May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 1

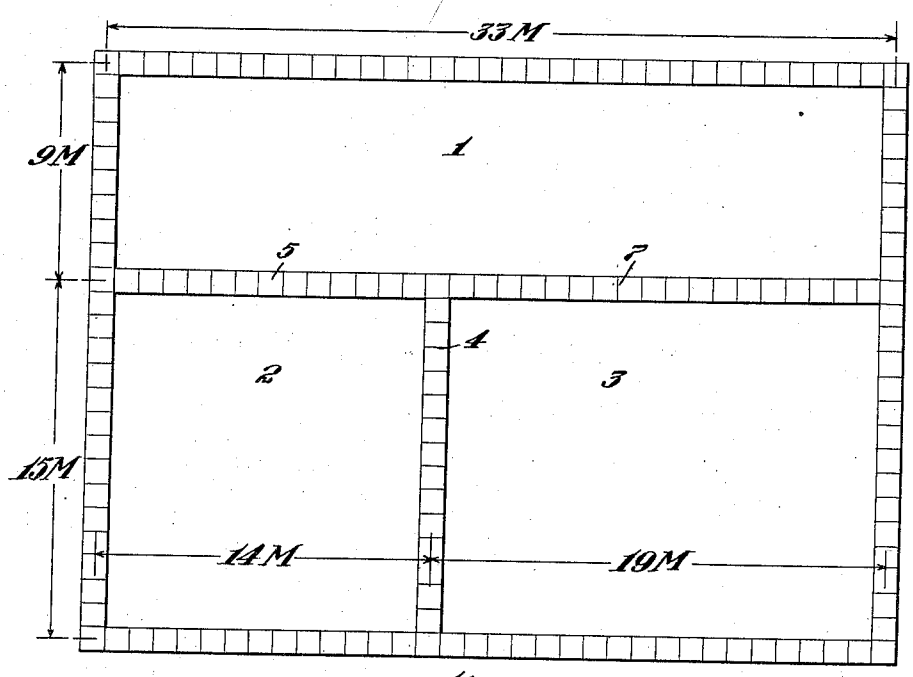


Fig. 1

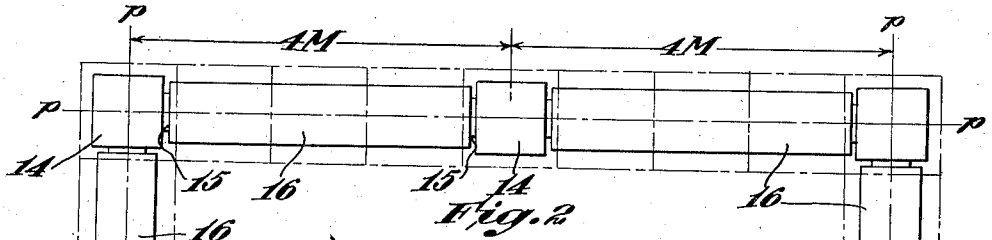


Fig. 2

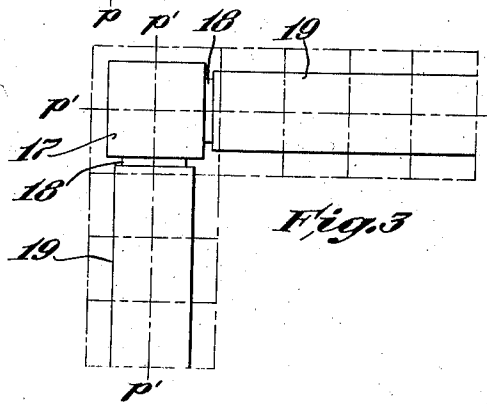


Fig. 3

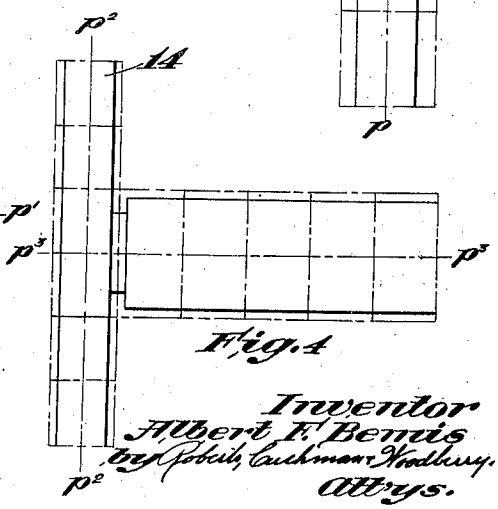


Fig. 4

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 2

Fig. 5

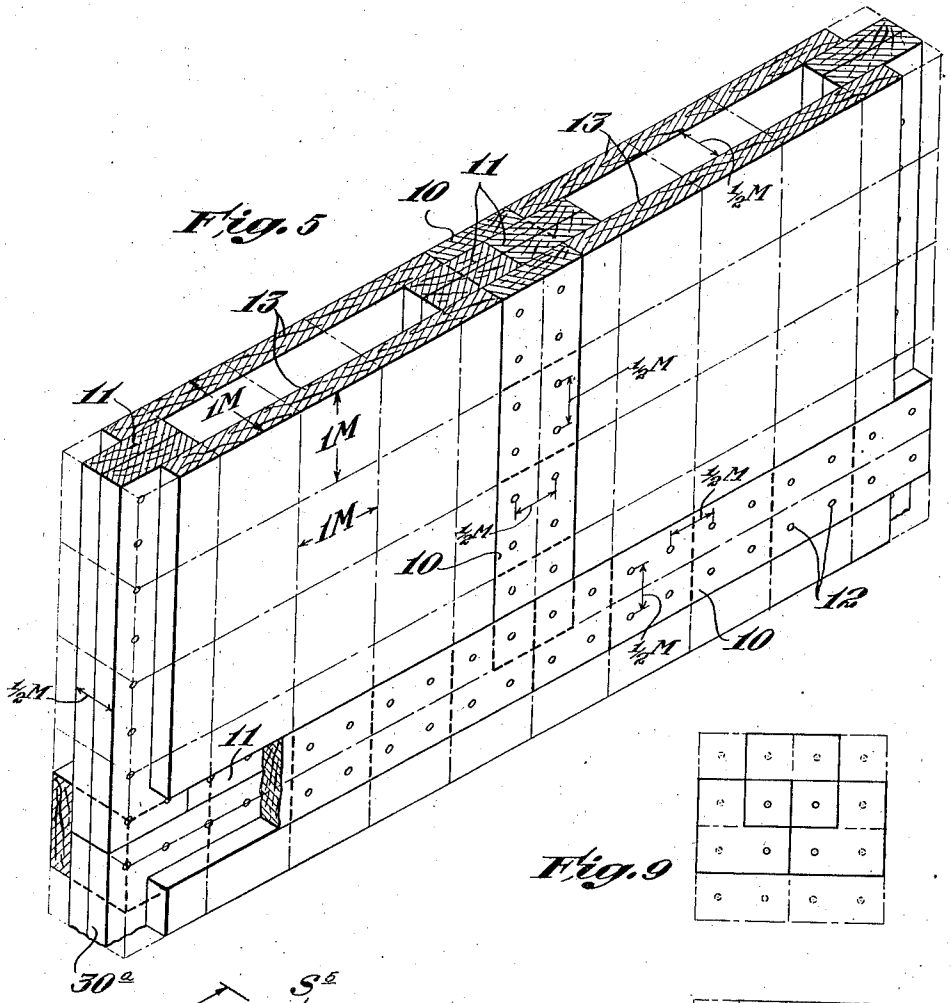


Fig. 9

Fig. 7

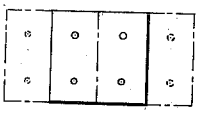
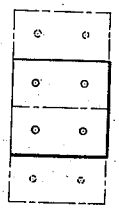


