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(54) **LIGHTWEIGHT CONCRETE WALL PANEL WITH METALLIC STUDS**

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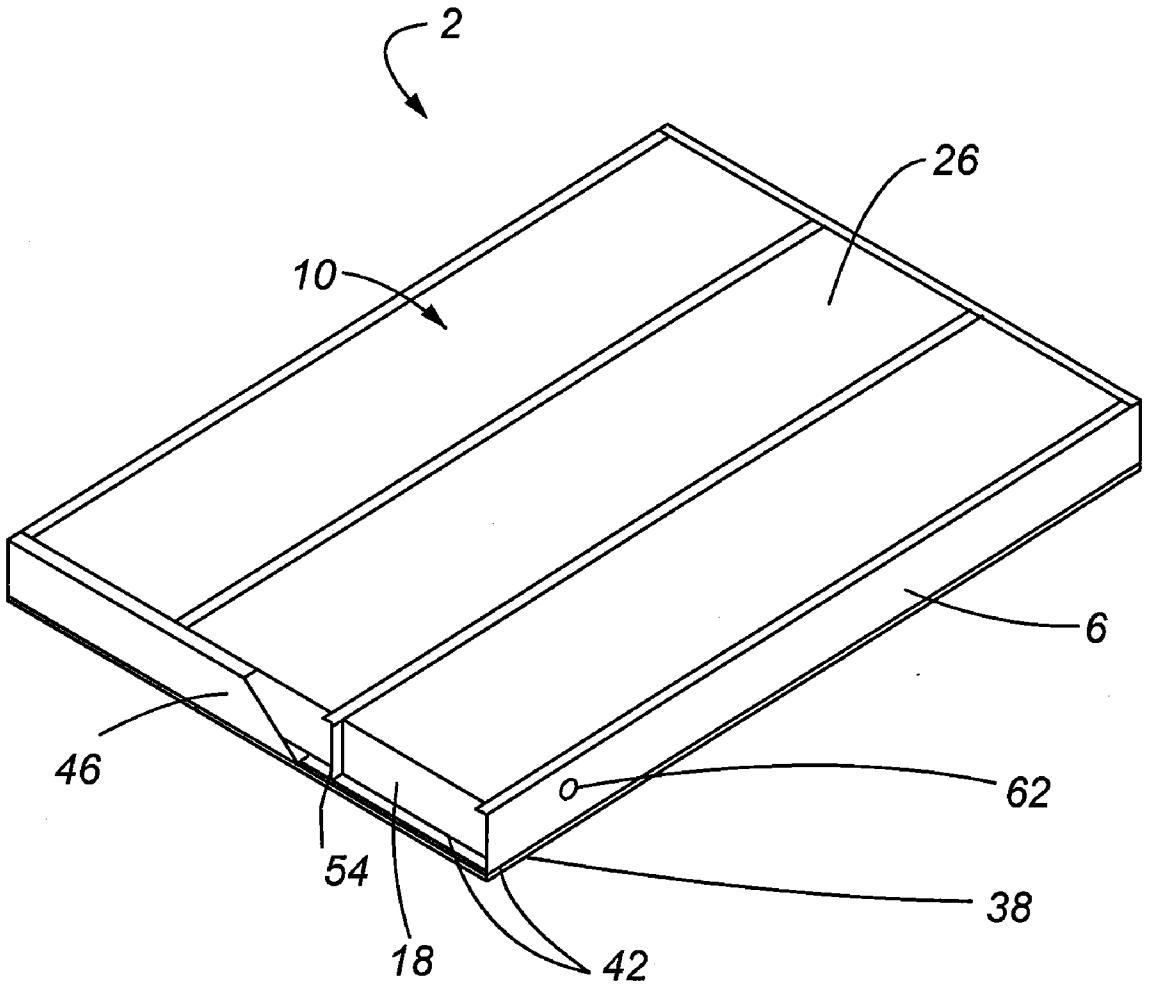
(57) **ABSTRACT**

A wall panel is provided that is comprised of a plurality of spaced foam insulative blocks. Between each block is a metal stud that spans the height of the wall panel and provides sufficient strength to counteract any compressive loads the wall panel may encounter. The presence of the insulation panels provides large surface areas for the receipt of a thin layer of cementious or gypsum based material that is adapted to receive nails and be easily cut. In addition, the decreased weight of the exterior wall allows for the omission of reinforcing internal structure within the exterior wall which is found in the prior art, thereby providing a lightweight and easy to fabricate wall.



