

[54] **WALL MADE OF A PLURALITY OF INTERCONNECTED COLLAPSIBLE MODULES AND METHOD OF ASSEMBLY**

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**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 95,009, Dec. 4, 1970, abandoned.

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[51] Int. Cl. .... **E04b 1/16, E04g 1/20**

[58] Field of Search ..... **52/380-383, 52/376, 645, 648, 745, 747, 650, 407-411, 378, 672, 250, 251; 46/14, 31**

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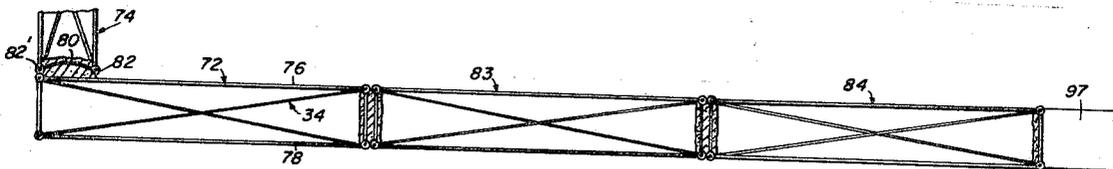
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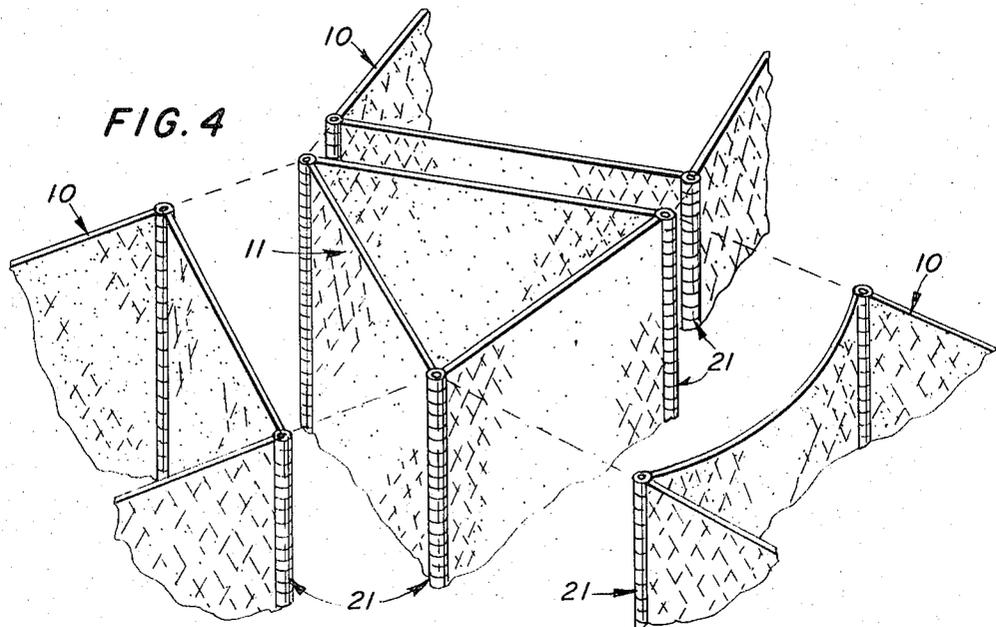
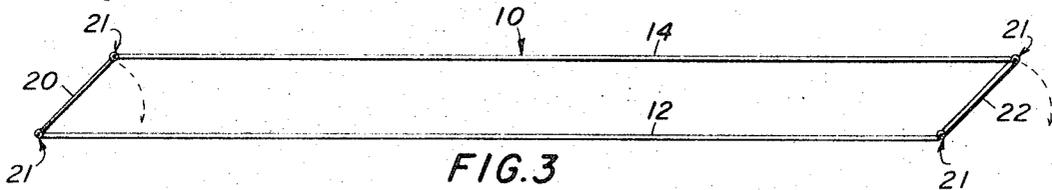
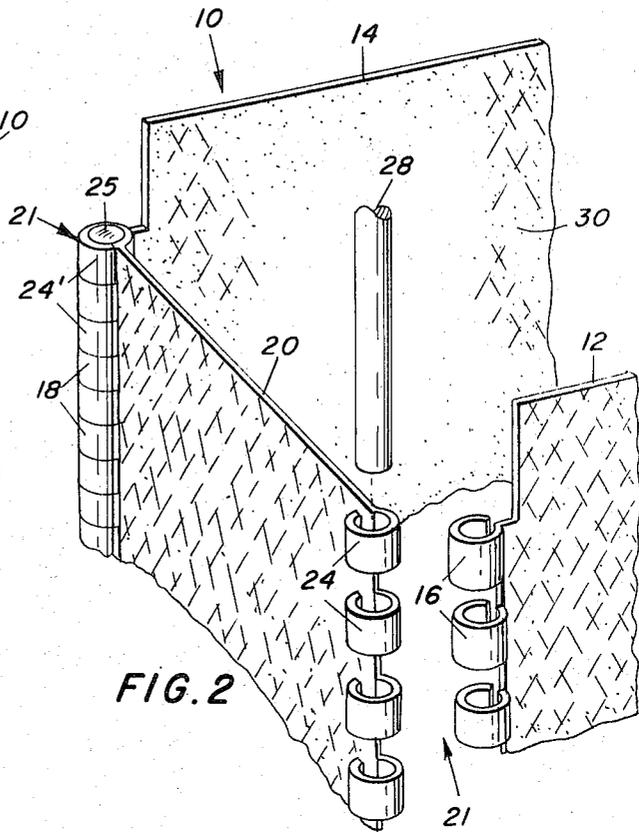
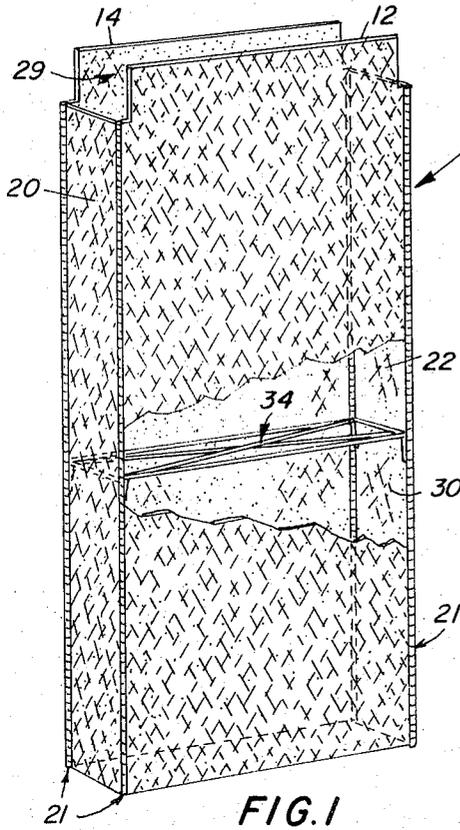
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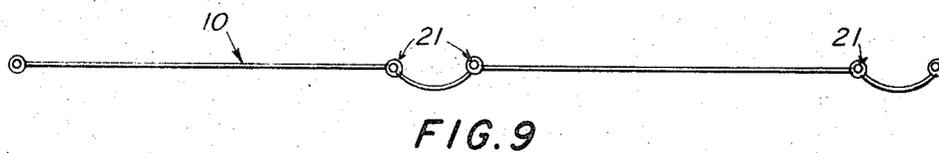
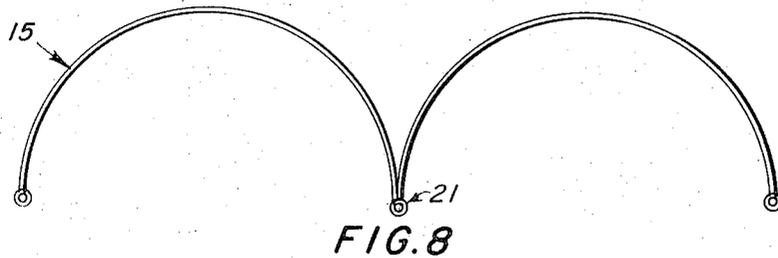
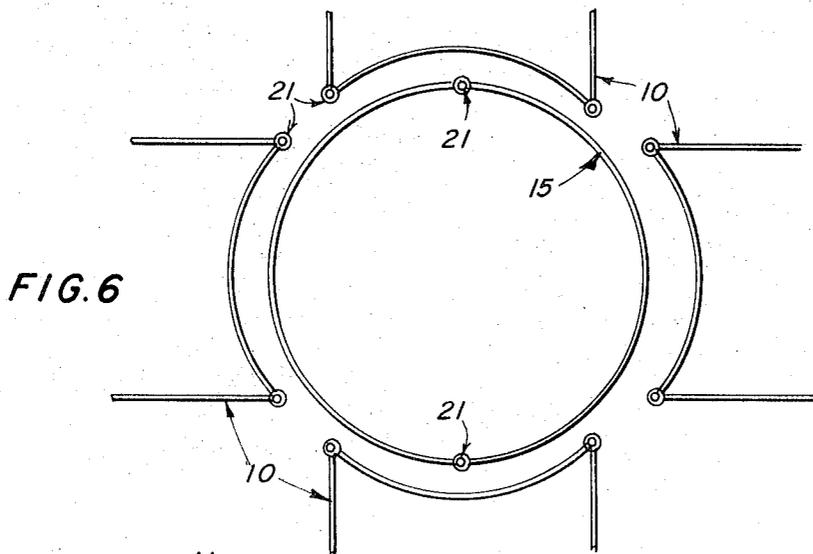
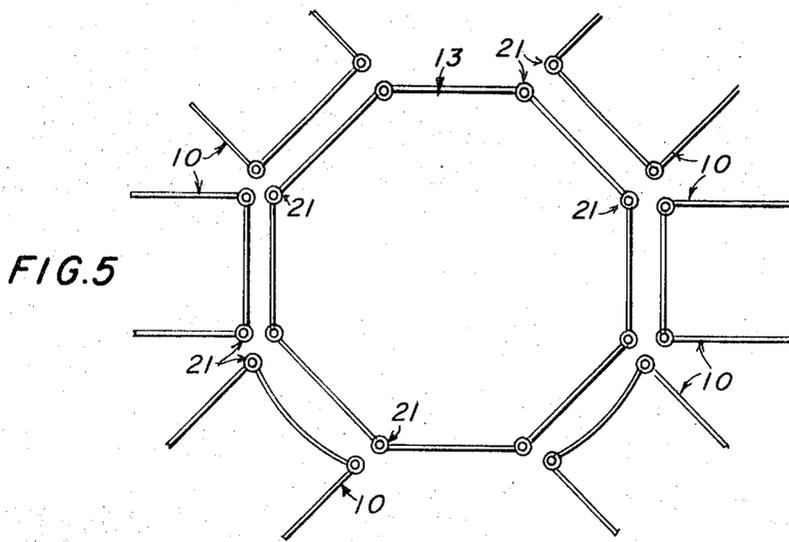
[57] **ABSTRACT**

