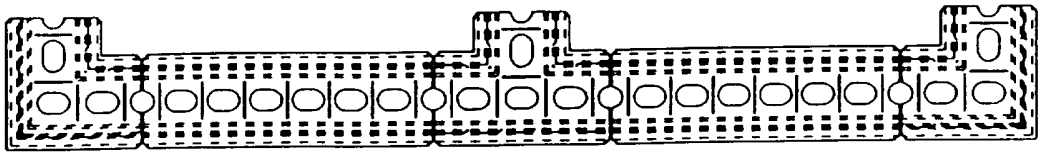


FIGURE 17A

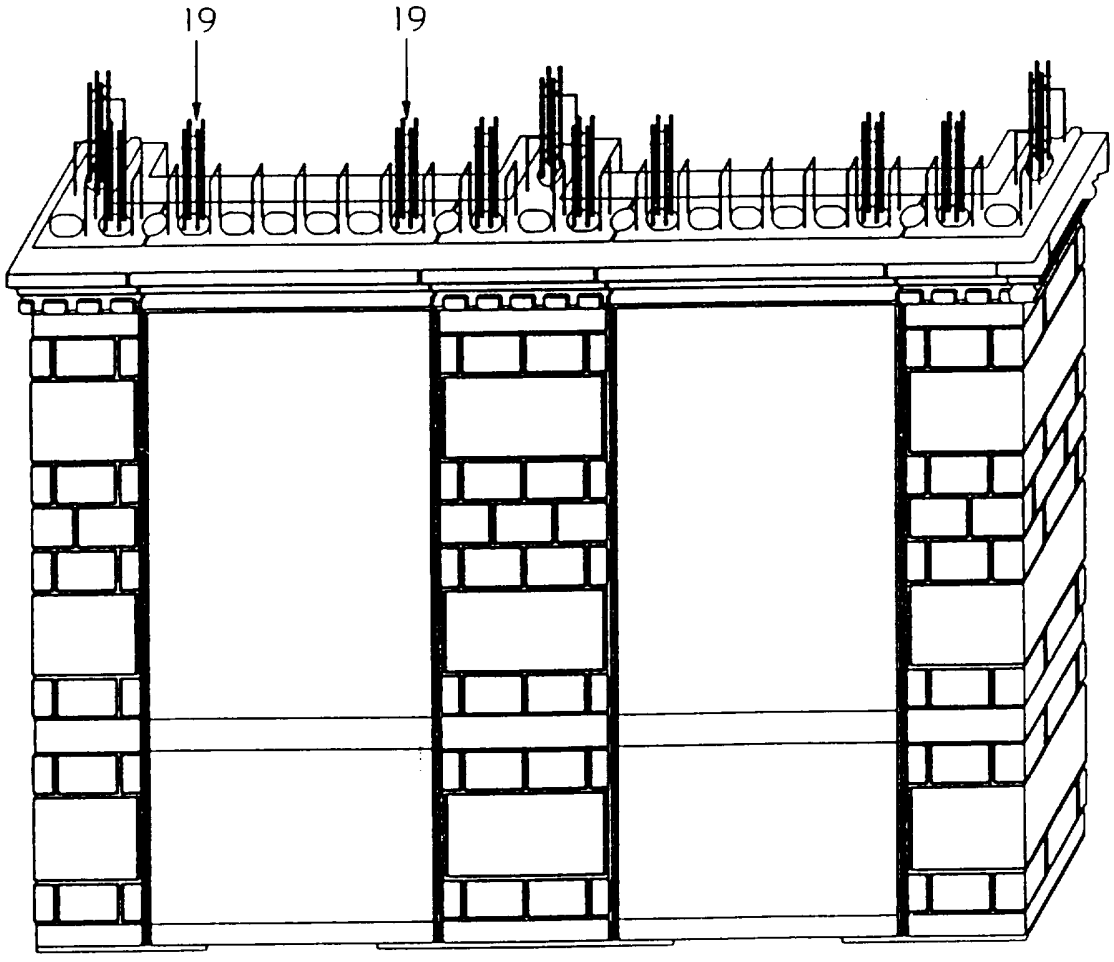


FIGURE 17B

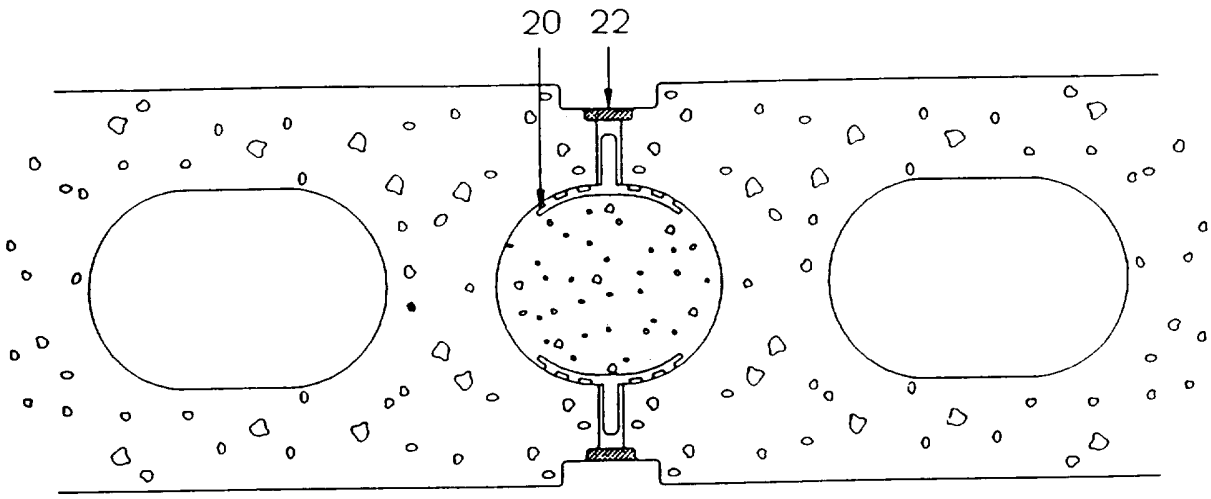


FIGURE 18

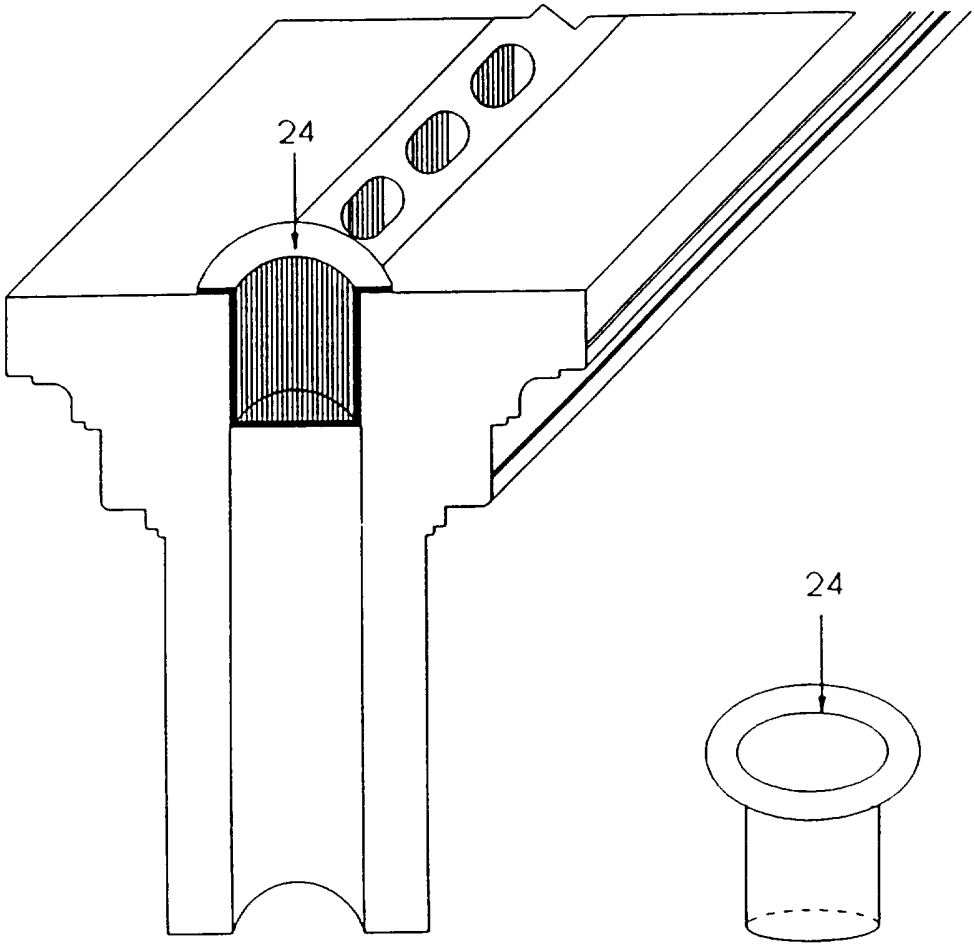


FIGURE 18A

FIGURE 18B

