March 17, 1970 R. S. BENNETT 3,500,595

MODULAR BUILDING CONSTRUCTION UNIT AND COLUMN

Filed Oct. 27, 1967 4 Sheets-Sheet 1

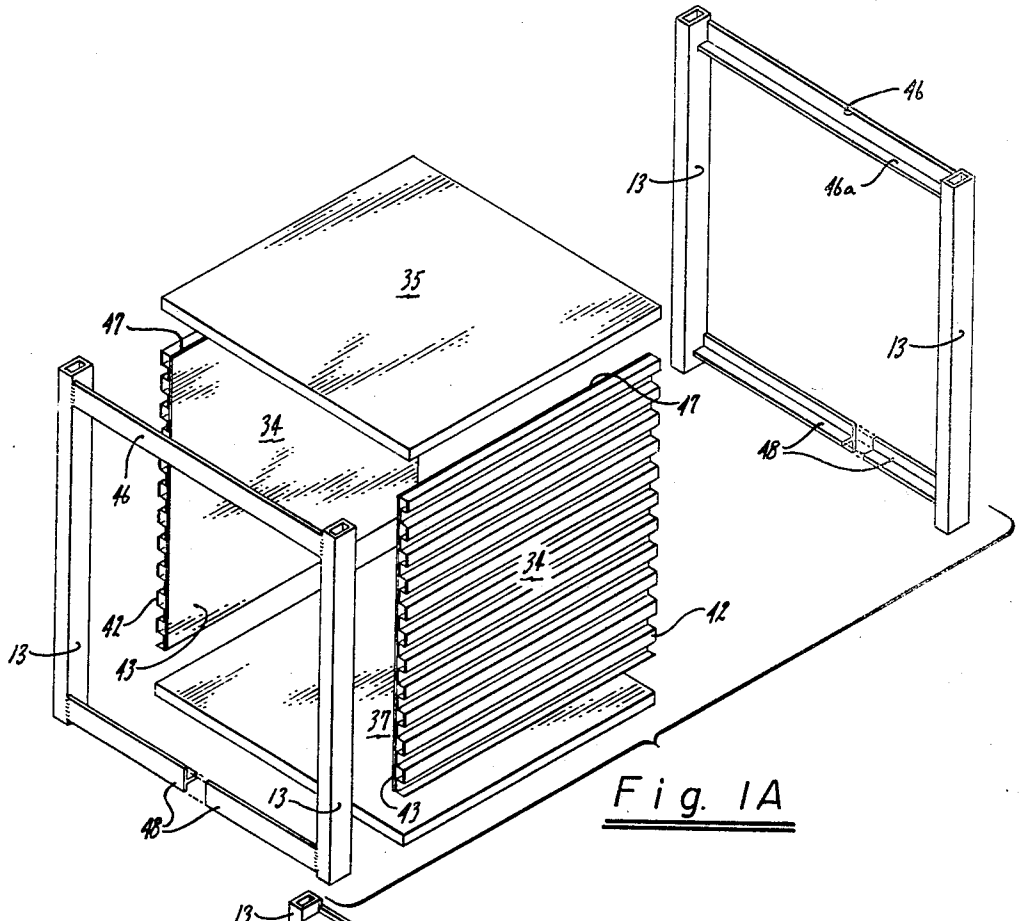


Fig. 1A

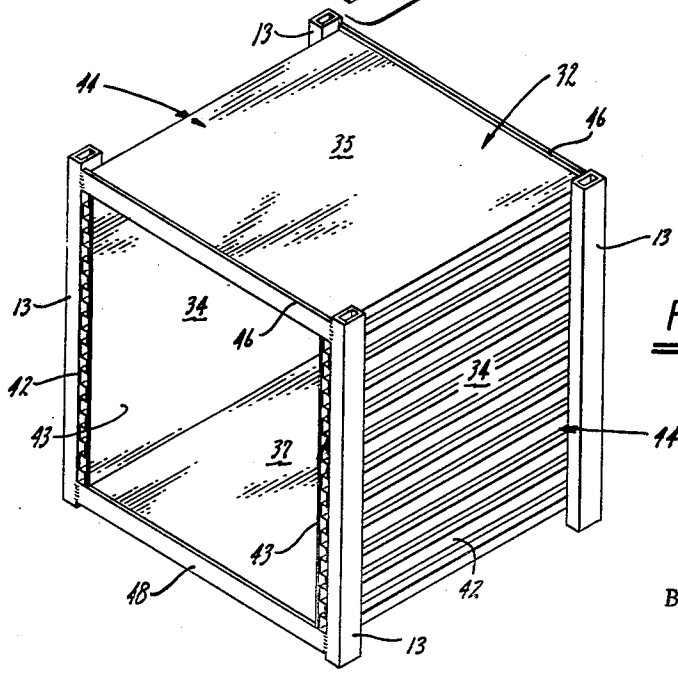


Fig. 1B

INVENTOR.
Ronald S. Bennett
BY Flehr, Hohbach, Test, Albritton & Herbert
Attorneys

