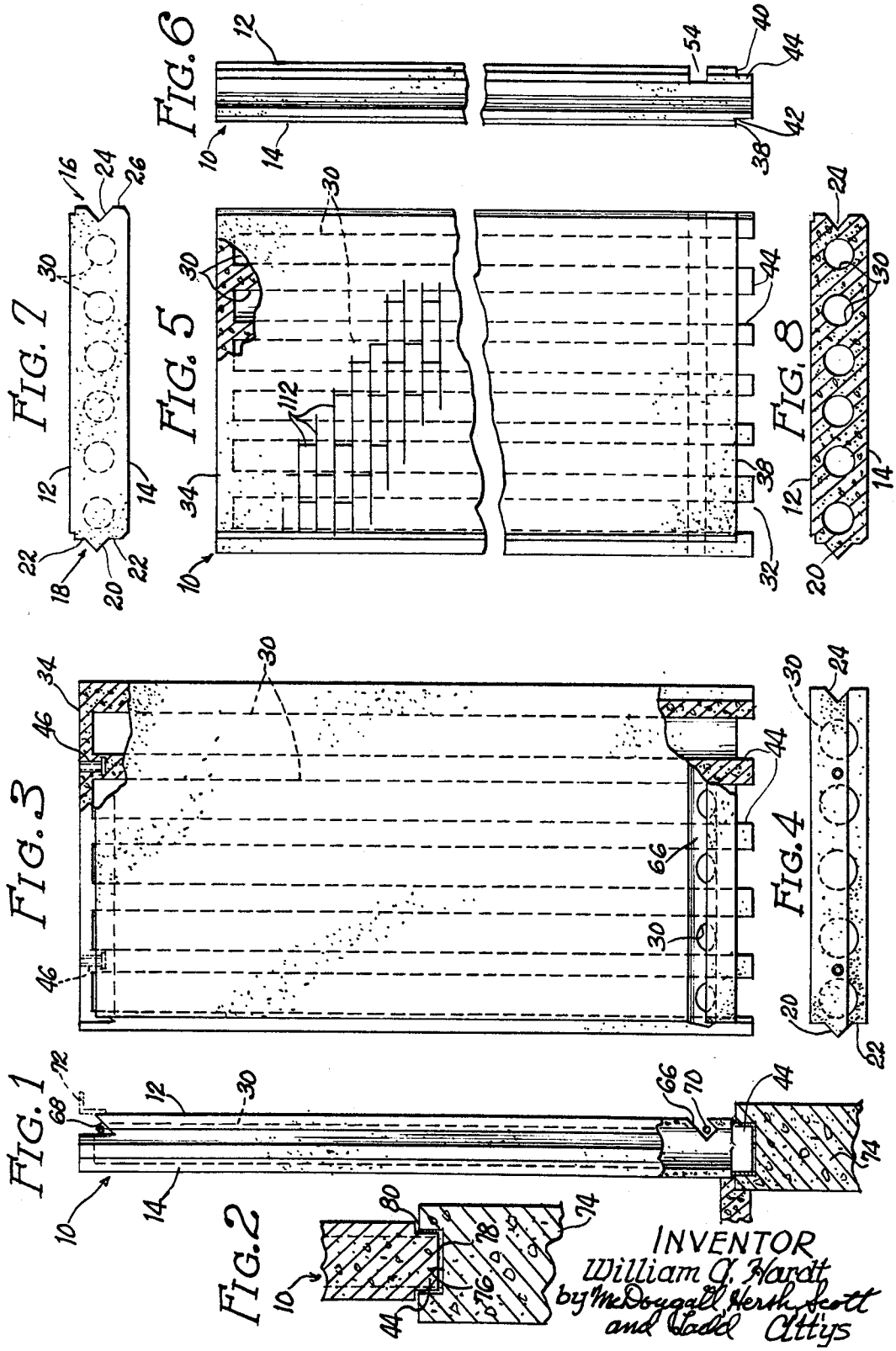
March 31, 1970 W. G. HARDT 3,503,165

PREFABRICATED LIGHT WEIGHT PANELS OF CEMENTITIOUS MATERIAL

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PREFABRICATED LIGHT WEIGHT PANELS OF CEMENTITIOUS MATERIAL

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FIG. 9

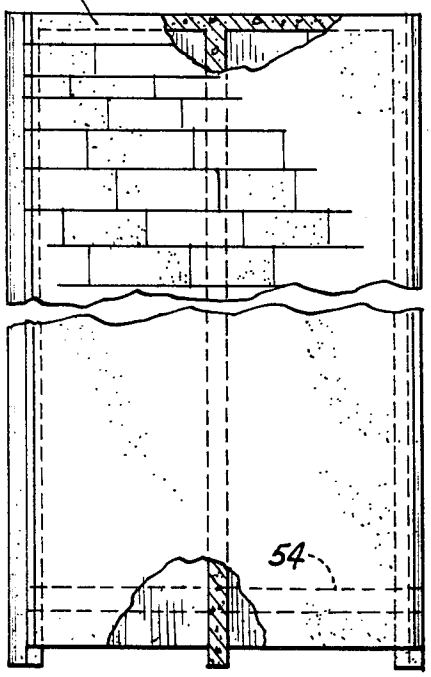