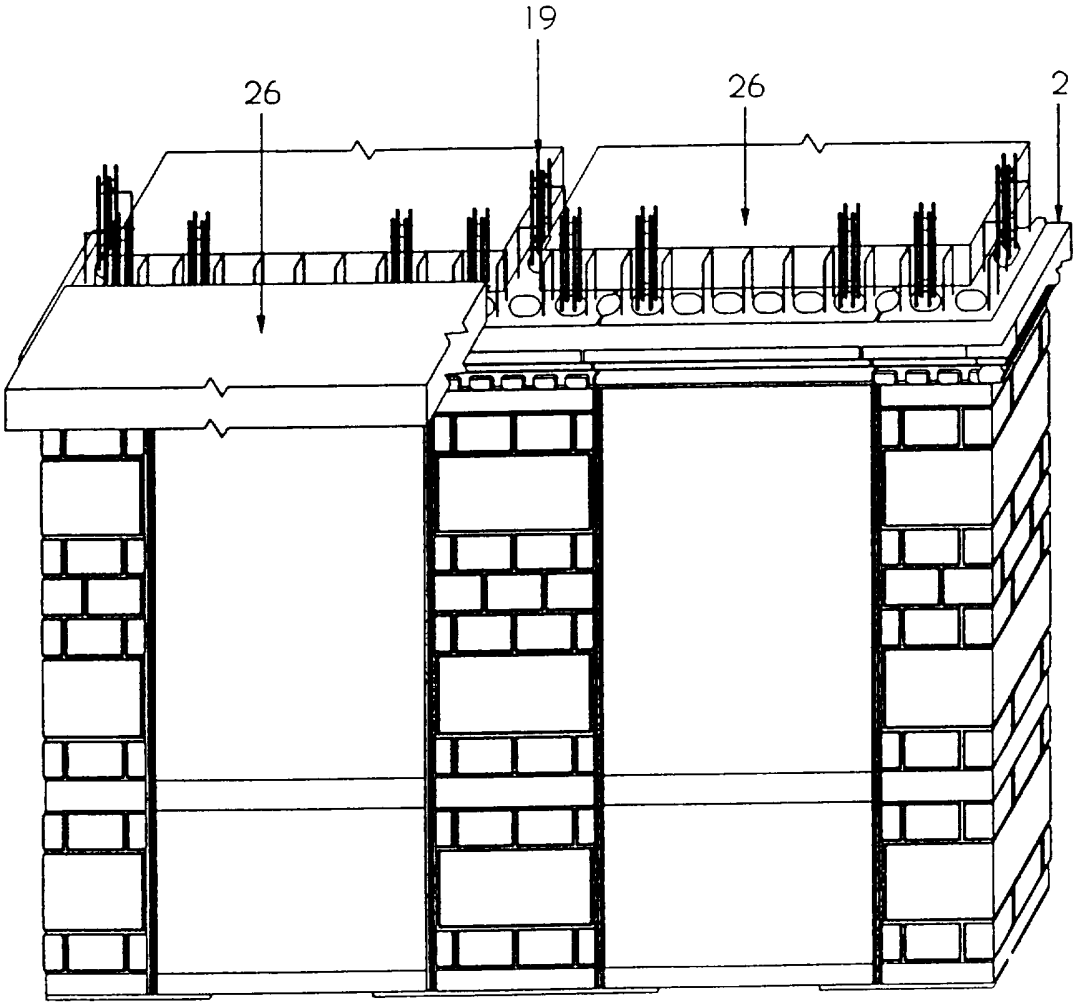


FIGURE 19

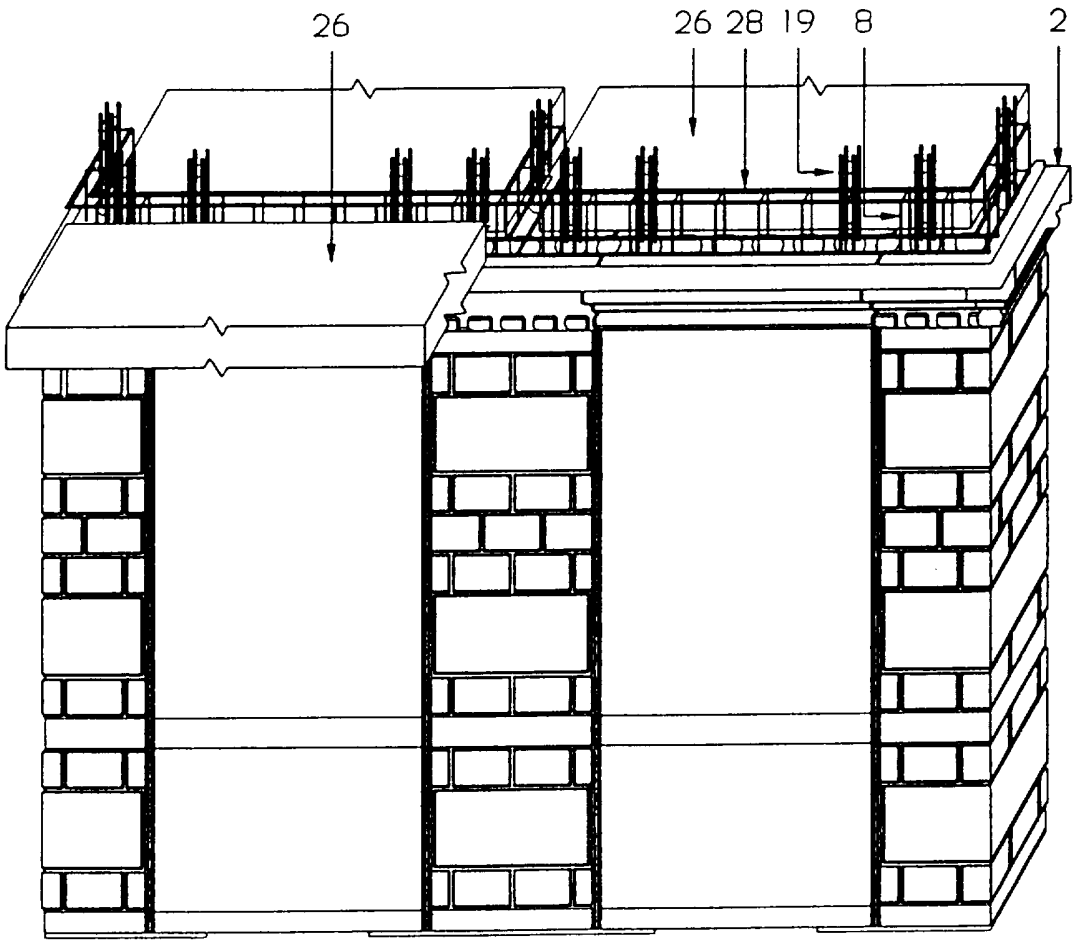


FIGURE 20

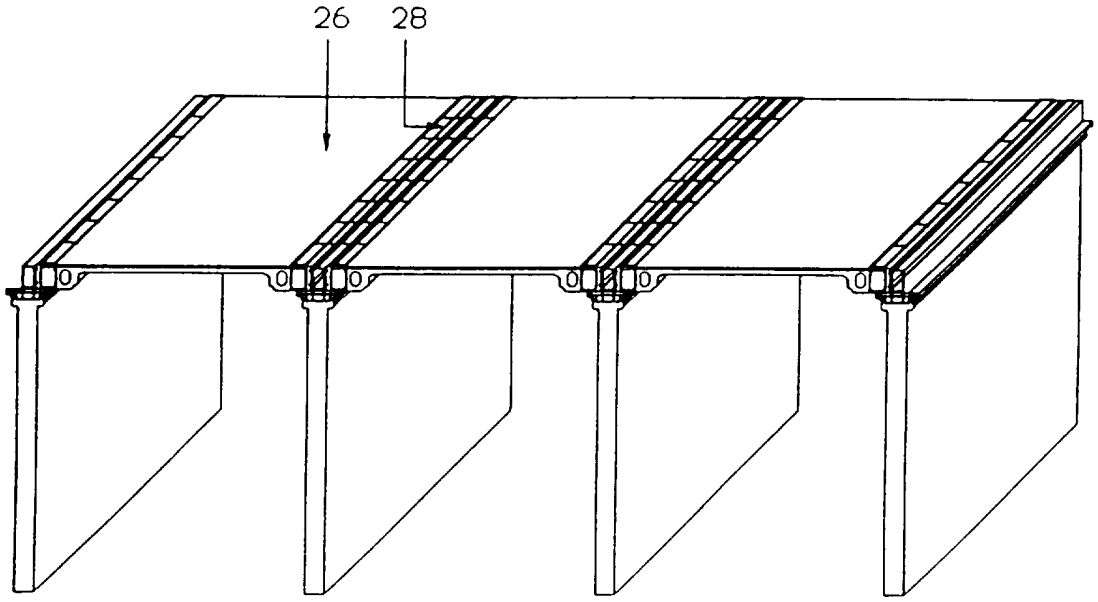


FIGURE 20A

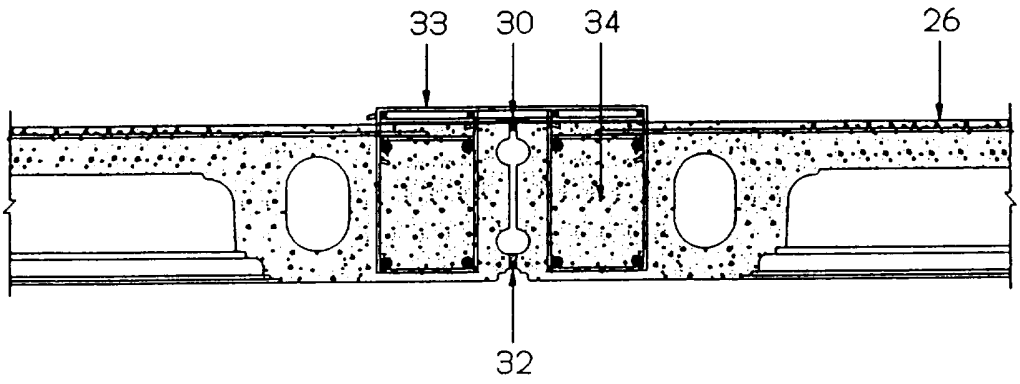


FIGURE 21A

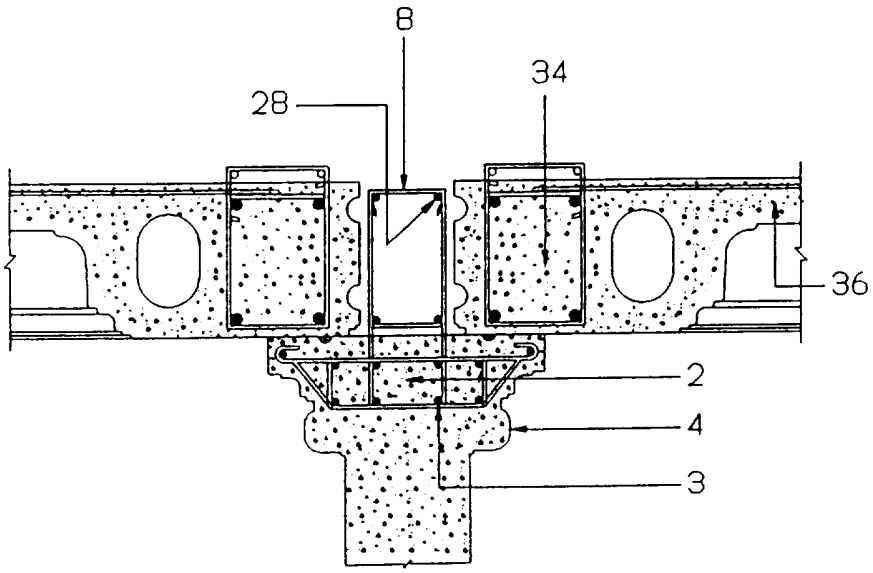