March 17, 1970 R. S. BENNETT 3,500,595

MODULAR BUILDING CONSTRUCTION UNIT AND COLUMN

Filed Oct. 27, 1967 4 Sheets-Sheet 2

Fig. 1C

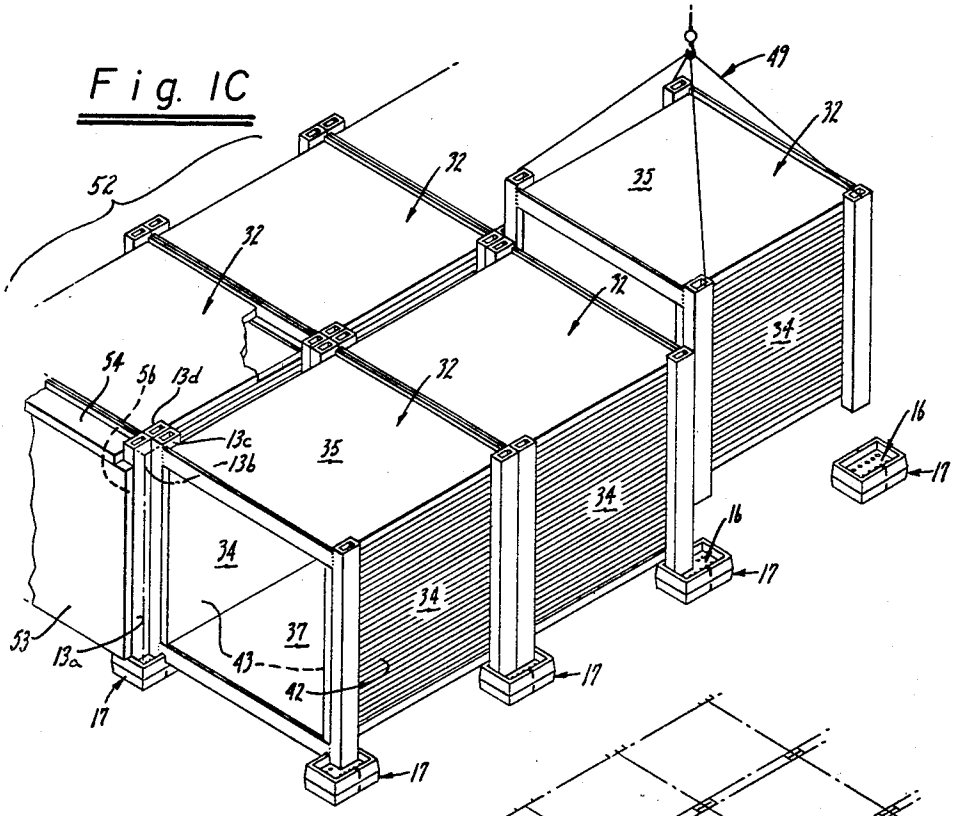
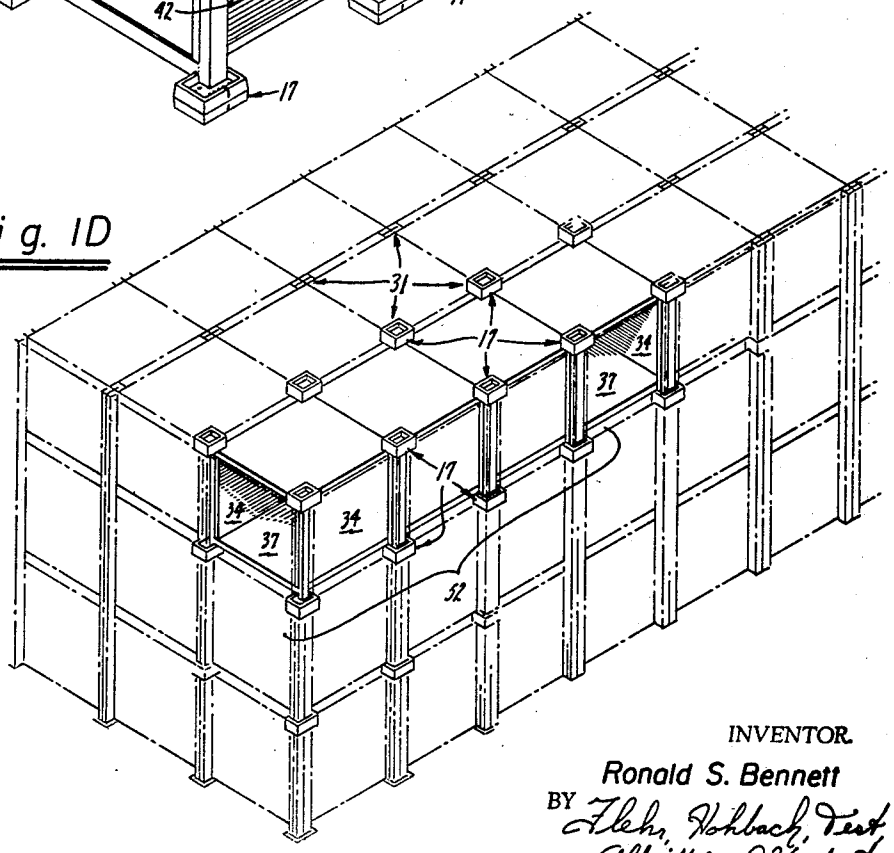


Fig. 1D



INVENTOR.
Ronald S. Bennett
BY Flehr, Hohbach, Test
Albritton & Herbert
Attorneys

