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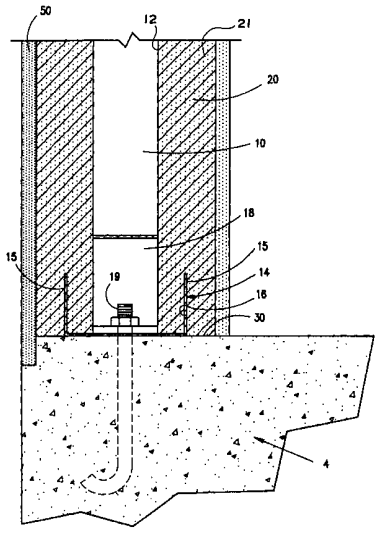
(54) Title: MINIMAL FRAMEWORK BUILDING SYSTEM AND METHOD OF CONSTRUCTION



(57) Abstract: The present invention comprises a minimum framework building system comprising a concrete foundation and one or more columns supporting a plurality of foam walls and a foam panel roof, wherein the walls and the roof comprise a load-bearing shell around them which comprises a spray on cementitious coating. A method for constructing a minimum framing building comprises constructing a concrete foundation, connecting juxtaposed foam panels to create walls for a building, connecting juxtaposed foam panels to create a roof, reinforcing the walls and the roof with one or more supports, and spraying a cementitious coating onto the walls and roof to form a load-bearing shell around the building. In the building system and method of the present invention, the foam wall panels (20) (fig. 4) are supported by steel tubing (10) vertically disposed between each of the wall panels (20). The steel tubing (10) reinforced walls are connected to the foundation via a "C" channel track (14) running along the top of the foundation (4), into the side walls of which "C" channel track (14) fit grooves (16) cut into the bottom of each of the foam panels (20). Further, bolted to the "C" channel track (14) are steel angle brackets (18) which are welded to each piece of steel tubing (10).

WO 01/14657 A2

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

MINIMAL FRAMEWORK BUILDING SYSTEM AND METHOD OF CONSTRUCTION

This application claims priority based on copending provisional patent application no. 60/150,104, filed August 20, 1999, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

This invention relates to a building system using a minimal amount of framing comprising foam panels that are bonded together using a sprayed-on cementitious coating that forms a load-bearing shell around the entire structure. The sprayed-on coating provides structural support, and the framing allows construction of large or multi-story buildings.

Conventional structures are built with a load-bearing frame, typically a series of metal or wood studs placed approximately 16 inches or 24 inches apart, then faced with surface material. In conventional buildings and structures, the frame provides all the support. There are two drawbacks to conventional building methods that this invention seeks to overcome. First, the large number of pieces in a typical frame results in a time consuming, somewhat complex, and expensive method of building. The conventional method also requires a large amount of materials and a number of workers skilled in the trade. The minimal framework structure disclosed herein has significantly fewer parts than a conventional structure which reduces the costs and expedites construction.

There are numerous conventional building methods. In the United States, houses are typically constructed with a load-bearing wood frame covered inside and out with various facing materials. Commercial buildings and offices are typically constructed from load-bearing steel frames covered with facing materials. These

methods are adaptable and modifiable to many different configurations. They are, however, relatively expensive, somewhat slow to build, and require a great deal of materials and skilled laborers. There is a need, therefore, for an inexpensive and easily constructed, yet structurally sound building system and method of construction.

SUMMARY OF THE INVENTION

The present invention comprises a minimum framework building system comprising a concrete foundation and one or more columns supporting a plurality of foam walls and a foam panel roof, wherein the walls and the roof comprise a load-bearing shell around them which comprises a spray on cementitious coating. A method for constructing a minimum framing building comprises constructing a concrete foundation, connecting juxtaposed foam panels to create walls for a building, connecting juxtaposed foam panels to create a roof, reinforcing the walls and the roof with one or more supports, and spraying a cementitious coating onto the walls and roof to form a load-bearing shell around the building. Given the inexpensive construction costs and high structural strength of the building, there is a low cost to strength ratio. Other advantages include, but are not limited to, relative ease of construction that requires few skilled laborers, and minimal construction materials. Additionally, the spray-on coating provides fire rated protection.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of an expository embodiment of the building system showing the position of walls and a foundation.

Fig. 2 is an expository elevation view showing the wall panels.

Fig. 3 is a detail of wall section A, showing the location of the steel tubing, the notch in the foam panels, the "C" channel track and the groove in the bottom of the foam panels.

Fig. 4 is a cut away detail of wall section B-B.

Fig. 5 is a detail view of an eave where the steel tubing meets the joist.

Fig. 6 is a detail view of the connection between two joists at the peak of the roof.

Fig. 7 is a detail of the corner of the roof.

Fig. 8 is a perspective view of a partially assembled frame skeleton.

Fig. 9 is a roof plan view showing multiple foam panels positioned side by side and joined together to form the roof.

Fig. 10 is a plan view of the foundation showing the location of trenches under the exterior and interior walls.

Fig. 11 is a cross-sectional view of the foundation at a cross section showing the trench at the edge of the foundation beneath the exterior wall.

Fig. 12 is a cross-sectional view of the foundation at a cross-section showing the trench under an interior wall.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a plan view of a minimal framework building system 2. The building may be constructed on any type of conventional foundation 4. A "C" channel track 14, shown in Fig. 3, is connected to the foundation, running along the top of the foundation where the walls 6 will be. Exterior walls 7 are typically placed over the perimeter of foundation 8. The "C" channel track 14, shown in Fig. 3, is an elongated metal channel

approximately 4 inches wide with two side walls extending up approximately 2 inches, on either side of the channel to form the "C". Fig. 1 also shows a thin coating 54 of cementitious material 50 sprayed-on the outside of the structure 2 to form a load-bearing shell 52.

Figs. 3 and 4 show in detail the connection between the steel tubing 10 or columns, similar to standard studs in the building trades which measure approximately 2 inches by about 4 inches, and the "C" channel track 14. The steel tubing 10 may be unitary in structure and no supporting filling within the hollow central portion of the steel tubing 10 is needed. The steel tubing 10 is spaced 4' [four feet] apart and extends upward from the "C" channel track 14. The steel tubing 10 can be connected to the "C" channel track 14 by any conventional means, including gluing. Figs. 3 and 4 show the use of an angle bracket 18 bolted to the "C" channel track 14 and welded to the steel tubing 10. Fig. 4 is an elevation of a wall showing foam panels 20 aligned side by side. The foam panels may comprise expanded polystyrene foam (EPS), polyurethane, or foamed plastic. The foam panels 20, which are approximately four feet [4'] wide, about six inches [6"] thick, and as tall as the respective ceiling requires, are placed on the "C" channel track 14 and between the steel tubing 10. To accomplish this, thin grooves 16 may be cut into the bottom 30 of the foam panels 20 to receive the 2 inch "C" channel track side walls 15, and approximately 2 inch by 2 inch [2"x2"] notches 12 are cut into the sides 21 of the foam panels 20 to receive the steel tubing 10. The foam panels 20 are thus securely placed in the proper position. There is no additional need to secure the panels because the sprayed-on cementitious material coating 50 adheres them in place. As shown in Fig. 5, at the top of the structure a system of joists 34 support a

roof 40 structure. The joists 34 can be angled to support a pitched roof, the pitch dependent upon taste and architectural design.

Fig. 2 is an elevation view of a side of the structure 2, showing the foam panels 20 positioned vertically side by side. The foam panels 20 will preferably have a width 22 of four feet. A uniform or standardized width allows for ease of construction. As described previously, steel tubing 10 is placed along the"C" channel track 14 every four feet. With the 2 inch by 2 inch [2"x2"] notch 12 cut into the side walls 21 of the foam panels 20, the foam panels 20 can be placed between the steel tubing 10 creating a vertical joint 26 between the foam panels 20. Fig. 2 also shows that the height 24 of foam panels 20 can vary, if required, to meet the roof joists 34. In other embodiments of the present invention, vertical joints 26 can be formed by gluing the side walls 21 of the foam panels 20 to each other or to the steel tubing 10.