Fig. 8



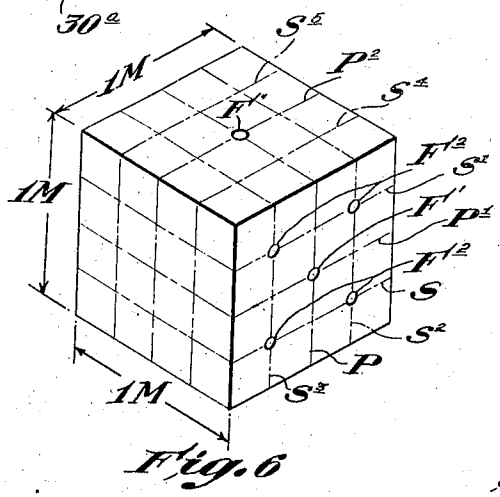


Fig. 6

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 3

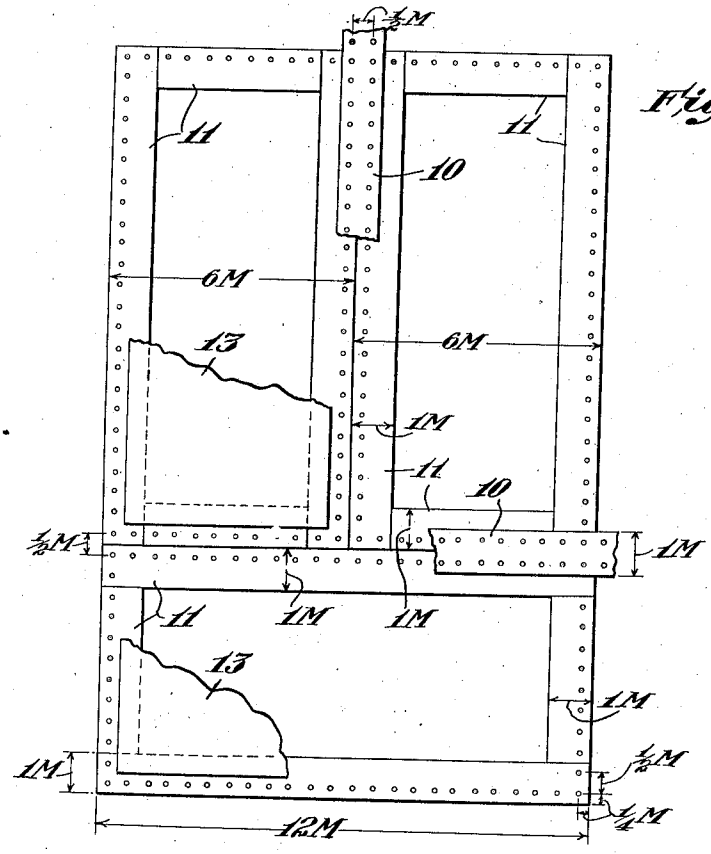


Fig. 10

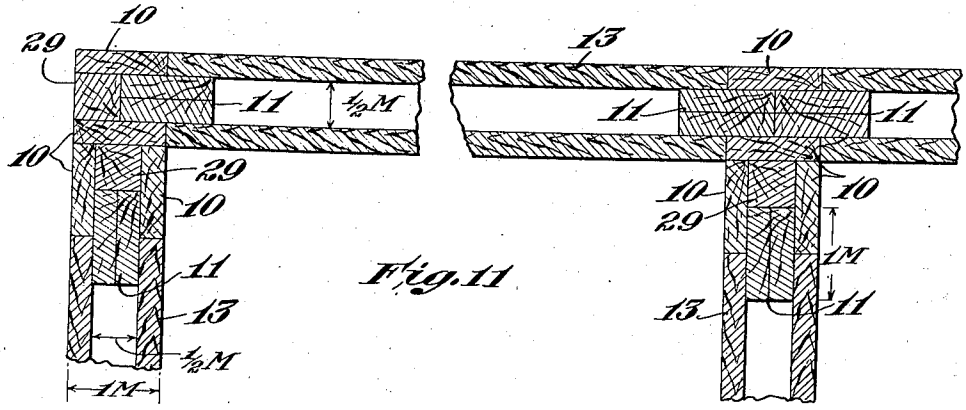


Fig. 11

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 4

Fig. 12

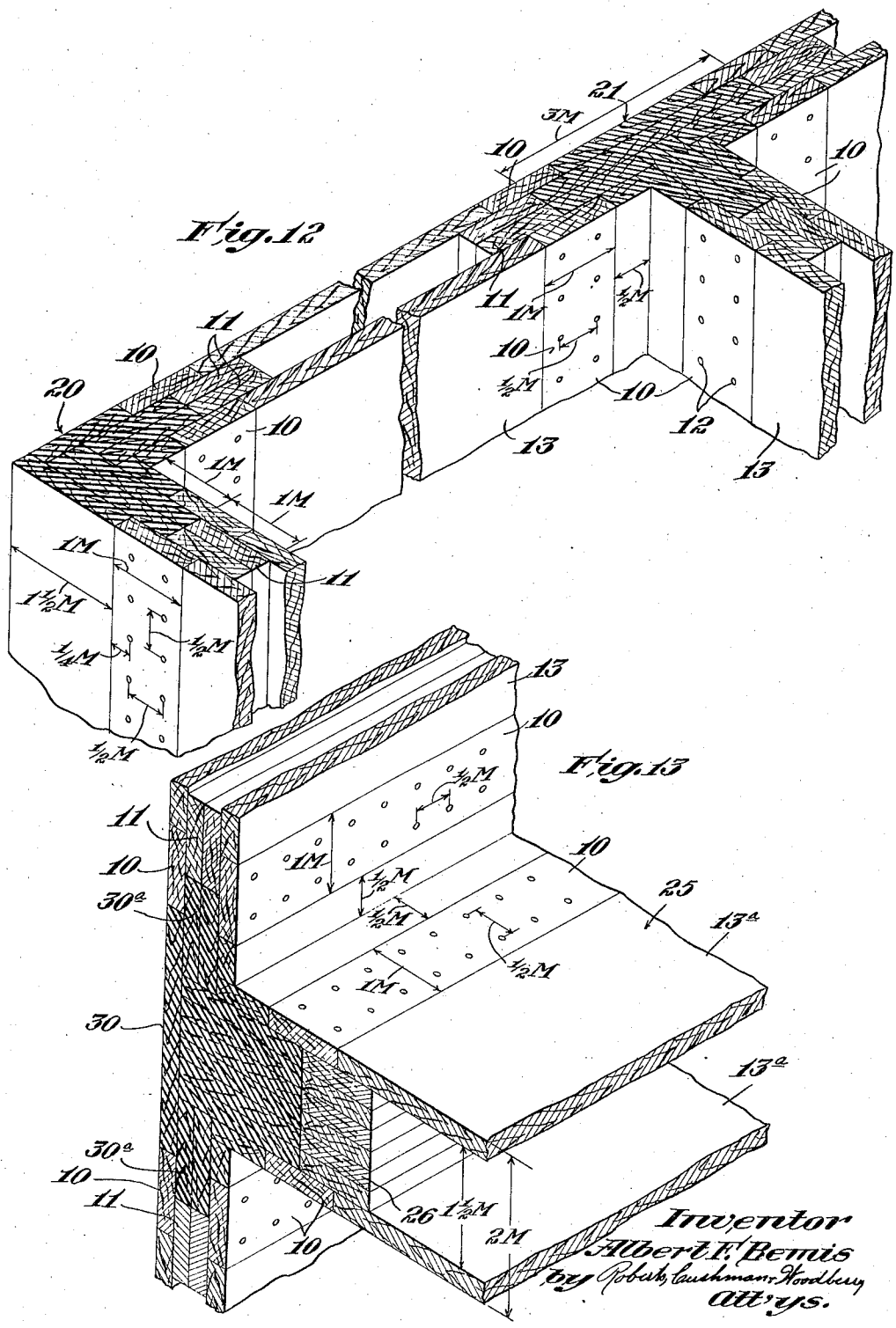


Fig. 13

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 5

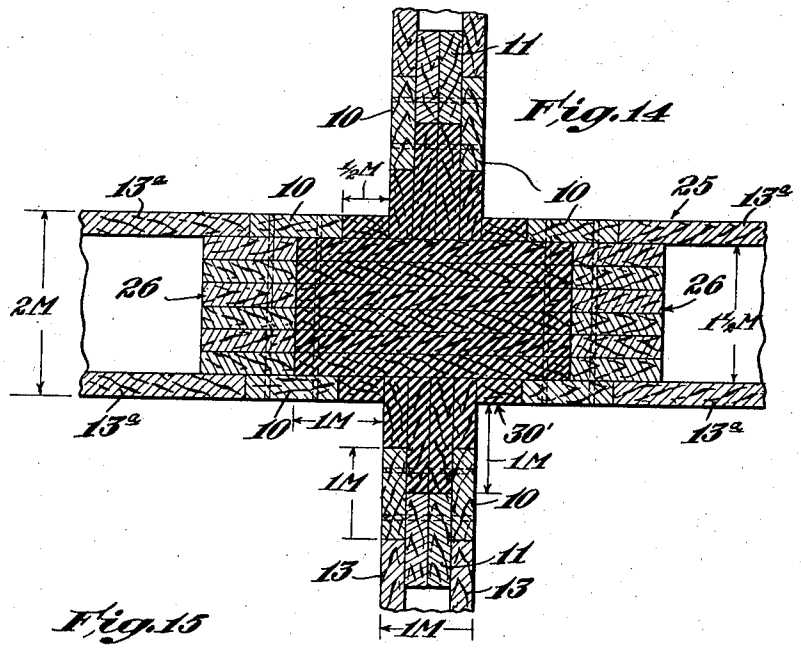
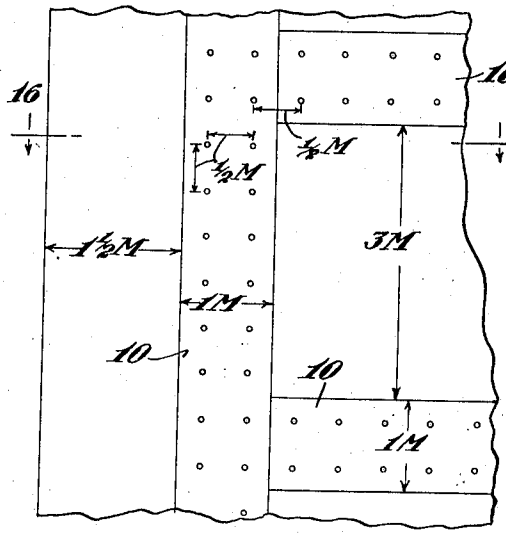