March 17, 1970 R. S. BENNETT 3,500,595

MODULAR BUILDING CONSTRUCTION UNIT AND COLUMN

Filed Oct. 27, 1967 4 Sheets-Sheet 3

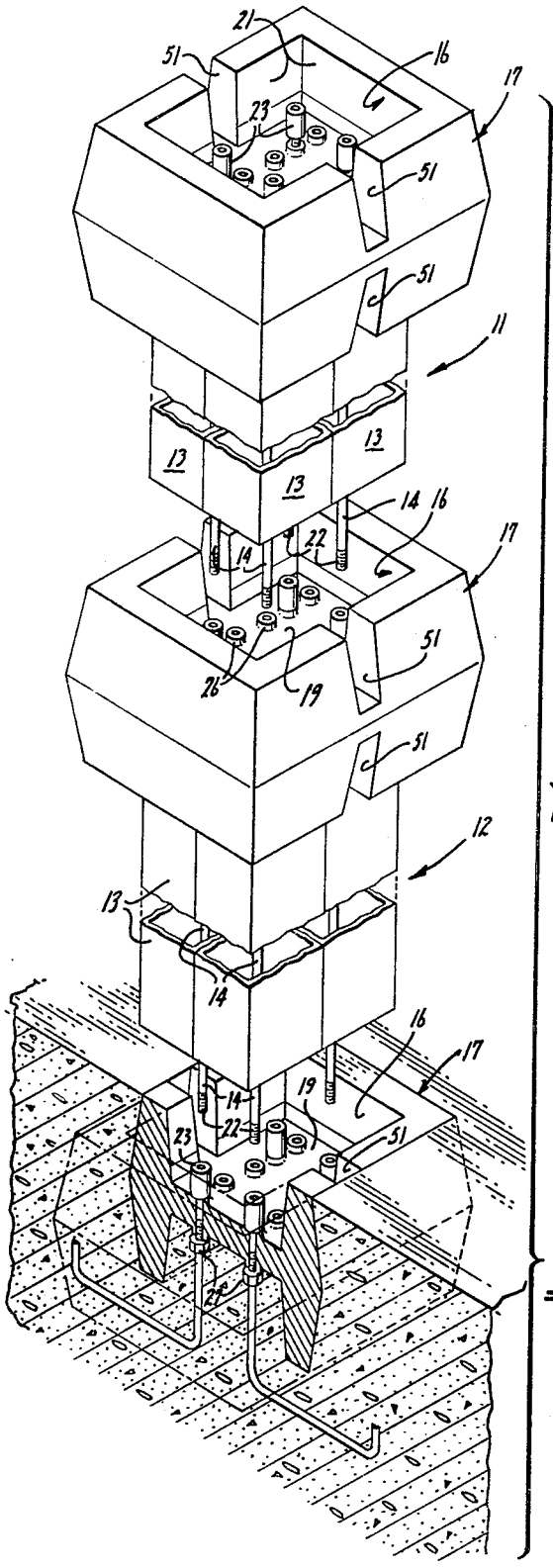


Fig. 2

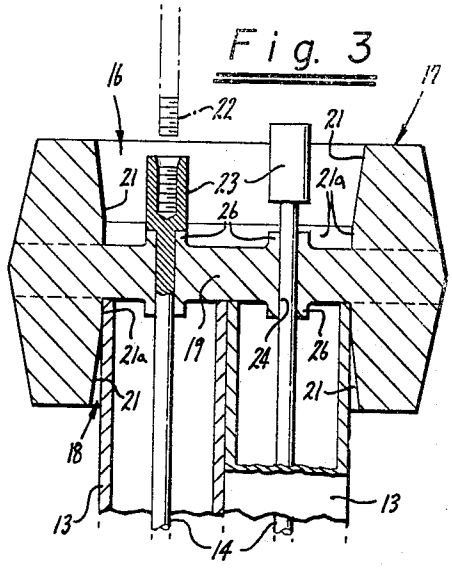


Fig. 3

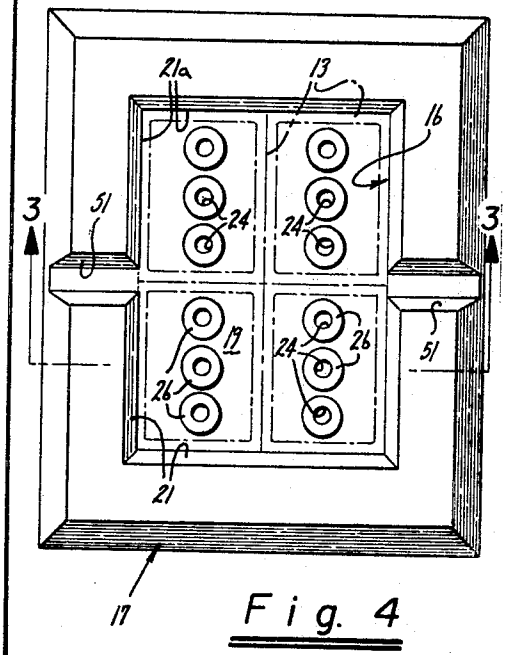


Fig. 4

INVENTOR.
Ronald S. Bennett
BY Flehr, Hohbach, Test, Albritton & Herbert
Attorneys