FIG. 11

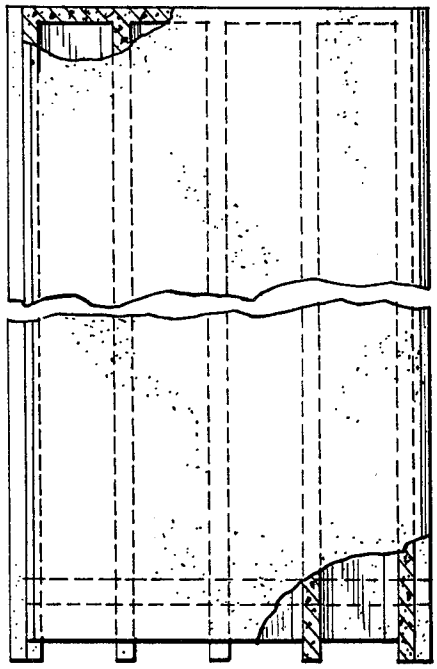


FIG. 10

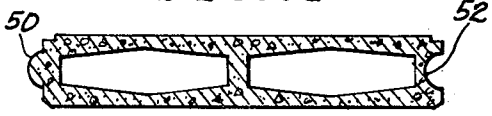


FIG. 12

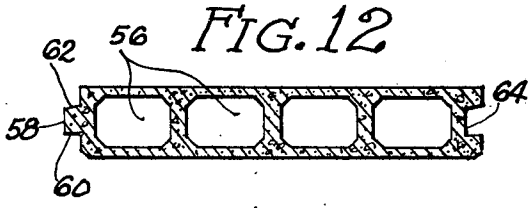


FIG. 13

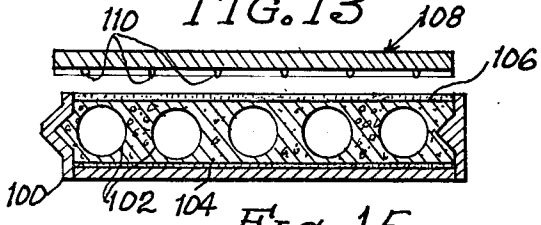


FIG. 14

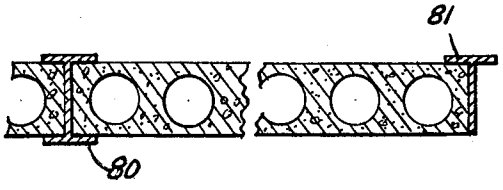


FIG. 15

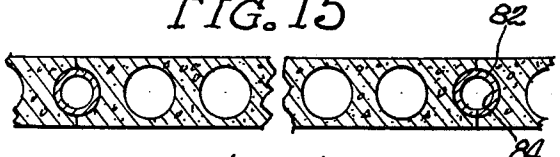
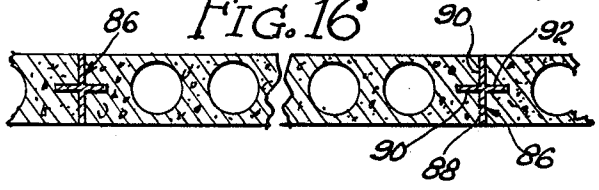