FIGURE 21B

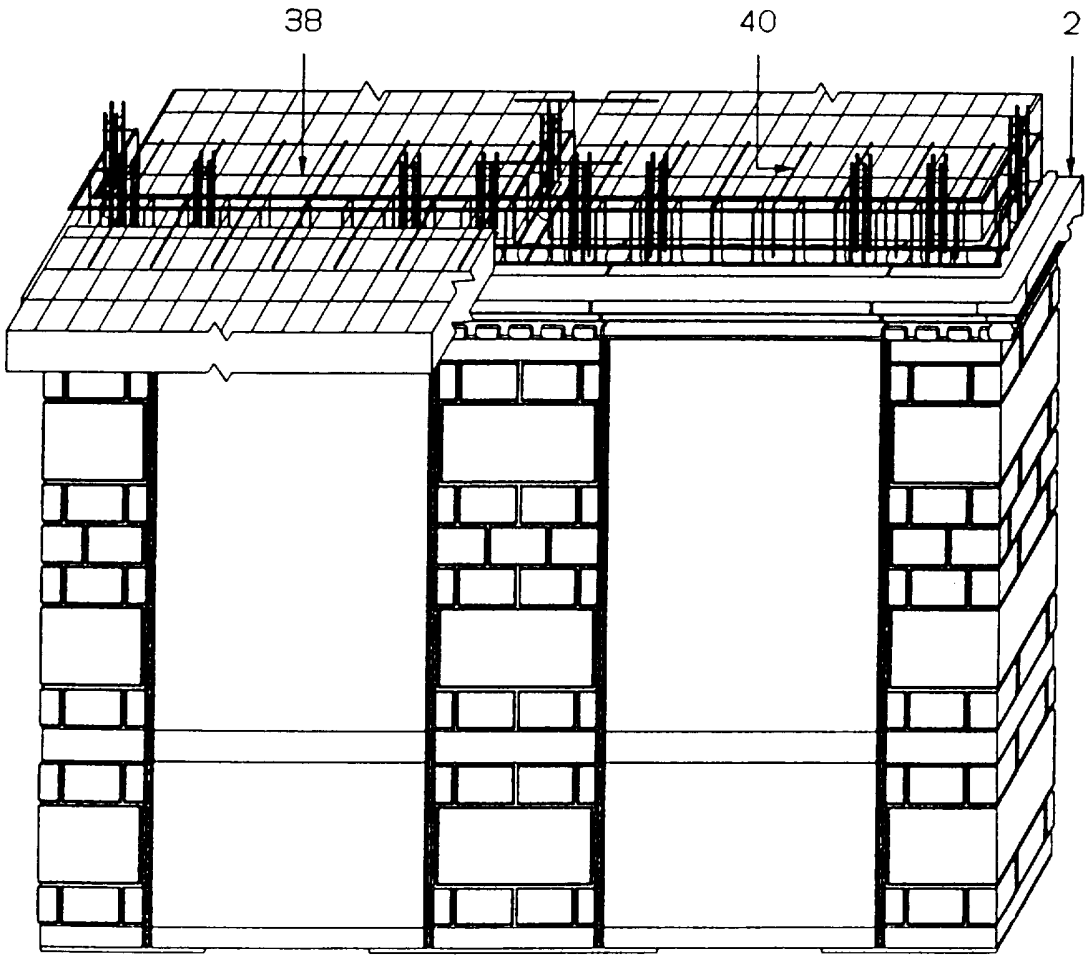


FIGURE 22

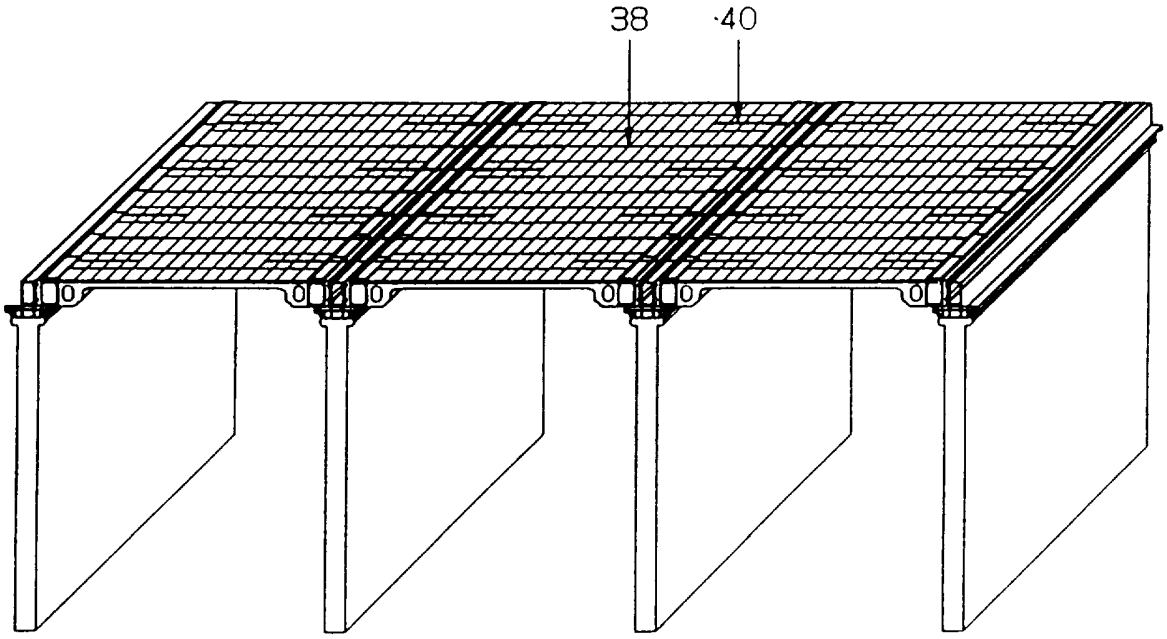


FIGURE 22A

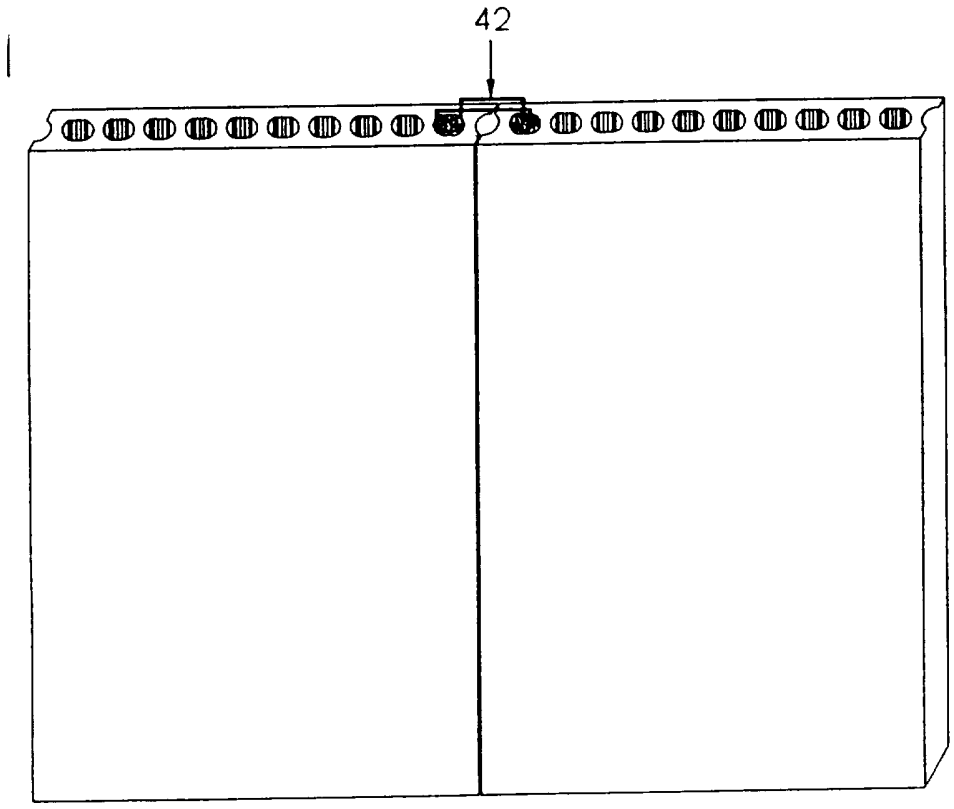


FIGURE 23

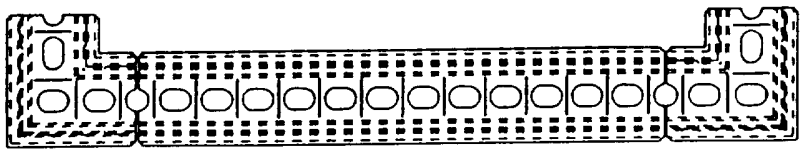


FIGURE 24A

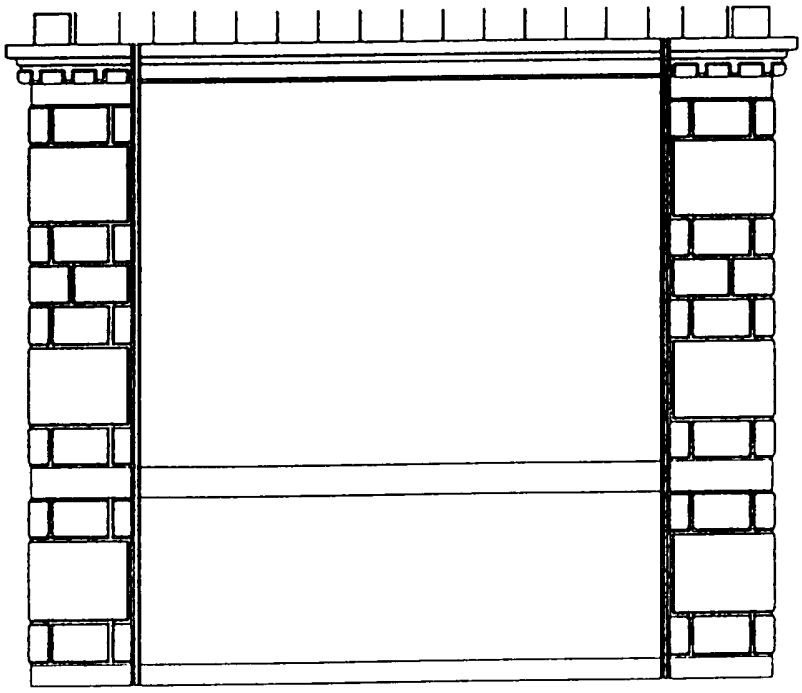