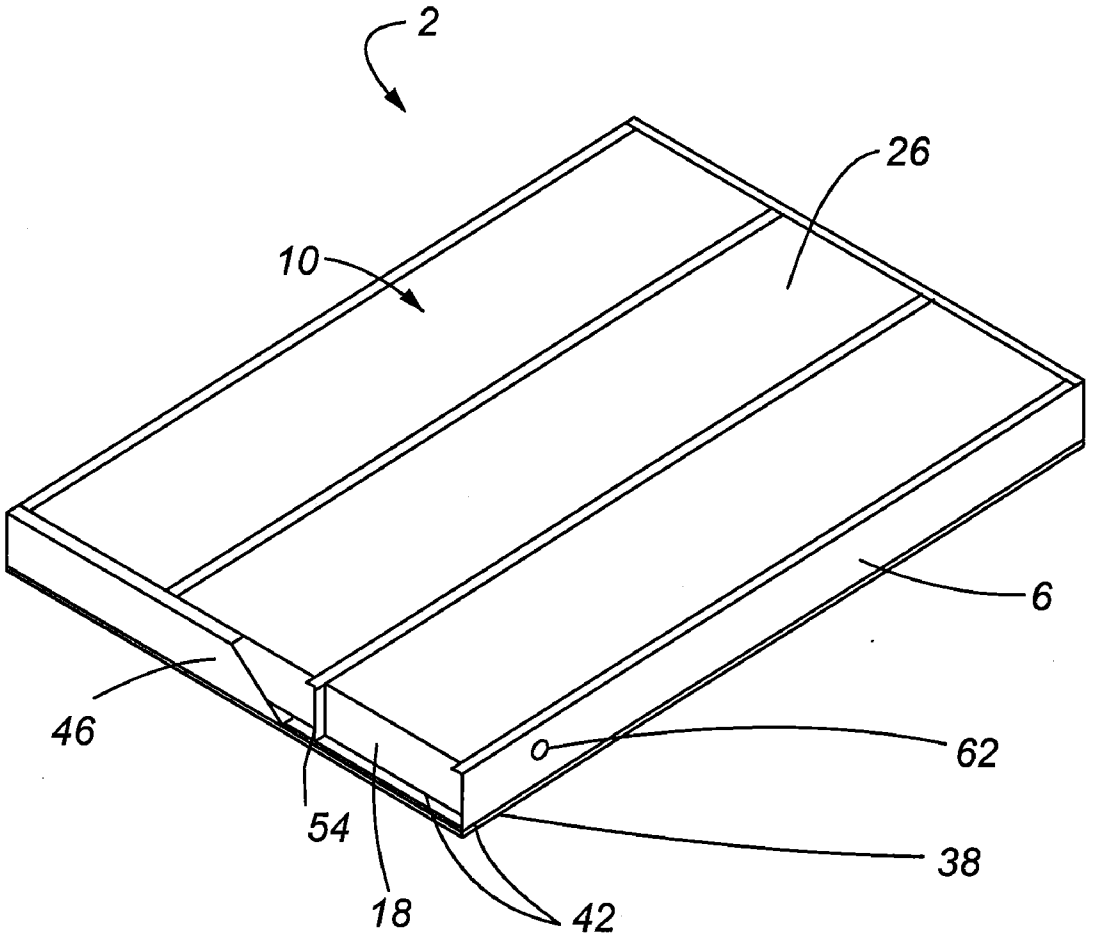


Fig. 1

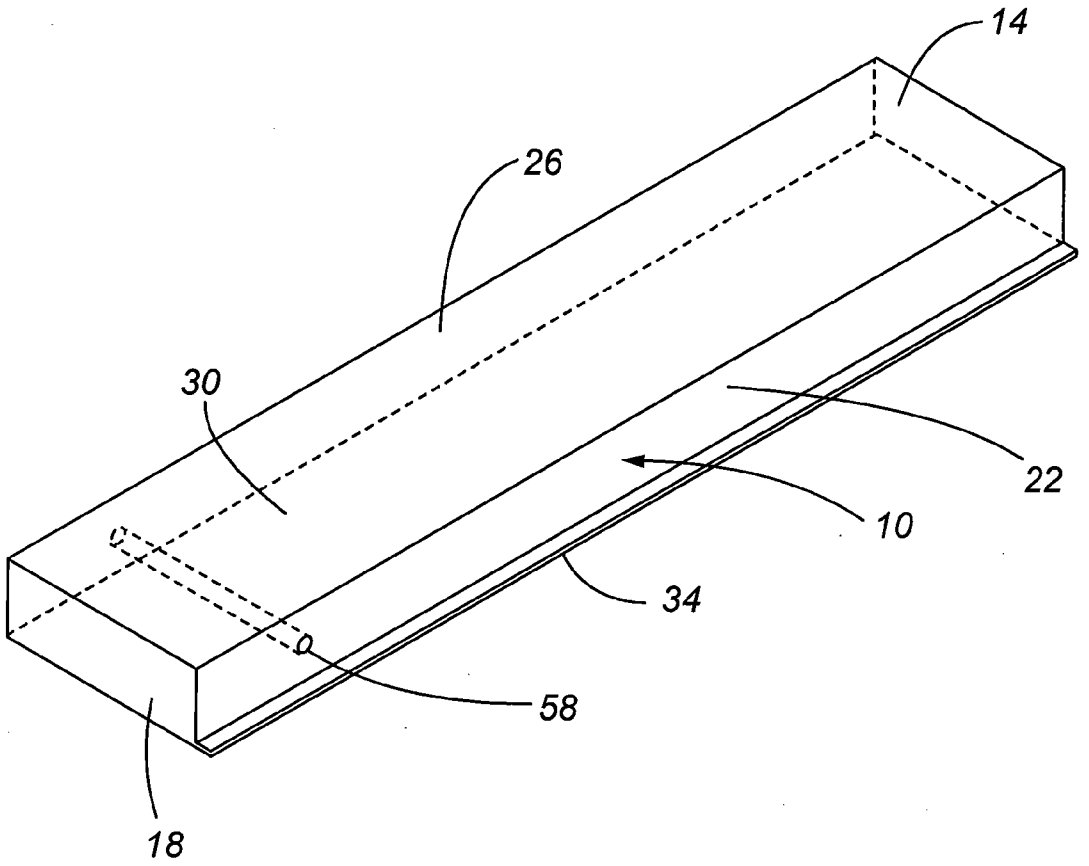


Fig. 2

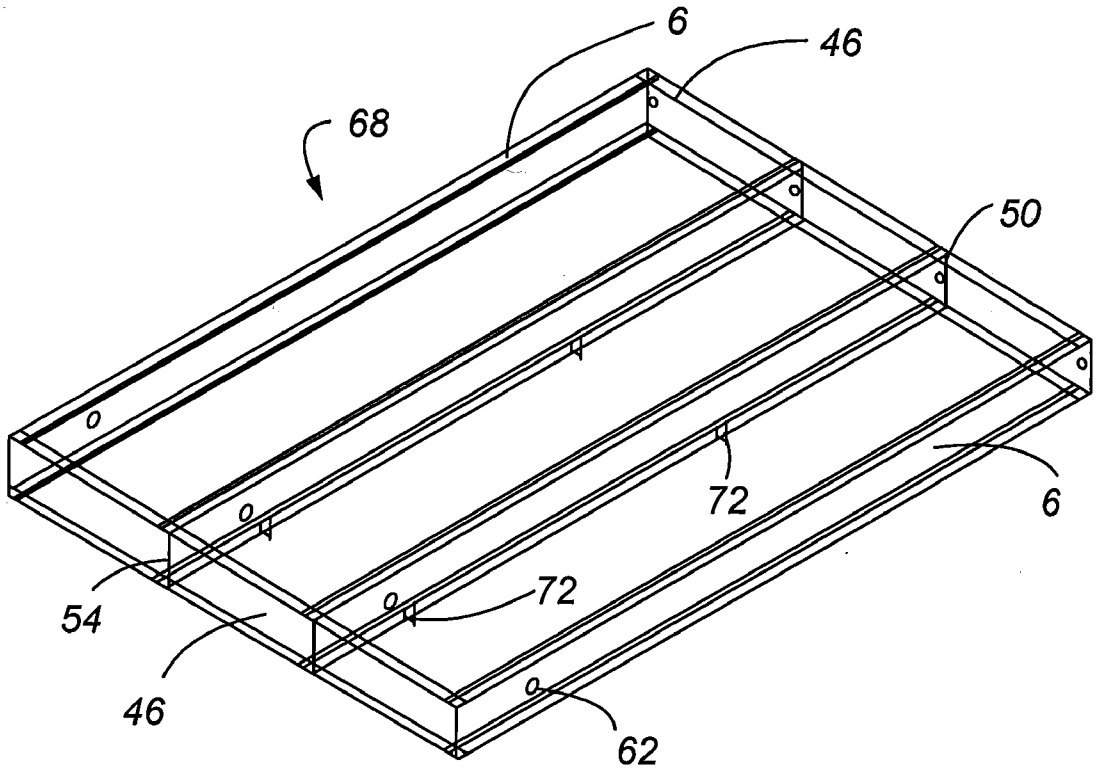


Fig. 3

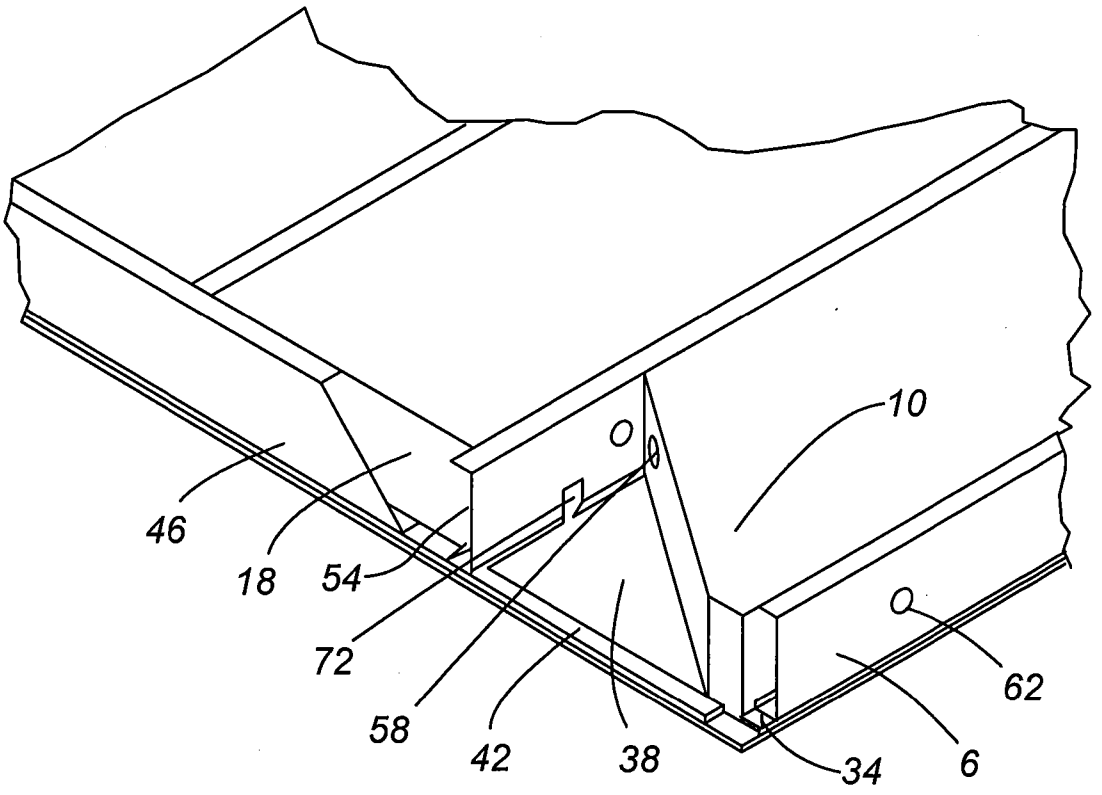


Fig. 4

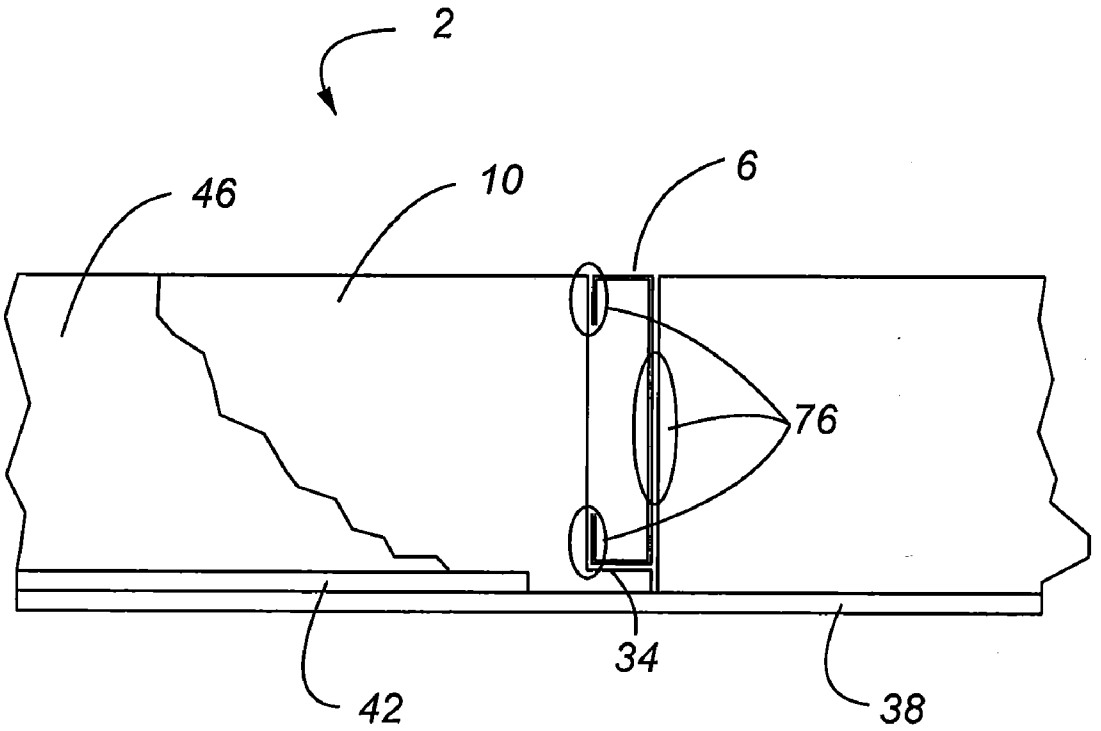


Fig. 5

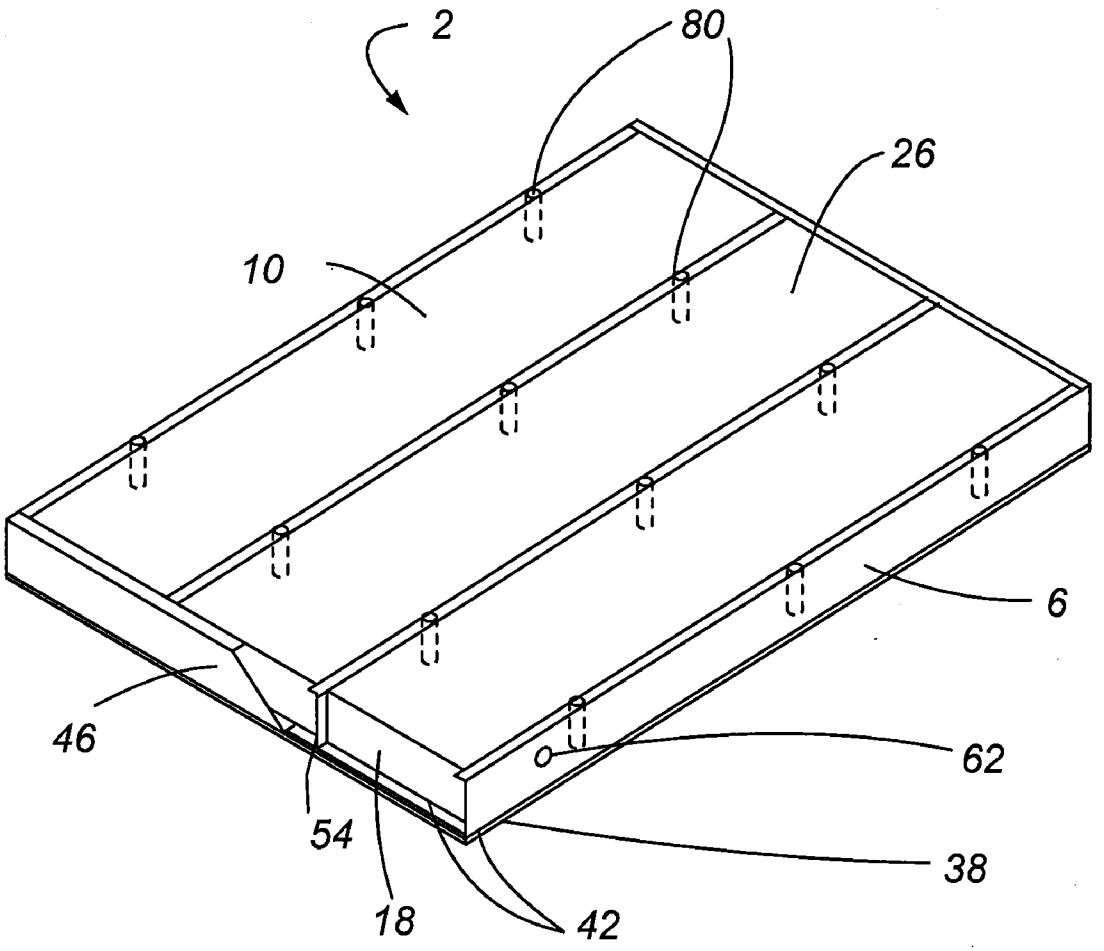


Fig. 6

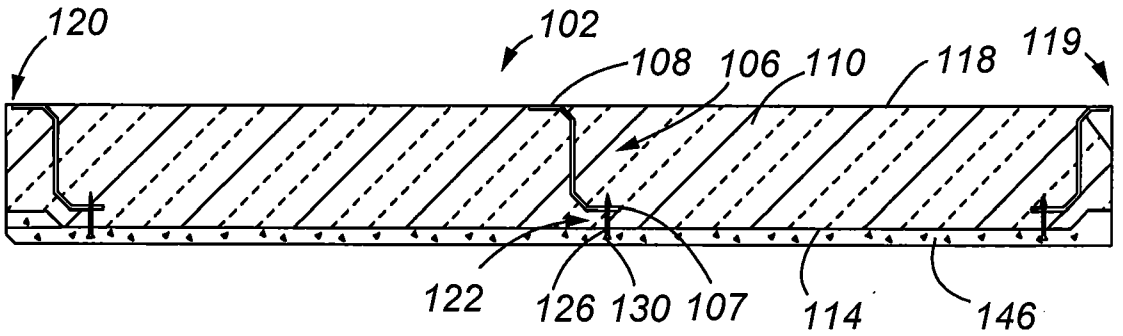


Fig. 7

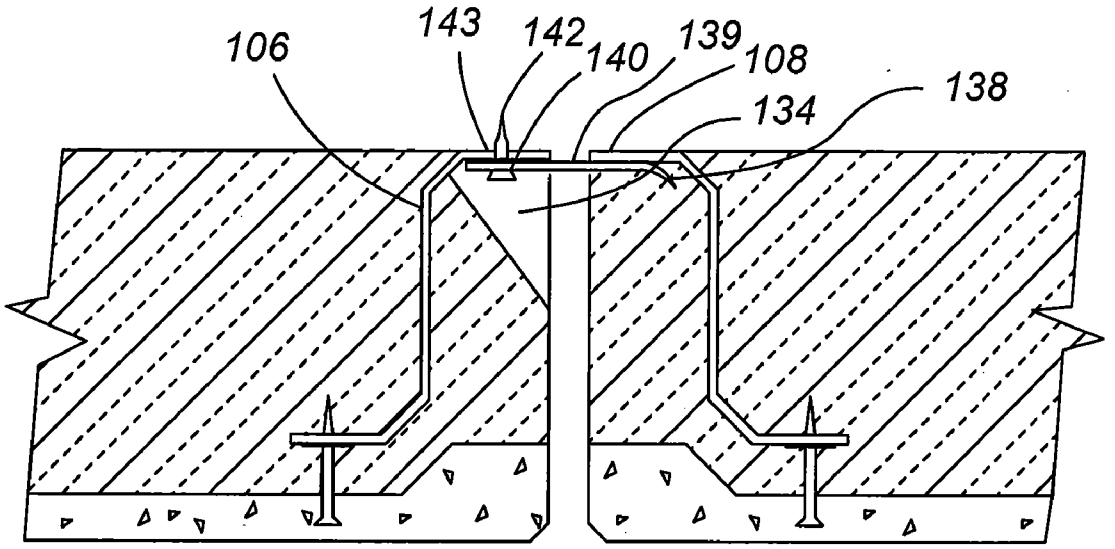


Fig. 8

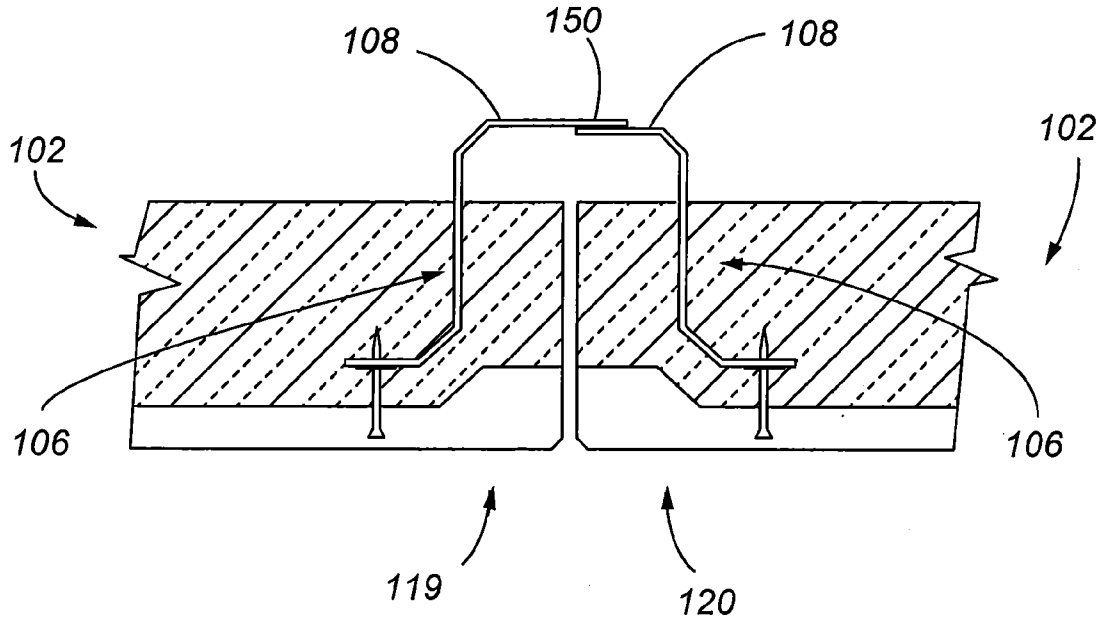


Fig. 8A

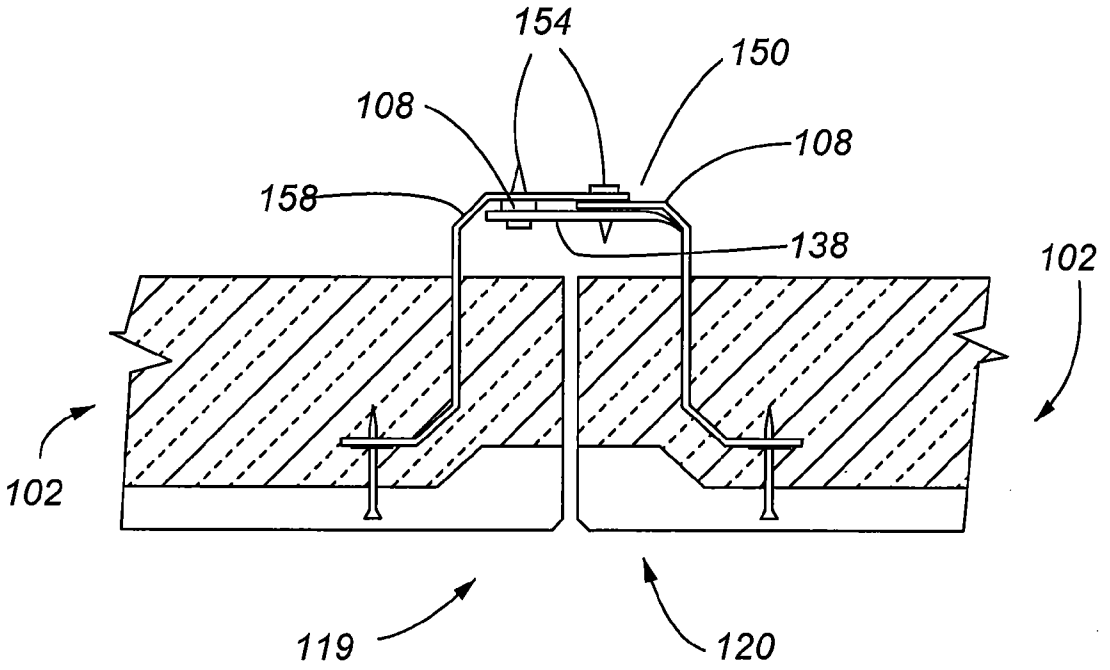


Fig. 8B

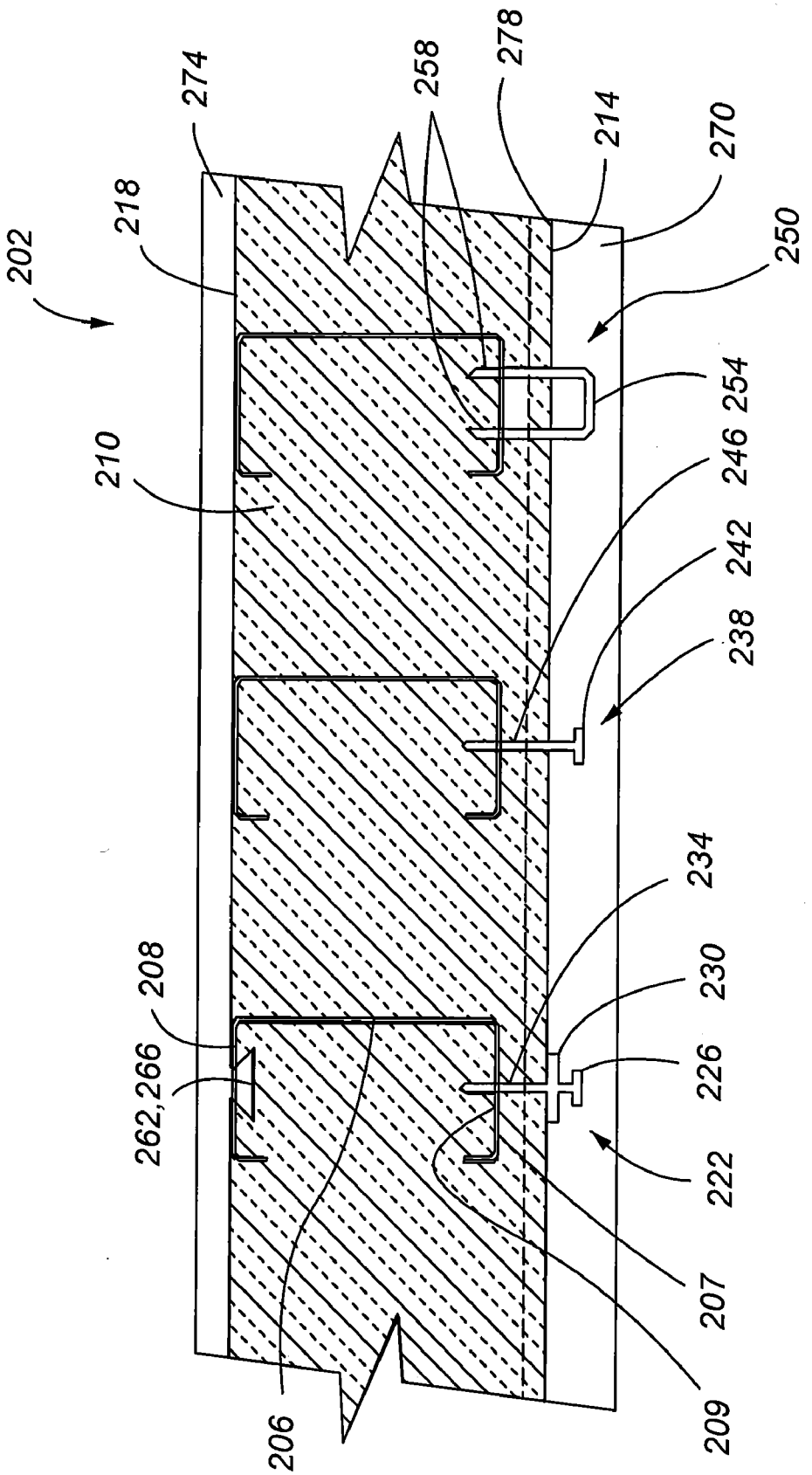

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Fig. 9

LIGHTWEIGHT CONCRETE WALL PANEL WITH METALLIC STUDS

[0001] This application claims benefit of U.S. Provisional Application Ser. No. 60/806,598, filed Jul. 5, 2006, the entire disclosure of which is hereby incorporated by reference.

[0002] This application is also related to pending U.S. patent application Ser. No. 11/122,792, filed May 4, 2005, which is a continuation-in-part of pending U.S. patent application Ser. No. 11/096,705, filed Apr. 1, 2005, which is a continuation-in-part of pending U.S. patent application Ser. No. 10/772,148, filed Feb. 3, 2004, now U.S. Pat. No. 7,100,336, which is a continuation-in-part of pending U.S. patent application Ser. No. 10/423,286, filed Apr. 24, 2003, now U.S. Pat. No. 6,898,908, which is a continuation-in-part of U.S. patent application Ser. No. 10/150,465, now U.S. Pat. No. 6,729,090, filed May 17, 2002, which is a continuation-in-part of U.S. patent application Ser. No. 10/093,292, now U.S. Pat. No. 6,701,683, filed Mar. 6, 2002. In addition, this application is related to U.S. patent application Ser. No. 11/121,267, filed May 2, 2005, to U.S. Provisional Patent Application Ser. No. 60/697,169, filed Jul. 6, 2005, and to U.S. Provisional Patent Application Ser. No. 60/741,487, filed Dec. 2, 2005 and Provisional Patent Application Ser. No. 60/744,736, filed Apr. 12, 2006. This application incorporates all of the applications and issued patents listed above by reference in their entirety herein.

FIELD OF THE INVENTION

[0003] The present invention relates to building components, and more specifically low density concrete wall panels that are manufactured in a controlled environment and can be selectively interconnected on-site to fabricate modular buildings.

BACKGROUND OF THE INVENTION