This disclosure relates to a collapsible module for use in the construction of panels such as walls, floors and roofs, and a system for using the panels in the construction of building enclosures. The collapsible module comprises at least two lath sheets which are hingedly connected along adjacent edges to form a hollow structural component having a generally polygonal cross-section configuration. The hingedly connected sheets permit the module to collapse when not in use. A light stiffener coating may be applied sometimes to the surface of one or more of the sheets, and braces may be inserted sometimes within the module to help prevent it from collapsing while handling. In one embodiment, the hinge joints are located at the outside corners of the module such that when two such modules are placed side-by-side and joined together to form a wall structure, the hinges, together with the proximal sides of adjacent modules, define a space which is filled with cementous material to provide an integral structural column for the wall so formed. In another embodiment, one or more of the proximal adjacent sides of the modules forming the wall may be curved so as to define a larger space for the integral structural column. The integral structural columns provide more than enough load bearing capacity for the wall and no additional reinforcement is necessary.

**12 Claims, 20 Drawing Figures**







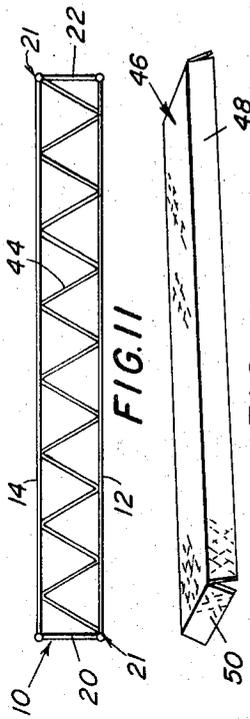


FIG. 10

FIG. 11

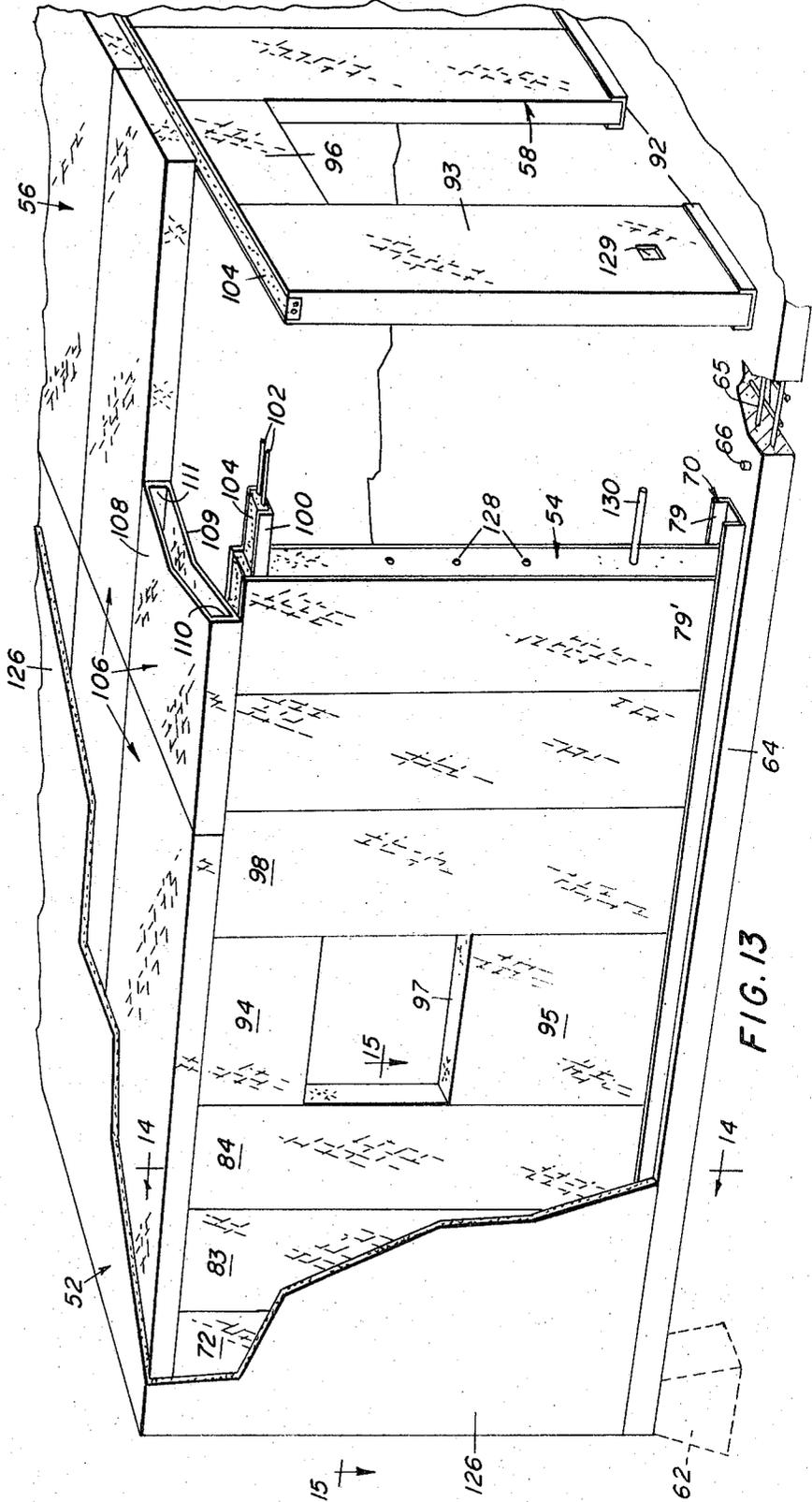


FIG. 12

FIG. 13

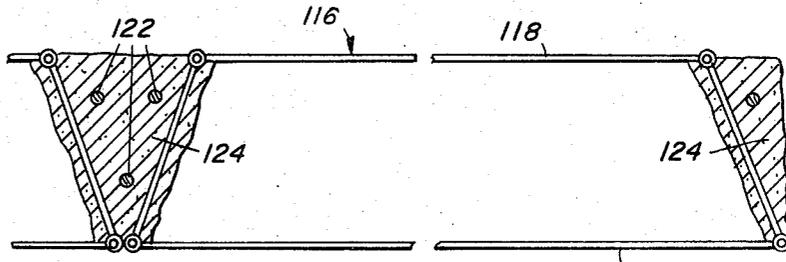
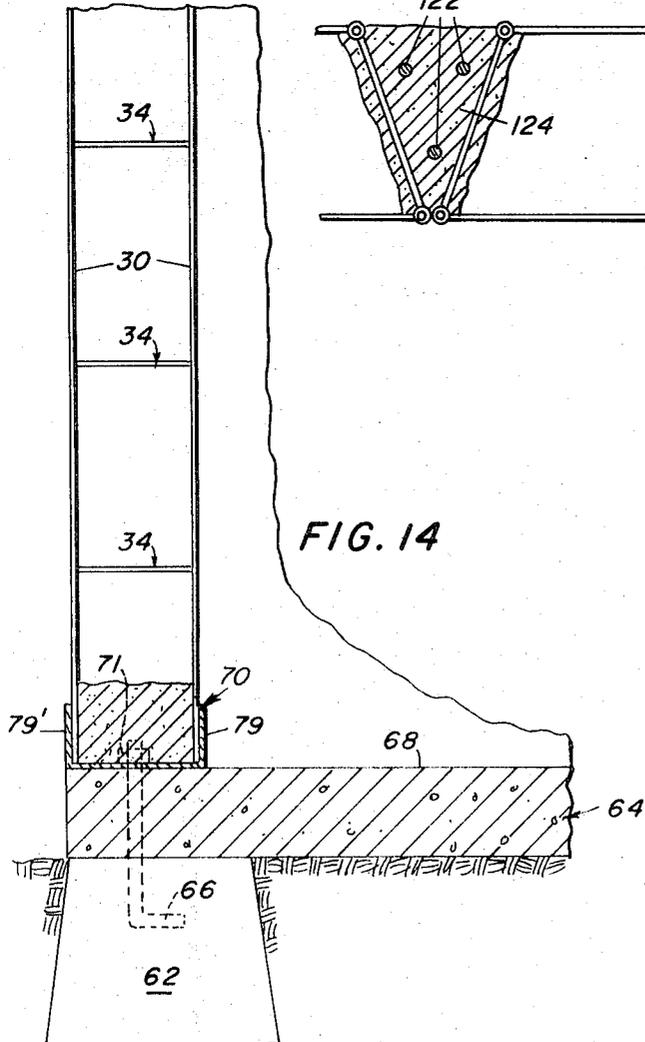
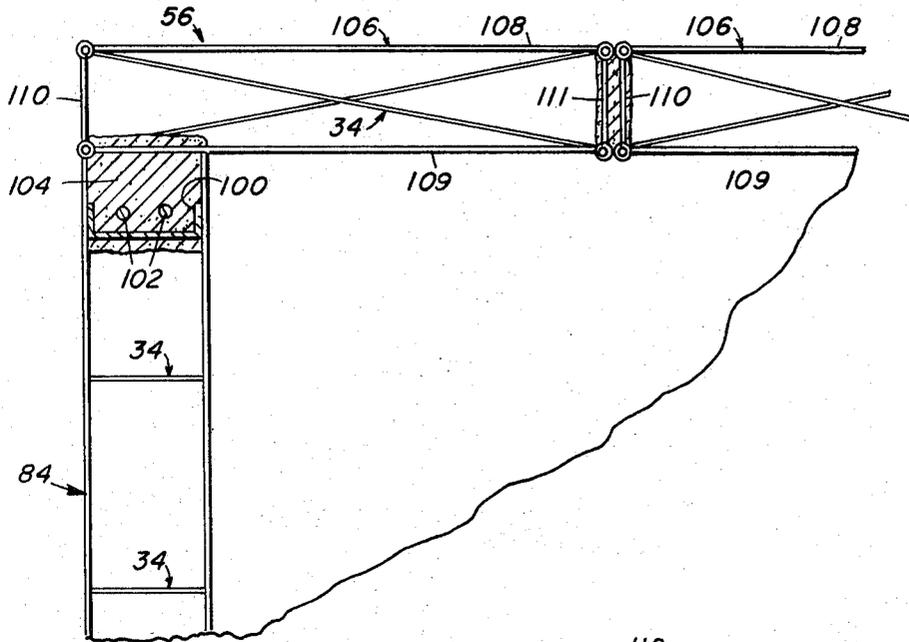


FIG. 19

FIG. 14

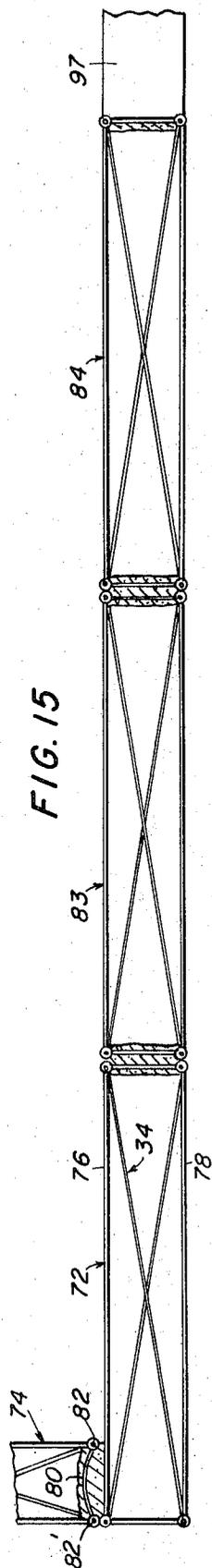


FIG. 15

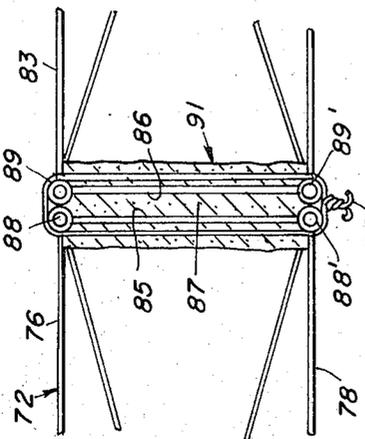
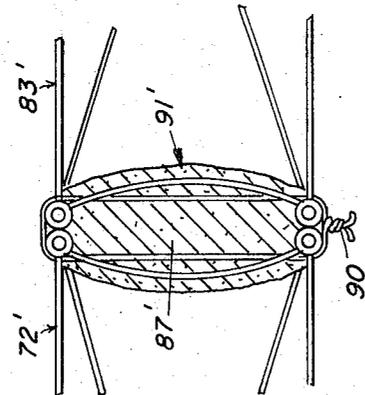
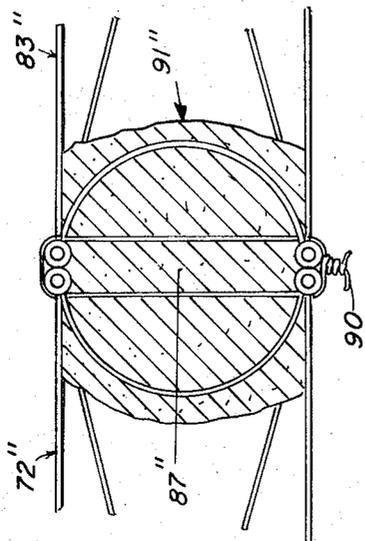


FIG. 16

FIG. 17

FIG. 18

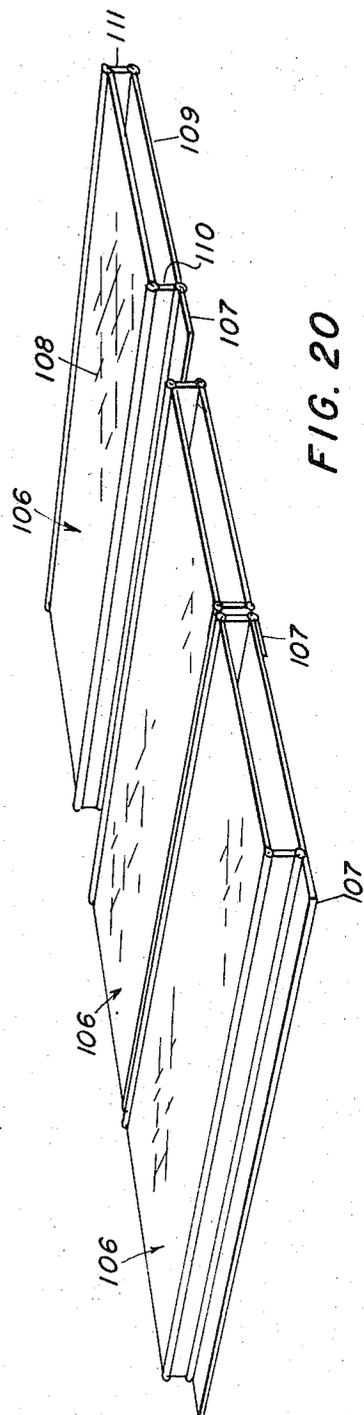


FIG. 20

**WALL MADE OF A PLURALITY OF  
INTERCONNECTED COLLAPSIBLE MODULES  
AND METHOD OF ASSEMBLY**

**RELATED APPLICATION**

This application is a continuation in part of Ser. No. 95,009, filed on Dec. 4, 1970, now abandoned.