March 17, 1970 R. S. BENNETT 3,500,595

MODULAR BUILDING CONSTRUCTION UNIT AND COLUMN

Filed Oct. 27, 1967 4 Sheets-Sheet 4

Fig. 8

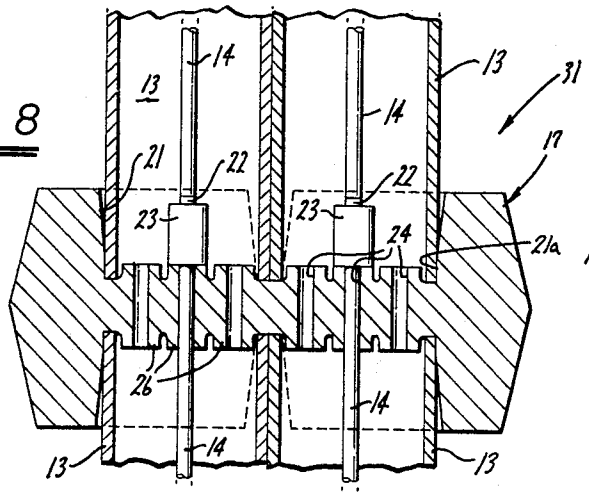


Fig. 5

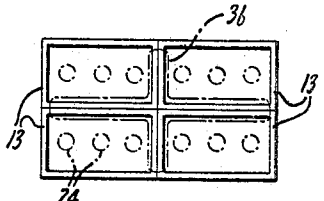
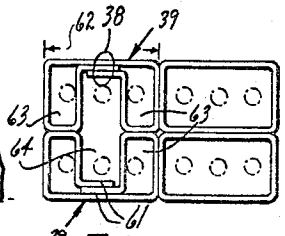


Fig. 6



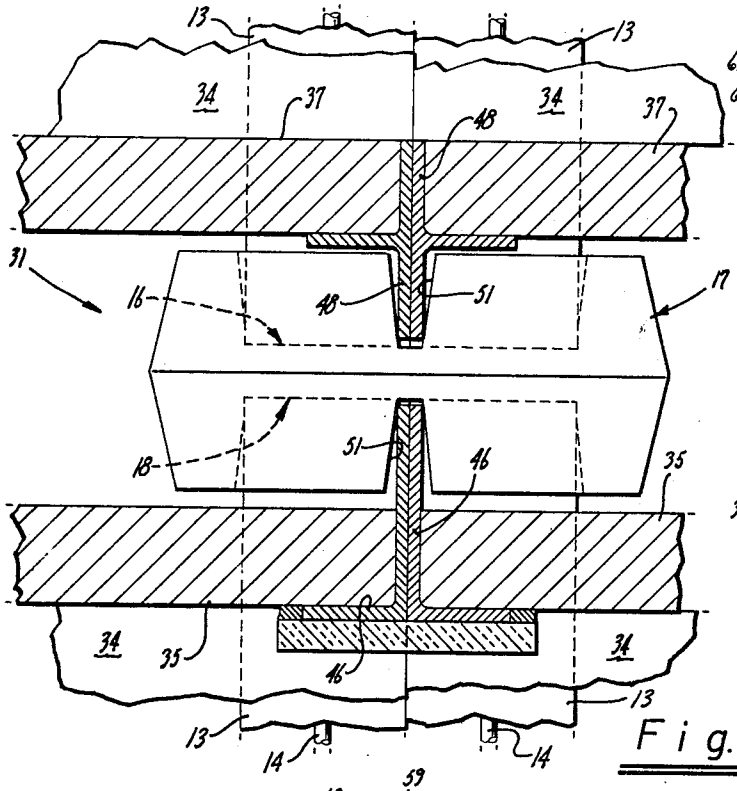


Fig. 9

Fig. 7

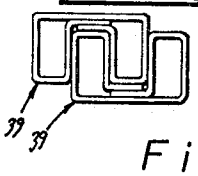


Fig. 11

Fig. 12

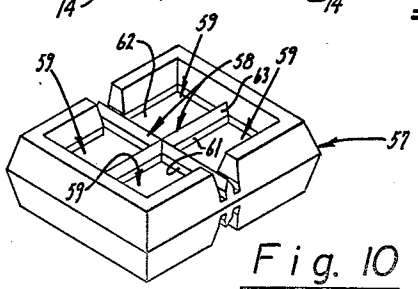


Fig. 10

INVENTOR.
Ronald S. Bennett
BY Fleit, Hobbach, Test, Albritton & Herbert
Attorneys

United States Patent Office 3,500,595
Patented Mar. 17, 1970

3,500,595

MODULAR BUILDING CONSTRUCTION UNIT AND COLUMN

Ronald S. Bennett, Honolulu, Hawaii (% Flehr, Hohbach et al., 160 Sansome St., San Francisco, Calif. 94104)

Filed Oct. 27, 1967, Ser. No. 679,941
Int. Cl. E04h 12/12, 1/00; E02d 27/42
U.S. Cl. 52—79 9 Claims

ABSTRACT OF THE DISCLOSURE

A modular building construction unit includes corner support members which, when assembled with others, provides a building support column. The column includes joints formed by fixtures held in place by tensioning rods extending from one fixture to the next. Each fixture includes oppositely facing receptacles serving to collect and seat the ends of the members forming the column. Several such modular units when so assembled form rooms of a building and ultimately a complete building supported by the columns.

BACKGROUND OF THE INVENTION

This invention pertains to building constructions and more particularly to modular building constructions and to means for readily forming a building comprised of modular room forming units.

Heretofore, it has been known to assemble a preformed room for assembly with additional such units in the forming of a multi-unit building having one or more floor levels.

OBJECTS

It is a general object of the present invention to provide an improved modular unit and an improved support column of a type suitable for use therein.