[0004] Due to the high cost of traditional concrete components and the expensive transportation and labor costs associated therewith, there is a significant need in the construction industry to provide lightweight, precast, composite building panels that have superior strength and insulative properties. Previous attempts to provide these types of building panels have failed due to the expensive transportation costs and less than ideal insulative and thermal conductivity properties associated with prefabricated concrete wire- reinforced products. Further, due to the brittle nature of concrete, many of the previously used building panels are prone to cracks and other damage during transportation.

[0005] The relatively large weight per square foot of building panels of the prior art has resulted in increased expenses arising not only from the amount of materials needed for fabrication, but also the cost of transporting and erecting the modules. Building panel weight also places effective limits on the height of structures, such as stacked modules e.g., due to load limitations of the building foundations, footings and/or lowermost modules. Furthermore, there is substantial fabrication labor expense that can arise from design, material, and labor costs associated with providing and integrating reinforcement materials. Accordingly, it would be useful to provide a wall panel system for modular construction that is relatively light, can be readily stacked to increased heights and, preferably, inexpensive to design, manufacture, transport and erect.

[0006] In many situations, wall panels are situated in locations where it is desirable to have openings to accommodate cables, pipes and the like. In some previous approaches, wall panels were cast so as to include any necessary openings that require careful planning and design, thus increasing costs. In other approaches, wall panels were cast without such openings and the required openings were formed after casting, e.g. by sawing, drilling, or similar procedures. Such post-casting procedures, for example cutting through thick and/or steel-reinforced panels are labor-intensive and expensive. Further, in many processes for creating openings, there is a relatively high potential for cracking or splitting of the wall panel. Accordingly, it would be useful to provide wall panels wherein passageways for fluid, air, and/or electrical conduits may be cost effectively integrated in desired locations with a reduced potential for cracking or splitting.