**BACKGROUND OF THE INVENTION**

This invention relates to a collapsible module for use in the construction of panels such as walls, floors, roofs, etc. and, more particularly, to a hollow module which includes a plurality of lath sheets that are hingedly connected to one another along adjacent edges so that the hollow module may be collapsed to permit the module to be transported and/or stored more easily. Furthermore, the subject invention relates to a system for using the collapsible modules in conjunction with an integral structural column of cementous material to form the wall, floor and roof panels for use in the construction of building enclosures such as houses, warehouses, etc.

Presently, there are many known structural building modules which are used in the construction of panels such as walls, roofs, etc., and the modules are, in turn, used in the construction of enclosures such as houses, warehouses and the like. A great many of the presently known modules are manufactured away from the work site and then transported to the work site for erection. It has been the practice in the building industry that many of these presently known modules are made of a reinforced concrete slab. Although a few of these concrete modules have met with limited commercial success, the problems caused by their bulky size and the excess weight have reduced the effectiveness of such modules since they are very difficult to transport and store. Special procedures and machines are generally required in order to handle the module properly to prevent cracking during transportation. These special precautions add to the cost of the finished structure, thus the modules become very expensive. The excess weight and bulky size of such modules also require that only a few modules be transported at a time, thereby many truck or railroad car loads of the modules are necessary for the construction of a single housing unit, warehouse, etc. These disadvantages make the reinforced concrete modules relatively unacceptable in the building industry for use in prefabricated building structures.

The building industry has been searching for a component or module which can be used in a system for constructing low cost prefabricated housing. Such a component should have the advantages of simplicity of design. It should be lightweight and collapsible so that it may be transported and stored easily. Moreover, it should be made of a very inexpensive material so as to reduce the cost of the housing. The module should be fireproof and weather resistant, and it should have the required reinforcing members to insure that a structure made of these modules will meet the strength specification of most building codes. Furthermore, the module should be adaptable so that it can be used in the construction of a variety of single story structures and multi-story structures. One of the major expenses in the building industry is the cost of labor; therefore, the module should be of such design so that non-skilled la-

bor, without any special handling or assembling tools, can easily handle and transport the modules to the work site, and assemble them into panels which can be joined to form the walls, floor and roof of an enclosure.

**SUMMARY OF THE INVENTION**

It is, therefore an object of this invention to provide an improved structural module which can be used in a system for the construction of prefabricated buildings.

Another object of this invention is to provide an improved system for erecting prefabrication enclosures through the use of a light weight, collapsible module which permits the entire enclosure to be fabricated away from the work site and then easily transported to the work site for erection.

Another object of this invention is to provide a building system wherein the modules are joined together to form walls having integral structural columns by applying a cementous material between the proximal surfaces of adjacent modules while they are being secured together.

Another object of this invention is to provide a building system wherein modules can be joined together to form a wall structure having integral structural columns that provide in themselves more than sufficient structural strength and load bearing capacity to support roof loads.

Another object of this invention is to provide a building system wherein modules are joined together to form reinforced roofs having integral structural beams by applying a cementous material between adjacent modules as or after they are secured together.

Another object is to provide a modular wall structure that can be reinforced and/or decorated by applying a suitable material to the surfaces of the modules.

Another object of this invention is to provide a collapsible module which has a trough along its upper edge that can be filled with a suitable material to form a reinforced integral beam.

Another object of this invention is to provide a collapsible module which, in its non-collapsed state, has an extension along its bottom surface that can be disposed beneath an adjacent module of a roof panel, such that the extension and the proximal sides of the adjacent modules define a trough that can be filled with a suitable material to form an integral structural beam.

Another object of this invention is to provide a structural module which can be transported without requiring special handling equipment and which can be erected into an enclosure without special tools.

Another object of this invention is to provide a modular building enclosure which is fireproof and weather resistant and which will meet the design specification for an earthquake environment.

Another object of this invention is to provide a building system having modules which can be adapted to construct panels for a variety of walls, floors, and roofs which can be used in the construction of multi-story structures.

Another object of this invention is to provide a module which can be used as a form for the construction of columns, beams, etc. when filled with a suitable filler material.

These and other objects are accomplished by the present invention through the use of a collapsible mod-

ule including at least two hingedly connected lath sheets which form a hollow component. The module, in its non-collapsed state, may vary in cross-sectional configuration depending upon the number of lath sheets from which it is comprised and upon whether the lath sheets are curved or flat. Thus, the modules may comprise two curved lath sheets so as to exhibit an oval or circular cross-section. Similarly, the modules may comprise three, four, five, etc. flat lath sheets so as to define a triangular, rectangular (or trapezoidal), pentagonal, etc. cross-section, respectively. In addition, the modules may comprise one or more curved sheets in combination with one or more flat sheets as described hereinbelow and illustrated in the drawings.

Regardless of the cross-sectional configuration of the modules in their non-collapsed state, each of the lath sheets comprising the modules is provided with a plurality of spaced rings along two parallel edges which are adapted to intermesh or interlock with corresponding rings on adjacent lath sheets. A securing means or rod is inserted through the interlocked rings of the adjacent lath sheets, thereby forming a hinge connection which permits each module to collapse. It should be noted that in all but the generally rectangularly shaped modules, at least one rod must be removable in order for the module to collapse.

The surface of the lath sheets may be lightly sprayed with a thin scratch or stiffener coating of a cementous material which adds rigidity to the lath sheets, thus reducing the buckling effect of the sheets when the modules are being handled. Furthermore, to permit the module to be handled more easily and prevent it from collapsing while adding to its strength when used in a structural environment, a plurality of braces may be inserted into the hollow component.

A building enclosure is formed from a plurality of noncollapsed modules which are erected in a base tract that is secured to a preformed foundation and floor. The base track defines the outline of the outer and inner walls of the building enclosure. The adjacent modules are secured together by wiring or stapling after first applying a coating of cementous material between the proximal sides thereof. As used herein, the term "cementous material" is meant to describe not only compositions or materials containing Portland cement, but also other suitable materials of construction characterized by a strength comparable to conventional mortar having a compression strength of 3,000 psi after 28 days and by a consistency which will permit the cementous material to be forced or otherwise exuded through the openings in the lath sheets of the modules. In a preferred embodiment, the cementous material is compounded to a consistency such that the portion of the cementous material that is forced through the openings in the lath sheets will bleed, run, or otherwise slump sufficiently to key the cementous material to the coated lath sheets. In a most preferred embodiment, the cementous material that is forced through the openings of the lath sheets will run together sufficiently to form a substantially continuous layer of cementous material on the inside surface as well as the outside surface of the coated lath sheets.

Thus, as the coating of cementous material on the proximal sides of the adjacent modules hardens, it forms an integral structural column at each place of connection between the adjacent modules and thus

provides more than sufficient structural strength and load bearing capacity to support roof loads.

Because of the strength contributed by the integral structural columns, the lath sheets comprising the inside and outside faces of the wall structure need not be reinforced. However, should a reinforced wall structure be desired, for example, as a foundation wall of a building, a coating of cementous material may also be applied to the surfaces of the modules such that a portion of the cementous material is forced through the openings in the lath sheets to form a layer on the inside surfaces of the lath sheets. A wall structure formed in this manner would thus comprise a reinforced wall panel having a plurality of spaced columns integrally formed within the panel at the place of connection between adjacent modules. Should an even stronger wall structure be desired, a fully erected and assembled wall of hollow modules may be used as a form for filling with poured concrete, thereby resulting in a solid masonry wall. Regardless of whether the lath sheets comprising the surfaces of the modules are reinforced, they may be coated with plaster or wall board, asphalt, gypsum, synthetic resins, etc., as desired to meet specific weather and/or decorative requirements.

In one embodiment, a trough is formed along the upper edge of the wall panel by reducing the height of the connecting lath sheets on each module. An upper closing track is secured within the trough to close the bottom thereof. Reinforcing rods are set within the trough which is then filled with a cementous material to form a reinforcing beam along the upper edge of the panel.

The module may be used to form roof components for the building structure which are similar to the wall modules. In one embodiment, each end of the roof module is stuffed with a lath lid which closes the open ends forming a closed module. Generally, the roof modules extend from the outer edge of the outside wall panel of a building enclosure to the midpoint of the interior wall panels, and they are generally secured to the wall panels by stapling, wiring or other suitable means. The adjacent roof modules are secured together by wiring, and a coating of cementous material is applied between the adjacent roof modules and, optionally, to the outside of the lath sheets. Thus, a continuous reinforced roof panel is formed having a plurality of integrally formed beams which are spaced throughout the roof panel at the connecting joints between adjacent roof modules. In another embodiment, one side of the bottom sheet of each roof module extends several inches beyond the corresponding connecting rod so that when a plurality of roof modules are placed along side each other, several inches apart, the lath sheet extension of each module would extend beneath and be secured to the adjacent module. The proximal sides of the adjacent modules and the lath sheet extensions would thus define troughs which can be filled with a cementous material to form integral beams spaced throughout the roof panel.