Fig. 14

Fig. 15



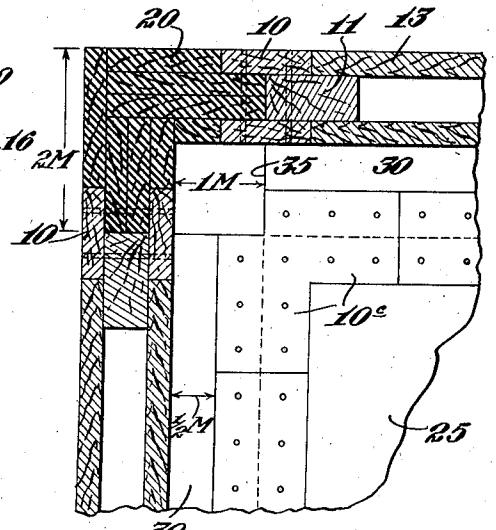


Fig. 16

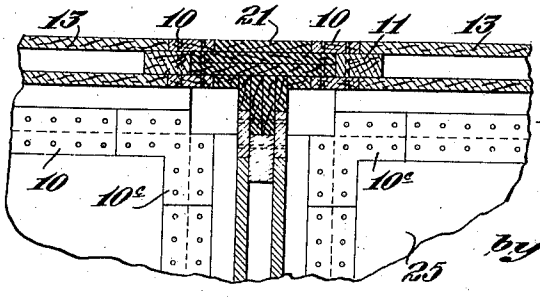


Fig. 17

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 6

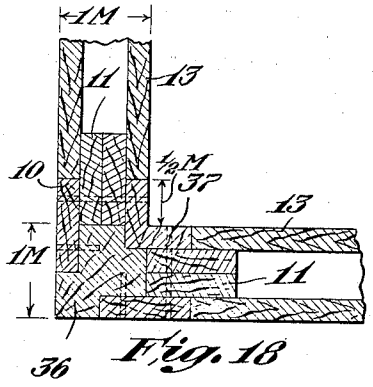


Fig. 18

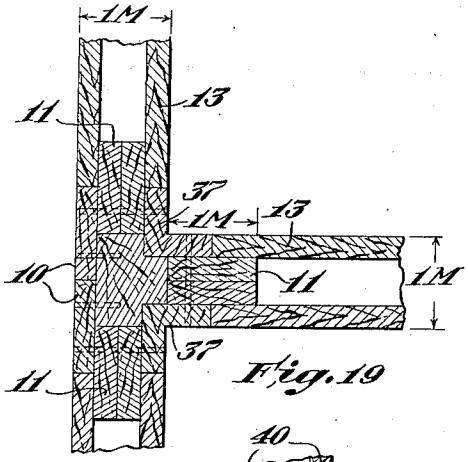


Fig. 19

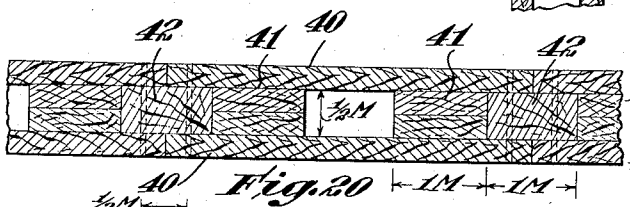


Fig. 20

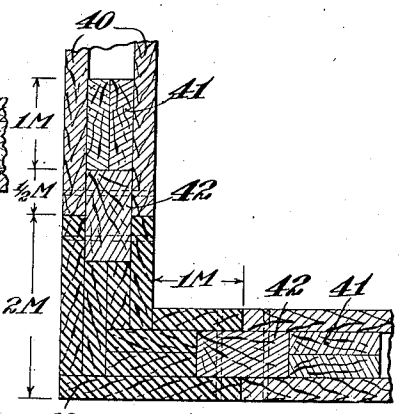


Fig. 22

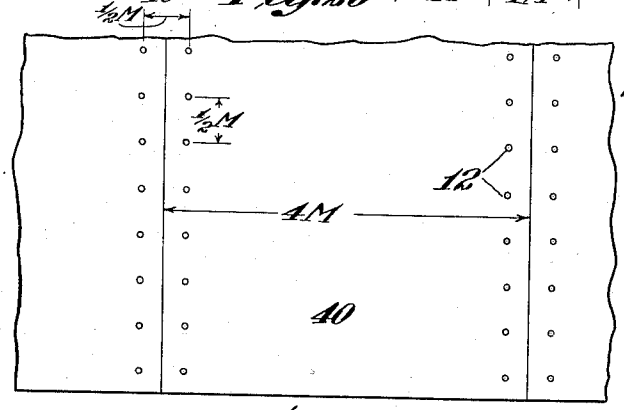


Fig. 21

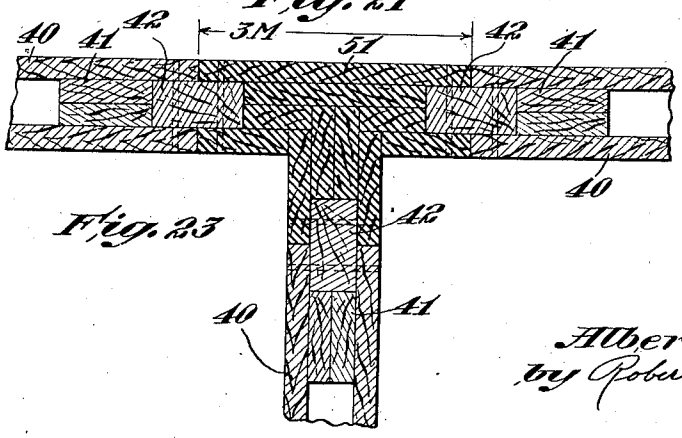


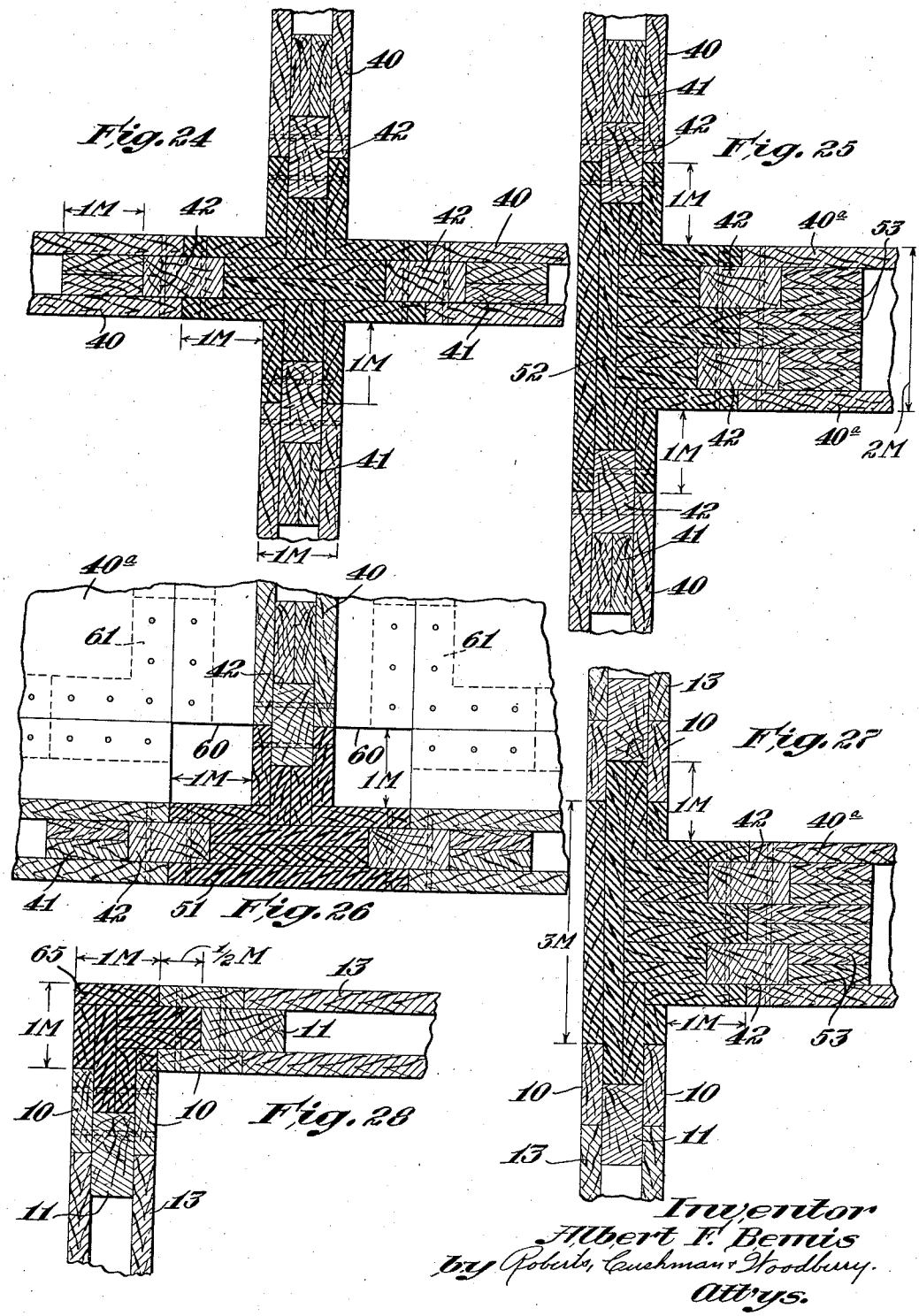
Fig. 23

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 7



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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 8