Fig. 3 is a detail of the wall section showing the connection between the steel tubing 10 and the "C" channel track 14. Fig. 3 also shows the notch 12 cut into the side walls 21 of the foam panels 20. Fig. 3 also shows the groove 16 in the bottom 30 of the foam panels 20. The groove 16 is cut to receive the two side walls 15 of the "C" channel track 14. In Fig. 3, the steel tubing 10 is attached to the "C" channel track 14 by an angle bracket 18. The angle bracket 18 is bolted to the "C" channel track 14 and welded to the steel tubing 10 so as to present a flat surface that is flush with the base of the steel tubing 10.

Fig. 4 is a cut away detail of wall section B-B showing the 6 inch foam panel 20, and the 2 inch x 4 inch [2"x4"] steel tubing 10. This view also shows the correspondence between the "C" channel track side wall 15 and the groove 16 in the

bottom of the foam panel 20. With the groove 16 cut into the bottom of the foam panel 20 receiving the "C" channel track side wall 15, and the notch 12 in the side wall 21 of the foam panel 20 receiving the steel tubing 10, the foam panels 20 fit securely into the frame of the structure 2. This eliminates the need for any type of connecting hardware or equipment.

Fig. 5 is a detail of the connection between the steel tubing 10 and the joist 34 which supports the roof 40. In one embodiment, the roof 40 is constructed of foam panels 20 sprayed with cementitious material 50. In another embodiment, the roof 40 is constructed by placing a series of hat channels 44 on the foam panels 20, overlaying with plywood 45, and constructing a conventional roof on the plywood roofing material with, for example, 30 lb. felt and 25 year composite roofing material or shingles.

The roof foam panels 20 may be 10 inches thick with grooves 16 located approximately 1 inch from each edge for receiving the edges or sides of the C-channel 35 of the roof joist 34. The steel tubing 10 may pass through a hole or notch in an angled C-channel 37 for attachment to and support of the roof joists 34. The tubing 10 may be secured or fastened to the angled C-channel 37 and to the roof joist 34 by welding, adhesive, bolts, or the like. The angled C-channel 37 may have its central portion angled to conform to the pitch of the roof. The two end portions of the angled C-channel 37 may be vertically disposed for fitting into grooves 16 at the top of the wall foam panels 20. The top of the vertical wall foam panels 20 may be cut at an angle to conform to the pitch of the roof.

Fig. 6 is a detail of the peak of the roof 40 showing the connection between the joists 34 with a steel plate 36. Also shown is the roof beam 42, which runs underneath

and supports the joists 34 at the peak of the roof 40. The roof beam 42 is supported on either end by steel tubing 10 in the exterior walls 7 of the building structure 2, and intermittently in the interior of the structure by steeling tubing 10 in the interior walls 5. The roof beam 42 is preferably wrapped by foam material and sprayed with cementitious coating 50. The roof beam 42 may comprise two "C" shaped channels joined back-to-back, by bolts for example, to obtain an I-shaped beam. The top segment 43 of each C-channel is bent to the pitch of the roof, so that the top of the I-beam is angled or bent to conform to the pitch or apex of the roof.

Fig. 7 shows a detail of the roof corner showing a foam panel 20 used for the roof. In one embodiment, a series of hat channels 44 may be placed on top of the roof 40 and conventional roofing built on top of the hat channel 44. The hat channel 44 is a galvanized steel channel approximately 2 inches by 4 inches running substantially the length of the roof 40. The hat channel 44 may be secured or fastened to the joist 34 with screws or other fasteners.

Fig. 8 shows a partially assembled skeletal framework for the building structure 2. In one embodiment, the structure 2 is constructed by placing the "C" channel track 14 on the perimeter 8 of the foundation 4. The "C" channel track 14 can be attached by a number of common methods as is well known in the construction industry, which may include gluing or bolting. The steel tubing 10 is then attached to the "C" channel track 14. The steel tubing is generally spaced 4 feet apart. Foam panels 20, which may be precut to the proper height 24, with notches 12 cut in either side 21, and with grooves 16 cut in the bottom 30 are then supplied. With the notches 12 and the grooves 16 precut, the foam panels 20 will fit into place between the steel tubing 10. A multi-

storied structure may be constructed by the addition of a beam 32, and a second series of steel tubing 10 added above the beam 32. A roof beam 42 is then placed with each end resting on steel tubing 10 at the middle of the structure 2, and joists 34 are connected between the steel tubing 10 and the roof beam 42. Depending on the requirements of the structure 2, it is possible to place the steel tubing 10 further apart than every four feet.

Fig. 9 is a plan view of the roof 40 showing foam panels 20 placed over the joists 34. While Fig. 9 shows an overhang in this embodiment, there is no requirement for one, and its presence or absence is dictated by the architectural and structural needs of the building. The foam panels 20 may be attached to the joists 34 by a wide variety of methods, from gluing to nailing. The means of attachment is irrelevant because the spray on cementitious material coating 50 provides structural support.

After the walls 6 and roof 40 are constructed, openings for doors, windows, electrical outlets and other features are cut into the foam panels 20. And, before the cementitious material 50 is applied, further aesthetic architectural details can be added to the structure around windows, doors, eaves, corners and in other areas easily by applying additional foam pieces to the walls. Such architectural foam pieces may be secured by toothpicks or glued into place as described above. In other preferred embodiments, architectural details are added to the structure 2 such as texture, color, decorative tile or brick, or architectural features that provide the structure 2 with contours. Foam trim panels, for example, may be placed at the corners of the structure 2 and around doors and windows to provide architectural contours. Architectural features of a great variety may be achieved. In one embodiment, wood frames

constructed preferably of 2' x 4's are installed around the openings for the doors and windows. Openings for windows and other items are then covered with plastic, and then a cementitious material 50 that sticks directly to the foam panels 20 is sprayed-onto the structure 2.

Once the structure 2 is assembled, it is sprayed with a cementitious coating material 50 which provides structural support as well as protection to the surfaces. One unique aspect of this invention is that, unlike stucco or other conventional materials, the cementitious material 50 is sprayed directly on the structure 2 without the need for wire or other meshing to hold the material.

In another preferred embodiment, the cementitious material 50 is prepared by mixing together water, sand, lime, marble particles, Portland cement, fibers, and an adhesive additive. Other known cementitious coating materials may be used, including those described in the following references, the entirety of each of which is herein incorporated by reference: U. S. Patent No. 5,803,964 to Scarborough, U. S. Patent No. 5,809,717 to Scarborough et al, U. S. Application Serial No. 09/490,505 filed January 25, 2000 in the names of Zoch et al, and U.S. Application Serial No. 09/178,909, filed October 26, 1998. In the most preferred method, about 2 gallons of water are mixed with about 100 pounds of sand. Next, approximately 2 gallons of water and about 100 pounds of sand are added and mixed. Then, about 60 pounds of marble particles and about 10 pounds of lime are mixed in, followed by about 1 gallon of water and about 94 pounds of Portland cement. Approximately 0.5 pounds of quarter-inch fibers are then mixed in, followed by about 1 gallon of water and about two gallons of acrylic latex. In total, the cementitious coating comprises about 5% by weight of the adhesive additive.

Other additives may be mixed in to improve the cement properties, such as a retarder. Further, up to about two more gallons of water may be mixed into the cement, depending on the heat, humidity and viscosity of the cement mix. The sand used in the process is preferably a blend of number three and four sands (about 50% of each) which may be commonly obtained (e.g., Specialty Sand, Houston, Texas). The lime and marble particles are available from suppliers such as General Terrazo in Houston, Texas. The marble is preferably in particles similar in size to number one size sand. Type one Portland cement is preferably used and can be obtained from concrete companies or hardware stores such as Home Depot. The fibers used are preferably quarter-inch fibrillated polypropylene fibers (Fibermesh, Synthetic Industries, Houston, Texas). However, the fibers may be made of many materials including fiberglass, or other plastics, or metal.