FIGURE 24B

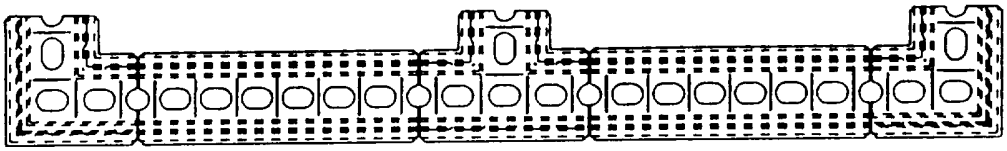


FIGURE 25A

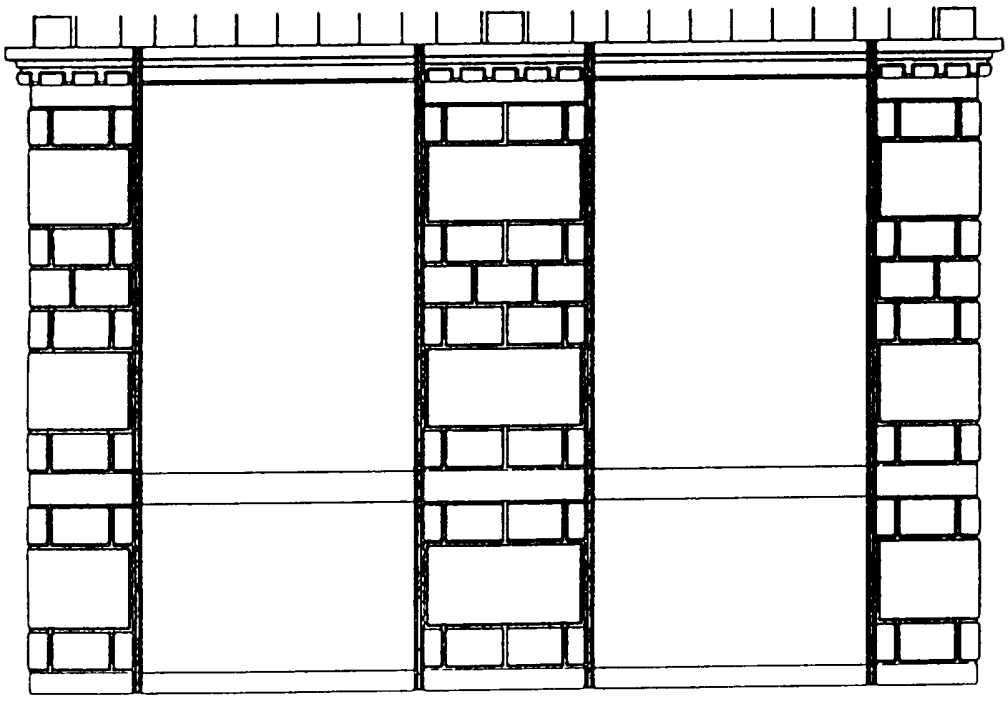


FIGURE 25B

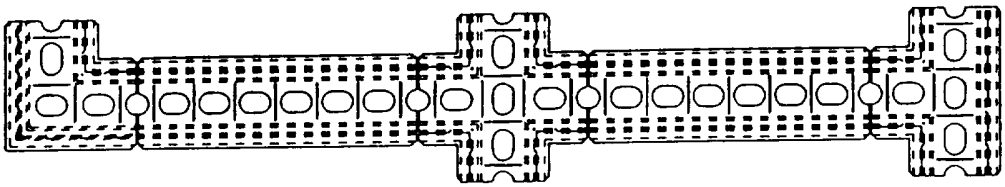


FIGURE 26A

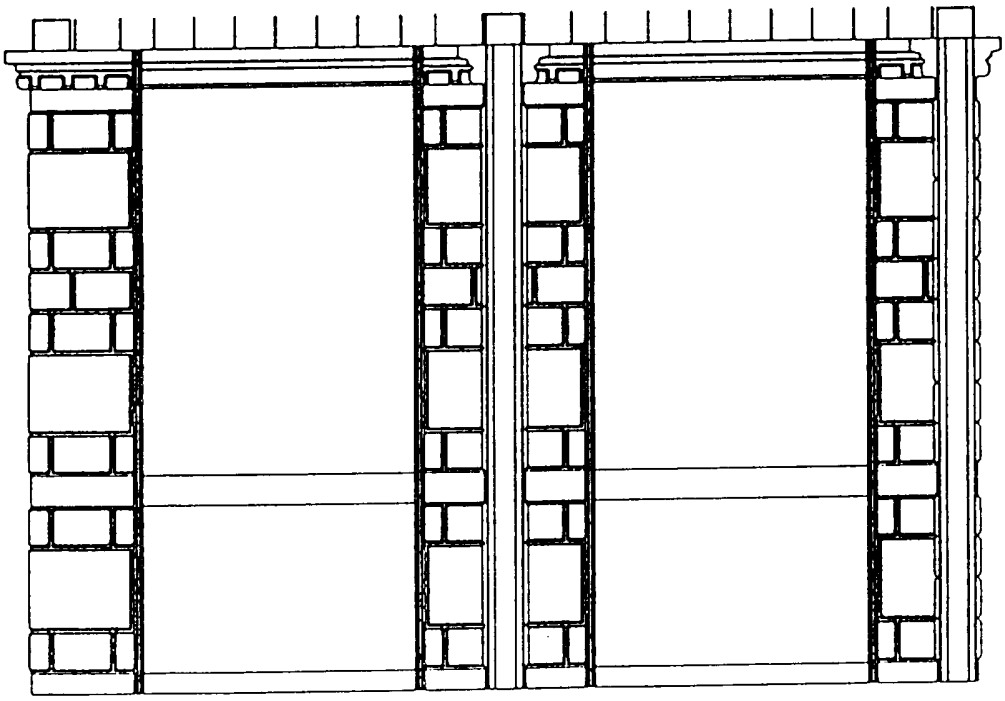


FIGURE 26B