FIG. 16



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3,503,165

PREFABRICATED LIGHT WEIGHT PANELS OF CEMENTITIOUS MATERIAL

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Filed June 12, 1967, Ser. No. 645,253
Int. Cl. E04c 2/52, 1/06, 2/04
U.S. Cl. 52—125 11 Claims

ABSTRACT OF THE DISCLOSURE

Panels and wall structures formed thereof in which the panels are prefabricated of cementitious material with voids extending continuously through the interior thereof from the lower edge to a distance short of the top edge with the portions between the hollow sections extending downwardly as feet adapted to be received and supported within grooves provided in a footing and with recessed portions extending continuously crosswise through one wall of the panel and for a distance inwardly to intersect the hollow sections for continuous circulation of air through the interior of the panel when in the assembled relationship and designs in the form of brickwork, stonework and the like impressed in one or both of the surfaces of the panel walls.

This invention relates to prefabricated, light weight, structural panels of cementitious material and it relates more particularly to a prefabricated panel of concrete or cementitious material which is light in weight and structurally strong and which can be used in foundation and wall structures with outward appearance and design to simulate brick, stone or slab constructions and it relates also to a method and means for producing same.

It is an object of this invention to produce and to provide a method for producing a prefabricated panel of cementitious material which is structurally strong, which is light in weight, which is capable of easy handling for transportation and use, which embodies means for proper alignment in the assembled relation to form a wall structure, which is capable of interlocking relationship one with another with a sealed relationship therebetween to provide a composite wall of attractive appearance, high strength and stability, which embodies means for accommodating heating and lighting elements for the finished wall structure and room, which embodies means for circulation of warm air through the interior of the panel to avoid condensations which might arise by reason of the differences in temperature existing on the opposite walls of the panel, which is capable of assembly in vertically stacked relation for multi-level construction, and which is capable of prefabrication with designs embodied in the outer wall surfaces for simulation of various structural materials such as bricks, stone, blocks, etc., of varying design and color, and which is also capable of various colors and designs on the interior surfaces to simulate wooden panels and the like.

These and other objects of this invention will hereinafter appear and for purposes of illustration, but not of limitation, embodiments of the invention are shown in the accompanying drawings, in which

FIG. 1 is an elevational view, partially in section, of a structural panel embodying the features of this invention in position of assembly on a suitable footing extending upwardly above the ground;

FIG. 2 is a sectional elevational view showing in detail the means for support and location of the panels on the footing;

FIG. 3 is a front elevational view of the panel shown in FIG. 1;

FIG. 4 is a top plan view of the panel shown in FIGS. 1 and 3;

FIG. 5 is a front elevational view of a modification in a prefabricated panel embodying the features of this invention;

FIG. 6 is an end elevational view of the panel shown in FIG. 5;

FIG. 7 is a top plan view of the panel shown in FIG. 5;

FIG. 8 is a sectional view of the panels shown in FIGS. 5–7;

FIG. 9 is a front elevational view of a further modification in a prefabricated panel;

FIG. 10 is a sectional view through the panel shown in FIG. 9;

FIG. 11 is a front elevational view of a still further modification in a prefabricated panel;

FIG. 12 is a sectional view through the panel shown in FIG. 11;

FIG. 13 is a schematic view illustrating the arrangement of elements for forming a design in the surface of the panel during the prefabrication thereof;

FIG. 14 is a sectional view which illustrates one means for alignment of the prefabricated panels in vertically stacked relation to form a wall structure;

FIG. 15 is a sectional view similar to that of FIG. 14 showing a modification in the vertical alignment means; and

FIG. 16 is a sectional view similar to those of FIGS. 14 and 15 showing a still further modification in the means for vertical alignment of panels in a wall assembly.