Fig. 29

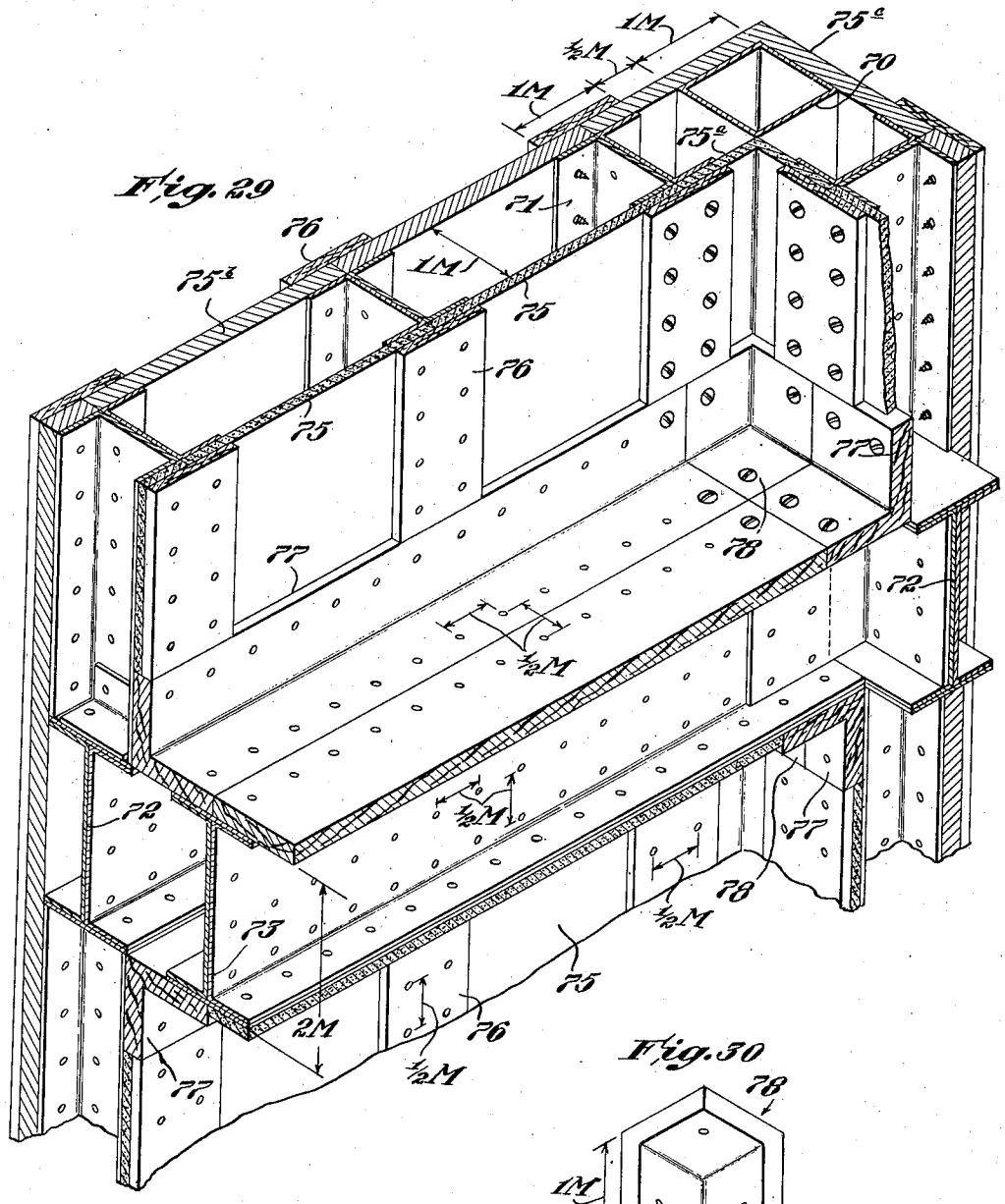


Fig. 30

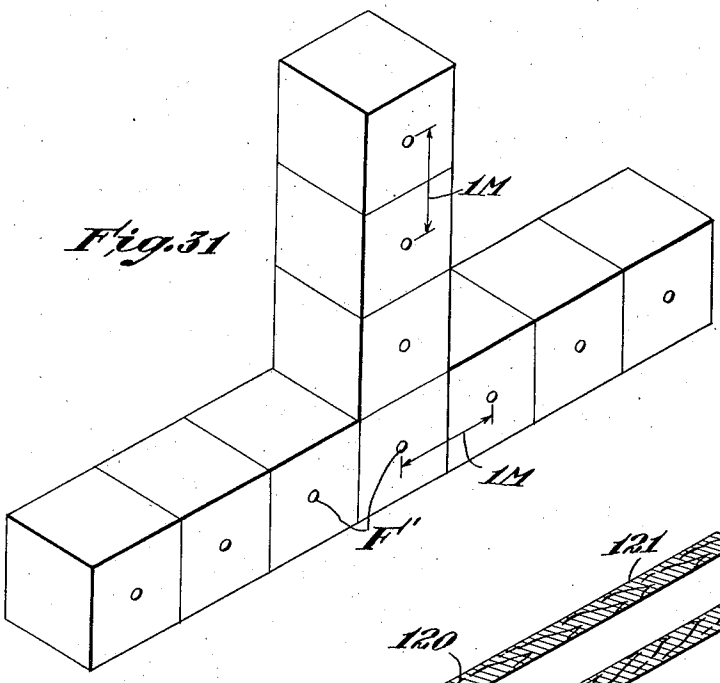
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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 9