This cement mixture is preferably mixed in the mixer of the machine that sprays the cement onto the structure. In the preferred embodiment, the spraying machine is a mixer/pump such as the Putzmeister P11S Vario Worm Pump (Germany). Other machines that may be used to mix and spray the cementitious coating include the Spray Force® drywall and plastering machine, model Hurricane 350 (Spray Force Manufacturing, Inc., Fresno, CA) or the Allentown Powercreter® (Master Builders, Inc., Cleveland, Ohio or Allentown Co., Allentown, PA). The spraying machine has a rubber hydraulic hose (available from Putzmeister) attached to its output that is preferably about 75 feet long. The first approximately 25 feet of the hose has an approximately 3 inch diameter, the second approximately 25 feet of hose has about a 2 inch diameter; and the last approximately 25 feet of hose has about a 1.5 inch diameter.

An adjustable nozzle, such as the type used for stucco or gunnite, is attached to the end of the hose. In the preferred embodiment, it has a 3/16 inch to a 3/4 inch variable tip diameter. In addition, an air hose is attached from the spray machine to the nozzle to provide air entrainment into the cement mix as it blows from the nozzle, as is well-known to those skilled in the art. According to the desired use, the air pressure and the nozzle tip size are adjusted. Preferably, a 3/8 inch nozzle tip is used with about 50 psi of air pressure when the air temperature is 95°; about 45 psi of air at 80°; and about 40 psi at 75°.

Before the cement is mixed in the spray machine, a primer mixture is made and pumped into the hose. The primer is comprised of about 60 lbs. of lime and about 4 gallons of water, which is mixed for about 3 minutes or until complete mixing occurs. Once the sprayable cement mixture is ready to spray onto the structure, the primer is pumped into buckets for reuse. Then, the cement mixture is sprayed-onto the structure in a thin coating. A single coating in the range of about 1/4 inch to about 3/4 inch is preferably applied. In the most preferred embodiment, two thin coatings are applied. The first coating is applied to a thickness of about 1/4 inch and allowed to cure for about 30 minutes or until a permanent set occurs. A second coating is then sprayed-on to a thickness of about 1/4 inch. The structure then cures and attains its final compressive strength as a load-bearing shell around the underlying building materials. In an alternative embodiment, the cement coating is applied by troweling or other non-spray methods.

Before the coating dries, it may be decorated by etching patterns into it; by pressing rocks or other appliques into it; by troweling the surface smooth, and by many

other decorative techniques. Alternatively, after the cement dries, appliques may be screwed into the cement. After the structure has cured for about five days, it may be painted or further water sealed. An elastomeric paint such as Hydrostop® accomplishes both water sealing and provides color to the structure. The paint or sealant is preferably applied by rolling, airless paint gun, or paint brush. In another preferred embodiment of the method, powdered dyes are added to the cementitious material when it is being mixed so that the sprayed cementitious material 50 is in a preferred color thus obviating any need for painting thereafter.

The structure may be built on any type of conventional foundation. Figs. 10, 11 and 12 show a preferred embodiment of a foundation. In the most preferred embodiment, a welded wire mesh 104, as shown in Figs. 11 and 12, is used to reinforce the concrete, such as No. 6 mesh (the wires run perpendicularly to each other at about 6 inch intervals). The wire fabric 104 is laid in a grid work pattern and is bent on the ends into a trench 102 that is excavated around the perimeter 8 of the concrete foundation 4, as further shown in Figs. 11 and 12. The foundation 4, in another preferred embodiment, may be constructed with a system of I-beams place under the perimeter 8 of the structure 2 as well as under interior walls 5. Concrete is poured around the I-beams.

The dimensions of the concrete foundation 4 should match the dimensions of the structure 2 at ground level, plus any porches, patios, loading docks, etc. affixed to the structure 2. The dimensions of the foundation 4 may be any size. In addition, the foundation 4 is preferably in the range of approximately 2 to 6 inches in thickness, but can be greater depending on need, for example, one foot or more for cold climates. In

one preferred embodiment of the invention, the concrete foundation 4 is about 2 inches thick across the entire foundation 4, except where trenches 102 are formed around the perimeter 8 of the structure 2 and under any walls 6 of the structure 2. Preferably, the trenches 102 are about 4 inches deep and about 6 inches wide and create additional support under the walls 6 of the structure 2. Fig. 11 shows a cross-section of the trench 102 across the line R-R in Fig. 10. Fig. 12 shows a cross-section of the trench 102 under an interior wall 5 of the structure 2 across the line S-S in Fig. 10.

WE CLAIM:

1. A minimum framework building system comprised of:

a concrete foundation;

a plurality of foam panel walls;

a foam panel roof;

one or more columns supporting the roof and walls; and

a sprayed-on cementitious coating that forms a load-bearing shell around the walls and roof.

2. The system of claim 1 wherein said cementitious coating comprises water, sand, lime, marble particles, Portland cement, fibers, and an adhesive additive.

3. The system of claim 1 wherein said columns supporting the roof and walls comprise steel tubing.

4. The system of claim 1 wherein said columns supporting the walls are connected to said concrete foundation by a "C" channel track running along the top of the foundation.

5. The system of claim 1 comprising a multi-storied structure.

6. The system of claim 1 wherein said walls and said foundation are connected by a "C" channel track which is connected to the foundation where the walls will be and which is bolted to angle brackets which are welded to a plurality of steel tubing columns supporting the walls.

7. The system of claim 1 wherein said walls comprise a plurality of foam panels, each of said panels comprising a notch in each of the side walls of the panel adapted to accommodate a steel tubing support or column.

8. The system of claim 1 wherein said walls comprise a plurality of foam panels, each of said panels comprising grooves in its bottom adapted to receive two side walls of a "C" channel track connected to said foundation.

9. The system of claim 1 wherein said walls comprise a plurality of foam panels, each of said panels comprising grooves in its top adapted to receive two side walls of a "C" channel track which is adapted to connect to said roof.

10. A method of constructing a minimum framework building comprising the steps of:

constructing a concrete foundation;

connecting juxtaposed foam panels to create walls for a building;

connecting juxtaposed foam panels to create a roof;

reinforcing the walls and roof with one or more supports; and

spraying a cementitious coating onto the walls and roof to form a load-bearing shell around the building.

11. A method of constructing a minimum framework building comprising:

constructing a concrete foundation having a C-channel track thereon;

connecting juxtaposed foam panels having a pair of grooves on the bottom of each panel to receive two side walls of said track to create walls for a building;

connecting juxtaposed foam panels to create a roof; and

spraying a cementitious coating onto the walls and roof to form a load-bearing shell around the building.

12. The method of claim 10 wherein said cementitious coating comprises

water, sand, lime, marble particles, Portland cement, fibers, and an adhesive additive.

13. The method of claim 10 wherein said supports comprise steel tubing.

14. The method of claim 10 wherein said supports supporting the walls are columns connected to said concrete foundation by a "C" channel track running along the top of the foundation.

15. The method of claim 10 comprising a multi-storied structure.

16. The method of claim 10 wherein said walls and said foundation are connected by a "C" channel track which is connected to the foundation where the walls will be and which is bolted to angle brackets which are welded to a plurality of steel tubing columns supporting the walls.

17. The method of claim 10 wherein said walls comprise a plurality of foam panels, each of said panels comprising a notch in each of the side walls of the panel adapted to accommodate a steel tubing support or column.

18. The method of claim 10 wherein said walls comprise a plurality of foam panels, each of said panels comprising grooves in its bottom adapted to receive two side walls of a "C" channel track connected to said foundation.

19. The method of claim 10 wherein said walls comprise a plurality of foam panels, each of said panels comprising grooves in its top adapted to receive two side walls of a "C" channel track which is adapted to connect to said roof.