[0007] Many types of tilt-up pre-fabricated wall panels have been employed in the past. More specifically, wall panels of the prior art are generally lightweight, durable, and can be manufactured with readily available material. However, the wall panels of the prior art usually employ a thickened exterior wall of concrete that is internally supported by a framework of metal, i.e. "re-bar". The thickness of the exterior wall and the presence of metallic reinforcement makes the wall panel difficult to modify during construction. It should be noted that previous attempts to fabricate thin shell wall panels have resulted in walls with reduced load carrying capacity, but for most low level residential structures the load carrying capability of thin shelled wall panels may be adequate.

[0008] Additionally, the exterior walls of buildings often include various types of siding that can be mounted directly to the building structure (i.e. framing). The siding protects the buildings from rain, wind, snow, etc. which in turn can cause damage to the framing and other elements of the building. For instance, a building may include wood siding, plastic siding, metal siding, or composite siding, etc. However, the siding, while meant to protect the interior of the building from the elements, is often itself susceptible to deterioration from the elements. For instance, a common type of siding is corrugated metal siding because of the wide array of design options it provides. This corrugated metal siding, however, is susceptible to rusting which can present an unsightly appearance along with allowing moisture and wind to penetrate into the interior of the building. While using galvanized steel or other rust resistance metals can help prevent rust from forming, these are often not perfect solutions. Additionally, in the case of corrugated metal siding mounted to the building structure, the insulation located between the metal siding and the building structure is often compressed therebetween, thereby reducing the R-value of the insulation. Accordingly, it would be useful to provide an aesthetically pleasing lightweight facade that can be mounted to the siding of a building and which is capable of preventing moisture and other natural elements from penetrating the interior building structures. Further, it would be useful to provide a lightweight facade that maintains or enhances the insulative properties of the wall.