It is a further object of the invention to provide means for readily and quickly assembling a multi-level building by using readily attachable room forming units and portions thereof wherein each modular unit can be locked in place relatively quickly.

It is another object of the invention to provide means forming a structural support column for building having one or more floor levels and wherein the support column is readily and quickly assembled when assembling the building being constructed.

These and other objects of the invention will become more readily apparent from the following detailed description of a preferred embodiment when considered in conjunction with the drawings.

SUMMARY OF THE INVENTION

Generally, I have provided a modular building construction unit providing portions of a room whereby several such units can form a complete room. Each such modular room-forming unit (hereafter "room-unit") includes four elongated, hollow, spaced support elements serving to carry a pair of spaced side walls, a ceiling panel, and a floor. I have further provided means for readily assembling such room-units into a room, one atop the other to provide a multi-level building. Such means comprises, in general, a fiture adapted to seat the tandemly disposed ends of the aligned support elements of superimposed room-units. Thus, the fixtures serve to seat and properly align the tandemly disposed ends of support members. Tensioning rods extend through the hollow support members and via the fixtures so as to draw all levels of each column into compression as desired.

Thus, a preferred column forming arrangement, I have generally provided means in the form of a fixture adapted

to form a joint between tandemly disposed ends of a first and second group of elongated rigid structural support elements. The fixture is formed, as by forging, to include a pair of oppositely facing pockets separated by a transverse wall adapted to form an interface between the ends of the two groups of support elements. Each pocket is formed and dimensioned to receive and to seat therein the assembled ends of each group. In one embodiment, the side walls of the pickets include inwardly sloping portions adapted to direct the assembled ends of each group laterally into compacted, mutually supporting relation under urging applied lengthwise to the groups of structural support elements.

Openings in the transverse wall pass tensioning rods therethrough which apply the lengthwise urging to the groups. Each opening is surrounded by a boss or collar portion adapted to cooperate with and receive the applied forces developed by the tension rods.

A tensioning rod extends along at least one of the support members at each corner of the room and is secured so as to draw the fixtures located at the opposite ends of the support members toward each other. Each fixture includes the surface portions mentioned above which serve to urge the ends of the support members resting therein in a direction laterally to consolidate the members into a section of a support column running upwardly through the building.

The foregoing general arrangement has been shown in more particular detail in the drawings, as now to be described.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURES 1A through 1D are perspective views sequentially illustrating the steps in forming a building construction unit and assembling the same to form a building according to the invention;

FIGURE 2 is an exploded perspective view, partially in section, showing a building construction column according to the invention;

FIGURE 3 is a elevation cross-section view taken in a direction along the line 3—3 of FIGURE 4 and showing portions of an assembled column;

FIGURE 4 is a plan view of a fixture employed to form a joint in the column shown in FIGURE 2;

FIGURE 5 is a diagram, in plan, showing a collection of four building support members grouped together as when forming a column according to the invention;

FIGURE 6 is a view similar to FIGURE 5 showing another construction of the elongated support members.

FIGURE 7 is a diagram indicating the position of members shown in FIGURE 6, nested for shipping;

FIGURE 8 is an elevation section view taken in a direction at right angles to the line 3—3 of FIGURE 4 and showing the formation of a joint, according to the invention;

FIGURE 9 is an elevation view, in section, taken through the floor and ceiling of vertically adjacent room forming units, according to the invention;

FIGURE 10 is a perspective view showing another embodiment of the joint forming fixture according to the invention.

FIGURES 11 and 12 are plan views showing additional embodiments of the support member shown in FIGURE 7.

DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to FIGURE 2, a support column of the type described generally above comprises an upper and a lower column assembly **11, 12**. The upper column assembly includes four tubular elongated structural support elements or members **13** having a rectanglar transverse cross-section. Each support member **13** is hollow

so as to accommodate the passage therethrough of at least one and possibly three tensioning rod **14**, depending upon the anticipated loads to which the building may be subjected. Support elements **13** lie alongside one another and are substantially coextensive so that the ends of each can be disposed in a common plane. It may even, for example, be desirable to cut each of the support elements **13** to a predetermined length under controlled environmental conditions common to each element and in this manner ensure that the opposite ends will lie in common planes.

Lower column assembly **12** also includes support members **13** and tension rods **14** of a type as described generally above. The lower ends of each of the support members **13** of assembly **12** rest in the upwardly facing receptacle or pocket **16** formed on the upper side of a fixture **17** which, as will be seen, serves to form a joint when used between two column assemblies such as assemblies **11, 12.**

Each fixture **17** serves as both the top cap member for the lower column assembly **12** and as the bottom cap member for the upper column assembly **11.** Thus, each fixture **17** includes the oppositely facing receptacles or pockets **16, 18** which are separated by a transversely extending wall **19** adapted to form the interface between the adjacent ends of each group of support members **13** associated respectively with the column assemblies **11, 12.**

Each pocket **16, 18** is formed and dimensioned to receive and to seat all of the adjacent ends of one or the other of the column assemblies **11, 12.** Accordingly, each pocket **16, 18** includes inwardly sloping side wall portions **21** adapted to direct the assembled ends of each group of support members **13** laterally into compacted, mutually supporting relation under longitudinal urging applied to each group of such members **13.**

The sloping wall portions **21** merge into portions **21*a*** disposed perpendicularly to wall **19** so as to snugly receive the ends of the group of members **13.** Thus, the area bounded by wall portions **21*a*** is substantially coextensive with the area defined by the group of ends of members **13.**

It will be readily apparent that when a group of support members **13** is placed loosely in a pocket, such as pocket **16,** for example, gravity will serve to a certain extent to seat the ends of the members.