20. The method of claim 11 wherein the wall panels comprise grooves in their tops adapted to receive two side walls of a "C" channel track which is adapted to connect to said roof.

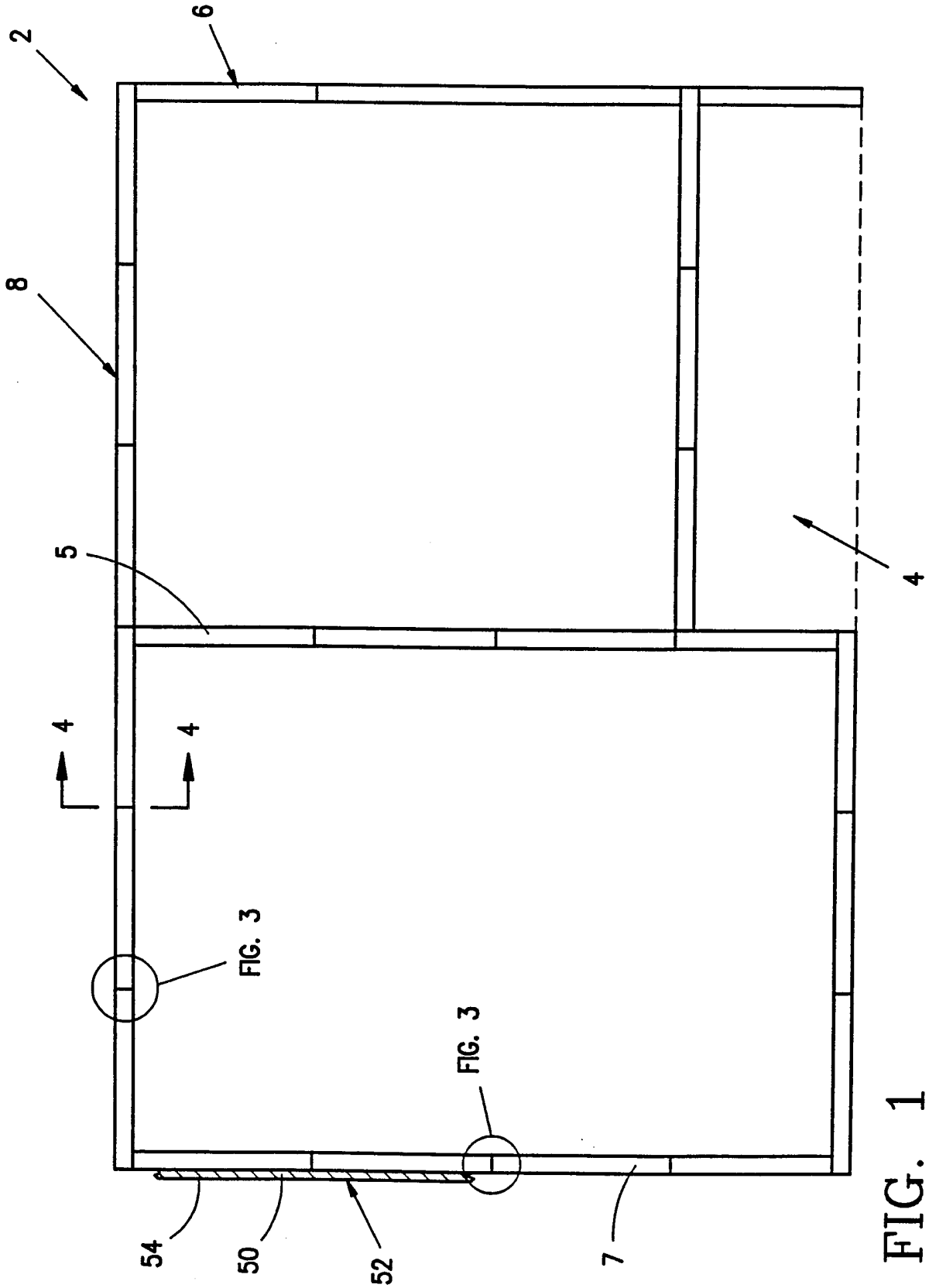


FIG. 1

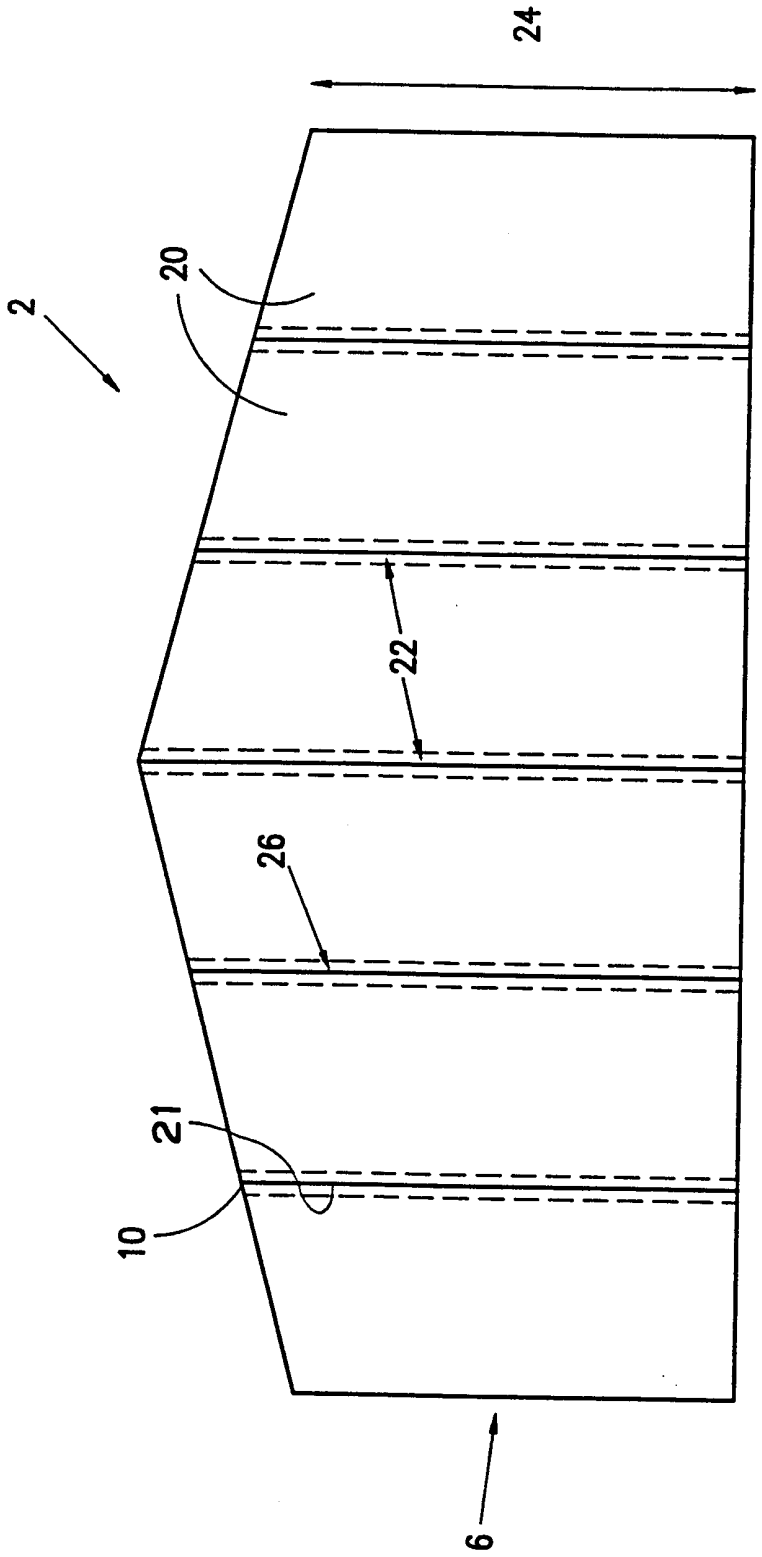


FIG. 2

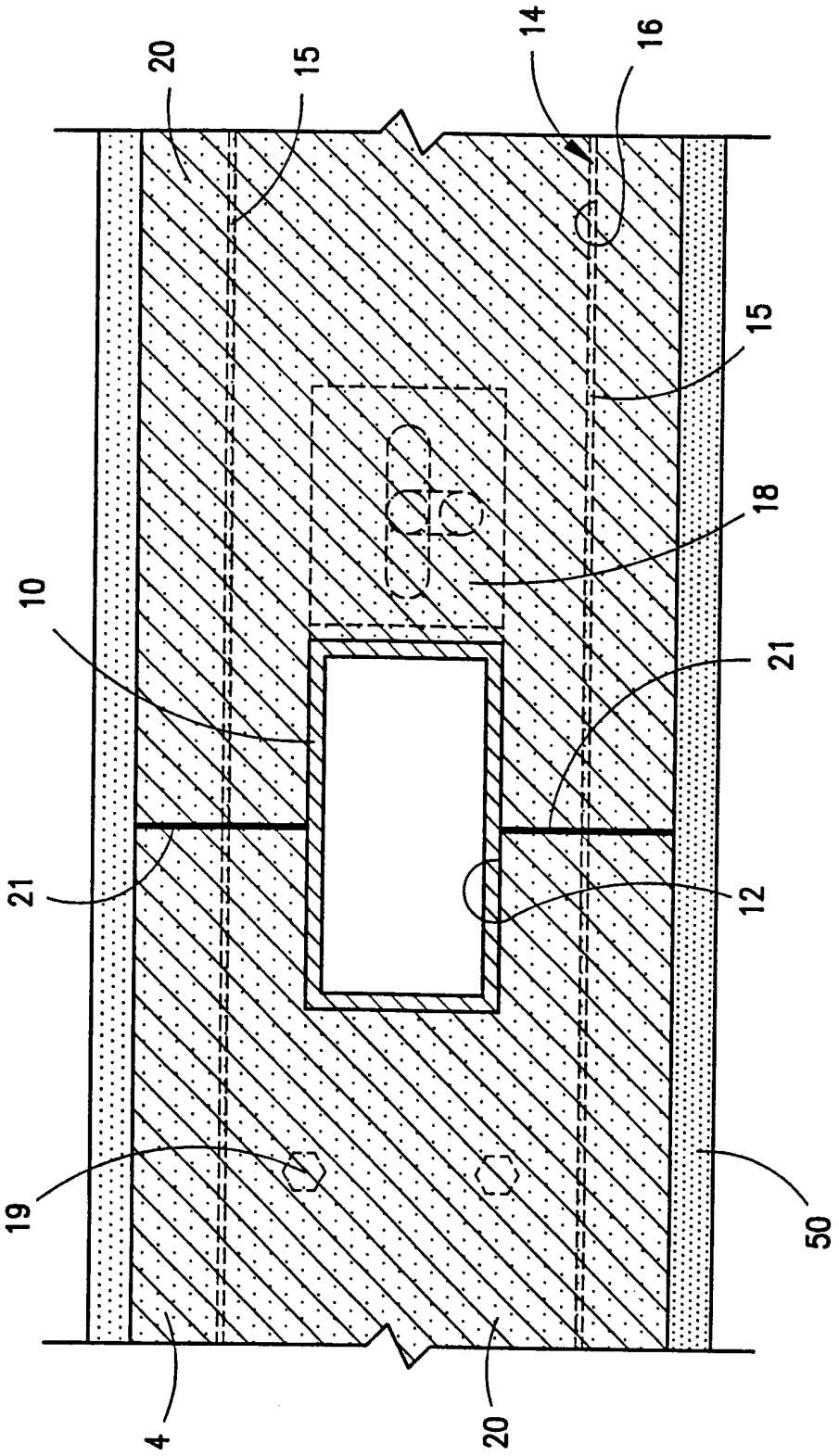