The modules are used for the construction of various types of single-story building enclosures and can also be used to construct multi-story buildings by simply erecting subsequent floor levels on one another by repeating the process for forming a single-story structure. The modules, particularly a round module comprising two curved lath sheets with hinged edges connected by

two rods, may also be used separately as a form for pouring a free-standing column.

### BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and additional objects, features and advantages of the present invention will be apparent to those skilled in the art from the following detailed description of a preferred embodiment taken with the accompanying drawings, in which:

FIG. 1 is a perspective view of a collapsible wall module according to the present invention, illustrating a rectangular cross-section;

FIG. 2 is an exploded detail view of a portion of the collapsible wall module shown in FIG. 1, illustrating a suitable means for securing adjacent lath sheets together according to the present invention;

FIG. 3 is a top plan view of a collapsible module according to the present invention, illustrating the module in a partially collapsed position;

FIG. 4 is a partial perspective view illustrating a collapsible module having a triangular cross-section adjacent three additional modules according to the present invention;

FIG. 5 is a plan view illustrating a module having an octagonal cross-section adjacent four additional modules according to the present invention;

FIG. 6 is a plan view illustrating a collapsible module having a circular cross-section, adjacent two additional modules that embody the present invention;

FIGS. 7 - 9 are plan views of modules according to the present invention, illustrating an alternative method of collapsing the modules by removing one of the securing rods so that the modules can be stacked for storage and/or transport.

FIG. 10 is a perspective view of a brace according to the present invention, which brace is inserted within the module to prevent the module from collapsing when it is used as a structural environment;

FIG. 11 is a plan view of a collapsible module showing an alternative bracing arrangement wherein a corrugated or folded lath sheet is inserted within the module to prevent its collapsing;

FIG. 12 is a perspective view of a lath bracing lid which is used as a closing member to be inserted into the ends of the module according to the present invention;

FIG. 13 is a perspective view of a portion of a building enclosure illustrating the various configurations of the collapsible modules which are used in a building system according to the subject invention;

FIG. 14 is a cross-section taken on line 14-14 of FIG. 13;

FIG. 15 is a cross-section taken on line 15-15 of FIG. 13;

FIGS. 16 - 18 are exploded detail views of typical connections between two adjacent modules according to the subject invention;

FIG. 19 is a partial end view of an alternative embodiment of a roof or floor module, illustrating a modified configuration of the module wherein a V-shaped groove is formed between adjacent modules; and

FIG. 20 is a partial perspective view of an alternative embodiment of a roof or floor module, illustrating a modified configuration of the module wherein an extended portion of the bottom of one module is disposed beneath the bottom of an adjacent module to define a trough between adjacent modules.

### DESCRIPTION OF THE INVENTION

#### Modules

Referring to the drawings, in FIG. 1, the numeral 10 indicates one embodiment of a collapsible module in accordance with the present invention, and more particularly, a collapsible module which is suitable for use as a component of a wall panel in a building enclosure. The module has a pair of spaced parallel side sheets 12 and 14 which can be made of any suitable material. In the preferred embodiment, the sheets are of a thin gauge lath sheet. Preferably, the side sheets are approximately 2 feet in width by 8 feet in height. Along their vertical edges, the lath side sheets 12 and 14 have a plurality of spaced rings, hooks or circular prongs 16, 16' (not shown) and 18, 18' (not shown) (see FIG. 2). A pair of flat connecting sheets 20 and 22 having a plurality of spaced rings or hooks 24, 24' and 26, 26' (not shown), respectively, along their vertical edges are intermeshed, or interlocked, with the rings 16 and 16' and 18 and 18' on the vertical edges of side sheets 12 and 14 such that the module 10 has a generally rectangular cross-section.

In one embodiment, the connecting sheets 20 and 22 are approximately 3 inches to 4 inches shorter than the side sheets 12 and 14 and approximately 6 inches in width, so as to form a trough 29 along the upper edge of the module. It should be understood, however, that the connecting sheets need not be shorter than the side sheets and that the lath sheets comprising the module can be fabricated to any desired size and configuration. Moreover, the gauge of the lath sheets can be varied to conform to the strength requirements for the module in accordance with the particular structure in which the module is to be used.

The rings on the side sheets 12 and 14 extend inwardly and the rings on the connecting sheets 20 and 22 extend outwardly, the significance of which will be explained hereinafter. In one embodiment, the interlocking rings of the adjacent lath sheets form a bore 25 approximately  $\frac{3}{8}$  inches in diameter through which a securing member 28 such as a steel rod may be inserted. The securing rod and interlocking rings along the four corners of the module form pivotal hinges 21 which permit the module to collapse as illustrated in FIG. 3. It will be appreciated that any suitable method may be used for forming hooks or rings on the vertical edges of the lath sheets. For example, the lath sheets can be cut by a suitable machine so that a plurality of flat, equally spaced tabs extend from the edges of the lath sheets. A suitable die pressing apparatus can be used to form the tabs into rings or hooks. Preferably, the rings on the side sheets are formed inwardly while the rings on the connecting sheets are formed outwardly, as seen in FIG. 2. The rings, hooks and rods can be replaced by forming or molding the edges of the sheets in any known manner to form a hinge connection between adjacent sheets. For example, the edges of one sheet can be curled to form a cylindrical rod the full length of the sheet and the edges of an adjacent sheet can be formed in a circular bore its full length so that the sheet can be connected by sliding the cylindrical rod into the circular bore. In an alternative embodiment, the rings could be replaced with perforated tabs designed to receive the connecting rods. This may be accomplished, for example, by a simple stamping and die press operation whereby the unperforated edges of

the lath sheets are cut to form tabs and holes are punched out of each tab to accommodate connecting rods. Thereafter, by simply twisting the tabs containing the holes, hinges would be formed ready to accommodate connecting rods.

Although the module 10 has a rectangular cross-section, any desired number of sheets may be used to form the module. Thus, a triangular module 11 (FIG. 4), an octagonal module 13 (FIG. 5), etc. can be formed merely by employing the appropriate number of lath sheets. The use of curved lath sheets adds still further to the flexibility of the present invention, since it enables the formation of a module 15 (FIG. 6) having a circular or oval cross-section. Modules comprised of flat lath sheets and curved lath sheets (FIGS. 4 - 6) offer additional advantages as discussed more fully hereinbelow. It will be appreciated that modules having other than a rectangular cross-section can still be collapsed for shipment or storage by simply removing one of the securing rods 28 and unfolding the given module into as flat a configuration as possible, as seen, for example, in FIGS. 7 - 9. Obviously, a module having a rectangular cross-section can also be collapsed by removing one of the securing rods.

The modules described above can be used in accordance with the method of the present invention to construct partitions, walls or the like, which would be capable of carrying normal roof loads. However, the individual modules, themselves, may not be strong enough to withstand the loads to which they might be subjected when being handled prior to or during the fabrication of building structures, since the lath sheets from which they are made are relatively flexible and may bend when suspended over a long span or buckel when a compression load is applied thereto. In order to alleviate this problem the gauge of the lath sheets can be increased somewhat or the size of the securing rods may be increased. Various other means can be used to strengthen the module, for example, a thin scratch or stiffener coating 30 (see FIGS. 1 and 2) may be trowled, sprayed or otherwise suitably applied to the surface of each of the lath sheets 12, 14, 20 and 22. The stiffener coating 30 may be a cementous material, plaster, plastic, etc. The stiffener coating is applied to the lath sheets so that it does not fill the openings in the lath sheets, and it has been found that it is preferable not to apply the coating to the ring portion of the sheets to insure that the module will collapse easily. It will be noted that the function of the stiffener coating 30 is merely to ensure that each module will have sufficient rigidity so that it may be handled easily without bending or otherwise being damaged. Thus, it can be seen, that the above-described module will be lightweight; a typical wall module will weigh approximately 25 pounds.

Although the stiffener coating 30 will increase the rigidity of the lath sheets of the modules, the modules may still be subjected to forces while being handled which will cause them to collapse. Therefore, it may be desirable to use a suitable bracing means to prevent the modules from collapsing. Various types of braces can be used, and one such brace 34 is illustrated in FIG. 10. The brace 34 has a rectangular wire frame having diagonal stiffeners 38 and 40 extending across the frame and being secured at the corners of the frame in any desired manner. At each corner of the rectangular frame is a downwardly and outwardly extending member 42

made of heavy wire which will permit the braces to be force fit within the module 10. The brace is installed merely by inserting the braces into the module to the desired level. The heavy "force fitting" wire members 42 at each corner will hold the brace in position. A plurality of braces 34 may be positioned within the module at predetermined locations, the number of braces needed being determined by the size of the module 10, the gauge of the lath sheets, etc. The braces not only prevent the module from collapsing during handling but they provide additional support for the lath sheets.