With reference now to FIGS. 5–8 of the drawings, illustration is made of a monolithic panel **10** formed of concrete or other cementitious material having a flat inside wall **12**, a flat outside wall **14** in parallel spaced relationship with the inside wall, side edge walls **16** and **18** with a V-shaped tongue **20** extending along one side edge spaced inwardly a short distance from the front and back walls to provide flat lands **22** therebetween, and a corresponding V-shaped groove **24** along the other edge **16** with the grooves spaced inwardly a short distance from the front and back walls **12** and **14** to provide flat lands **26** therebetween and in which the groove **24** is dimensioned to have a cross-section corresponding to the tongue **20** for receiving the tongues of adjacent panels in fitting relationship therein.

The panel is formed at its bottom edge **32** with rectangularly shaped grooved portions **38** and **40** across the front and back walls and dimensioned to extend inwardly a short distance to intersect with the tubular voids to provide horizontally disposed flanged portions **42** a short distance above the lower edge of the panel with the portions alongside the tubular voids extending downwardly as feet **44** having a width less than the thickness of the panel. The voids extend vertically through the panel in laterally spaced apart relation from the bottom edge of the panel to a distance short of the top edge.

Embedded within the top edge, in laterally spaced apart relation, are two or more inserts **46** (see FIGS. 3 and 4) which are provided with threaded openings for receipt of bolts adapted to be engaged by clamps or other hook members for lifting the prefabricated panel for movement from place to place or for conveying the panel to its position of use and for support thereof during assembly.

In FIGS. 9 and 10, the voids extending vertically through the interior portion of the panel are of polygonal shape having a width considerably greater than their thickness thereby to provide for a higher percentage of voids while the structural elements otherwise are sub-

stantially the same except for the modification in the tongue and groove arrangement in the side edges. In the modification of FIGS. 9 and 10, the tongue **50** on one side is in the form of a semi-circular section and the groove **52** in the other side edge is in the form of a semi-circular recess of the same cross-sectional dimension as that of the tongue.

In the modifications shown in FIGS. 5–10, the inside wall **12** is formed with a recessed portion **54** extending crosswise of the panel and spaced a short distance upwardly from its lower edge. The crosswise extending groove **54** can be utilized to accommodate the electrical wiring, heating tubes and the like for use in the room. The grooves **54** can be concealed behind a baseboard or other like border panels usually employed in wall construction.

In the modification shown in FIGS. 11 and 12, the voids **56** are rectangular in cross-section and are dimensioned to occupy a major proportion of the prefabricated panel. The tongue and groove arrangement in the side edges are in the form of trapezoidal sections **58** with a straight edge **60** and an inclined cam edge **62** on opposite sides for camming the tongue into proper alignment with the groove **64** of the same cross-section in the adjacent panel.

In the preferred modification shown in FIGS. 1–4, the panel is of the construction shown in FIGS. 5–8. As shown in FIGS. 1–4, the lower end portion of the panel is shown with a recess **66** extending continuously crosswise of the panel from the inside wall **12** angularly downwardly into the interior of the panel for a distance to intersect the lower end portions of the tubular voids **30**. Another recess **68** across the upper end of the panel extends angularly downwardly from the upper edge into the interior of the panel for a distance to intersect the upper end portions of the tubular voids **30** thereby to provide for a continuous communication between the upper and lower end portions of the voids and the interior of the room. Heating elements **70** can be disposed within the lower recessed portion **66** or positioned adjacent thereto in the room for the circulation of heat downwardly through the groove and into the voids **30** whereby the heat rises through the voids for issuance from the outlets **68** at the top to provide for constant circulation of heat upwardly through the interior of the panels whereby moisture which otherwise condenses between the cold and hot walls of the panel is carried out.