[0009] Accordingly, there is a significant need in the construction and building industry to provide a selectively alterable composite building wall panels that may be used in modular construction that are lightweight, that provide supe-

rior strength and that have high insulative values. Further, a method of making these types of building panels is needed that is inexpensive, utilizes commonly known manufacturing equipment, and which can be used to mass produce building panels for use in the modular construction of warehouses, low cost permanent housing, hotels, and other buildings.

SUMMARY OF THE INVENTION

[0010] It is one aspect of the present invention to provide a lightweight wall panel. More specifically, embodiments of the present invention are comprised of a plurality of lightweight foam insulative blocks separated by metal studs. The metal studs provide sufficient compressive strength to the wall panel. In addition, a layer of lightweight concrete is employed on one side of the insulative foam blocks to provide a surface that is resistant to heat, cold, wind, water and other natural conditions. The wall panel as provided herein is contemplated to become an exterior of a building. However, one skilled in the art will appreciate that the wall panel as disclosed herein is ideal for interior walls of a building. The insulative foam blocks provide thermal isolation between the metal components of the wall and the concrete components of the wall. In addition, the insulation provides an excellent barrier from the outside elements. Further, the insulation panels in accordance with embodiments of the present invention provide added structural support for the thin layer of concrete, which allows for the omission of reinforcing bar structures that are generally embedded in the concrete wall panels of the prior art. More specifically, in the past, thicker external walls were required to provide sufficient structural support. Since wall panels as described herein employ insulation panels that carry some of the load, a reinforcing bar substructure is not required. That is, by utilizing foam blocks positioned between the metallic studs, a great degree of surface area is provided for which a thin concrete layer can bond, thereby allowing the omission of the reinforcing bar structure generally embedded in the wall structure and which allows for thinner, lighter wall section.

[0011] As briefly mentioned above, the exterior wall of embodiments of the present invention is made of high performance or lightweight concrete. For example, the concrete may be comprised partially of sand expanded perlite or the like for aggregate with polyvinyl acelate (PVA) fiber embedded therein. Concrete of this type allows for the incorporation of fasteners, such as nails and screws and allows the wall panel to be cut like wood, which translates to flexibility in the construction of residential buildings. It is also another aspect of the present invention that the concrete layer be easily modified to accept any number of interior and exterior textures, surfaces or cladding materials. More specifically, the present invention is capable of being finished with stucco, siding, brick, drywall or other type of interior or exterior surface finish. More importantly, exterior claddings of bricks or stones for example, may be employed into the casting when the wall panel is being fabricated thereby yielding a finished exterior facade. Additionally, the exterior layer may comprise SHEETCRETE™ by Oldcastle Precast, Inc." or glasscrete as an alternative material to concrete.

[0012] It is another aspect of the present invention to provide wall panels that can be employed to quickly and efficiently construct modular buildings and temporary shelters and is designed to be completely functional with regard to electrical wiring or other utilities such as telephone lines, etc. Thus embodiments of the present invention include at least one utility conduit that is positioned at least partially within the wall panel for the receipt of substantially any type of utility line which may be required in residential or commercial construction. Utility conduits integrated into the wall panels may be oriented in one or more directions are generally positioned in the insulation panels near the interior surface of the wall panel.

[0013] It is yet another aspect of the present invention to provide a finished interior wall. As will be appreciated by one skilled in the art, portions of the metallic studs that are situated away from the concrete exterior wall may be used to accept dry wall, or wood strips that are used to interconnect dry wall or other types of interior surface material. Additionally, a layer of dens armor, traditional gypsum, drywall, or other building material may be placed in the fixture during fabrication to yield a wall panel with a completed interior wall. Preferably, a layer of "sheet crete" or other gypsum or cementious material as disclosed in U.S. provisional patent application 60/741,487, entitled "Lightweight Structural Concrete With Properties Similar to Wood" may be employed to form the interior faces of the wall panel. Therefore, since the exterior of the wall panel is substantially comprised of concrete based materials or metallic materials, the finished product is fire resistant, substantially maintenance free, mold resistant, insect proof, wind resistant and projectile resistant. To increase the fire and smoke resistance of the panel a fire and smoke resistant surface may be affixed to the interior and exterior walls or the insulative foam itself. In addition, the use of insulation provides a wall panel that is insulated, and one embodiment having an enhanced resistance to heat flow (R-value). Further, with proper treatment of the concrete, the wall panel is substantially water resistant.

[0014] Further, it is another aspect of the present invention that the wall panel will have sufficient rigidity and structural strength to allow for the interconnection of hardware such as screws, bolts, etc. Without requiring the location of a stud. Thus cabinets, pictures and other interior items may be hung directly from hardware penetrating the wall panel.

[0015] It is still yet another aspect of the present invention to provide a wall panel that has a substantially joint free internal surface. As briefly alluded to above, embodiments of the present invention utilize a concrete like internal surface thereby yielding an internal wall having substantially no joints. Thus the wall panel is provided that does not require further post direction finishing to prepare drywall, for example. Further, previous wall panels similar to those described herein may have included wood strips or other surfaces for drywall nails, a feature no longer required. However, one skilled in the art will appreciate that wood or other materials may be integrated in the wall to provide an interface for wood framing if so desired.

[0016] It is another aspect of the present invention to provide a wall panel that is easy to construct. More specifically, wall panels of the prior art generally require the use of clips that are permanently attached to the metal studs that interface with the layer of concrete. Since the concrete layer of embodiments of the present invention is substantially thinner than those previously used, fewer clips are required because the majority of structural support of the concrete wall panel is provided by the insulation foam blocks. Thus embodiments of the present invention utilize a plurality of clips interconnected to the metal studs along the height thereof. During fabrication, the clips are inserted into the still wet concrete wherein curing of the concrete permanently affixes the exte-

rior wall onto the metal studs. Nylon cladding is used on the clips in one embodiment to minimize the heat transfer between the concrete wall and the metal stud. Since the clips are a secondary attachment mechanism, fewer clips are needed to interconnect the exterior wall to the metal studs. This unique modification reduces the number of thermal transmission points between the concrete and metal frame, thus improving the thermal efficiency of the wall panel.

[0017] In order to ensure that the concrete wall is affixed firmly to the metallic studs, a bonding material may additionally be used. The bonding of the insulation panels to the exterior wall also provides additional structural support of the exterior wall. Some embodiments of the present invention thus employ a primer coat onto the exterior wall after it is initially placed. This primer coat may be PVA or acrylic resin. Preferably, the bonding coat is cementious that includes portland cement, flyash and super plasticizer. Alternatively, and emulsion polymer or a moisture cured urethane may be used to ensure fast and easy application. Generally, these materials are applied to the exterior wall by a roller or a spray. Bonding may be used on all surfaces of the metal stud as well to ensure that the sides of the insulation panel are affixed securely thereto. Finally, the clips may be coated with some sort of bonding material to enhance their interconnection with the exterior wall.

[0018] According to yet another aspect of the present invention, a lightweight wall panel is provided that provides a building facade for the exterior of a building. More specifically, wall panels of some embodiments of the present invention include a lightweight foam insulative block with embedded studs. The studs provide compressive strength to the wall panel. In one variation, the studs comprise metal studs. However, ordinary artisans will realize that other materials, such as composite materials or plastic for instance, can be utilized to construct the studs. In addition, a layer of lightweight concrete (see discussion of concrete supra) is employed on one side of the insulative foam block to provide a surface that is resistant to heat, cold, wind, water and other natural conditions. Further, multiple wall panels can be connected together in an end-to-end relationship to provide a facade of a desired width for a building. More specifically, one end of a wall panel may be provided with a cutout allowing a portion of a stud to protrude therefrom. Additionally, one end of an adjacent wall panel may be provided with a bracket protruding therefrom. Thereafter, the bracket may be connected to protruding portion of the stud so as to mount the wall panels together in an end-to-end relationship. Ordinary artisans will realize that the bracket can be connected to the protruding portion of the stud in multiple ways, including, but not limited to, welding, riveting, a threaded connection, etc. While the wall panel as provided herein is contemplated to become an exterior of a building, one skilled in the art will appreciate that the wall panel as disclosed herein is ideal for interior walls of a building.

[0019] According to yet another aspect of the present invention, a lightweight wall panel is provided that includes a foam block with a plurality of embedded studs for providing compressive strength to the panel. The studs are preferably C-shaped metal studs that substantially extend from a front surface to a back surface of the foam block. However, ordinary artisans will realize that studs of various other shapes and materials or studs that do not extend the entire length of the foam block can be utilized. After the foam block is formed with reinforcement therein, it is placed on top of a not yet cured layer of lightweight concrete in order to form the lightweight wall panel. In one variation, various types of fasteners can be inserted into the foam block and into the stud (via a threaded connection, interference fit, etc) so that the foam block can be placed on top of the uncured concrete or other exterior layer wherein the fasteners are inserted into the uncured concrete or other exterior layer. Thereafter, once the exterior layer fully cures, the foam block will be more rigidly connected to the exterior layer due to its mechanical bond with the fasteners. Additionally, if desired, a second layer of concrete or other material can be placed or otherwise formed on the side of the foam block opposite from the first layer of concrete or other material. To aid in the bonding strength of the foam block to the second layer, bores can be formed through the foam block and a portion of the studs. Thereafter, as the second layer of concrete or other material is placed on top of the foam block, a portion of the concrete or other material will flow into the bores. As a result, after cure, a more rigid connection between the foam block and the second layer will exist. One of ordinary skill will understand that additional bores can be formed through the foam block and not through the studs for flowing of the uncured second layer. Embodiments of the present invention thus include foam blocks and studs with bores along with the aforementioned fasteners that provide a more robust and durable wall panel.