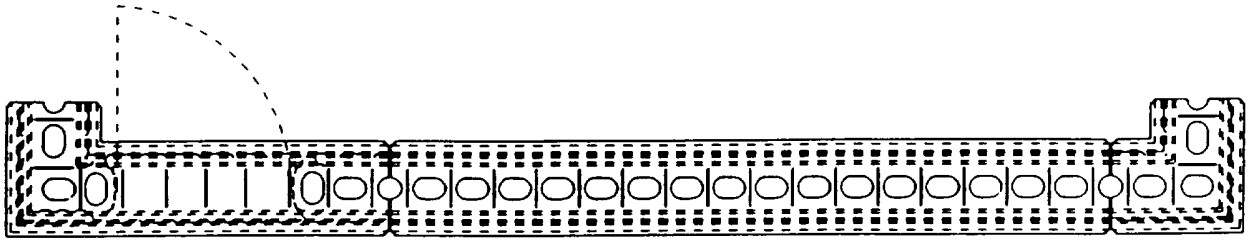


FIGURE 27A

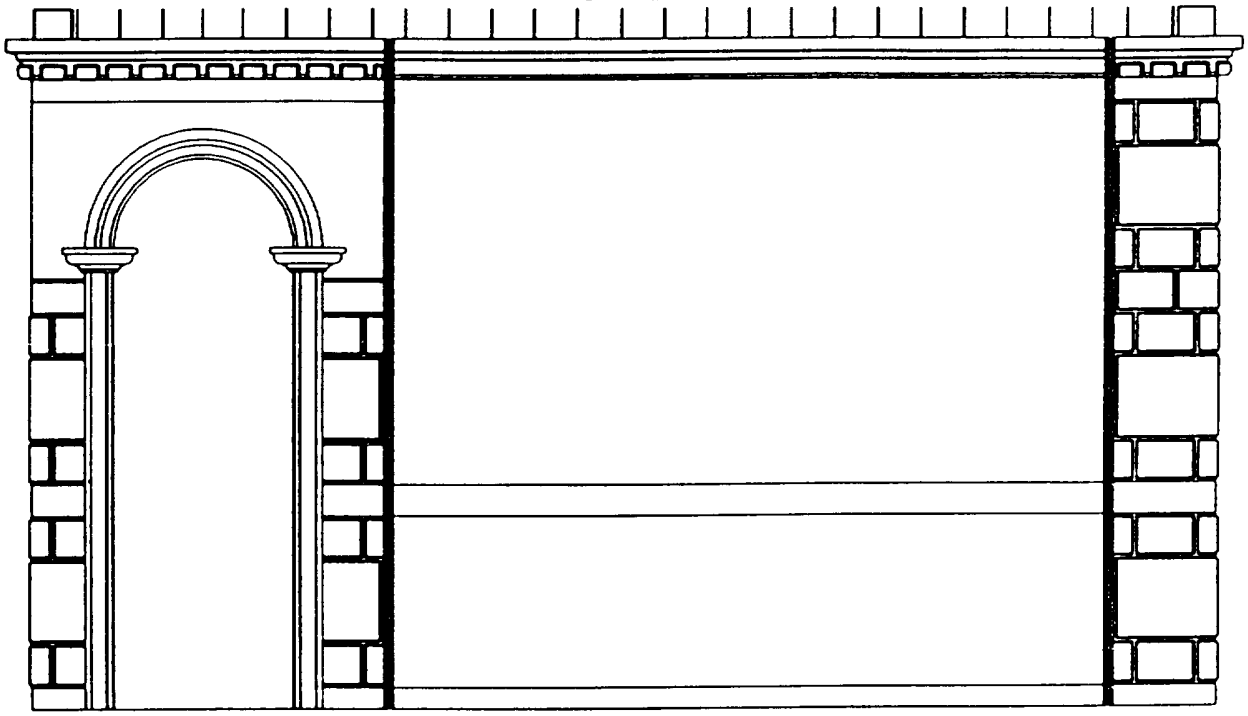


FIGURE 27B

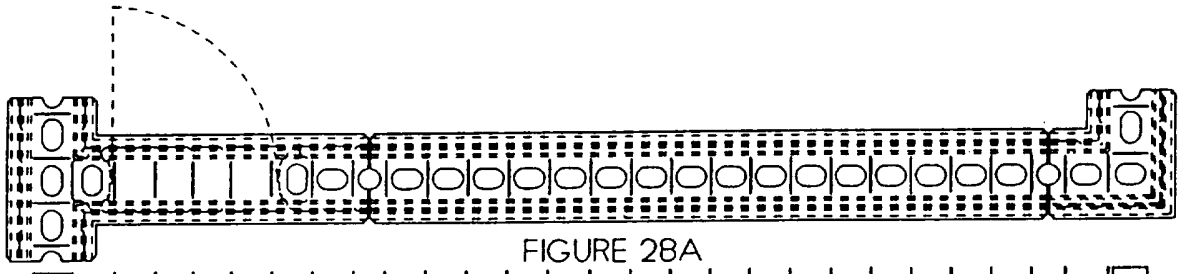


FIGURE 28A

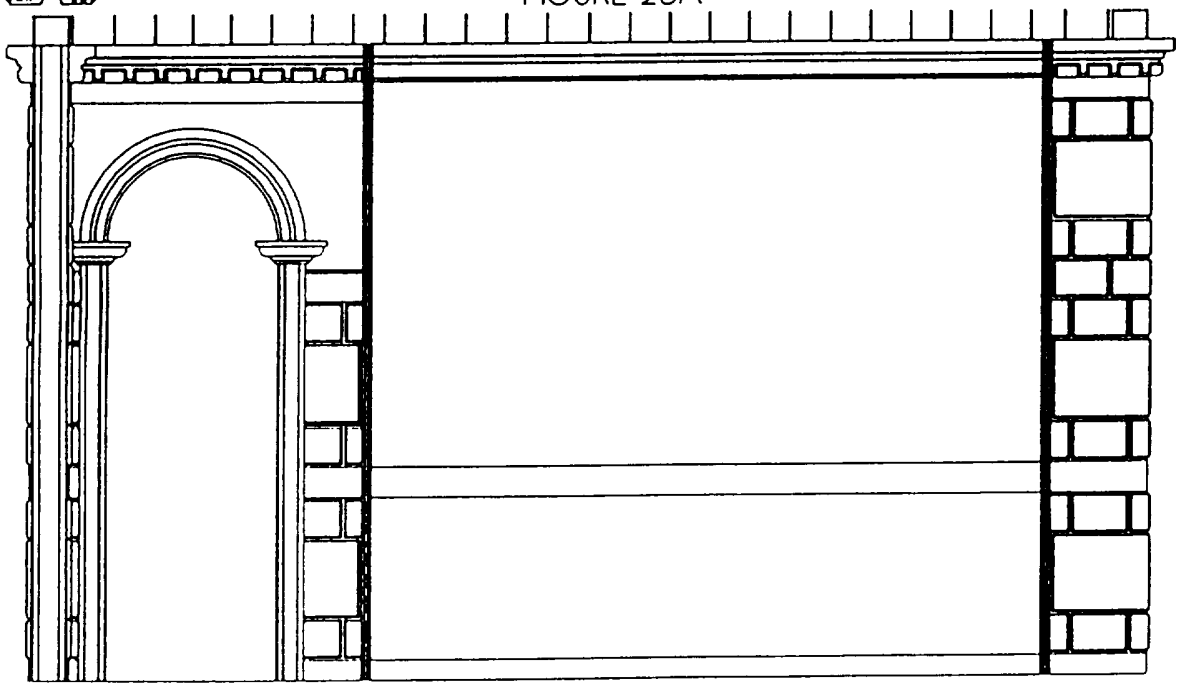


FIGURE 28B

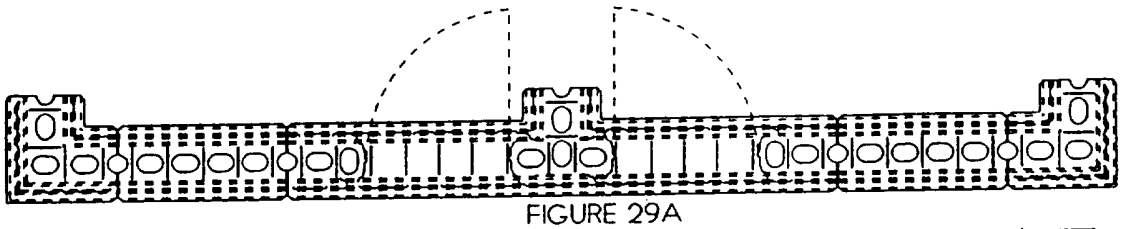