The grooved portions **66** and **68** also permit electrical wires to be strung in concealed relationship about the room for passage of the wire vertically through the connecting tubular voids to switch plates or outlets in various parts of the panel wall. The lower groove can be covered by the baseboard while the upper groove can be concealed behind molding **72**.

The described hollowed prefabricated monolithic panels are considerably lighter in weight than solid panels formed to the same dimension of cementitious material. Very little, if any, strength characteristics are sacrificed by the described construction with voids extending through the interior of the panels. Thus the prefabricated panels of this invention are capable of easy handling in construction and in assembly to form the wall structure. For this purpose, use can be made of slings with hooks adapted to be connected to the bolts in inserts **46** whereby the panels can be lifted, moved about and supported in position for assembly.

The voids **30** extending vertically through the panels with inlets and outlets at their lower and upper ends respectively permit the circulation of warm air through the interior of the panels to minimize objectionable condensation when the outside temperature is as low as −20° F. while the inside temperature is as high as 60° F. The described tongue and groove arrangement in the opposite side edges of the prefabricated panels permits the panels to be interfitted one with another in proper alignment to form a wall structure, or proper assembly, as will hereinafter be defined.

To form the voids, use can be made of metal inserts in the form of tubular members of the desired cross-section and length which are laid down in the desired arrangement in the form for casting the concrete or cementitious material thereabout in preparation of the panel. When formed of metal, plastics or the like dimensionally stable and structurally strong material, the tubular members can be withdrawn after the initial set of the cementitious material has occurred for re-use of the tubular members in forming subsequent panels. In the preferred practice, use is made of tubular members of paper or the like cellulosic material treated with wax or plastics to render the tubular members impervious to water for holding out the cementitious material during formation of the panel. Under such circumstances, such low cost tubular materials can be allowed to remain to form a part of the completed panel. Such voids, lined with the wax treated paper, enjoy a higher U factor to give still better insulation while eliminating the cost for removal and cleaning of the tubular members.

In a typical construction, the panels are formed to a height of 8 to 16 feet, a width of 4 to 8 feet, and a thickness of 8 to 12 inches. The flanges **42** at the lower ends are formed to a depth of 1 inch and a height of about 2 inches for use with a footing **74** (see FIG. 2) formed with a central groove **76** in its upper surface having a depth about ½ inch less than the height of the feet **44** and a width about 1 inch greater than the width of the feet **44**.

In assembly, a layer **78** of adhesive, such as an epoxy based resinous adhesive, is brushed or otherwise applied to the base of the groove **76** and the panel **10** is lowered onto the footing with the feet **44** of the panel centered in the groove **76** until the feet come to rest for support on the base of the grooves. The space remaining between the feet and the side walls of the groove is filled with grout injected between the slight opening **80** between the flanged portions **42** and the footing to effect a sealing relationship between the base of the panel and the supporting footing.

Adjacent panels are sealed one to the other by means of adhesive applied to the surfaces of the interfitting tongues and grooves. When formed of epoxy or other resinous adhesive, cure can be effected by means of an amine or other catalyst formulated into the adhesive. In the event that the temperature is too cold for advancing the adhesive to a set stage, use can be made of infrared ray lamps to provide heat sufficient for cure.

The prefabricated panels can be stacked one on another for building a multi-level wall structure. For this purpose, the upper edges of the panels are formed with grooves for receipt of feet extending downwardly from the lower edge of the panels to interfit the panels vertically as well as laterally. Instead, the upper level of panels can be formed with a tongue and groove arrangement of the types described for centering the panels in their interfitting relationship with a sealing adhesive in between.