Fig. 31



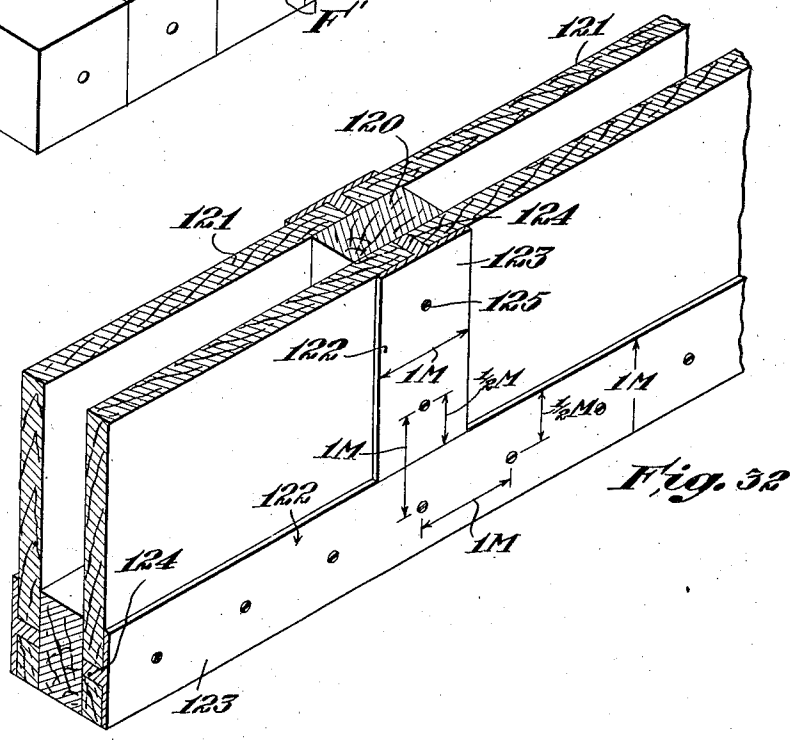


Fig. 32

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 10

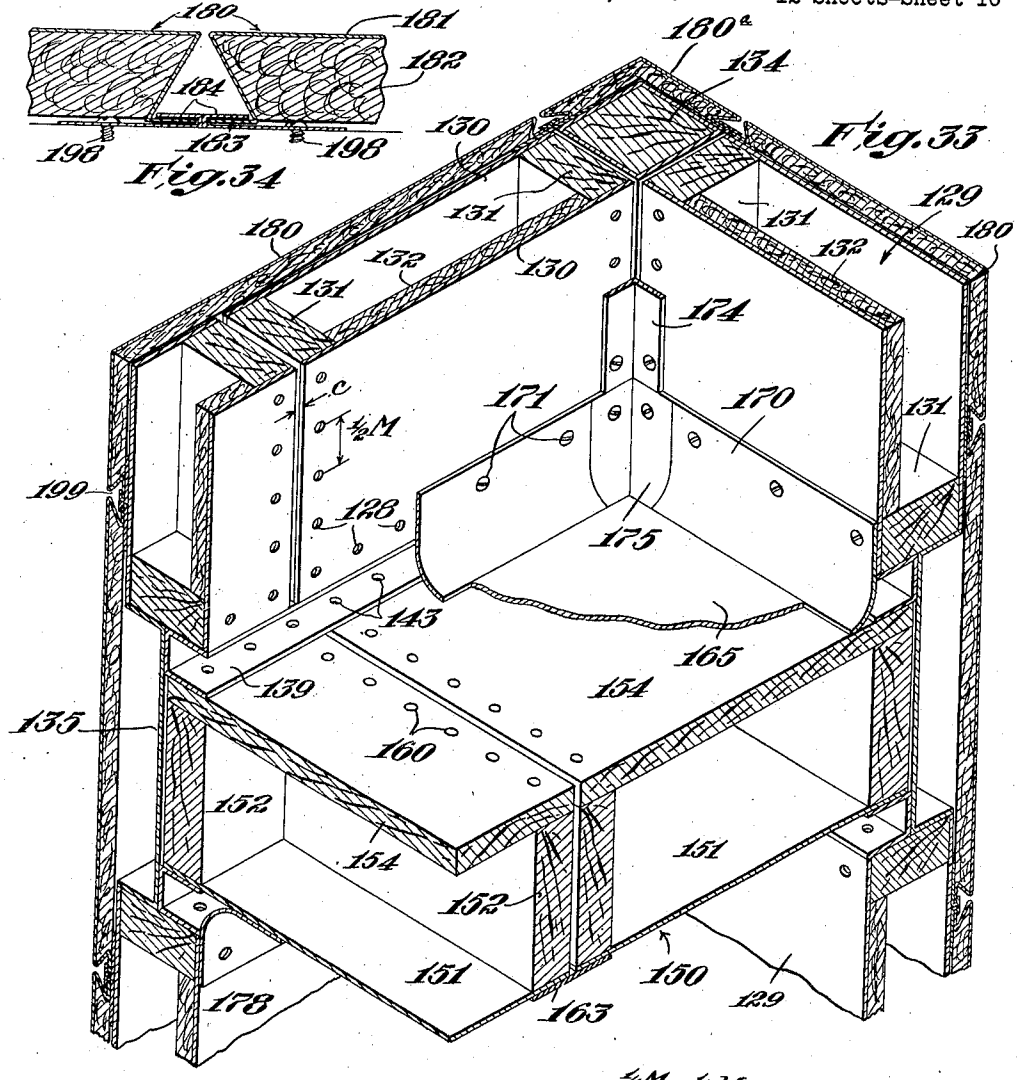


Fig. 34

Fig. 33

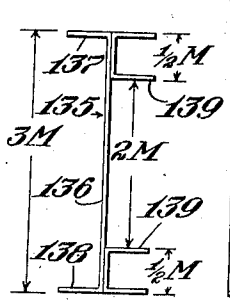


Fig. 35

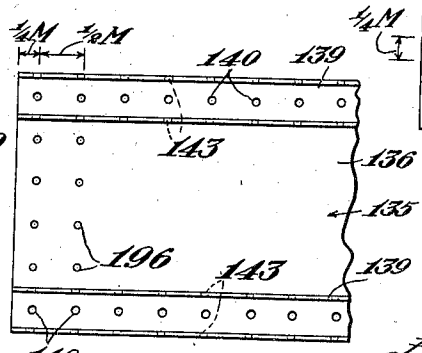


Fig. 36

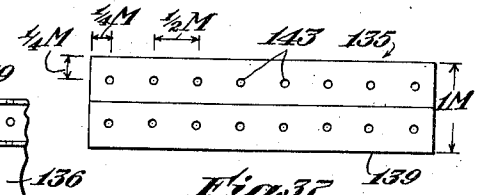


Fig. 37

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 11

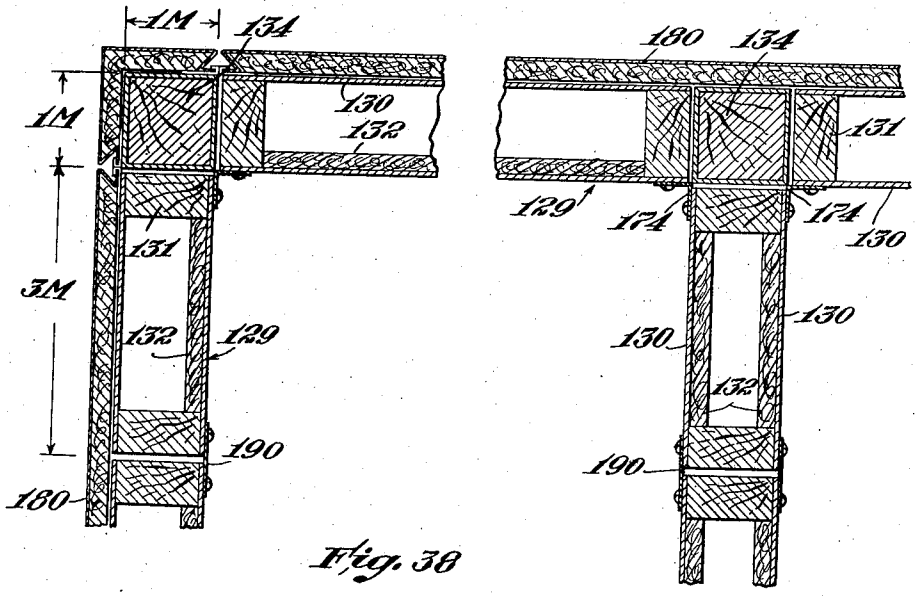


Fig. 38

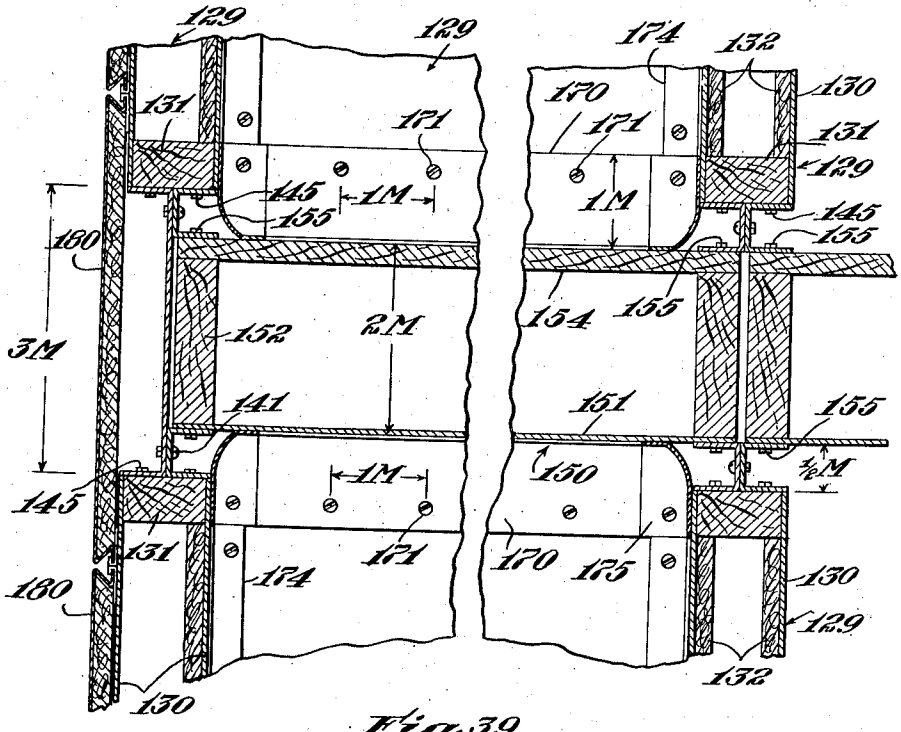


Fig. 39

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May 17, 1938. A. F. BEMIS 2,117,934