An alternative brace means, shown in FIG. 11, comprises an elongated lath sheet 44 formed in a corrugated or sawtooth configuration so that the peaks of the corrugated member extend between the side edges 12 and 14 of the module 10. This type of brace is more expensive than the brace shown at 34 but gives more support to the module because the lath sheet extends the entire length of the module 10. Another type of brace which can be used to prevent collapsing of the module is shown in FIG. 12. The brace or lid 46 is made of a sheet of lath which has outwardly extending sides 48 and 48' (not shown) and downwardly extending ends 50 and 50' (not shown). The brace 46 can be inserted within the module 10 in a similar manner as the brace 34, and can be stapled or wired within the module in any suitable manner. The brace or lid 46 is primarily used in the open ends of the module in order to make a completely enclosed module such as a roof module which will be described hereinafter.

#### BUILDING SYSTEM

Turning now to a building system embodying the present invention, FIG. 13 illustrates a portion of the building enclosure 52 having an upstanding vertical outside wall panel 54, a roof panel 56 and interior wall panel 58, all of which are formed from various configurations of the collapsible structural module 10 which is described hereinabove. Prior to the erection of the building enclosure 52, the site must be prepared and any method known in the art can be used. For example, a plurality of spaced footings 62 can be poured in a desired arrangement or a single continuous foundation having a rectangular cross-section and defining the outline of the enclosure can be poured into a prepared trench. The foundation can be made of any standard material such as concrete and should conform to the requirements of the building code specifications in the particular area in which the enclosure is built. After the site has been prepared and the foundation poured and cured, a floor slab 64 is formed on the foundation. In a preferred embodiment, slab 64 is of standard size which is approximately 4 inches thick and has reinforcing members such as wire grid 65 or No. 4 steel bars embedded within the slab. Any known method of forming the floor slab may be used such as pouring the filler material into an enclosed form or preforming the slab in sections which are in turn installed on the footing or foundation.

#### WALL PANEL

In a preferred embodiment, the floor slab is prepared with a plurality of J bolts 66 or other suitable securing means extending therethrough and embedded in the foundation 62 (see FIG. 14). The J bolts 66 extend upwardly through the top surface 68 of the floor slab 64,

thereby permitting a U-shaped base track 70 (see FIGS. 14 and 15), runner, channel, etc. to be secured to the floor slab. The base track 70 in the preferred embodiment is fabricated from lath or light perforated metal. The base track 70 is secured to the floor slab and defines the outline location of the outside walls 54 and inner walls 58 of the building enclosure. Suitable nuts 71 are threaded onto the J bolts 66 to hold the base track in place, as can be seen in FIG. 14. Other suitable means can be used such as molly anchors, cement nails, etc., to secure the base track 70 in place.

After the base track 70 has been secured to the floor slab 64, the locations of the various types of modules which are used in the wall construction are marked on the track and then the outer wall modules are erected. Normally, the first two wall modules to be erected form the corner of the building structure 52 as indicated by modules 72 and 74 illustrated in FIGS. 14 and 15. Corner wall module 72 is secured to the base track by stapling or wiring the side lath sheets 76 and 78 to the up-standing legs 79 and 79' of base track 70. The corner module 74 is then placed within the base track 70 at right angles to module 72 but is not yet secured in place. Prior to stapling or securing the corner module 74 to the base track 70 and to corner module 72, a coating of cementous material is applied to the connecting lath sheet 80 of module 74 and to the end portion of side sheet 76 of module 72. The coating may be applied to the lath sheets in any suitable manner, for example, by troweling so that when the module 74 is moved along the base track to the position shown in FIG. 15, the space 81 between connecting lath sheet 80 and side lath sheet 76 which is formed, in part, by the rings 82 and 82' along the edges of the module 74 will be filled with the cementous material. The consistency of the cementous material is such that the movement of module 74 toward the side of module 72 will cause a portion of the cementous material to exude or pass through the openings in the lath sheets 76 and 80 thereby forming a keying layer of cementous material 85, 85' approximately 1/2 inch in thickness which adheres to the inside surface of the respective lath sheets. It is preferred that the consistency of the cementous material be such that the portion which exudes through the openings in the lath sheets will blend and run together on the inside surfaces of the sheets to form the continuous layer. After the cementous material is applied to each of the modules 72 and 74, and the module 74 is positioned in place, the module 74 is wired or stapled to track 70 and to module 72 along their proximal surfaces. Upon erection of the two corner modules 72 and 74, the outer wall 54 of the enclosure 52 is then erected by securing subsequent wall modules to the corner modules 72 and 74 in the manner described above. It will be appreciated that the cementous material in the space 81 and on the lath sheets 76 and 86 will set to form an integral structural load-bearing column, and that similar load-bearing columns will be formed between each adjacent module in the wall structure. It will be appreciated, further that the integral structural columns will provide substantially all of the necessary load bearing capacity of the wall structure.

#### INTEGRAL STRUCTURAL COLUMNS

The formation of integral structural columns between adjacent modules, simultaneously with the erection of the modules into a wall structure is an important

feature of the present invention. In this regard, it will be appreciated that the shape and load-bearing capacity of the respective integral columns can be controlled by preselecting the configuration of adjacent modules, the spacing between adjacent modules, and the manner in which they are connected. For example, as illustrated in FIGS. 16 - 18 where corresponding parts have corresponding numbers, the structural columns may be formed so as to have a generally rectangular, oval or circular cross-section, respectively. As explained above with respect to corner modules 72 and 74, a coating of cementous material is applied to connecting sheet 85 of module 72 and connecting sheet 86 of module 83 prior to securing module 83 to the base track 70. Then, by moving module 83 towards module 72, the coating is forced through the openings in the lath sheets so that a 1/2 to 3/4 inch layer adheres to the inside surface of the lath connecting sheets 85 and 86. A sufficient quantity of the cementous material is applied to the outside surfaces of the connecting sheets 85 and 86 so that the space 87 between the sheets 85 and 86 is filled. The width of the space 87 can be controlled by the workman erecting the wall structure merely by controlling the amount of cementous material applied to the sheets 85 and 86 and the force used to move module 83 toward module 72. In this latter regard, it will be appreciated that when sufficient force is used to bring adjacent modules into contact, the width of the space 87 between the modules is defined largely by the outwardly extending rings 88 and 88' along the edges of module 72 contacting the rings 89 and 89' along the edges of module 83. When modules of rectangular configuration are used (FIG. 16) this space would normally be approximately 3/4 inch if 3/8 inch securing rods 28 are used in the modules. The module 83 is secured to the base track 70 by wiring the side sheets to the upturned edges of the base track, and the adjacent modules 72 and 83 are secured together by forcing a plurality of U-shaped securing fasteners or wires 90 through the openings in the side sheets of the module 72 and 83 and the cementous material which is applied to the connecting sheets 85 and 86 so that the securing wire 90 will extend through the module and emerge on the opposite side of the module. The ends of the securing wires 90 are then twisted together and either bend upward or downward to contact the surface of the module. As can be seen, this typical connection produces a reinforced laminated integral column 91 or stud having a cross-sectional area of approximately 13 1/2 square inches (2 1/4 inches x 6 inches). It should be understood that the above-described securing method for adjacent modules, which is merely exemplary, is typical and can be used at the connecting joint between adjacent modules in the outer and inner wall panels.

The inner wall panels 58 are formed similarly to the outer wall panels. For example, an inner base track 92 (shown in FIG. 13) defining the configuration of the rooms of the building enclosure 52 is secured directly to slab 64 by molly anchors or the like. The inner wall modules 93 are fabricated in the same configuration as the outer wall modules and are secured to the base track 92 in a similar fashion by stapling the side sheets of the modules to the upright legs of the base track.

#### WINDOWS AND DOORWAYS

Although the outer wall panel 54 and inner wall panel 58 can be a solid wall with no openings, there will

normally be window and doorway openings through these wall panels at preselected locations. As can be seen in FIG. 13, the preferred embodiment has an upper and lower window module 94 and 95, respectively, located in the outer wall 54 and an upper doorway module 96 located in the inner wall panel 58. It should be understood that similar window and doorway modules can be used in any of the wall panels, and that the location, size and number of the doorway and window openings will be within the discretion of the designer and/or should correspond to the number and size required by the building code of the area where the structure is erected.

The window and doorway modules will be structurally the same without regard to the particular location in which they are located except in some situations, the size of the modules will vary. It should, therefore, be understood that the following description of the window and doorway modules, and the method of securing them in their respective locations will be typical of all installations throughout the building enclosure.

The lower window module 95 is made similar to the module 10 illustrated in FIG. 1 and has two lath side sheets connected on each end by a connecting sheet. Preferably, the connecting sheets are approximately 30 to 45 inches in length and 6 inches in width while the side sheets are 30 to 45 inches in length and 2 to 4 feet in width. One or more braces as desired, conforming to the configuration shown in FIG. 10, are positioned within the module. One end of the lower window module 95 has a lid 97 (illustrated in FIG. 12) to close off the end of the module and form the window sill. The lower window module 95 is installed within the base track 70 and is secured to adjacent wall modules 84 and 98 in the same manner as two standard wall modules described hereinabove.