Means are further provided, however, for drawing all of the members tightly into the pocket thereby utilizing the functions of the inwardly sloping side wall portions **21** to positively urge members **13** laterally into compacted and mutually supporting relation with respect to each other.

Thus, tension rods **14** are each provided with threads at their lower ends **22** and at their upper ends with an enlarged or expanded head **23** counterbored with interior threads adapted to cooperate with the threads on the lower ends **22** of rods **14.**

The transversely extending wall **19** of each fixture **17** includes a number of passages or holes **24** leading therethrough for passing an associated one of several tension rods **14.** Each hole **24** has been formed with an enlarged protruding boss or shoulder **26** therearound to receive the thrust of tension rods **14** whenever they have been tightened sufficiently to draw the bottom of heads **23** into engagement therewith.

As thus arranged, a column is formed comprised of a number of asemblies **11, 12,** stacked in tandem. By interconnecting rods **14,** there will then be an elongated tensioning device for placing the entire length of the column, as thus assembled, under compression.

At the bottom of the column **10,** the entire column is anchored as by means of placing the lowermost fixture **17** in concrete with the lower threaded ends **22** of tension rods **14** being bent laterally outwardly and provided with retainer nuts **27** taken up to a point adapted to bear against the shoulders **26** on the underside of wall **19** of the lowermost fixture **17.**

In assembling a column of the foregoing type, the lowermost column section is formed by merely providing the base of a column assembly with a fixture **17** into which is located four of the structural support members **13.** Another fixture **17** is then placed on top of the four assembled support members and by so locating the cap members **17** at opposite ends of the support members **13,** they will be held together by tension rods **14** which are inserted through holes **24** of both the top and bottom fixtures **17.** Subsequently, the retaining nuts **27** are screwed along the threaded ends **22** of the rods **14.**

As tension is applied to rods **14,** it will be readily evident that the inwardly sloping wall portions **21** serve to direct members **13** laterally into compacted, mutually supporting relationship. Subsequently, the lower ends of the tension rods **14** are bent as shown in FIGURE 2 and the lower column assembly **12** placed in concrete to form the initial stage for an upwardly extending support column.

Subsequent column sections are then readily easily disposed in a similar manner merely by assembling four members **13** in the upwardly facing pocket **16** located at the upper end of the lower column assembly **12** and subsequently held together by disposing another fixture **17** at the upper end thereof.

Tensioning proceeds as before but with the distinction that the tension rods of the upper column assembly **11** are screwed into the threaded ends provided by the expanded heads **23** aligned therewith. Accordingly, by tightening the upper tension rods **14,** tensioning will be applied throughout the entire length of the column, including portions of lower column assembly **12.**

From the foregoing, it will be readily apparent that a support column has been provided wherein a number of column sections are held in tandemly disposed relationship by means of the fixtures **17,** arranged to provide joints **31** between the column sections, and by the tensioning rods **14** which extend longitudinally between successive joints in a manner whereby the entire column can be subjected to a single uniform tensioning force.

Having in mind the above column-forming arrangement, there is provided a modular building construction unit **32** of a type for forming portions of rooms and hereinafter referred to as a room-unit.

Unit **32** may be assembled with a number of similar units to form the building as schematically shown in FIGURE 1D. Thus, by pre-forming a number of modular building construction units **32** of the type shown, each construction unit **32** can be hoisted into position and assembled to form larger rooms and in their entirety to form a complete building.

Each modular building construction unit (i.e., room-unit) comprises four support members **13** located at the four corners of unit **32.** In general, unit **32** includes a ceiling panel **35,** a pair of spaced side walls **34** and a floor **37.** It is to be observed that each unit **32** is open at opposite ends **41** whereby a plurality of units **32** can be disposed in adjacent relationship in completing a room **52** comprised of several units **32.**

Each side wall **34** is secured, as by welding, to the side faces of an associated pair of the support members **13.** Each side wall **34** includes a corrugated iron reinforcement layer **42** oriented whereby the ridges and valleys run along the length of each side wall **34** to provide strength thereto. Layer **42** further supports a finish facing panel **43** of suitable material such as gypsum wallboard, or the like, for forming an interior finishing surface to a room. The reverse surface of the corrugated layer **42** may, for example, be sprayed with an adhesive foam of suitable type for providing thermal insulation and a fire retardant coating.

As thus arranged, each side panel assembly **44** includes a pair of support members **13,** a corrugated reinforcing layer **42** and the finish facing panel **43.**

L-shaped angle members **46** extend between the two side panel assemblies **44** and are secured at their ends, as by

welding, to the end regions of the side faces of a support member **13** of each of the two assemblies **44**. L-shaped angle members **46** are disposed to provide a lower ledge portion **46***a* arranged to receive the ceiling panel **35** therein. Ledge portions **46***a* are disposed in a plane at a level substantially corresponding to the upper edge **47** of each facing panel **43**. Thus, all four side edges of ceiling panel **35** will rest upon a supporting surface.