FIG. 3

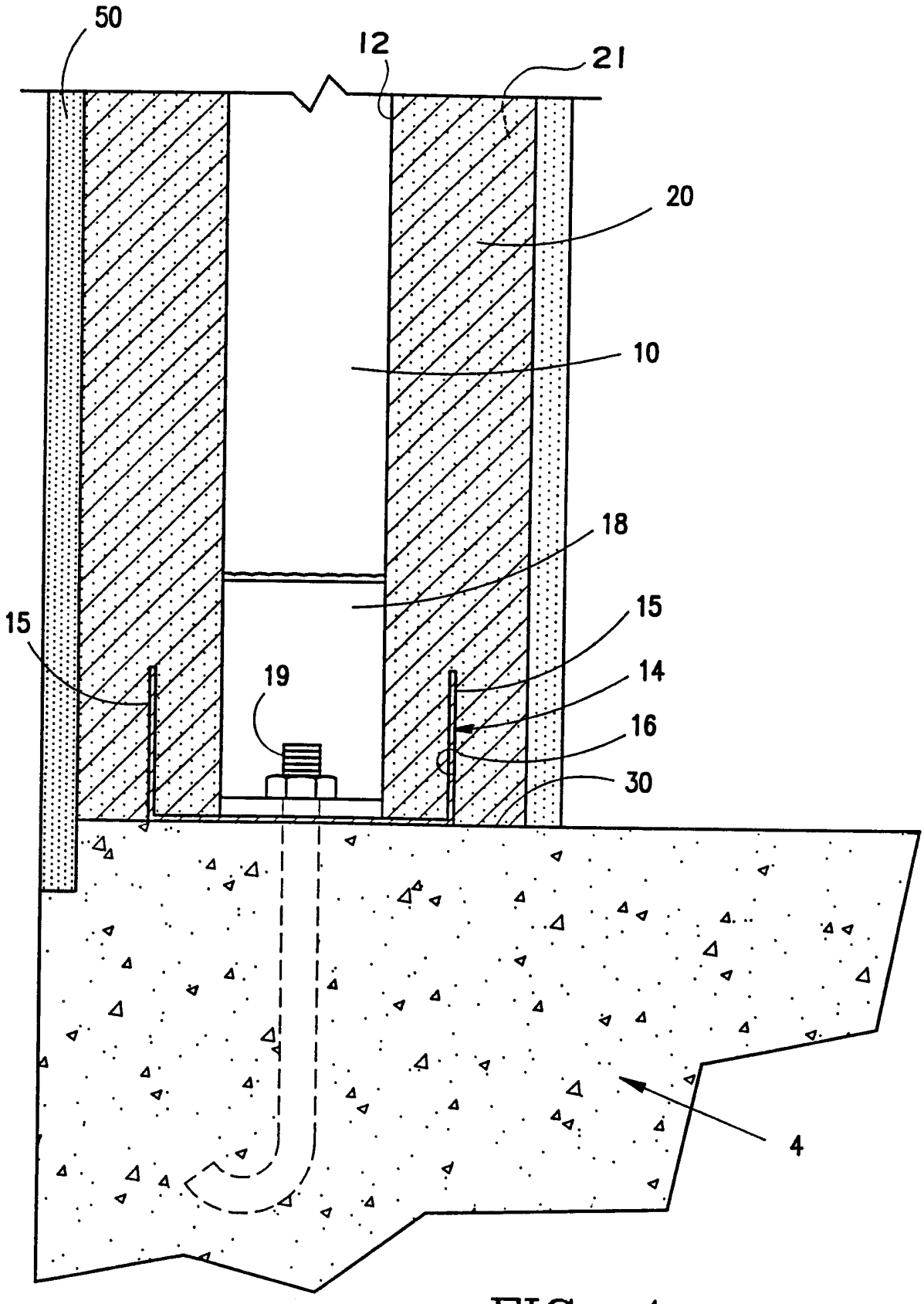


FIG. 4

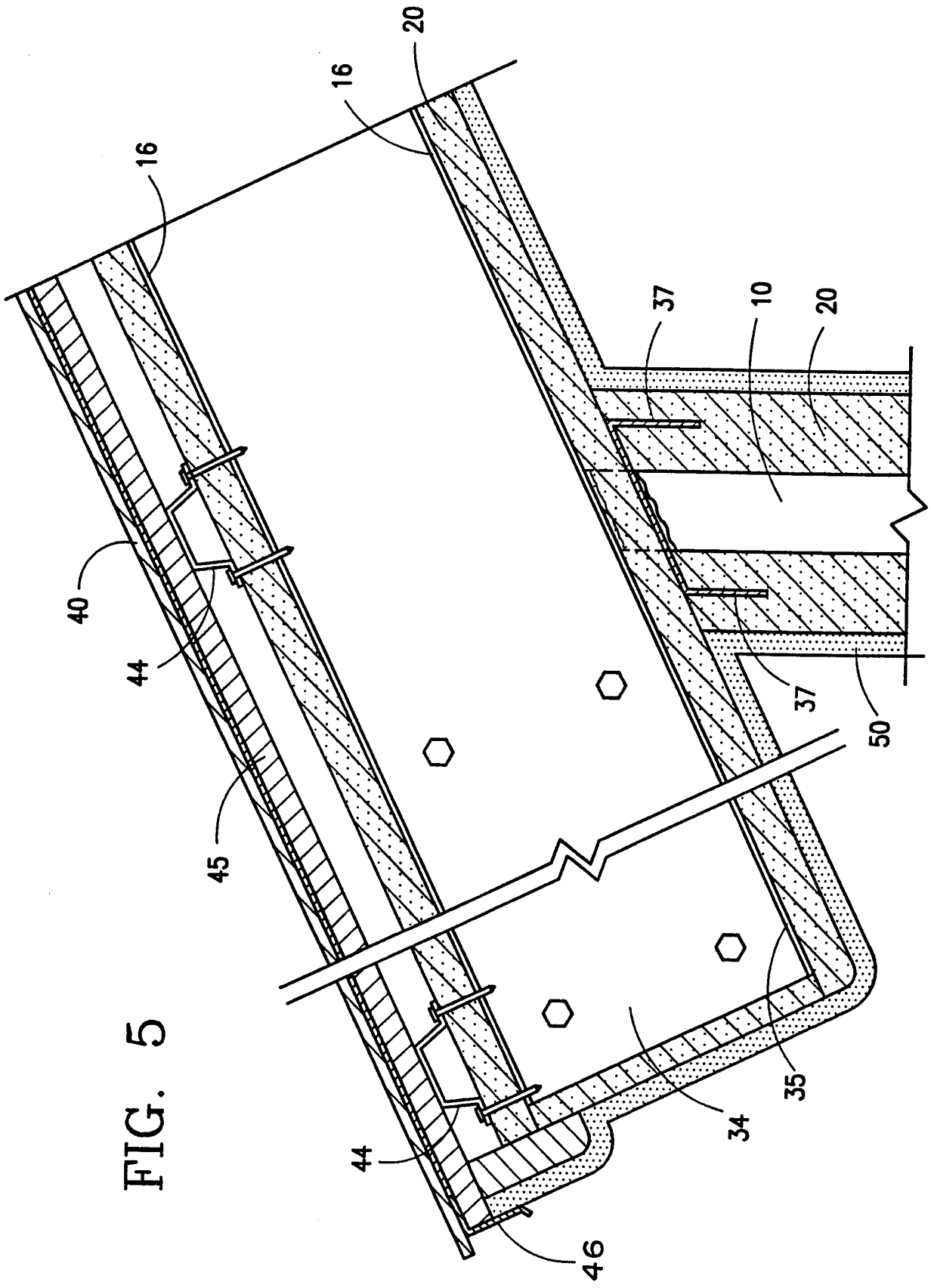


FIG. 5

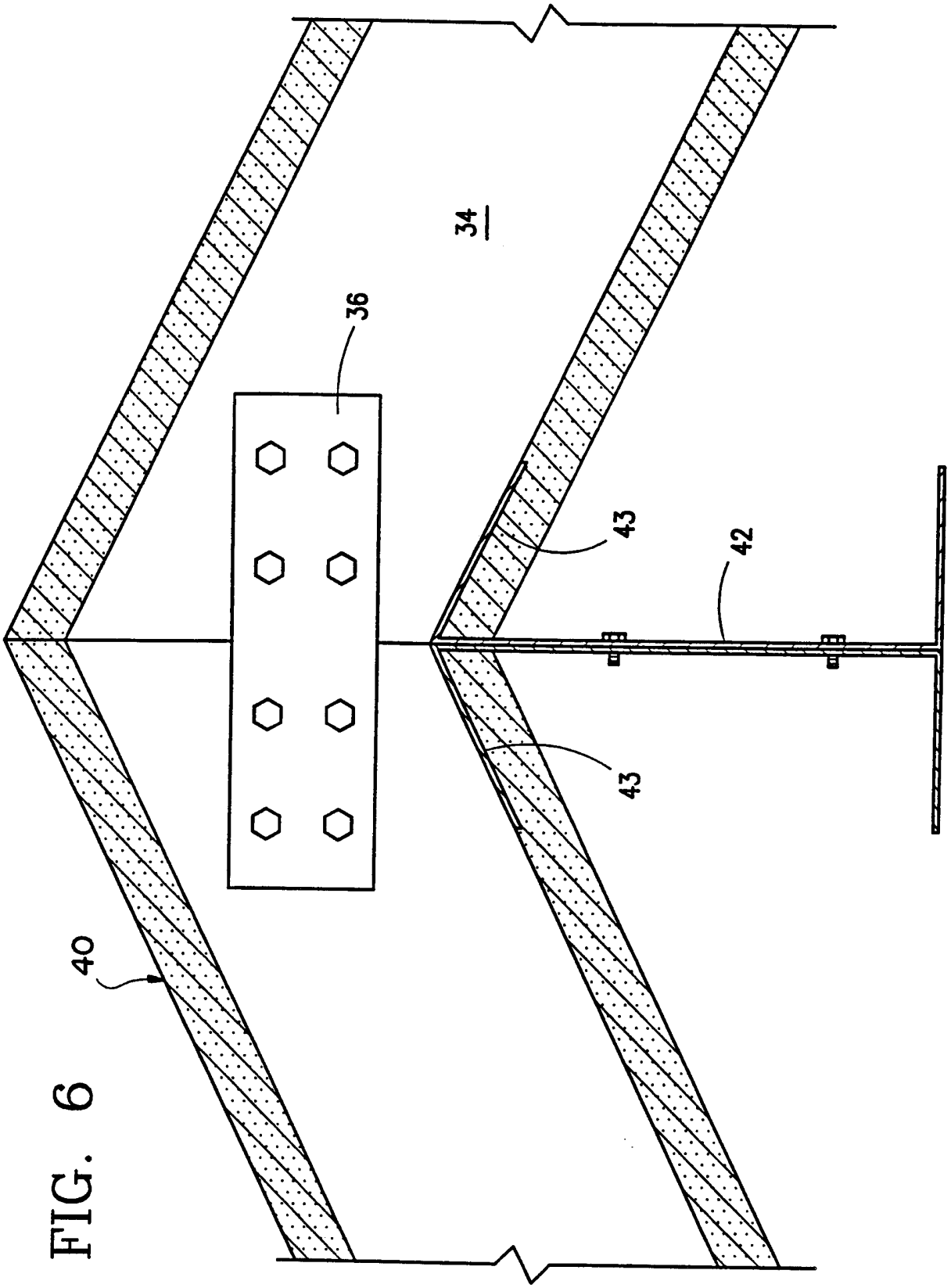