The upper window module 94 is of similar configuration to the standard module 10, however, it is shorter in length, since its size will depend upon the size of the window opening desired. The upper window module 94 has the short connecting sheets, therefore, when it is installed between wall modules 84 and 98, the trough along the upper edge of the wall modules will be continued. The lower end of the window module 94 has a lid secured therein to close off the module and form the window head.

Turning now to the upper doorway module 96, this module is fabricated in the same configuration as the upper window module 94 except it will generally vary in size to conform to the width and height of a standard doorway passage. As can be seen in FIG. 13, the doorway module 96 is installed in the inner wall panel 58 between adjacent wall modules and forms the head of the doorway. The inner base track 92 in which the inner wall panel 58 is secured is discontinued through the doorway passage portion of the wall as can be seen in FIG. 13.

Simultaneously or after the inner and outer wall panels are erected, a plurality of U-shaped channel members or top tracks 100 (see FIGS. 13 and 14) are secured along the top edge of the connecting sheets of each of the modules and, therefore, on top of the integral structural columns between the modules, to form the bottom of the trough 29 along the entire upper edge of the inner and outer wall panels. The channel members 100 can be made of any suitable material, but preferably lath sheets should be used. The channels 100 are

secured to the side sheets of the wall panels and to the top of the connecting sheets by wiring, stapling or in any other suitable manner. After the channels 100 are secured to the modules, a pair of reinforcing rods 102 such as No. 4 steel rods are set and suitably secured within the trough 29 so that they will be embedded in a filler material 104 which is then poured into the trough. The filler material may be the same as the cementous material used to form the integral structural columns, or any other suitable material. The filler and reinforcing rods provide for a reinforced beam along the upper edge of the wall panels, thus providing a beam to receive and support the roof panel. As mentioned above, the beam is supported by the integral structural columns located at the connection between the adjacent modules of the wall panel.

### ROOF PANEL

Turning now to the installation of the roof panel 56, as can be seen in FIGS. 13 and 14, each of the roof panels 106 is made similarly to the wall panels 10, in that, each has lath side sheets 108 and 109 and lath connecting sheets 110 and 111; however, the side and connecting lath sheets of the roof modules illustrated in FIGS. 13 and 14 are the same length. The roof modules 106 generally extend from the outside sheet of the outer wall modules to the midpoint of the inner wall panels. Therefore, in a building enclosure having rooms of standard size, the roof modules have an unsupported length of approximately 12 to 18 feet. It has been found that a module having an unsupported length of 10 feet and being approximately 2 feet in width does not have sufficient rigidity to prevent overstressing of the roof modules, but there are various modifications which can be made to the basic module to increase its rigidity. For example, the lath gauge and securing rod size can be increased, a scratch coat can be applied to both sides of the lath sheets in the module, an increased number of wire braces 34 or the sawtooth brace 44 can be used, the connecting sheets can be widened to a 10 inch width so that the depth of the module is increased, and/or the side sheets can be reduced in width from 2 feet to 18 to 12 inches. Any one or a combination of these modifications can be used.

Each of the roof modules 106 has a pair of lids 113 and 113' (not shown), which are similar to the lid 46 described above and illustrated in FIG. 12, and which are inserted and secured in a suitable manner in the opposite open ends of the module. Therefore, a completely closed module is formed. Normally, the corner roof module is installed first (see FIG. 14) by applying a coating of cementous material to a portion of the side 109 of the module 106 which will be in contact with the filler material 104 along the upper edge of the outer wall panel modules 54, and then forcing the roof module against the upper edge of the wall panel. Successive roof panels can be secured together in the same manner as has been hereinabove explained with respect to the wall modules. A coating of cementous material is applied to the adjacent connecting sheets of the roof modules and the modules are wired together to form the roof panel. This method of installation produces a plurality of reinforced beams 115 integrally formed throughout the roof panel. In an alternative embodiment, illustrated in FIG. 20, one side of the lath side sheet 109 of the roof modules 106 is provided with a lip 107 which extends several inches beyond the con-

necting rod that joins the side lath sheet 109 to the connecting lath sheet 111. In this manner, successive roof panels can be secured next to each other such that the lip 107 of a given module is beneath the side lath sheet 109 of the next adjacent module, and such that the connecting lath sheet 111 of the given roof module is spaced a short distance from the connecting lath sheet 110 of the adjacent module. The connecting lath sheets 110 and 111 and the lip 107 thus define a trough or channel between the adjacent roof modules which can be used to form a reinforced beam as has been described hereinabove in connection with the trough 29 and channel members 100.

FIG. 19 illustrates still another modification which can be employed to increase the strength of the modules which are used to form roof or floor panels. The modified module 116 is fabricated so that its cross-sectional area is in the form of a trapezoid. As can be seen in FIG. 19, the upper side sheet 118 of the module 116 is fabricated at a width less than the lower side sheet 120, approximately 2 to 3 inches less, thus when two of the modified modules 116 are secured together, a V-shaped groove will be formed. Thus V-shaped groove or channel serves as a form so that a plurality of reinforcing rods 122 and a filler material 124 can be disposed within the groove, and thus form a reinforced beam which is substantially larger than one which would be formed by using the standard roof modules 106. The braces and lids which are used in the modified module will necessarily conform to the cross-sectional area of the module 116.

#### SURFACE COATINGS

As indicated above, it is often desirable to coat the exposed surfaces of the respective wall, roof and floor panels with a material that will render such panels weather resistant, attractive, and the like. Accordingly, it is contemplated that the individual modules and erected panels described herein would be coated, or covered with various materials in varying amounts. The method and procedure for applying such coating materials can be varied. For example, as each individual module is installed one or more coating materials can be applied thereto by hand trowel. Similarly, a plurality of modules may be erected into a wall, roof or floor panel, whereafter a suitable coating material may be applied to all exposed lath surfaces by any suitable means including hand trowel, spraying, blowing, etc. The coating can be of any suitable material, such as asphalt, cement, plaster, synthetic resins and the like. However, in a preferred embodiment a cementous material is used, and a coating 126 is applied on the exposed surfaces of the lath sheets (see FIG. 13). Preferably, the cementous material would be of such consistency that it would run together and blend into a solid layer after the material had been applied to the lath sheets. It will be appreciated that even though a coating material such as cement may impart added strength to the resultant module or fully erected wall, roof or floor panel, the added strength is of minimal consideration since the integral structural columns in the wall panels and the integral structural beams in the roof and floor panels provide the respective panels with more than sufficient load bearing capacity. The coating material can be made more attractive by decorating the same in various ways, such as painting, wall papering, plastering the inside walls or applying siding of a variety such as

stucco, brickwork to the outside walls of the enclosure. Similarly, tar, shingles, slate, or other weatherproofing materials can be applied to the roof panels.

#### UTILITIES

When using the present invention to form a building enclosure wherein electricity, plumbing and heating utilities and facilities are to be installed, the wall and roof modules may be modified so that a plurality of uniform openings or holes 128 and 129 can be precut in the connecting lath sheets or side sheets to form passageways for electrical conduits 130, piping or electrical outlet boxes. Preferably, the conduit and piping would be installed prior to applying any decorative coating material to the modules. The wall modules having the holes through the connecting sheets may also serve as air ducts for ventilation, heating or air conditioning systems.

Although the modules described above are primarily used for building panels for the construction of enclosures and the like, modules of the type illustrated in FIGS. 4 - 6 are suitable for use as a form for a column or beam. The module forms would not be removed, and thus would become an integral part of the finished column. In such case, the module would be positioned similarly as described above and the cavity of the module can be filled with a cementous or concrete material to the top of the wall by pumping the material into the form from the bottom to the top. It is desirable to pump the material into the cavity from the bottom to the top because if the material is poured into the cavity and falls from a great height, it will exert extreme pressures on the lath sheet, thereby deforming the lath sheets. This latter problem is minimized, however, where modules having a circular cross-section (FIG. 6) are employed.

Furthermore, in order to eliminate the requirement of expensive excavations when forming the footings of an enclosure, the wall panel installation can be modified to provide a lateral reinforced beam along the lower edge of the wall panel. A plurality of cementous or concrete pads can be formed in the outline of the enclosure in the usual manner approximately 15 feet apart. The wall modules are modified by cutting a hole through each of the connecting sheets a predetermined distance for the lower edge of the module so that a plurality of rods may be inserted therethrough after the modules are erected into a panel. The rods should run the full length of the wall panel. A cementous filler material approximately 1 foot in height is then pumped into each of the module cavities, thus creating a lateral reinforced beam at ground level.