Similarly, at the lower ends of support members **13**, another pair of angle members **48** extends between laterally spaced support members **13**. The lower angle members **48** serve to support the floor panel **37** resting thereon and secured by suitable means to remain fixed in place during hoisting and placement of unit **32**.

Notches **51** in the sides of fixtures **17** prevent the edges of angle members **46** from "bottoming" against fixtures **17** when tension rods **14** have been tightened.

Having formed a unit **32** of the type described, it is now possible to merely employ a hoisting sling **49** as shown in phantom lines in the drawing and attached suitably to the corners of unit **32**. As thus arranged, the lower ends of each of support members **13** of the unit **32** being hoisted into place will nest readily into the upper pocket **16** of each of four fixtures **17** carried atop a similar unit **32** located underneath. At such time as four support members **13** have filled a respective one of the fixtures **17**, tension rods **14** can be utilized to collect or draw the support members for a related corner of room-unit **32** snugly into the pocket **16**.

When it is desired to finish off the ends of a room **52** comprised of room units **32**, an additional pair of support members **13***a*, **13***b* are grouped with two others **13***c*, **13***d* to fit within an associated pocket **16**, **18** and thereby provide full column support at each corner of the room **52**.

An end wall closure panel **53** of suitable size can then be secured to members **13***a*, **13***b* where the ceiling and side walls are of the standard modular dimension. Relatively long, narrow filler panels **54**, **56** serve to finish off the ceiling and side walls, respectively.

According to another embodiment of the invention (FIGURE 10), a consolidating fixture **57** serves to seat a plurality of members **13** in a manner forming a column having a somewhat "stiffer" characteristic due to the fact that the adjacent column support members **13** are held spaced slightly apart by wedging separator portions **58** therebetween. Portions **58** thereby define separately spaced receptacles or pockets **59** wherein each is dimensioned to snugly receive and seat the end of one of members **13**. Wedging portions **58** include relatively straight side portions **61** perpendicular to divider wall **62** to define the inner bounding dimensions of pockets **59**. The ends of members **13** are guided into pockets **59**, however, by the tapered surface portions **63** which thereby direct the ends of members **13** to a proper seating position.

In general, as shown, for example in FIGURE 5, it will be readily apparent that a support column of the type described above has the advantage of forming essentially an X shaped reinforcement **36** within the rectangular construction of the column. This X shaped reinforcement **36** is defined, of course, by the mutually supporting side surfaces of members **13**.

According to another embodiment, the elongated, hollow, rigid structural support members **13** are formed, as shown in FIGURE 6, in a manner whereby the support members **39** (FIGURE 6) are fully compatible with the manner shown in FIGURE 5 but with the additional advantage of providing increased strength by provision of the triple thickness of material in the region **38** which thereby increases the amount of supporting steel (or other material) present for the same cross-section. In addition, manufacture of the elongated, hollow structural support members **39** can be more readily achieved inasmuch as the tolerances and requirements to provide the overlapped seal in the region **38** are considerably less stringent. Further, support members **39**, as shown in FIGURE 7, can be stored and carried in a nested relation in considerably less space so that the cost of shipping such members may be considerably reduced.

The support member **39** therefore is formed of a sheet of structural material folded to provide a transverse cross-section forming a closed loop. The longitudinal marginal edges **61** are overlapped and are secured to each other, as by welding, in a position adjacent an intermediate span portion **62** of the sheet. As thus arranged, the transverse cross-section of each support member **39** will include laterally spaced hollow support portions **63** defining an indentation **64** therebetween. This particular arrangement of cross-section, as noted above, serves to increase the amount of supporting steel or other material present within the rectangular space otherwise taken up by support members **13**.

From the foregoing, it will be readily evident that there has been provided a modular building construction unit of a type for forming rooms and wherein a building comprised of such rooms will include a number of support columns. The support columns each include elongated tensioning rods extending upwardly through the building. The rods are coupled together from one floor level to the next and are arranged whereby each column may be independently and selectively placed variously under compression by action of its associated tensioning device whereby various stresses and loads acting upon the building may be compensated.

It will be further evident that a building so constructed may also be readily disassembled and transported elsewhere merely be decoupling the tension rods and hoisting the room units out of their related receptacles as are engaging the four corners thereof.

FIGURES 11 and 12 show additional embodiments of the support member **37** shown in FIGURE 7. The main distinction between these embodiments pertains to the self-evident manner of constructing same wherein it may be desirable not to overlap the margin edges of the sheet of material employed to form such members.

I claim:

1. A support column comprising a group of elongated structural support members each of which is of a type adapted to participate in joining one section of a room with another section of a room, said support members being disposed alongside each other, a cap member disposed transversely of and enclosing the ends of the group and formed to receive therein one of the ends of each member of said group, said cap member further being formed with tapered portions for receiving and seating all the assembled ends of said support members, said tapered portions serving to move and consolidate the members of said group laterally of each other and form a unitary column, said cap member being further formed with additional portions for receiving and seating the ends of other structural members forming another said group, and means serving to draw the ends of at least one of said groups of members tightly to said cap member to cooperate with said tapered portions in moving the last named ends laterally of each other.

2. A support column comprising a group of elongated structural support members disposed alongside each other, a cap member at each end of said group disposed transversely of the group and formed to receive one of the ends of each member of said group, said cap members further being formed with wedging portions for directing said members laterally to consolidate the members of said group in response to movement of said cap members toward an opposite end of said group, at least one of said cap members being further formed to receive the ends of other members forming another said group, and means serving to draw said cap members toward one another to cause said wedging portions to direct said support members to move laterally together into engagement with each other to form a tightly compacted group of ends thereat.