FIG. 6

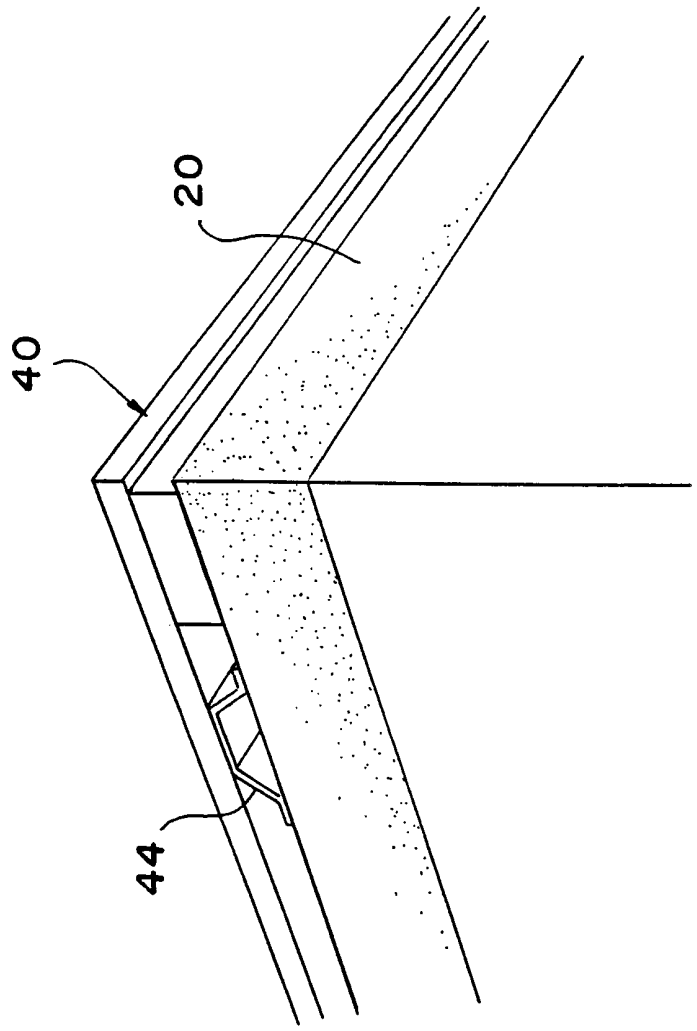


FIG. 7

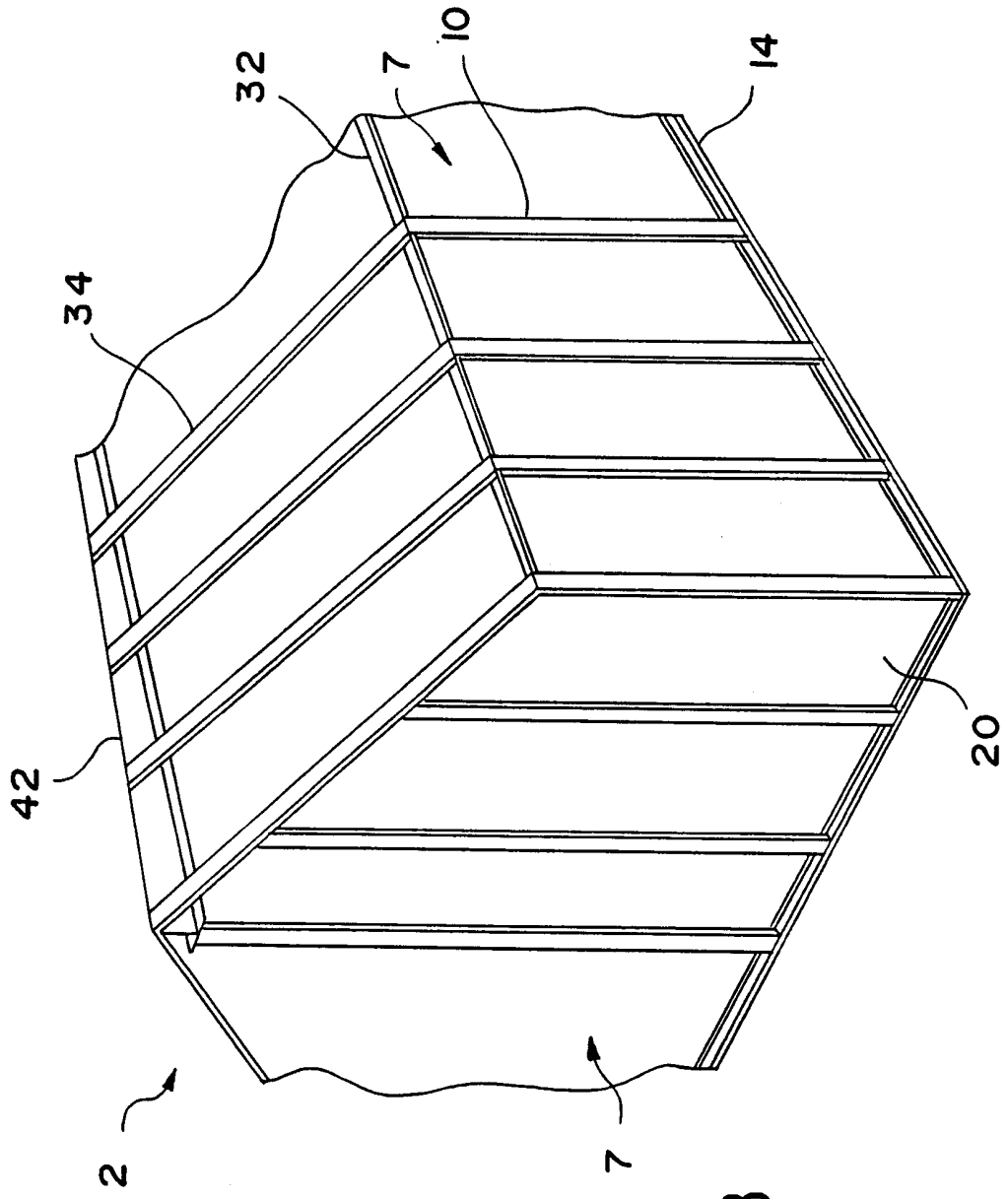


FIG. 8

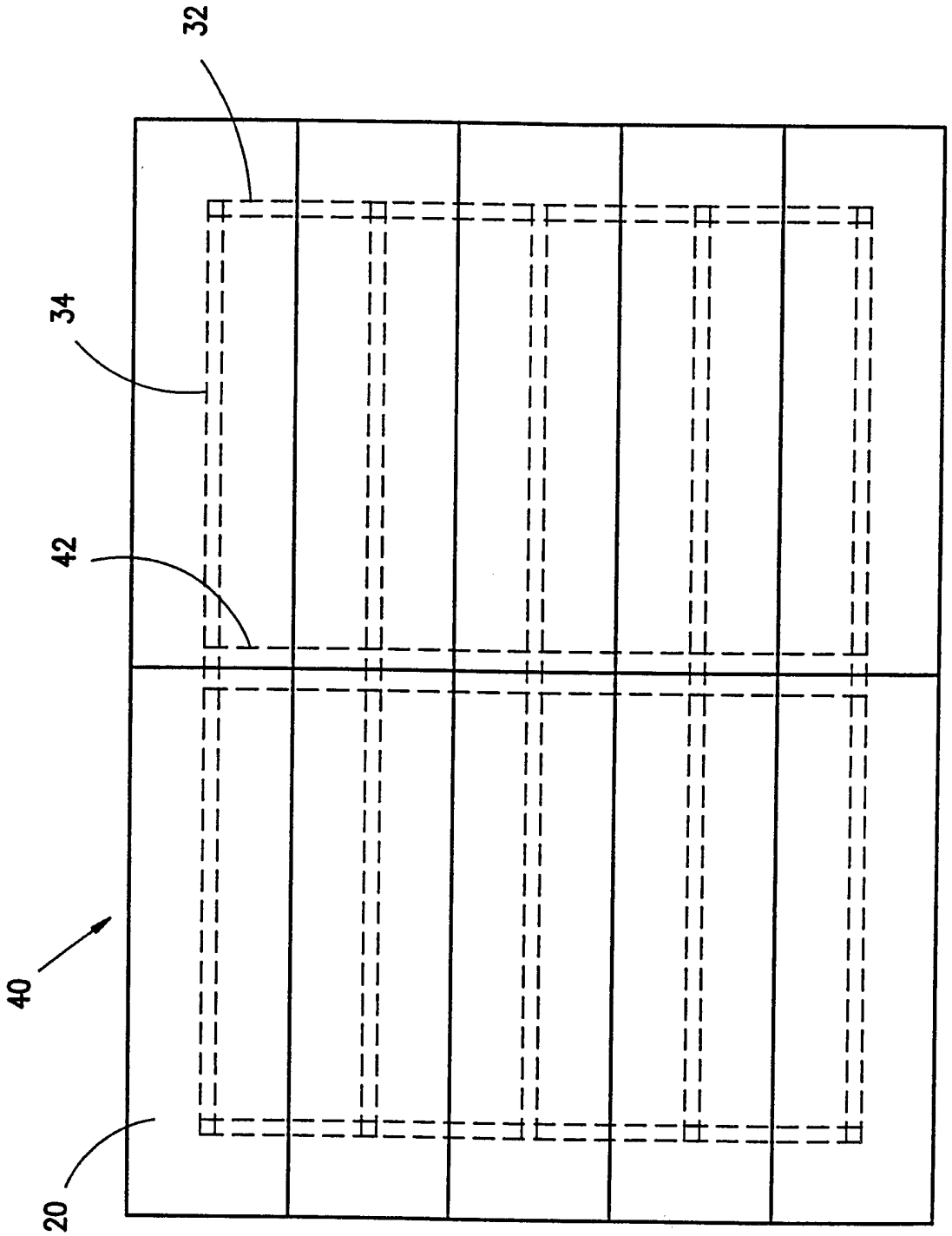