[0020] It will be appreciated that shipping the wall panels of the present invention from the factory to the job site will be enhanced because of the low weight of the wall panels. Building erection at the job site will be enhanced for similar reasons. For instance, buildings can be retrofitted by mounting the lightweight wall panels of the present invention directly onto the exterior of the building or by removing exterior layers of the building and then mounting the wall panels of the present invention onto desired sections of the building.

[0021] Moreover, those of ordinary skill in the art will recognize that the concrete may include color additives to provide for a wall of a desired appearance. Also, methods known in the art can be used to create the impression of bricks or other shapes in the layer of concrete or other material.

[0022] Thus, in one embodiment of the present invention, a low density concrete wall panel is provided, comprising:

[0023] an exterior layer comprised of at least one of a cementious or gypsum based material;

[0024] a plurality of generally parallel spaced foam blocks positioned on said layer of cementious or gypsum based material, each foam block having an upper end, a lower end and two lateral sides extending therebetween wherein one lateral side further comprises a lip extending therefrom that defines a space between adjacent foam blocks;

[0025] a plurality of metallic framing members each with an upper end and a lower end, at least one framing member of the plurality thereof positioned within the space between adjacent foam blocks;

[0026] a first channel interconnected to said upper ends of said plurality of spaced metallic framing members; and

[0027] a second channel interconnected to said lower ends of said plurality of spaced framing members.

[0028] Further, in another embodiment of the present invention, a low density wall panel is provided, comprising:

[0029] a first exterior layer comprised of at least one of a cementious or gypsum based material;

[0030] a foam block positioned on the first exterior layer, the foam block having a front surface and a rear surface, the front surface being in contact with the first exterior layer;

[0031] a plurality of studs embedded in the foam block, wherein each stud includes first and second portions, the first portion being adjacent the front surface of the foam block and the second portion being generally opposite the first portion; and

[0032] at least one fastener extending into the foam block and the first exterior layer.

[0033] The Summary of the Invention is neither intended nor should it be construed as being representative of the full extent and scope of the present invention. The present invention is set forth in various levels of detail in the Summary of the Invention as well as in the attached drawings and the Detailed Description of the Invention and no limitation as to the scope of the present invention is intended by either the inclusion or non-inclusion of elements, components, etc. in this Summary of the Invention. Additional aspects of the present invention will become more readily apparent from the Detail Description, particularly when taken together with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and together with the general description of the invention given above and the detailed description of the drawings given below, serve to explain the principles of these inventions.

[0035] FIG. **1** is a top perspective view of a wall panel of one embodiment of the present invention;

[0036] FIG. **2** is a top perspective view of a foam insulation block of one embodiment of the present invention;

[0037] FIG. **3** is a top perspective view of a metal frame employed in embodiments of the present invention;

[0038] FIG. **4** is a partial detailed perspective view of the embodiment shown in FIG. **1**;

[0039] FIG. **5** is a partial bottom plan view of the embodiment of the present invention shown in FIG. **1**;

[0040] FIG. **6** is a variation of the embodiment of FIG. **1** illustrating a series of bores to aid in attachment of a second layer of concrete or other material;

[0041] FIG. **7** is a top plan view of a wall panel of another embodiment of the present invention;

[0042] FIG. **8** is a partial top plan view illustrating the end-to-end interconnection of two wall panels according to another embodiment of the present invention;

[0043] FIG. **9** is a partial top plan view of a wall panel of another embodiment of the present invention.

[0044] To assist in interpreting the drawings, the following table is herein which identifies the various components of the present invention and the numbering associated therewith:

#	Component
2	Wall panel
6	Metal stud
10	Foam block
14	Upper surface
18	Lower surface
22	Lateral surface
26	Interior surface
34	Lip
38	Exterior wall
46	Channel
50	Upper edge
54	Lower edge
58	Passage
62	Stud aperture
64	Channel apertures
68	Frame system
72	Clip
76	Adhesive
80	Bores
102	Wall panel
106	Stud
107	First portion
108	Second portion
110	Foam block
114	Front surface
118	Rear surface
119	First end
120	Second end
122	First fastener
126	Protruding portion
130	Head portion
134	Cutout
138	Bracket
139	Protruding portion
140	Aperture
142	Second fastener
143	Aperture
146	Exterior wall
150	Overlapping region
154	Fasteners
158	Washer
202	Wall panel
206	Stud
207	First portion
208	Second portion
209	Aperture
210	Foam block
214	Front surface
218	Rear surface
222	First fastener
226	Head
230	Abutting portion
234	Protruding portion
238	Second fastener
242	Head
246	Protruding portion
250	Third fastener
254	Bridge portion
258	Legs
262	Bore
266	Bore
270	Exterior layer
274	Second layer
278	Cutout

[0045] It should be understood that the drawings are not necessarily to scale. In certain instances, details that are not necessary for an understanding of the invention or that render other details difficult to perceive may have been omitted. It should be understood, of course, that the invention is not necessarily limited to the particular embodiments illustrated herein.

DETAILED DESCRIPTION

[0046] Referring now to FIGS. **1-5**, a lightweight wall panel **2** is provided that includes a plurality of metal studs **6** that receive foam insulation blocks **10** positioned therebetween. The foam blocks **10** used in the present invention are generally rectangular with an upper surface **14**, a lower surface **18** and two lateral side surfaces **22**. In addition, an interior **26** and exterior surface **30** is provided. Further, at

least one lateral side surface has a lip **34** depending therefrom that generally extends the exterior surface **30**. The lip **34** is adapted to receive the metallic stud **6** and separates the metallic stud **6** from a layer of lightweight concrete material **38** that is affixed to the exterior surface **30** of the foam block. Wall panels **2** as contemplated herein also may include insulative strips **42** adjacent to a lower surface **18** and an upper surface **14** of the foam blocks **10** that provide a location for the interconnection of a channel **46** that also interconnects to upper **50** and lower **54** edges of the metallic studs **6**. The channel **46** provides a location wherein air, utility, or fluid conduits may be situated. Further, it is also contemplated that some foam blocks **10** of the wall panel **2** may include at least one passage **58** for the receipt of conduits for receiving electrical wiring, piping, etc. as well. In order to allow the conduits to traverse the entire width of the wall panel, one skilled in the art will appreciate that apertures **62** may also be included into the metal studs **6**.

[0047] Referring now to FIG. **1** the wall panel **2** of one embodiment of the present invention is provided herein. The wall panel **2** is comprised generally of an exterior wall **38** of a lightweight concrete material. After the concrete material is placed, a plurality of foam blocks **10** are positioned thereon. As the exterior wall **38** cures, the foam blocks **10** will adhere thereto. To enhance adherence of the foam blocks to the exterior wall, dovetails or other shaped cutouts may be made into the surface of the foam block in any location and in any direction that contacts the exterior wall **38**. Such cutouts will allow a portion of the exterior wall **38** to flow into the cutout before the exterior wall **38** is fully cured thus increasing the aforementioned adherence once the exterior wall **38** is fully cured. Other methods of securing the interior components of the wall will be described below. In addition, the foam blocks **10** may include a lip **34** that receives the metal studs **6** that effectively separate the foam blocks **10**. The metal studs **6** may be comprised of a c-channel or a solid piece of metal depending on the required strength of the wall panel **2**. In the illustrated embodiment, the upper surface and the lower surface of the foam blocks **10** do not entirely match the height of the exterior wall **38** thereby providing a gap that separates the foam blocks **10** from a metal channel **46** that spans between the ends of the metal studs **6**. In addition, foam strips **42** are added adjacent to the upper surface and the lower surface **54** of the foam blocks **10** that receive a portion of the channel **46** and the metal studs **6**. These measures are taken such that the metal stud **6** is separated from the exterior wall concrete material **38** which is important because each material has different expansion rates wherein quicker expansion of the metallic material may cause cracking of the exterior wall **38**. Exterior walls **38** of embodiments of the present invention are created of a lightweight concrete. However, as alluded to above, one skilled in the art will appreciate the other materials, such as dry wall, SHEETCRETE™ by Oldcastle Precast, Inc., glasscrete, or other similar materials may be utilized without departing from the scope of the invention. The metal studs **6** may also include stud apertures **62** that provide access to passages **58** built into the foam block **10**. A plurality of passages **58** may further be aligned to incorporate conduit through the width of the wall panel **10**. In addition, the channel **46**, which is positioned at the top edge and the bottom edge of the wall may be used for conduit as well. Further, if c-channels are utilized for the metallic studs, an air space is also provided that is useful for the transition of conduit therethrough. The channel may also have apertures **64** that allow access to the space provided by the metallic studs **6**.

[0048] Referring now to FIG. **2**, the foam block **10** of one embodiment of the present invention is provided. More specifically, the foam block **10** includes the upper surface **14**, the lower surface **18** and two lateral surfaces **22** extending therebetween. In addition, an interior surface **26** and an exterior surface **30** is provided. A lip **34** extends from at least one lateral surface **22** that provides a location for the positioning of the metal stud. This lip **34** performs a double function by providing the required spacing between two adjacent foam blocks **10** and providing a pad that receives the metal stud so that it does not contact the concrete exterior surface limiting undesirable heat transfer. The foam blocks **10** of some embodiments of the present invention include at least one passage **58** forwarded therethrough for the receipt of conduit. Although the passage **58** in FIG. **2** is shown to extend horizontally, one skilled in the art will appreciate that any shape or angulation or orientation of the passage **58** may be used without departing from the scope of the invention.