As can be seen, there are many variations and changes which can be made to the module, for example, various types, grades, weights of lath sheets can be used to form the modules. The material for making the lath sheets can be varied, for example, glass, fiber glass, and plastic can be used. The cementous material used for the stiffener coating could be replaced with a plastic, resin, plaster, etc., while various types of material could be used for the decorative or surface coating. Such variations and changes in the module and the system for installing the modules will not detract from the distinct advantages over the prior art in that the manufacture and fabrication of the module is relatively simple and inexpensive. The shipping cost will be minimized since the modules can be transported in a flat or

collapsed configuration. Also, the various types of braces and channel members can be stacked so that they will not take up an excessive amount of space when being transported. No unusual tools are necessary for the installation of the modules, and it is relatively easy for unskilled labor to transport, assemble and finally erect the modules into the wall, floor and roof panels. Furthermore, no more than two men will be required to erect a simple one story structure because the assembled modules are lightweight and easy to handle. The variations and changes described above can be made to the present invention as herein described and illustrated without departing from the true spirit and scope thereof as defined by the following claims.

What is claimed is:

1. A building structure comprising a plurality of interconnected module assemblies, said module assemblies comprising:

I. a plurality of collapsible modules, each of said modules comprising:

- a. at least two sheets of metal lath, each sheet having a top edge, a bottom edge, and first and second side edges;
- b. a plurality of ring means spaced along said first and second side edges and projecting a predetermined distance therefrom, the ring means extending from said first side edge of each said sheet being intermeshable with the ring means extending from said second side edge of each corresponding sheet such that when the corresponding ring means of two of said sheets are intermeshed, the intermeshed ring means define hinge joints that project away from said sheets, at least one sheet and the ring means projecting from each side thereof thus defining a channel means;
- c. a securing rod inserted through the intermeshing ring means of each of said hinge joints; and
- d. a cementous material applied to at least one channel means;

II. means for anchoring a first of said plurality of modules such that the channel means thereof are disposed in a vertical position;

III. means for anchoring a second of said plurality of modules adjacent said first module such that the cementous material in a channel of said second modules is forced against the cementous material in a corresponding channel of said first module, the corresponding channel means of said first and second modules, together with the cementous material therein, forming an integral, structural column between said first and second modules; and

IV. means for similarly anchoring the remainder of said plurality of modules so as to define an interconnected module assembly comprising alternately spaced modules and integral structural columns.

2. A building structure comprising:

a plurality of interconnected module assemblies, said module assemblies comprising;

a plurality of collapsible modules, each of said modules comprising,

- a. spaced, parallel first and second side sheets of metal lath, each side sheet having a top edge, a bottom edge, and first and second side edges;
- b. a plurality of aligned ring means spaced along said first and second side edges of said side

sheets, said ring means extending a predetermined distance from said side sheets;

c. spaced first and second connecting sheets of metal lath, each connecting sheet having a top edge, a bottom edge and first and second side edges;

d. a plurality of aligned ring means spaced along said first and second side edges of said connecting sheets and extending a predetermined distance therefrom, the ring means extending from said connecting sheets intermeshing with the ring means extending from corresponding side sheets which adjoin said connecting sheets, said intermeshing ring means forming a hinge joint that projects from each corner of said module such that when a first module is disposed adjacent a second module, the hinge joints which project from the corners of the first module cooperate with the hinge points that project from the corresponding corners of the second module to define a space of predetermined width between the proximal connecting sheets of the adjacent modules;

e. a securing rod inserted through the intermeshing ring means of each of said hinge joints; and

f. a force coating of cementous material filling the space between the proximal connecting sheets formed by the corresponding hinge joints of adjacent modules, said force coating, opposing connecting sheets and securing rods forming reinforced structural columns within the wall between each pair of adjacent modules.

3. The building structure of claim 2, wherein at least two adjacent modules are vertically disposed to define a wall panel, and wherein the top edges of the side sheets of the vertically disposed modules extend a predetermined distance above the top edges of the connecting sheets thereof;

a channel member disposed between the side sheets of the vertically disposed modules and resting on the top edges of the connecting sheets thereof to define a trough means; and

cementous material applied to said trough means to fill the same and thereby form a structural beam along the top of the adjacent modules.

4. The building structure of claim 3, further including a plurality of horizontally supported modules adjacently disposed relative to said vertically disposed modules.

5. In combination, a plurality of interconnected modules for forming floor and ceiling panels in a building, comprising:

a. spaced, parallel top and bottom sheets of metal lath forming the bases of a module having a trapezoidal cross-section when expanded, said top sheet being the lesser base and said bottom sheet being the larger base, each of said top and bottom sheets having spaced integrally formed rings along first and second opposite side edges;

b. spaced first and second connecting sheets of metal lath forming the sides of said module, each connecting sheet having spaced integrally formed rings along first and second opposite side edges, said rings along the edges of said top and bottom sheets intermeshing with rings along corresponding edges of said connecting sheets adjoining said top and

bottom sheets, said intermeshing rings forming a hinge joint at each corner of said module;

- c. a securing rod inserted through the intermeshing rings of each said hinge joint;
- d. the hinge joints at the side edges of the bottom sheets of a module being adjacent the hinge joints at the side edges of the bottom sheets of adjacent modules within said roof and floor panels, and the hinge joints at the side edges of the top sheets of said adjacent modules being spaced to form V-shaped grooves between adjacent modules; and
- e. reinforcing members and cementous material disposed within said grooves to form a structural beam within said roof and floor panels at each juncture of said interconnected modules.

6. The combination of claim 5 wherein the hinge joints at the said edges of the bottom sheets of each module abut the hinge joints at the side edges of the bottom sheets of adjacent modules.

7. In a method of fabricating a building structure, wherein a plurality of prefabricated modules are adjacently disposed in a vertical position, and wherein each of the prefabricated modules has a top, a bottom and two vertically disposed sides, the improvement which comprises:

- anchoring a first module in a vertical position;
- applying a cementous material to a first side of said first module;
- movably supporting a second module in a vertical position adjacent said first side of said first module;
- applying a cementous material to the side of said second module nearest said first side of said first module;
- moving said second modules toward said first module to force the cementous material on said second module against the cementous material on said first module, said cementous material thus forming an integral structural column between the corresponding sides of said first and second modules; and

repeating the above sequence to form a structure comprising a predetermined number of adjacent modules each having an integral structural column therebetween.

8. In a method of fabricating a building structure, wherein a plurality of prefabricated modules are adjacently disposed in a horizontal position, and wherein each of the prefabricated modules has two horizontally disposed sides, the improvement which comprises:

- anchoring a first module in a horizontal position;
- applying a cementous material to a first side of said first module;
- movably supporting a second module in a horizontal position adjacent said first side of said first module;

applying a cementous material to the side of said second module nearest said first side of said first module;

moving said second module toward said first module to thereby force the cementous material on said second module against the cementous material on said first module, said cementous material thus forming an integral structural beam between the corresponding sides of said first and second modules; and

repeating the above sequence to form a structure comprising a predetermined number of adjacent

modules each having an integral structural beam therebetween.

9. In a method of fabricating a building structure, wherein a plurality of prefabricated modules are adjacently disposed in a vertical position, and wherein each of the prefabricated modules has a top, a bottom and two vertically disposed sides, the improvement which comprises:

- anchoring a first module in a vertical position;
- applying a cementous material to one side of said first module;
- applying a cementous material to one side of a second module;
- moving said second module in a vertical position against said first module to press the cementous material on the side of said second module against the cementous material on the side of said first module thereby forming an integral structural column between said first and second modules; and
- repeating the above sequence to form a structure comprising a predetermined number of adjacent modules each having an integral structural column therebetween.

10. An improved wall structure including a plurality of adjacent and interconnected modules, said modules having a generally rectangular cross section when expanded, said modules comprising:

- a. spaced, parallel first and second side sheets of metal lathe, each side sheet having a top edge, a bottom edge, and first and second side edges, and having spaced integrally formed rings along its said first and second side edges;
- b. spaced parallel first and second connecting sheets of metal lathe, each connecting sheet having a top edge, a bottom edge and first and second side edges and having spaced integrally formed rings along its said first and second side edges, said first and second side sheets forming the front and back of said module and said first and second connecting sheets forming the sides of said modules, said rings along the first and second side edges of said side sheets intermeshing with the rings along corresponding edges of said connecting sheets which adjoin said side sheets, said intermeshing rings forming a hinge joint at each corner of said module;
- c. a securing rod inserted through the intermeshing rings of each of said hinge joints, at least one of said securing rods being removable from its respective hinge joint; and
- d. a force coating of cementous material between the adjacent sheets of said interconnected modules and filling the space between said adjacent sheets formed by said corner hinge joints, said force coating, adjacent sheets and securing rods forming reinforced structural columns within the wall at each juncture of the abutted modules.

11. The improved wall structure of claim 10, further including at least one transverse brace secured within said module to prevent said module from collapsing when said module is used in forming a wall of said building enclosure.

12. The improved wall structure of claim 10, further including a trough extending along the top edge of the wall structure, said trough being defined by extending the top edges of said first and second side sheets of said modules above the top edges of said connecting sheets thereof.