FIG. 9

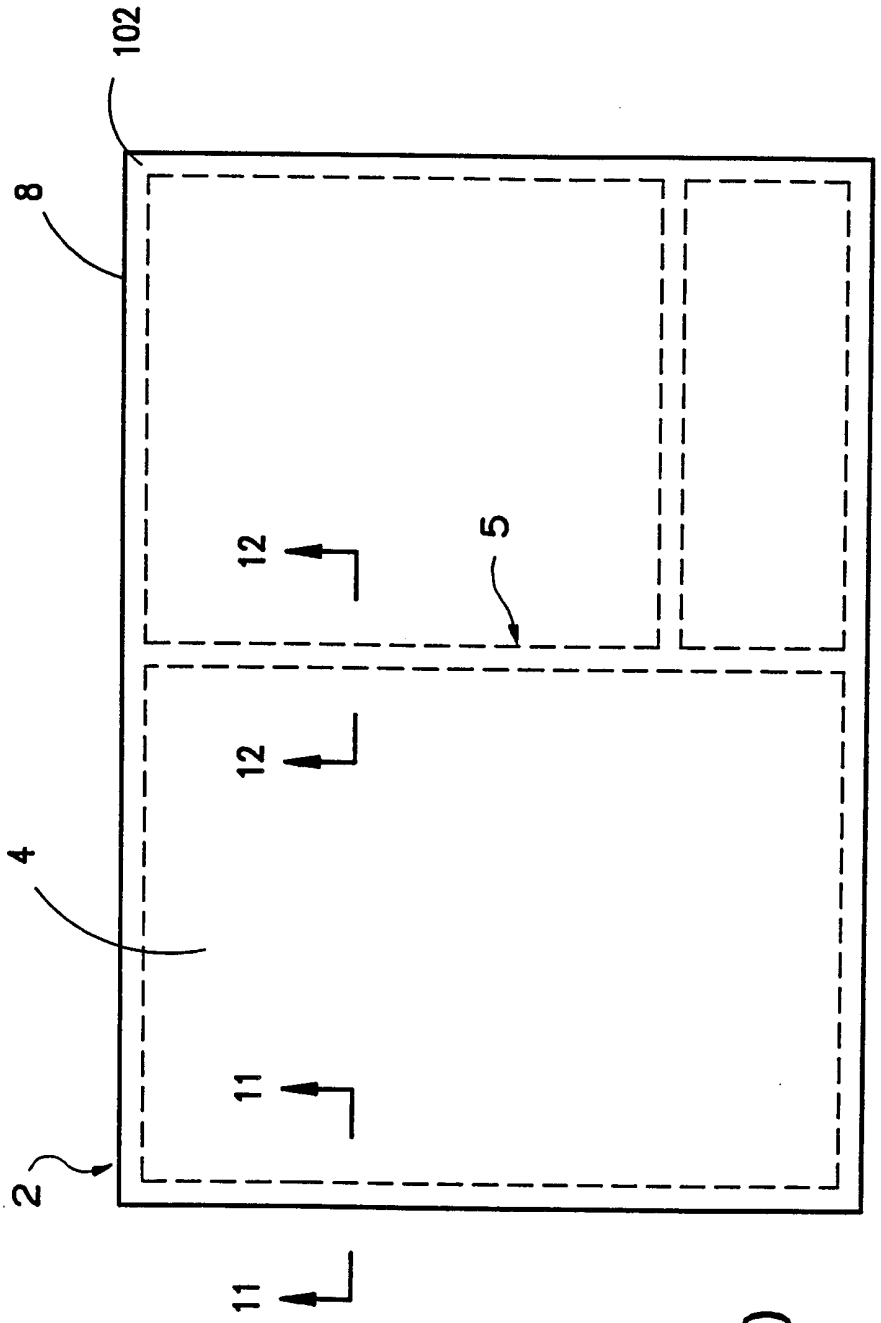


FIG. 10

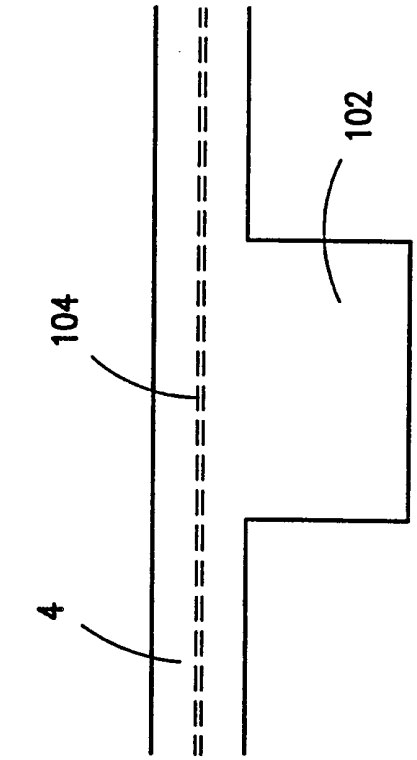


FIG. 12

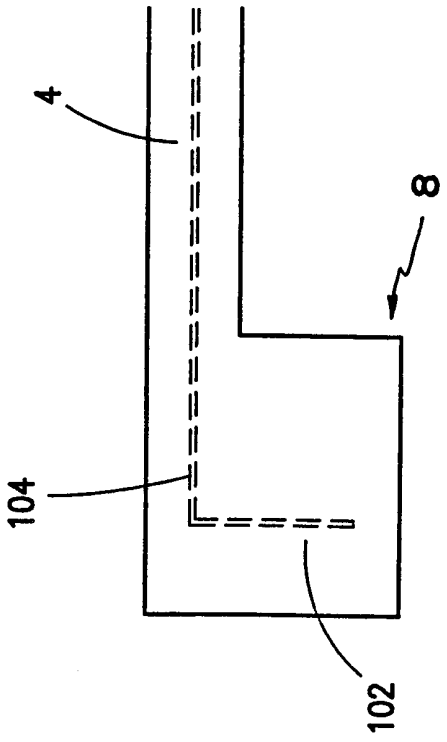


FIG. 11