FIGURE 29A

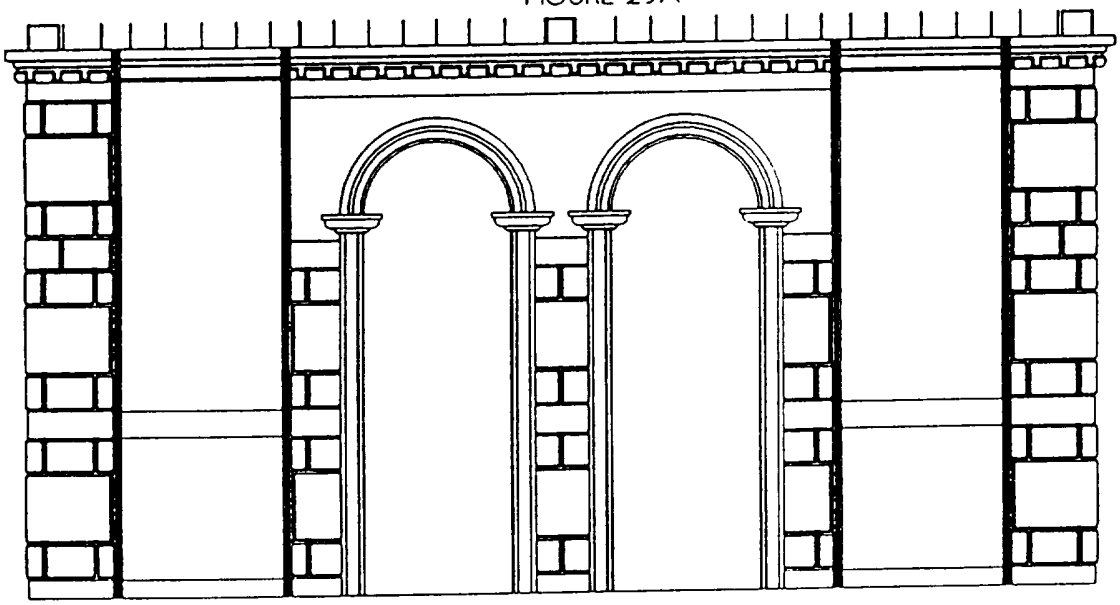


FIGURE 29B

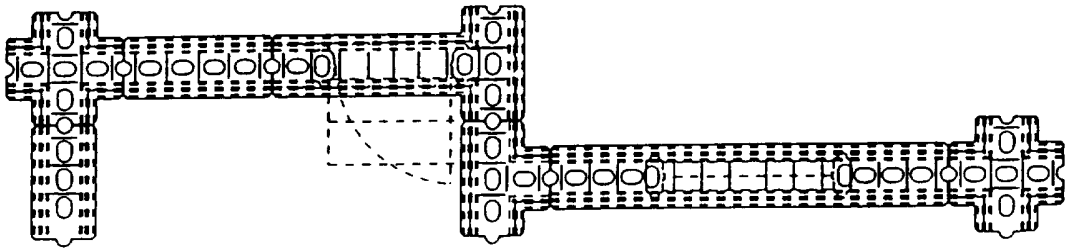


FIGURE 30A

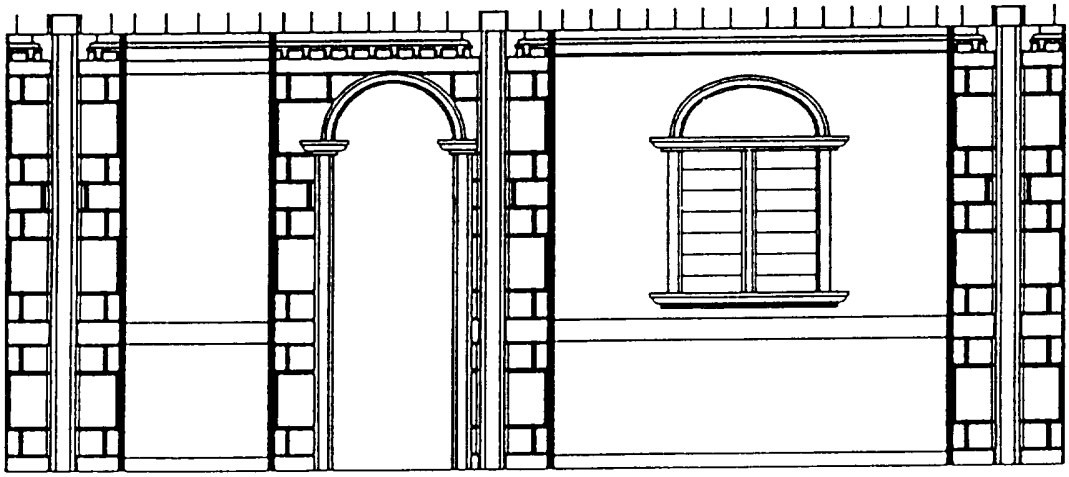


FIGURE 30B

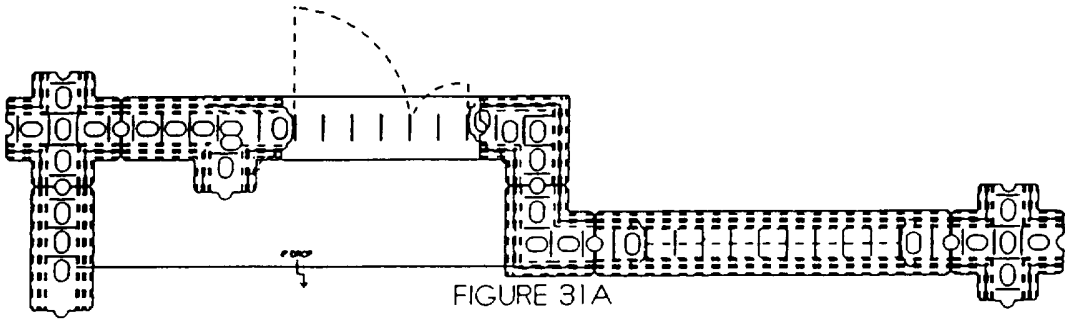


FIGURE 31A