BUILDING CONSTRUCTION

Filed March 20, 1936 12 Sheets-Sheet 12

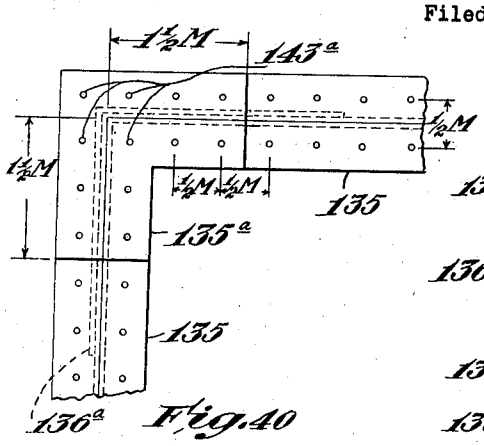


Fig. 40

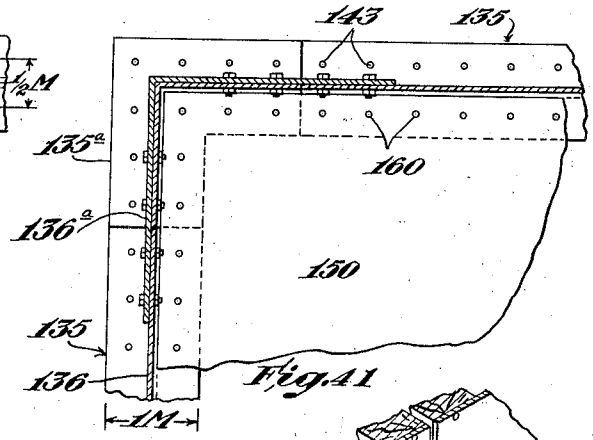


Fig. 41

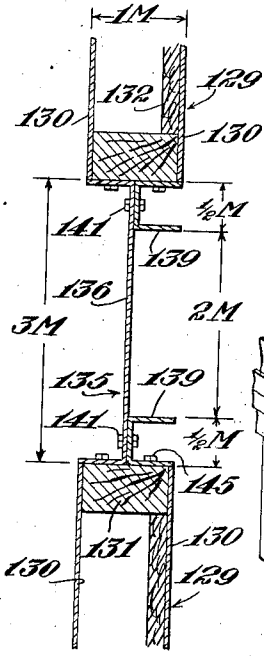


Fig. 42

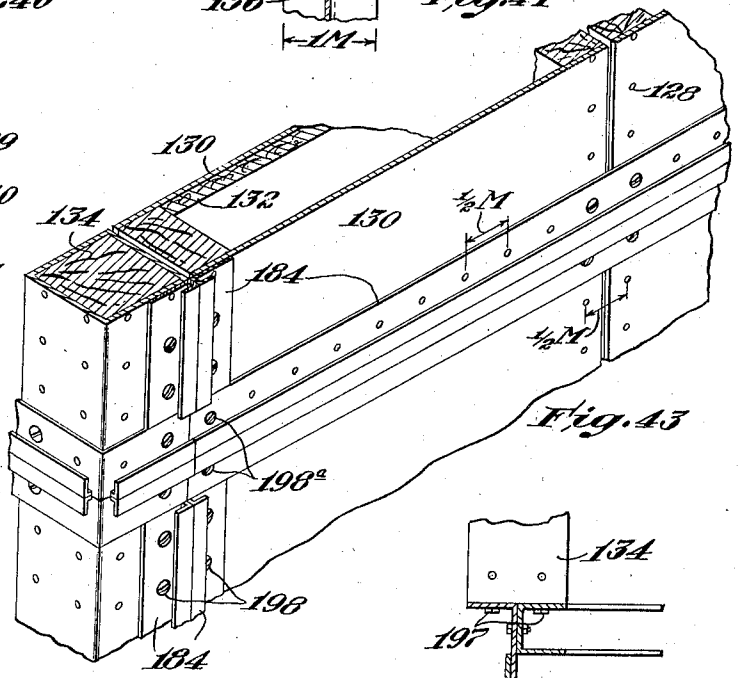


Fig. 43

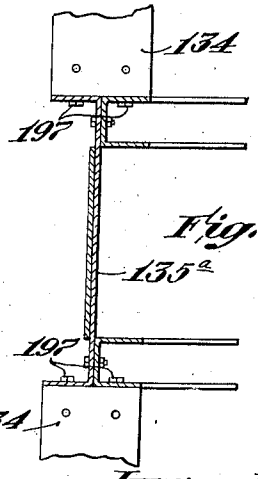


Fig. 44

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Patented May 17, 1938

2,117,934

UNITED STATES PATENT OFFICE

2,117,934

BUILDING CONSTRUCTION

Albert F. Bemis, Newton, Mass., assignor to Bemis Industries, Incorporated, Boston, Mass., a corporation of Delaware

Application March 20, 1936, Serial No. 69,867

9 Claims. (Cl. 20—1)

This invention relates to an improved method of building construction and resulting products and involves the employment of parts which are manufactured in quantities and in a limited number of standard sizes and shapes suitable for such quantity production, so that they may be transported to a building site and assembled without requiring substantially any cutting or special fitting, thus greatly facilitating the construction of dwelling houses or the like, while permitting versatility in design and avoiding a standardized or stereotyped appearance. The present invention affords improvements upon and further developments of the invention disclosed in my United States Patent No. 1,878,367, and, in some aspects, this application is a continuation-in-part of my copending application Serial No. 649,158, filed December 8, 1932.

My above-identified patent discloses a method of modular construction permitting members to be supplied with dimensions which differ only by a module M or a multiple of the same from the dimensions of other similar members, thus permitting parts to be provided in a range of standardized sizes for constructing a building of practically any desired design while avoiding the necessity of cutting to special lengths. The modular dimension M preferably may be of the order of the thickness of a structural wall or may equal the same. A characteristic of such buildings is that the median planes of parallel structural walls are ordinarily spaced at integral multiples of the module M, while there is an interdimensional relationship between the lengths and transverse dimensions of structural members.

A further aspect of the invention disclosed in my prior above-identified patent involves the arrangement of apertures for fastenings at modular distances, such apertures being disposed in longitudinal rows in elongate frame members, the rows being symmetrically disposed relative to the ends of the members and the openings in each row being spaced at modular distances.

The present invention provides constructions involving the general principles taught by the above-identified patent, providing modularization not only of frame members, wall parts, finish members and the like, but also of connecting means for the same. One aspect of the present invention involves the modular dimensioning of jointing means, for example, splines, stiles, tongues and grooves, and the disposition of such jointing means in definite uniform relations to the structure. A further and related aspect of the invention relates to the modular disposition of fastening means, including apertures to receive pins, bolts, rivets, or the like, in definite modular relationship to each other, to the structural walls, and to parts of the same; and further aspects of the invention relate to the modular disposition of finishing and accessory means, such as corner strips and units, as well as the fastening means therefor.

In order properly to correlate the various features which have just been named, I have discovered that it is often advantageous to regard the structural walls, jointing means, etc., as being included in and/or symmetrically disposed relative to certain modular matrices, which form a convenient system of reference for the interrelation of the linear dimensions of parts that interfit or engage each other. A wall matrix may be regarded as being made up of theoretical cubes, one M on a side, the structural wall being symmetrically related to the cube group, which is, of course, bisected by the median plane of the wall. If, for example, the structural wall has a thickness of one M, the faces of the cubes of the matrix coincide with the faces of the wall and the ends of wall parts may ordinarily be disposed symmetrically at or within the end surfaces of the end cubes, while the upper and lower edges of the wall parts may be disposed inwardly of the faces of cubes extending along the top and bottom of the cubical matrix or may coincide with the same. Each wall matrix may be divided into smaller groups of cubes which correspond to a structural part or wall member.

Joints between wall parts and between such parts and frame members may be designed symmetrically within jointing matrices which consist of rows of reference cubes (one M on a side) that may be disposed in offset relation to the cubes of the modular wall matrix. Thus, for example, an elongate jointing member disposed at the end of a wall may be symmetrically disposed within a vertical row of modular cubes which may be offset ½ M transversely of the jointing member relative to the cubes of the wall matrix. Such jointing matrices in each wall may be spaced apart (i. e., have their center lines spaced) at distances which are multiples of the module M and may also have a definite modular relationship with the median planes of transversely extending walls as will be more fully explained.

A modular relationship which I have found of importance involves the division of the individual one-M cubes of a matrix by means of primary and/or secondary axial planes and the disposi-

tion of jointing means and connecting means in definite relation to such planes. Thus, for example, the cubes of a jointing matrix may be divided by axial planes which intersect at focal lines that determine the location of fastening means, such as apertures, in proper modular relationship to the parts of the jointing means. In other cases, the cubes of a jointing matrix may not only thus be divided by axial planes into eight smaller cubes, ½ M on a side, but may also be divided by secondary planes disposed midway between the axial planes and the faces of the cubes so that each modular cube is subdivided into sixty-four cubes, ¼ M on a side. These secondary planes I have found to be particularly advantageous in determining the location of certain faces of jointing parts such as stiles, splines, tongues, and the like, while the intersections of such secondary planes define secondary focal lines which are particularly advantageous in determining the position of connecting means, for example, apertures to receive fastening pins, bolts, rivets, or the like.

While my above-identified patent suggested the arrangement of means such as apertures for fastening elements in longitudinal rows in which the apertures were spaced at modular intervals, i. e., at distances of one module from each other or at distances having a common divisor with one module, I have discovered that it is particularly advantageous to dispose the apertures on the secondary foci of the matrix cubes at a modular distance, for example ½ M from each other, not only longitudinally of a frame or jointing member, but transversely of the same. When the cubes of the jointing matrices are offset ½ M relative to the cubes of the wall matrices, such an arrangement permits apertures on the secondary foci of the wall and jointing cubes to register with each other. While the apertures may also be disposed at aliquot parts of the ½ M distances from each other, if the module is of the order of the structural wall thickness, the spacing of fastenings at ½ M distance ordinarily is more consistent with practical considerations of structural design.

A further aspect of the invention relates to the disposition of finish and accessory members, such as panels, battens, corner strips and corner units, in definite relation to the faces and the primary and secondary axial planes of the cubes of the jointing matrices and uniform arrangements of fastening means therefor at the foci defined by the intersections of primary and secondary axial planes of the modular cubes.