[0049] Referring now to FIG. **3**, a frame system **68** of one embodiment of the present invention is shown. More specifically, the frame system **68** is comprised of a plurality of spaced metal studs **6** wherein the upper edge **50** and lower edge **54** thereof are interconnected to a channel **46**. In addition, to ensure that the metal studs **6** are firmly interconnected to the concrete exterior wall, a plurality of clips **72** are provided that are interconnected to the metal studs **6**. The clips **72** are preferably coated with nylon or other insulative material thereby limiting the amount of heat transferred between the metal studs **6** and the concrete wall. In addition, since the insulation panels provide additional structural support to the exterior concrete wall, the amount of clips **72** required in many embodiments of the present invention are significantly reduced, thus further ensuring that some thermal expansion issues are alleviated. One skilled in the art will appreciate that the channel **46** may be affixed to the metal studs **6** in any way previously used in the art, such as welding, riveting, screwing, nailing, bonding, to name a few.

[0050] Referring now to FIG. **4**, a cut away view of one embodiment of the present invention is shown. Upon review of this figure, one skilled in the art will appreciate the method of manufacture of wall panels **2** as contemplated herein. More specifically, initially a layer of lightweight concrete **38** is placed then in a form, preferably to a depth of about 1½ to 1 inch in thickness. Next, a plurality of foam blocks **10** are located in the form wherein the lips **34** of the foam blocks **10** are abutted against the adjacent foam blocks **10** to provide a space for the receipt of metal studs **6**. The metal studs **6**, which may include the clips **72** interconnected thereto, is then placed on the lip **34** wherein the metal clip **72** includes a portion that penetrates into the still wet and uncured concrete **38** or other wall material. In addition, the clip **72** is of such a thickness that it can fit easily between any gap provided between the metal stud **6** and the foam block **10** situated next to the metal stud **6**. Prior to placing the metal studs **6**, a foam strip is placed adjacent to the upper and lower surfaces **18** of the foam block **10** over an exposed section of lightweight concrete **38**. This small overlap allows the channel **46** to be interconnected to the edges **54** of the metal studs **6** that provide a space between the upper and lower surfaces **18** of the foam block **10** and the channel **46**. The channels **46** provide an excellent location for the positioning of wiring, piping, etc. And to provide an insulative air barrier.

[0051] Referring now to FIG. **5**, a front elevation view of one embodiment of the present invention is shown. This figure illustrates the spacing of the metal stud **6** with respect to the layer of lightweight concrete **38**. It also shows that when a C-shaped metallic stud **6** is used, an air barrier and channel is provided that provides a location for conduits. Embodiments of the present invention may use adhesives **76** to secure portions of the metal stud **6** onto the foam blocks **10** that are situated adjacent thereto. In addition, as one skilled in the art will appreciate, adhesives may be employed onto the layer of concrete **38** prior to placing the foam blocks **10** thereon thereby ensuring a tighter bond.

[0052] With reference to FIG. **6**, a variation of the embodiment of FIG. **1** is shown whereby a second layer of concrete or other material can effectively be placed onto the foam block opposite from the first layer of concrete or other material. To aid in the attachment of the second layer to the wall panel, bores **80** are formed through a portion of the studs and into the foam block. As the second layer is being placed, a portion of the second layer will flow into the bores **80**. Thereafter, once the second layer fully cures, the second layer will be more effectively bonded to the wall panel due to the second layer curing within the bores **80** of the foam block and the studs.

[0053] Referring now to FIG. **7** and according to another embodiment of the present invention, a lightweight wall panel **102** is provided that includes a foam insulation block **110** with a plurality of studs **106** embedded therein. The foam block includes a front surface **114**, a rear surface **118**, a first end **119**, a second end **120**, and a length, and can comprise any number of materials including, but not limited to, expanded polystyrene (EPS), expanded polystyrene (XPS), polyurethane, etc.

[0054] Each stud **106** is metal and includes first and second portions **107**, **108** that are respectively situated near the front and rear surfaces **114**, **118** of the foam block. In the illustrated embodiment, each stud **106** comprises a z-shaped channel. However, ordinary artisans will recognize that other shapes such as c-shaped channels or other shaped channels can be utilized depending on the required strength of the wall panel **102**. While each stud will preferably extend from the top to the bottom of the foam block **110**, multiple studs can be utilized from the top to the bottom of the foam block instead of a just a single stud **106**. Further, the studs **106** are preferably equally spaced along the length of the foam block. However, ordinary artisans will recognize that other spacings between studs may be required depending upon the desired design requirements. Further, at least one first fastener **122** is mounted to the front surface **114** of the foam block and the first portion **107** of the stud **106**. The first fastener **122** is mounted to the front surface **114** and the first portion **107** via a threaded connection, an interference fit, etc. Each first fastener **122** includes a portion **126** that protrudes from the front surface **114** of the foam block **110**. The first fastener **122** may comprise a screw, bolt, nail, etc., among others, and may further include a head portion **130** for reasons that will be described below.

[0055] With continued reference to FIG. **7**, each wall panel **102** also includes an exterior wall **146** constructed of, for instance, a lightweight concrete material. However, one skilled in the art will appreciate that other lightweight materials such as SHEETCRETE™ by Oldcastle Precast, Inc. and glasscrete can also be utilized. Each exterior wall **146** is mounted on the front surface **114** of the wall panel **102**. As will be described more fully below, before the material of the exterior wall **146** is fully cured, the protruding portion **126** of each first fastener **122** is pressed into the exterior wall **142** until the front surface **114** of the foam block **110** abuts the exterior wall **146**. It will be appreciated that a cutout or cutouts, such as but not limited to, dovetail cutouts, can be provided on the front surface **214** of the foam block to interact with the concrete or other material. These cutouts can be provided in any location and in any direction along the front surface of the foam block. Thereafter, once the concrete has fully cured around the protruding portion **126** of each first fastener **122**, and within the cutout(s), the exterior wall **146** will be rigidly mounted to the front surface **114** of the foam block **110**. Moreover, if a head portion **130** is provided on the first fastener **122**, additional rigidity can be provided between the exterior wall **146** and the foam block **110** due to the concrete curing around the head portion **130**.

[0056] Referring now to FIG. **8**, an end-to-end interconnection between two of the wall panels **102** of one embodiment is shown. More specifically, a cutout **134** is formed on the first end **119** of the foam block **110** of a first wall panel **102** thus exposing the second portion **108** of a stud **106**. The second portion **108** of the stud **106** may be provided with an aperture **143** for receiving a second fastener **142** as will be described below. The second end **120** of a second wall panel **102** includes a bracket **138** with a portion **139** protruding from the second end **120** mounted adjacent to the second portion **108** of a stud **106**. One skilled in the art will appreciate that the bracket **138** can be mounted to the second end **120** in various ways, such as by curing the foam around the bracket, a threaded connection, gluing, etc. Additionally, the bracket **138** may include an aperture **140** for reasons that will be described below.

[0057] In operation, two wall panels **102** are interconnected in an end-to-end relationship by initially placing the first end **119** of a first wall panel **102** adjacent to the second end **120** of a second wall panel **102** such that the protruding portion **139** is located in the cutout **134**. Thereafter, the aperture **143** of the second portion **108** of the stud **106** of the first wall panel **102** and the aperture **140** of the bracket **138** of the second wall panel **102** are aligned and a second fastener **143** is inserted therethrough to rigidly interconnect the first and second wall panels **102**. Preferably, the second fastener **143** is threaded such that after the fastener **143** is placed through the apertures **143**, **140**, the fastener **143** is threaded into the siding of a building thus mounting the wall panels to the building. However, ordinary artisans will appreciate that various other interconnection schemes can be used such as nailing, riveting, welding, etc. Further, although only a single bracket, second fastener, etc. have been shown, it will be appreciated that multiple brackets, second fasteners, etc. can be used to provide a desired rigidity between the panels themselves and/or desired rigidity between the panels and the exterior of a building. Moreover, while the first and second wall panels **102** are shown to be in a collinear arrangement in FIG. **8**, it is contemplated that the first and second wall panels **102** could be interconnected such that the first wall panel is arranged at an angle to the second wall panel.

[0058] With respect to FIG. **8***a*, a variation of the end-to-end interconnection between two adjacent wall panels **102** is shown. More specifically, the second portion **108** of a stud **106** protrudes from a first wall panel **102** adjacent the first end **119** of first wall panel **102**. The second portion **108** of a stud **106** protrudes from a second wall panel **102** adjacent the second end **120** of the second wall panel **102**. In operation, the

second portions **108** of the studs **106** of the first and second wall panels are brought into contact at an overlapping region **150**. Thereafter, the second portions are rigidly connected at the overlapping region **150** by any method known in the art, such as, but not limited to, welding, a threaded connection, clamping, etc.

[0059] With respect to FIG. **8***b*, another variation of the end-to-end interconnection between two adjacent wall panels **102** is shown. More specifically, the second portion **108** of a stud **106** protrudes from a first wall panel **102** adjacent the first end **119** of first wall panel **102**. The second portion **108** of a stud **106** protrudes from a second wall panel **102** adjacent the second end **120** of the second wall panel **102**. In operation, the second portions **108** of the studs **106** of the first and second wall panels are brought into contact at an overlapping region **150**. Thereafter, a bracket **138** is provided for providing additional support to the overlapping region **150**. Finally, fasteners **154** are provided for rigidly interconnecting the second portions **108** of the studs and the bracket **138**. To further provide for a robust connection, a washer **158** can be provided to fill in any gaps that exist between the bracket **138** and the second portions **108** of the studs **106** as shown in FIG. **8***b*. It will be appreciated that while the aforementioned connection arrangements have been illustrated to rigidly interconnect two adjacent wall panels **102**, others known to ordinary artisans are contemplated as being within the scope of the present invention.