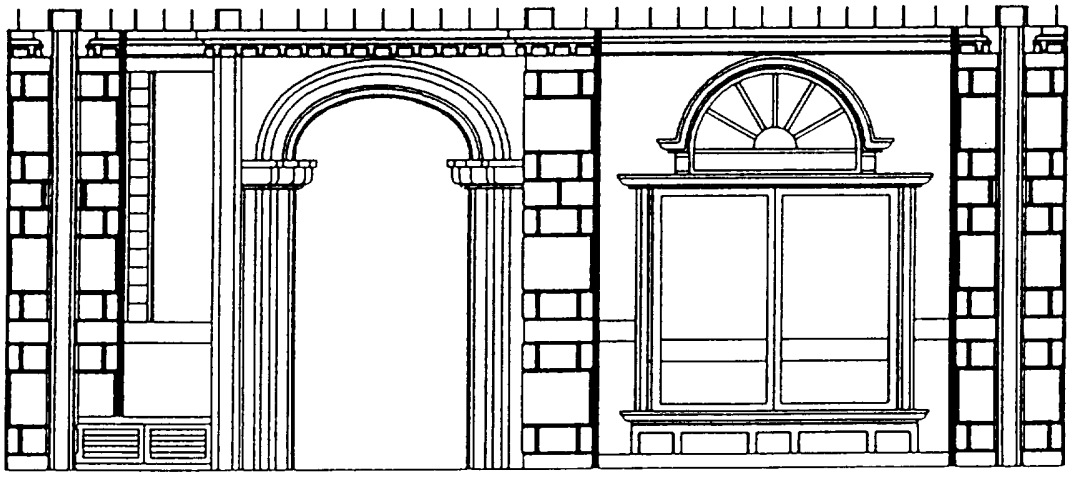


FIGURE 31B

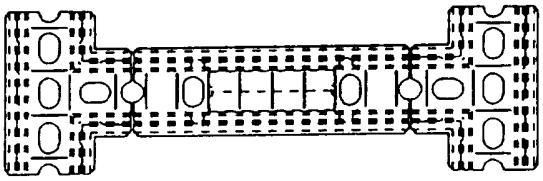


FIGURE 32A

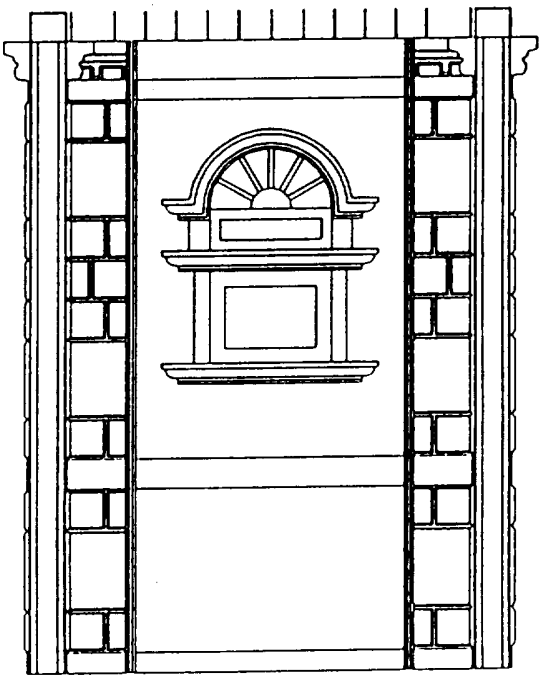


FIGURE 32B

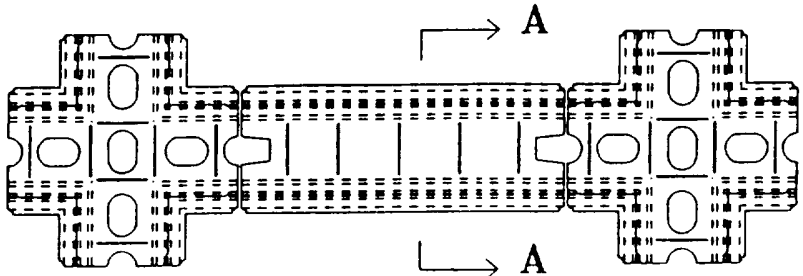
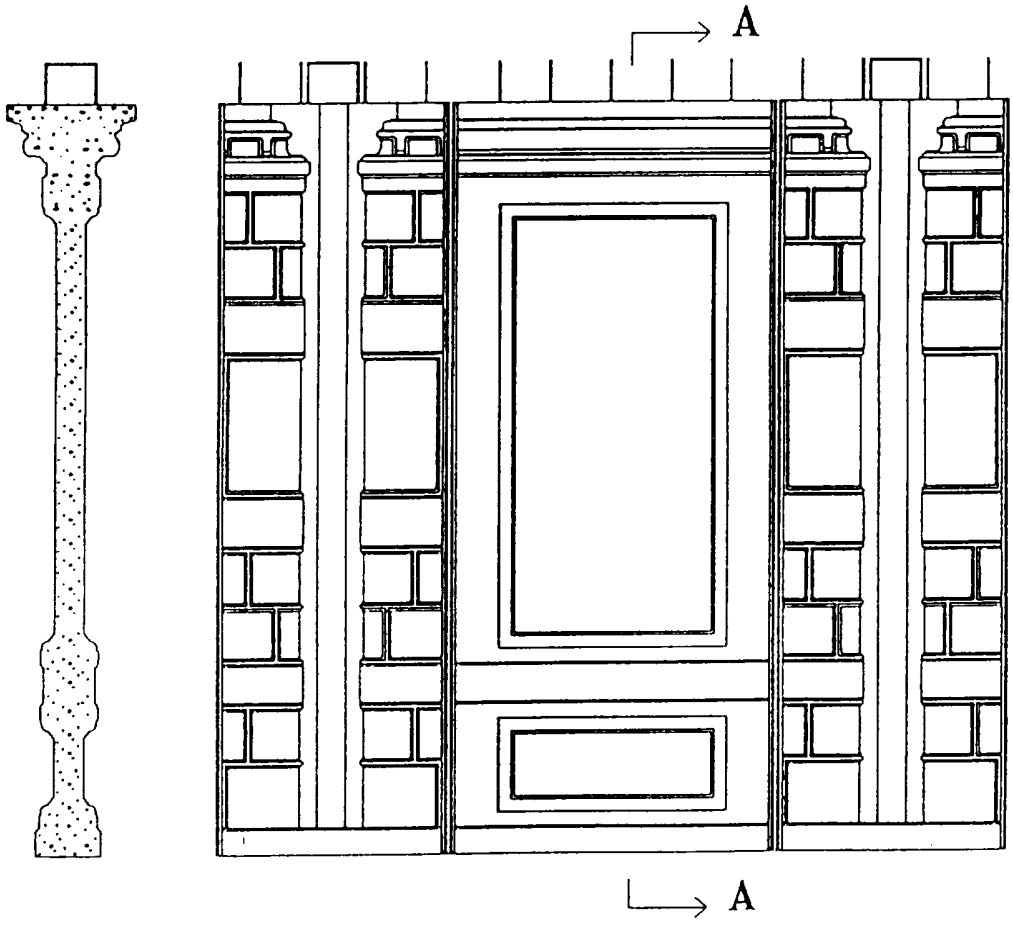