To assist in proper vertical alignment of the panels, use is preferably made of guide members dimensioned to have a length to overlap the adjacent vertical edges of the stacked panels. In the modification shown in FIG. 14, the vertical guide member comprises an H bracket **80** dimensioned to receive the side edge portions of adjacent panels therein for purposes of stabilization and alignment, or a T **81** with the stem between panels and the arms abutting the outer or inner walls of adjacent panels. Instead, use can be made of tubular members **82** adapted to be received in interfitting relationship within semi-circular grooved portions **84** in the side walls of adjacent panels, as shown in FIG. 15, or the guide members may be in the form of a cross **86** adapted to be positioned between the side walls of adjacent panels with the forwardly and rearwardly extending arms **88** and **90** located between the

adjacent laterally disposed panels and with the oppositely extending cross arms **90** and **92** received in fitting relationship in corresponding grooves provided in the side walls of adjacent panels, as shown in FIG. 16. The stabilizers are arranged to extend vertically and to overlap the adjacent upper and lower end portions of the adjacent vertically disposed panels to lock the panels in a properly aligned relationship. The described construction in the side walls, for accommodating the stabilizer members, can be limited to the end portions of the panels with the remainder in between having the tongue and groove arrangement previously described, or the stabilizers can be dimensioned to extend the entire length of the panels.

In the fabrication of panels with surface designs, such as the brick design of FIG. 5 or the stone design of FIG. 9, the panels are formed in a mold part **100** with the tubular members **102** supported by suitable elements to extend horizontally lengthwise through the central portion of the mold in the desired laterally spaced apart relation. If the inside wall **12** of the panel is to have a color or wood simulation, concrete of the particular color is introduced first to form the bottom layer **104** in the mold. Thereafter, or when no color is employed on the inside wall surface, the concrete is introduced into the mold to enclose the tubular members and to fill the mold except for a top layer of about ¼ to 1 inch in thickness. Cement or concrete embodying pigmentation for imparting the color of the desired brick is poured onto the surface in an amount to complete the panel thereby to provide a top layer **106** having a thickness of ¼ to 1 inch while the concrete filling the remainder is still wet.

Thereafter a template **108** formed with downwardly extend ribs **110** arranged to give the desired outline for brick construction is pressed downwardly into the surface of the colored layer **106** to impress the design into the layer. The grooves **112** representing the mortar lines in the impressed design are then painted with a cement or concrete composition or paint to bring out the mortar color in the depressed portions thereby to simulate a brick construction. Instead of using a cement, use can be made of a suitably colored paint composition. It will be apparent that instead of forming the mortar lines and subsequently coloring the impressions, the ribs of the template can be precoated to introduce the mortar color into the composite during the formation of the design in the colored layer.

The stone design in FIG. 9 can be similarly formed with a suitable cementitious layer and template or other desirable designs or configurations can be impressed as a permanent design into the surface. Similarly, by using a bottom mold wall having a ribbed design, a panel of corresponding design in the form of impressions can be formed on the inside wall.

It will be apparent from the foregoing that I have provided a new and novel monolithic panel formed of cementitious material which is characterized by high strength and light weight and which is adapted for mass production and assembly to produce an improved wall structure which avoids the problems of condensation and which provides means for heating, lighting and the like in the room.

The applicant's copending design applications Ser. Nos. D1247, D1248 and D1249, filed Mar. 2, 1966, are incorporated herein by reference for their initial filing date and disclosure of the panels shown in FIGS. 5 through 12.

It will be understood that changes may be made in the details of construction, arrangement and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. A wall comprising a plurality of precast, light weight, high strength monolithic panels of cementitious material each panel having flat front and back walls, side edges and top and bottom edges, tubular voids extending continuously through the interior of the panel in laterally spaced apart parallel relation from the bottom edge to a short distance from the top edge, the portions alongside and between the tubular voids extending downwardly as feet having a front to back thickness less than the thickness of the panel to provide horizontally disposed flanged portions extending inwardly from the front and back walls of the panel to the feet at a level slightly above the lower end of the feet, a tongue extending outwardly from one side edge and a groove dimensioned to correspond with the tongue in the other side edge for interfitting one panel with the others adjacent thereto in proper alignment to form a wall with said tongue and groove spaced inwardly a short distance from the front and back walls to provide flat lands on the side edges adjacent said tongue and groove portions, said panels being mounted in side by side relationship with the tongue in the side of one panel nesting in the groove in the side of adjacent panels, and a sealing adhesive joining the panels in sealing relation.