In the accompanying drawings:

Fig. 1 is a diagrammatic plan view of the structural matrix for a building having an irregular room layout and with modularly spaced walls, said matrix being formed of cubes which are one M on a side;

Fig. 2 is a diagrammatic plan view of a portion of the structural walls of a building with modular wall matrix cubes illustrated in light dot and dash lines;

Fig. 3 is a similar view of the corner of a building having another type of modularly dimensioned frame;

Fig. 4 is a side elevation of a portion of the frame of a building;

Fig. 5 is an isometric view of a portion of wall showing the disposition of modular wall matrix cubes and jointing matrix cubes;

Fig. 6 is an isometric view of a modular cube showing the arrangement of primary and secondary axial planes and primary and secondary foci;

Figs. 7, 8 and 9 are diagrammatic views showing various relationships which may be provided between jointing matrix cubes and adjoining wall matrix cubes;

Fig. 10 is a broken elevational view showing the arrangement of modular jointing means with the parts connected thereby;

Fig. 11 is a broken sectional view of a portion of a building employing modularly dimensioned parts;

Fig. 12 is a broken isometric view showing the arrangement of certain joints at wall intersections in a construction which may be employed with a floor plan such as shown in Fig. 1 and which includes wall units such as shown in Fig. 5;

Fig. 13 is an isometric view, partly in section, showing a joint between a floor and a vertical wall in a building of the type disclosed in Fig. 12;

Fig. 14 is a vertical section through an interior girt which may be employed for a building of the type illustrated in Figs. 12 and 13;

Fig. 15 is a side elevational view of a portion of an outer right-angled corner of such a building;

Fig. 16 is a horizontal section indicated by line 16—16 of Fig. 15, and showing the corner joint where a horizontal wall meets two vertical walls;

Fig. 17 is a similar sectional view but showing connections between three vertical walls and a horizontal wall;

Figs. 18 and 19 are horizontal sectional views of optional corner constructions which may be employed with wall units of the type illustrated in Fig. 5;

Fig. 20 is a horizontal sectional view of a wall including units connected by spline members;

Fig. 21 is a side elevation of such a wall;

Fig. 22 is a horizontal section of a right-angled corner connecting two walls of the type shown in Fig. 20;

Figs. 23 and 24 are similar horizontal sectional views showing three-way and four-way corner connections, respectively;

Fig. 25 is a vertical section showing the connection between a vertical wall such as illustrated in Fig. 20 and a horizontal wall;

Fig. 26 is a horizontal section showing connecting means employed between a horizontal wall and three intersecting vertical walls;

Fig. 27 is a view similar to Fig. 25, but showing optional jointing means;

Fig. 28 is a sectional view similar to Fig. 16, but showing an optional splined construction;

Fig. 29 is an isometric view of a corner of a building showing the manner in which finish members may be applied to the walls thereof;

Fig. 30 is an isometric view of an upper corner unit employed with the arrangement shown in Fig. 29;

Fig. 31 is a diagrammatic view showing the arrangement of jointing matrices and the relation of their primary foci;

Fig. 32 is an isometric view of a wall provided with jointing means having fastening elements disposed on the primary foci of the cubes of the jointing matrices;

Fig. 33 is an isometric view of a corner of a building constructed in accordance with this invention and showing the manner in which composite units may be employed;

Fig. 34 is a horizontal sectional detail showing the arrangement of retaining means for the exterior panels illustrated in Fig. 33;

Fig. 35 is an end view of a girt of the type shown in Fig. 33;

Fig. 36 is a side elevation of a portion of such a girt;

Fig. 37 is a detail plan of a short girt of the type shown in Figs. 35 and 36;

Fig. 38 is a broken horizontal sectional view through a portion of the building shown in Fig. 35;

Fig. 39 is a broken vertical sectional view of such a building;

Fig. 40 is a plan view of a girt assembly at the corner of the building;

Fig. 41 is a horizontal sectional view through such a girt assembly showing the arrangement of a floor unit in relation thereto;

Fig. 42 is a vertical section of a girt showing the vertical wall units connected thereto but with the horizontal wall unit omitted;

Fig. 43 is an isometric view of a corner of the building before the finish panels are applied thereto; and

Fig. 44 is a sectional view of an angular girt member showing the manner in which the corner posts are connected thereto.

Since the present invention particularly relates to the dimensional and spatial relationship of building parts, it may now be conveniently noted that certain terms as employed herein should be construed in accordance with the following definitions and explanations, except when the context clearly indicates otherwise:

The term "multiple" or "integral multiple", as employed herein, means that a factor is multiplied by any whole number, including one. Thus, for example, an integral multiple of ½ M might be ½M, one M, 1½ M, etc.

When parts are herein referred to as being "spaced at certain distances" or "being certain distances apart", such spacings or distances are from the center lines of the parts referred to. Thus when two openings are described as spaced one M apart, their central axes are spaced at that distance.

A "structural wall" is the load or stress-bearing portion of a wall and does not include finish panels or material except when the surface paneling has a distinct structural or wall reinforcing function, as when units which include such paneling are employed to provide the wall structure. The module M may ordinarily be of the general order of the structural wall thickness. When the horizontal walls are much thicker than vertical walls, the module ordinarily may be of the order of the thickness of the vertical walls, and, when the exterior vertical walls are substantially thicker than the interior load-bearing walls, the module may ordinarily be of the order of the thickness of the interior walls.

Fig. 1 illustrates a system of one-M reference cubes arranged in a modular matrix system to define the floor plan of a building. Such a building has a room 1 extending along one of its sides and two rooms 2 and 3 beside the room 1 and separated from each other by an intervening partition defined by a layer of matrix cubes 4, a partition defined by a layer of matrix cubes 5 separating the rooms 1 and 2 and a partition defined by a layer of matrix cubes 7 separating the rooms 1 and 3. In such a building the distances between center lines of parallel structural members of the same class, for example girts or posts, may differ from each other only by an integral multiple of a module M.

As indicated in Fig. 1, the horizontal distances between the median planes of corresponding parallel walls which are included within the wall matrices are integral multiples of the module M, and when the vertical dimensions are also modular, as explained in my above-identified patent, a similar relationship may be provided between the median planes of horizontal walls. Thus a modular building of this type may consist of walls which are included in wall matrices, the matrices preferably being spaced apart both vertically and horizontally so that the median planes of parallel wall matrices are spaced at integral multiples of the module M.

However, in certain cases some walls, as the exterior walls of a building, may be thicker than other walls, as the interior walls of a building. In such cases, for example, the exterior walls might be defined by wall matrices which are two M thick and the interior walls defined by matrices which are one M thick. In such cases the median planes of parallel interior wall matrices would still be spaced an integral number of modules apart, while the corresponding planes for the parallel exterior walls would be similarly spaced, the median planes of interior and exterior walls being spaced at distances which are integral multiples of ½ M.

Preferably the various wall sections are definitely related to and may advantageously be symmetrically disposed within corresponding groups of matrix cubes, while at corners and wall intersections there may be rows of intersection cubes which may define the positions of posts or the like. In certain cases it may be desirable not only to regard cubes disposed at the intersections defined by the projections of the intersecting walls as intersection cubes, but also contiguous rows of cubes disposed in the respective walls, parts of the posts being disposed in such rows of contiguous cubes.

While in order to obtain the full advantages of modular construction and design it is preferable to have the faces of the walls coincide with the faces of the modular cubes, some advantages of the modular arrangements may be obtained when the faces of the walls are disposed within the faces of the modular cubes and when the ends of wall sections do not coincide with or are not disposed symmetrically within corresponding faces of wall cubes. Such arrangements are illustrated in Figs. 2, 3 and 4.

Fig. 2 illustrates the relation of structural walls which are less than one M thick to wall matrices of a building, the posts 14 being connected by brackets 15 to girts 16 and the median planes of the walls being indicated by the walls *p*, *p* and being spaced at integral multiples of the module M from the corresponding planes of parallel walls. In Fig. 2 the posts 14 are shown as being disposed symmetrically within groups of intersection cubes while the girts 16 are disposed symmetrically transversely of the wall within the cubes of the wall matrix, the special arrangement illustrated in this figure showing the ends of the girts disposed outwardly of the faces of the wall matrix cubes rather than coinciding with the same as is preferable for reasons which will be described.

Fig. 3 illustrates an arrangement of corresponding wall matrices when the walls are included in matrix layers which are more than one M thick, the posts 17 in this construction being connected to the girts 19 by brackets 18. This post 17, as shown, is symmetrically disposed in an intersection matrix which is made up of four

vertical rows of modular cubes, the wall matrices being made up of layers of modular cubes which are two M thick and walls being disposed symmetrically in a transverse direction in relation to these wall matrices.

In many cases, the horizontal or floor matrices may be two M thick, as shown in Fig. 4, while the wall matrices may be one M thick, the median plane of the vertical wall being indicated by line p^2, p^2 and the median plane of the horizontal wall by line p^3, p^3.

Fig. 5 illustrates a construction employing wall units which in many cases may be preformed at the manufacturing plant and which may, if desired, have surfaces suitable for the exterior and/or interior finish of the wall, so that additional layers of finishing material are not necessary, it being evident that such units may thus combine the functions of structural members and finish members. The principles of this invention may be employed with such constructions or with constructions involving the employment of structural walls of modular dimensions which are adapted to receive layers of finishing material.

In Fig. 5 the preferred arrangement is illustrated wherein the faces of the structural wall substantially coincide with the faces of the wall cubes which are shown in light dot and dash lines. Furthermore, the vertical and horizontal edges of the wall units may substantially coincide with corresponding faces of the wall matrix cubes. It is thus evident that the wall units may have widths and heights as well as thicknesses which are multiples of the module M. The jointing means which connect the wall units to each other and to the frame members extending along wall intersections may conveniently be regarded as included in jointing matrix cubes, indicated by heavy dotted lines in Fig. 5. Thus adjoining wall units have tongues 11 extending along both vertical and horizontal edges and engaging stiles 10. The latter are included within rows of jointing matrix cubes, the faces of these cubes, transverse to the plane of the wall, are offset ½ M from the parallel faces of the wall matrix cubes, so that the axial plane of each joint matrix coincides with the transverse faces of matrix cubes at the edges of the wall units.

Fig. 6 shows a single modular cube which is one M on a side and shows this cube divided by axial planes P, P^1 and P^2 into 8 smaller cubes which are ½ M on a side. It also shows secondary axial planes S, S^1, S^2, S^3, S^4 and S^5 which cooperate with the main axial planes P, P^1 and P^2 to divide the cube into 64 small cubes each ¼ M on a side.