3. In a building construction, a column comprising a first and second plurality of substantially coextensive elon-

gated tubular support members, the members of each said plurality being disposed alongside each other, each support member being adapted to participate in the formation of a portion of a room, said first and second plurality being disposed in tandem to form a support column, and means serving to move the support members into a grouped assembly and to compress said column longitudinally thereof throughout both of said pluralities, the last named means including a connecting fixture interposed between said first and second plurality, said fixture being formed to include oppositely directed open pockets each receiving an associated one of said pluralities therein, a common wall between said pockets serving to form the interface between said pluralities, and portions within the pockets serving to direct the ends of each said plurality laterally into mutually compacted relation.

4. In a building, a modular building construction unit for forming portions of a room, said units being adapted to be stacked one upon another and side by side to form a building having a plurality of levels for occupancy, said unit comprising means defining a floor, a ceiling and pairs of spaced side walls, elongated support members at the corners of the unit adapted to form, together with like support members of others of said modular units, groups of said support members meeting at the corners of the unit to provide a support column, the opposite ends of said support members of the column extending to projected positions, a fixture disposed to encircle the plurality of said ends of a group at each end of the column and to laterally adjust the seating of said ends of the column relative to each other, said fixtures being formed to receive the opposite ends of said support members of said groups and formed with means responsive to movement of the fixtures of the group toward each other to consolidate the members of the group to form a single support column therefrom common to a plurality of said modular units meeting at said column, and means for drawing said fixtures of the group together.

5. A modular building construction unit for assembly with others in construction of a multi-room building comprising means for forming spaced pairs of side walls of the room unit, each said wall-forming means including an elongated, hollow, rigid, structural support member adapted to stand upright along each end of its associated wall, a joint-forming cap member receiving the opposite ends of those support members associated with the room unit and meeting at the corners of the room unit, and a tensioning rod extending along at least one of said support members at each corner of the room and secured to draw said cap members toward each other, each said cap member including surface portions serving to direct the ends of said support members therein laterally to consolidate said members into a support column assembly.

6. A demountable building construction characterized by a number of room forming units and by a number of support columns extending upwardly through the building and associated with said room forming units, each of said columns being formed of a group of individual support members disposed alongside each other, fixtures serving to collect and seat the opposite ends of said members, and elongated tension rods extending along said members and readily releasably retaining said fixtures and support members together, said individual support members being formed of a sheet of structural material folded to provide a transverse cross-section forming a closed loop, the longitudinal marginal edges of the sheet being overlapped and secured to each other in a position adjacent an intermediate span of said sheet, said formed to provide said cross-section to include a pair of laterally spaced hollow portions defining an indentation therebetween.

7. In a construction for forming rooms of a building the combination comprising a plurality of elongated structural support members adapted to be assembled to form a support column section, another plurality of elongated structural support members adapted to form a support column section substantially aligned in tandem with the first named section, means forming a joint between said sections, said joint including a fixture formed to include oppositely facing open receptacles for respectively receiving and seating the ends of said tandemly disposed sections, said open receptacles being formed to include tapered side wall surfaces serving to engage the ends of said members to laterally urge said members together to consolidate same into a column.

8. A joint construction comprised of the ends of a first and second plurality of rigid structural support elements, said pluralities being disposed in tandem, the ends of one plurality being adjacent the ends of the other plurality, means forming a joint connection between said tandemly disposed ends including a unitary, rigid fixture formed to include oppositely facing open receptacles separated by a transverse portion for forming an interface between the ends of said pluralities, the receptacles being formed and dimensioned to receive and seat therein the ends of said support elements, said transverse portion including openings serving to pass tensioning rods therethrough, each said opening being surrounded by a boss portion adapted to cooperate with and receive the applied forces developed by said rods, and further wherein the side walls of said receptacles include inwardly sloping portions serving to laterally direct the ends of said support elements into seated engagement within their receptacles.

9. A support column comprising a group of elongated structural support members disposed alongside each other, a cap member at each end of said group disposed transversely of the group and formed to receive one of the ends of each member of said group, said cap members further being formed with portions for directing said members laterally to consolidate the members of said group in response to movement of said cap members toward an opposite end of said group, at least one of said cap members being further formed to receive the ends of other members forming another said group, and means serving to draw said cap members toward one another to direct said support members to move laterally together, the last named means comprising a tensioning rod extending between said cap members for variable tensioning thereof to place said column variously under compression and thereby urge the members of said group laterally as directed by said portions, said tensioning rod including means for readily releasably coupling said rod to another said rod of another said group of elongated support members having one end of each member received in said cap member.

References Cited

UNITED STATES PATENTS

259,048	6/1882	Richardson	285—137
868,942	10/1907	Reid	285—137
1,362,069	12/1920	Witzel	52—236 X
1,416,709	5/1922	Hahn	52—281
1,529,895	3/1925	Lachance	52—227
2,449,000	9/1948	Merrill	52—720 X
2,837,183	6/1958	Heiman	52—720 X
2,982,379	5/1961	Fisher	52—726 X
3,378,971	4/1968	Singer	52—236

FOREIGN PATENTS

608,401	1960	Italy.

JOHN E. MURTAGH, Primary Examiner

U.S. Cl. X.R.

52—228, 236, 726, 732