2. A panel as claimed in claim **1** which includes inserts embedded in laterally spaced apart relation in the top edge of the panel for receiving lifting devices.

3. A panel as claimed in claim **1** which includes a patterned design across the front wall of the panel.

4. A panel as claimed in claim **3** in which the patterned design comprises rectangularly raised portions of one color and recessed portions between said rectangularly raised portions of another color.

5. A precast, light weight high strength monolithic panel of cementitious material comprising a panel having flat front and back walls, side edges and top and bottom edges, tubular voids extending continuously through the interior of the panel in laterally spaced apart relation from the bottom edge to a short distance from the top edge, the portions alongside and between the tubular voids extending downwardly as feet having a front to back thickness less than the thickness of the panel to provide horizontally disposed flanged portions extending inwardly from the front and back walls of the panel at a level slightly above the lower end of the feet, a tongue extending outwardly from one side edge and a groove dimensioned to correspond with the tongue in the other side edge for interfitting one panel with the others adjacent thereto in proper alignment to form a wall, and which includes a continuous crosswise extending recessed portion in the inside wall of the panel adjacent the lower edge thereof, which extends into the panel for a distance to intersect the tubular voids and another recessed portion extending continuously crosswise in the wall of the panel at the upper end thereof for a distance to intersect the tubular voids to provide a continuous passage from the lower recessed portion upwardly through the tubular voids and out through the upper recessed portions for circulation through the interior of the panel.

6. A panel as claimed in claim **5** in which the recessed portion extends angularly downwardly from the back wall.

7. A wall formed of panels with each panel having flat front and back walls, side edges and top and bottom edges, hollow sections extending continuously through the interior of the panel in laterally spaced apart parallel relation from the bottom edge to a short distance from the top edge, the portions alongside and between the hollow sections extending downwardly beyond the remainder as feet having a front to back thickness less than the thickness of the panel to provide horizontally disposed flanged portions extending inwardly from the front and back walls of the panel at a level slightly above the lower end of the feet, a tongue extending outwardly from one side edge and a groove dimensioned to correspond with the tongue in the other side edge for interfitting one panel with the other adjacent thereto in proper alignment to form a wall, said panels being mounted in side by side relationship in the

wall and aligned and interfitted with the tongue in the side wall of one panel in nesting relationship with the grooves in the side wall of the adjacent panel in which the panels are also stacked vertically one on another and which includes stabilizers at the intersections between adjacent lateral and vertical panels in which the stabilizer comprises an elongate member vertically disposed between adjacent vertically disposed panels with portions thereof overlapping adjacent end portions of the adjacent vertically disposed panels vertically to align the panels.

8. A structure as claimed in claim **7** in which the stabilizer is T shaped in cross-section with the cross arms of the T abutting the edge portions of the adjacent panels and with the stem of the T interposed between the side edges of the adjacent panels.

9. A structure as claimed in claim **7** in which the stabilizer is H shaped in cross-section with the side edge portions of adjacent panels received in fitting relationship within the H slots and with the cross arm of the H extending between the side edges of the adjacent panels.

10. A structure as claimed in claim **7** in which the stabilizer is in the form of a tubular member and in which the overlapped side edges on the adjacent panels are formed with substantially semi-circular grooves to receive the tubular member therebetween.

11. A structure as claimed in claim **7** in which the stabilizer is in the form of a cross in cross-section with the arms extending in one direction between the side edges of adjacent panels and with the cross arms extending into grooves provided in the side edges of the adjacent panels.

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U.S. Cl. X.R.

52—221, 293, 303, 314, 436, 442, 593, 607