[0060] A method of a manufacturing the wall panel of FIGS. **7** and **8** will now be described. Initially, a mold is provided for curing of the foam blocks. After a plurality of studs are placed in the mold at desired locations, a foam solution is introduced into the mold and allowed to cool and/or cure. After curing, the foam block is removed and if desired, cut into appropriate lengths. Once the foam block has been produced, a form for producing an exterior wall **146** is provided on-site or prefabricated of a shape and size corresponding to the foam block. After the concrete or other material has been placed into the form but before the concrete has completely cured, the protruding portion **126** of each first fastener **122** of the foam block **110** is pressed into the concrete or other material until the front surface **114** of the foam block **110** abuts the concrete or other material and the concrete or other material flows into in provided cutouts on the front surface **114**. Thereafter, once the concrete or other material has fully cured around the protruding portion **126** of each first fastener **122** and within the cutouts, the exterior wall **146** will be rigidly mounted to the front surface **114** of the foam block **110**. As previously described, if a head portion **130** is provided on the first fastener **122**, additional rigidity can be provided between the exterior wall **146** and the foam block **110** due to the concrete curing around the head portion **130**.

[0061] Referring now to FIG. **9** and according to another embodiment of the present invention, a lightweight wall panel **202** is provided that includes a foam insulation block **210** with a plurality of studs **206** embedded therein. The foam block includes front and rear surfaces **114**, **118** and can comprise any number of materials including, but not limited to, expanded polystyrene (EPS), expanded polystyrene (XPS), polyurethane, etc. Each stud **206** is metal and includes first and second portions **207**, **208** that are respectively situated near the front and rear surfaces **214**, **218** of the foam block. In the illustrated embodiment, each stud **206** comprises a c-shaped channel. However, ordinary artisans will recognize that other shapes such as z-shaped channels or other shaped channels can be utilized depending on the required strength of the wall panel **202**. While each stud **206** will generally extend from the top to the bottom of the foam block **210**, ordinary artisans will appreciate that multiple studs can be utilized from the top to the bottom of the foam block instead of a just a single stud **206**. Further, the studs **206** are preferably equally spaced along the length of the foam block. However, it is recognized that other spacings between studs may be required depending upon the desired design requirements.

[0062] Further, at least one first fastener **222** is mounted to the front surface **214** of the foam block **210** as well the first portion **207** of one of the studs **206**. Each first fastener **222** includes a head **226**, an abutment portion **230**, and a protruding portion **234**. The protruding portion **234** is inserted into front surface **214** and aperture **209** of first portion **207** until the abutment portion **234** abuts the front surface **214**. It is appreciated that the first fastener **222** can be mounted to the front surface **214** and first portion **207** via a threaded connection, an interference fit, etc.

[0063] It is contemplated that fasteners of varied shapes can be provided. For instance, at least one second fastener **238** is mounted to the front surface **214** of the foam block **210** as well as the first portion **207** of another one of the studs **206**. Each second fastener **238** includes a head **242** and a protruding portion **246**. The protruding portion **246** is inserted into front surface **214** and aperture **209** of first portion **207** such that the head **242** remains separated from the front surface. As ordinary artisans will recognize, the second fastener **238** can be mounted to the front surface **214** and first portion **207** via a threaded connection, an interference fit, etc. Also, at least one third fastener **250** is mounted to the front surface **214** of the foam block **210** as well as the first portion **207** of another one of the studs **206**. Each third fastener **250** includes a bridge portion **254** and a pair of legs **258**. The legs **258** are inserted into front surface **214** and apertures **209** of first portion **207** such that the bridge portion **254** remains separated from the front surface.

[0064] With continued reference to FIG. **9**, each wall panel **202** also includes an exterior wall **270** constructed of, for instance, a lightweight concrete material. However, ordinary artisans will realize that other lightweight materials such as SHEETCRETE™ by Oldcastle Precast, Inc. and glasscrete can also be utilized. Before the material of the exterior wall **270** is fully cured, the head portion **226**, head portion **242** and bridge portion **254** of first, second and third fasteners **222**, **238**, **250** respectively are pressed into the exterior wall **270** until the front surface **214** of the foam block **210** abuts the exterior wall **270**. Also, the front surface **214** of the foam block is provided with a cutout **278**, such as a dovetail-shaped cutout, to interact with the concrete or other material. It will be appreciated that more than one cutout can be provided, and also that the cutout(s) can be provided any location and in any direction along the front surface of the foam block. Thereafter, once the concrete or other material has fully cured around the head portion **226**, head portion **242** and bridge portion **254**, and within the cutout **278**, the exterior wall **270** will be rigidly mounted to the front surface **214** of the foam block **210**.

[0065] Moreover, if desired, a second layer of concrete or other material **274** can be provided on the foam block **210** opposite from the exterior wall **270**. To aid in the bonding strength of the foam block to the second layer, bores **262**, **266** can be formed through the foam block and a portion of the studs. Thereafter, as the second layer of concrete or other

material **274** is placed on top of the foam block, a portion of the concrete or other material will flow into the bores **262**, **266**. As a result, once the concrete or other material has fully cured, a more rigid connection between the foam block and the second layer will exist. One of ordinary skill will understand that additional bores can be formed through the foam block and not through the studs for flowing of the uncured second layer.

[0066] The method of manufacturing the wall panel of FIG. **9** is similar to the method of manufacturing the wall panel of FIG. **7** and **8**.

[0067] One of ordinary skill in the art will appreciate how many of the aforementioned features are interchangeable with the various embodiments described. For instance, any of the aforementioned fasteners can be utilized in any of the embodiments to aid in bonding of the foam block to the concrete or other material. Further, only a single type of the aforementioned fasteners can be used throughout the wall panel if desired. Additionally, dovetails, bores or other cutouts can be formed in any locations and in any directions in the foam block and the studs to allow for flowing of the concrete or other material into the dovetails, bores or other cutouts. This increases the bonding strength between the foam block and the concrete or other material as well as enhances the crack resistance of the wall panel. Moreover, second layers of concrete or other material can be formed on the wall panels opposite from the first exterior layer or concrete or other material depending upon a user's specific design requirements.

[0068] The foregoing description of the present invention has been presented for purposes of illustration and description. Furthermore, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commenced here with the above teachings and the skill or knowledge of the relevant art are within the scope in the present invention. The embodiments described herein above are further extended to explain best modes known for practicing the invention and to enable others skilled in the art to utilize the invention in such, or other, embodiments or various modifications required by the particular applications or uses of present invention. It is intended that the dependent claims be construed to include all possible embodiments to the extent permitted by the prior art.

What is claimed:

1. A wall panel with metallic studs comprising:

an exterior layer comprised of at least one of a cementious or gypsum based material;

a plurality of generally parallel spaced foam blocks positioned on said layer of cementious or gypsum based material, each foam block having an upper end, a lower end and two lateral sides extending therebetween, wherein one lateral side further comprises a lip extending therefrom that defines a space between adjacent foam blocks;

a plurality of metallic framing members each with an upper end and a lower end, at least one said plurality of metallic framing members positioned within the space between the adjacent foam blocks; and

a fastening device interconnecting said metallic framing members to said exterior layer.

2. The wall panel of claim **1** wherein said wall panel is adapted to be cut with a hand saw.

3. The wall panel of claim **1** wherein said plurality of foam blocks are adhered to said plurality of frame members to increase bonding strength.

4. The wall panel of claim **1** wherein said plurality of foam blocks include a passageway therethrough and said plurality of frame members include apertures that are adapted to receive utility wiring or plumbing.

5. The wall panel of claim **1**, further comprising a first channel interconnected to said upper ends of said plurality of spaced metallic framing members.

6. The wall panel of claim **1**, wherein said fastening device is comprised of a stamped flat metal member coated with nylon and is adapted for attachment to said plurality of frame members with at least one of screws, rivets, welds and adhesives.

7. The wall panel of claim **1**, further comprising a bonding agent positioned between said layer of cementious or gypsum material and said foam blocks.

8. The wall panel of claim **1**, further comprising a second channel interconnected to said lower ends of said plurality of spaced framing members.

9. The wall panel of claim **1**, further comprising at least one bore formed through at least a portion of at least one of the framing members and at least one of the foam blocks opposite from the exterior layer for aiding in the bonding of a second exterior layer comprised of at least one of a cementious or gypsum based material.

10. The wall panel of claim **1**, wherein the exterior layer comprises concrete.

11. The wall panel of claim **1**, wherein the exterior layer comprises SHEETCRETE™ by Oldcastle Precast, Inc.

12. The wall panel of claim **1**, wherein the exterior layer comprises glasscrete.

13. A low density wall panel, comprising:

a first exterior layer comprised of at least one of a cementious or gypsum based material;

a foam block positioned on the first exterior layer, the foam block having a front surface and a rear surface, the front surface being in contact with the first exterior layer;

a plurality of studs embedded in the foam block, wherein each stud includes first and second portions, the first portion being adjacent the front surface of the foam block and the second portion being generally opposite the first portion; and

at least one fastener extending into the foam block and the first exterior layer.

14. The wall panel of claim **13**, wherein at least one bore is formed through the foam block and the second portion of at least one of the plurality of studs for aiding in the bonding of a second layer of at least one of a cementious or gypsum based material to the foam block opposite from the first exterior layer.

15. The wall panel of claim **13**, wherein the front surface of the foam block includes at least one cutout for aiding in the bonding of the first exterior layer to the foam block.

16. The wall panel of claim **15**, wherein the cutout includes a dovetail-shaped cutout.

17. The wall panel of claim **13**, wherein the fastener includes a head, an abutment portion, and a protruding portion; wherein when the protruding portion is mounted in the

foam block, the abutment portion contacts the front surface of the foam block and the head is mounted in the exterior layer.

18. The wall panel of claim **17**, wherein the protruding portion is threaded.

19. The wall panel of claim **13**, wherein the fastener includes a head and a protruding portion; wherein when the protruding portion is mounted in the foam block, the head is mounted in the exterior layer.

20. The wall panel of claim **19**, wherein the protruding portion is threaded.

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