FIGURE 33A

PLAN



SECTION A-A

FIGURE 33C

ELEVATION

FIGURE 33B

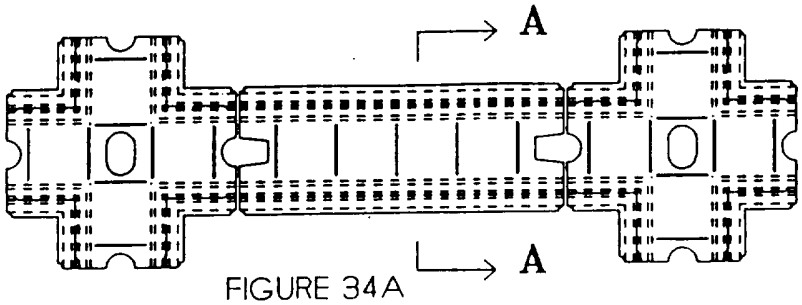


FIGURE 34A

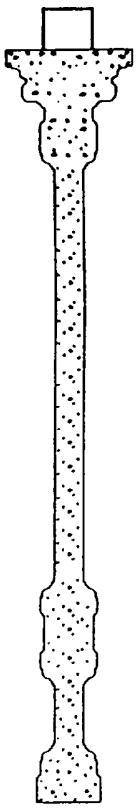


FIGURE 34C

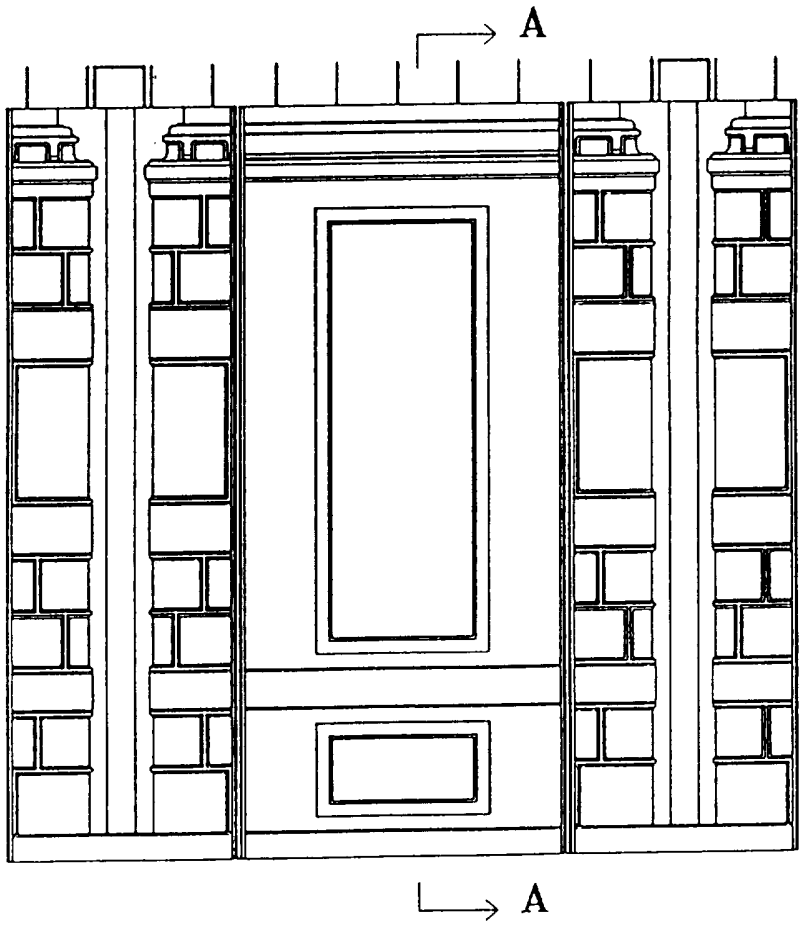


FIGURE 34B

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/SG 96/00012

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: E04B 1/04, 1/16, 1/343, 2/00, 2/68, 5/02, 5/23; E04C 2/06

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)
IPC E04B 1/04, 1/16, 1/343, 2/00, 2/68, 2/84, 5/02, 5/23, 5/26; E04C 2/04, 2/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above, E04C 2/38

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	CH 447543 A (TARANTO) 29 March 1968 figures 7 and 11	1-5,8,10,15-18 7,9
X	EP 80980 A (RUSCICA) 8 June 1983 page 17 lines 6-10 page 21 paragraph 3, figure 14	1-5,7,10,15-18
X	FR 2495207 A (GOLD) 4 June 1982 page 11 line 30 - page 12 line 9; figure 9	1-4,7

[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 document 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
20 February 1997	27 FEB 1997
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929	Authorized officer D Melhuish **DAVID MELHUISH** Telephone No.: (06) 283 2426

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/SG 96/00012

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2467923 A (OLLE) 30 April 1981 figures 1 and 3	1-4,7,15-18
X	WO 94/17259 A (MARMORITH BETONINDUSTRIE) 4 August 1994 page 3 line 29 - page 4 line 2	6
X	GB 1402259 A (JANJZ) 6 August 1975 page 2 lines 9-15	6
X	DE 2728911 A (I. Ge. Co. Pontello Prefabbricati S.p.A.) 9 February 1978 figures 1 and 7	7-10,12,18
Y	FR 2441127 A (FALICON) 11 July 1980 page 1 lines 27-41	7
X	FR 938349 A (SOCIETE GENERALE D'ENTERPRISES) 10 September 1948 figure 3	8
X	DE 2430635 A (TROUE) 15 January 1976 figure	8,10
X Y	GB 650634 A (SEMERARO) 28 February 1951 figure 1	8,10 1-5,9
X	US 3662506 A (DILLON) 16 May 1972 figure 1	12,14,18
X A	Patent Abstracts of Japan, JP, 7-229203 A (OAK SEKKEI:KK) 29 August 1995	12 11
A	FR 1006076 A (LEBELLE) 18 April 1952 figure 5	12
A	US 3821869 A (MORGAN) 2 July 1980 figure 4	12
X	AU 27062/67 (417720) B (GILBERT-ASH LIMITED) 20 March 1969 figures 6 and 7	6,15,16,17
X	AU 3443/51 (152250) B (WESTENBURG) 23 August 1951 figure 16	6,15,16,17

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/SG 96/00012

Box 1 Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

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

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

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

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

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

(see extra sheet)

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

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

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

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

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/SG 96/00012

Box II continued

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International searching authority has found that there are seven inventions:

1. Claims 1-5, 9, 17 directed to a precast concrete panel comprising a beam at an upper edge and longitudinal bores. The beam and the bores are considered to comprise a first "special technical feature".

2. Claim 6 directed to a precast concrete slab with perimeter beam and central recess. The beam and the recess are considered to comprise a second "special technical feature".

3. Claim 7 directed to a construction system using concrete panels of various shapes. It is considered the various shapes comprise a third "special technical feature".

4. Claim 8 directed to a concrete panel with columns cast in situ at the ends of the panel. The columns cast in situ comprise a fourth "special technical feature".

5. Claim 10 directed to structures using precast concrete panels that have longitudinal recesses in them. The longitudinal recesses comprises a fifth "special technical feature".

6. Claims 12-14 directed to a method of construction using precast panels and slabs. The whole method comprises a sixth "special technical feature".

7. Claims 15, 16 directed a method of making structures in which beams are formed by precast beams being coupled with cast in situ beams.

Since the abovementioned groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international applications does not relate to one invention or to a single inventive concept.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No.
PCT/SG 96/00012

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					
CH	447543						
EP	80980	AU	90994/82	ES	529330	IT	1143450
		ZA	8208745				
FR	2495207						
FR	2467923						
WO	9417259	AU	58066/94				
GB	1402259	NL	7213760				
DE	2728911	AU	26558/77	CH	616194	ES	461132
		FR	2360723	GB	1590301	IL	52417
		IT	1091801				
FR	2441127						
DE	2430635						
US	3662506	CA	934567	DE	2101084	FR	2076062
		GB	1336748				
US	3821869						

END OF ANNEX