For the purposes of the present invention, the primary foci such as are provided by the intersections of the planes P and P^2, or P and P^1, and designated F^1, may be of importance as defining the proper position of fastening or connecting means, while the secondary foci F^2 at the intersections of secondary planes are often more important as defining the proper location of connecting means. Furthermore, the secondary axial planes, such as S^4 and S^5, may be significant in defining the advantageous positioning of certain faces of jointing members such as splines, stiles, tongues or the like.

Thus, as shown in Fig. 5, the wall units may be provided with the tongues 11 which are ½ M thick, so that their outer faces are disposed upon secondary planes of the vertical jointing matrices corresponding to the secondary planes S^4 and S^5 of the cube shown in Fig. 6. Such an arrangement with wall units of the type shown in Fig. 5 involves the provision of plates 13 between which portions of the tongue members are interposed, these plates obviously having inner faces disposed on the secondary planes of the modular cubes of the wall matrix.

Furthermore, in order to provide the highest degree of convenience and flexibility in design and construction, it is advantageous to have the outer faces of the plates 13 coincide with faces of wall cubes and their edges coincide with horizontal and vertical faces of jointing cubes, while each vertical and horizontal tongue member 11 may have its transverse vertical and horizontal faces in the planes of the faces of wall cubes. The vertical and horizontal stiles 10 preferably have their inner faces disposed on secondary planes, corresponding to the planes S^4 and S^5 of Fig. 6 and preferably have modular widths so that their edge faces coincide with the faces of the corresponding jointing matrices, while their outer faces coincide with the outer faces of the jointing matrix cubes. The stiles 10 may have lengths which are multiples of the M module but have their ends spaced ½ M from the faces of cubes at the ends of the corresponding jointing matrices, this relationship being shown at the lower part of the vertical jointing matrix of Fig. 5. It is evident that each of the members 10, 11 and 13 is provided with dimensions in the plane of the wall which are integral multiples of the module M. Transversely of the wall the above-named members all have dimensions which are integral multiples of ¼ M, the members 10 and 13 having transverse dimensions equal to ¼ M and the tongues 11 having transverse dimensions equal to ½ M.

Suitable apertures for fastening pins or dowels 12 are arranged in the stiles 10 to register with corresponding openings in the tongue members 11 and adjoining parts such as a part 30a of an adjoining frame member, these openings being centered on the secondary foci F^2 of the modular cubes of the corresponding jointing matrices. Thus each of the openings and of the pins has its axis determined by one of the foci F^2, indicated on the theoretical cube illustrated in Fig. 6, there being a row of openings extending along each of the similar margins of the wall units, the openings being uniformly spaced in each row and being uniformly spaced from the adjoining edges of the tongues 11.

When the fastening means, e. g. apertures, are disposed upon the secondary foci of the jointing matrix cubes and corresponding foci of the wall matrix cubes, such means may register in the manner illustrated in Figs. 7, 8 and 9. In these figures jointing matrix cubes are indicated in full lines and are shown with openings at their secondary foci, while adjoining wall matrix cubes are shown in dot and dash lines and with openings at their secondary foci. If, as shown in Fig. 7, a jointing matrix cube is offset ½ M horizontally from the wall matrix cubes, the cubes have vertical secondary planes coinciding and the openings on the secondary foci of the jointing and wall matrix cubes register, this being the relationship of the cubes along the vertical joint shown in Fig. 5. If the jointing matrix cube is offset ½ M vertically relative to the adjoining wall matrix cubes, as shown in Fig. 8, the cubes have horizontal secondary planes coinciding and the openings on the secondary foci also register, this being the relationship of the cubes along the horizontal joint of Fig. 5.

At the region of juncture of horizontal and

vertical jointing matrices the jointing cubes are offset ½ M both vertically and horizontally relative to each other with vertical and horizontal secondary planes coinciding, so that each of these cubes has one-quarter of its total volume in common with one-quarter of the volume of a cube in a matrix extending at right angles thereto. The openings centered on the secondary foci of these quarter cubes register, as shown in Fig. 9. It is thus evident that when openings are disposed upon the secondary foci of modular cubes, such cubes may be offset ½ M vertically, horizontally, or both. Fig. 9 also shows the relationship of the adjoining cubes of the wall matrix to the cubes of the jointing matrices at their region of intersection. It is furthermore evident that in certain cases the jointing cubes may be regarded as the wall cubes when the openings disposed on the secondary foci obviously will coincide. It will be apparent from the subsequent description that the matrix cubes of one wall are definitely related to the matrices of transversely extending walls so that the location of the openings at secondary foci not only permits the openings of the parts of one wall to register with each other but permits these parts to be disposed in definite modular relationship to the parts of intersecting walls.

One advantage of the arrangement of the openings at the secondary foci may be observed from the construction illustrated in Figs. 5 and 10. Rectangular parts such as, for example, core frames for wall units, each made up of a pair of horizontal and a pair of vertical tongue members 11, are provided with openings disposed on the secondary foci of the wall matrix cubes. Such rectangular parts or units may have widths and heights which are multiples of the module, the rows of openings extending along the margins of the parts being spaced uniformly from the adjoining edges and the openings at corners being common to two rows which extend at right angles to each other. The rectangular parts may be disposed either vertically as shown at the upper part of Fig. 10 or horizontally, as shown in the lower part of that figure, and may have their openings registering with the openings in jointing members, for example stiles 10, such openings being disposed upon the secondary foci of the jointing matrix cubes. The openings extending along each margin of a jointing member 10 are spaced from the adjoining edge of the member at a distance equal to the spacing of the rows of openings in the rectangular parts from the corresponding edges of these parts. Such an arrangement permits parts such as wall units and jointing members to be provided in ranges of sizes characterized by widths and lengths which are multiples of the module or which differ by multiples of the module so that these parts may fit together with their openings in proper registration.

Such preformed parts may be readily joined in a variety of differently arranged assemblies to meet individual requirements of design without necessity of individual cutting or of providing specially located openings. Not only may wall parts be assembled and interconnected in such a manner, but, as will be more fully described, the units may be similarly connected to frame members extending along wall intersections. For this purpose the frame members may be provided with marginal parts similar to the margins of the wall parts and having similarly disposed openings, the part 30a, shown in Fig. 5, being such a part of a frame member.

When the core frames have modular dimensions, as has been described, their edges will abut at each joint, and the horizontal and vertical jointing members, i. e., stiles, when provided with modular dimensions, will have abutting surfaces at the juncture of the vertical and horizontal jointing matrices in the manner illustrated in Fig. 5. Referring to Figs. 5 and 10, it is evident that two horizontal stiles 10 might be provided to meet the end of the vertical stile 10 which could be extended downwardly one module to exactly fill the space between the ends of the horizontal stiles. It is furthermore evident that, if desired, the core units in Fig. 10 could be arranged so that the shorter transverse members 11 were two modules longer and the longer members 11 two modules shorter, so that the shorter members would extend past the ends of the longer members, the core members or frames still having the same dimensions as are shown herein.

If a standardized clearance is desired between the parts being joined, such as plates, core frames, or the like, the arrangement of the openings in this manner permits members to have dimensions which are integral multiples of the module minus the clearance, so that the standardized clearance may be obtained at both the horizontal and vertical joints between the members, while the openings in the members may properly register with the openings in the connecting stiles or the like. Furthermore, such an arrangement permits a suitable clearance between vertical and horizontal jointing members, e. g. stiles, with or without a similar clearance between the joined members, e. g., core frames. It is furthermore, of course, evident that such a construction permits the provision of the jointing members and the core frames or the like in ranges of sizes with dimensions which differ from each other by integral multiples of the module M.

It may also be observed that certain advantages of the arrangement of the fastening means, such as apertures, in this manner may be obtained when full employment of the modular principle in all three dimensions is not involved. For example, the horizontal dimensions of the building might be modular and under such conditions, with the openings arranged and spaced in the general manner which has been described, the openings would be arranged, for example, in the jointing means of the floor in rows which are spaced at distances of ½ M or a multiple thereof from each other, the openings in each row being spaced at ½ M or an aliquot part thereof from each other and the rows being disposed at distances which are multiples of ¼ M from the median planes of the walls parallel to said rows of openings, while the end openings in each row are spaced at distances which are multiples of ¼ M from the median planes of walls extending transversely of the row. Furthermore, the modular dimensioning of the parts such as stiles, tongue members and plates or the like might be advantageously employed in the vertical walls of such a building, certain standardized corner or filler pieces being employed at the upper and/or lower parts of such a wall.

While constructions of this type are particularly useful in buildings of complete modular construction having structural walls one M or two M thick, some of the advantages of arrangements of this character can be realized with

frame arrangements such as are illustrated in Figs. 2, 3 and 4. When the walls are arranged in this manner so that their faces are not spaced at exact modular distances from each other, special corner constructions may be employed to permit the main portions of the walls to be modular or certain parts, such as stiles, may be provided in lengths which differ from each other by integral multiples of the modules without being exact multiples of the same.

Fig. 11 is a sectional view illustrating jointing arrangements which may be employed to provide post assemblies connecting wall units of the character disclosed in Fig. 5. Such post assemblies may include parts of the tongue members 11 of adjoining wall units, certain stiles 10, and filler members 29 which are ½ M square in cross section. Thus, as shown at the left of Fig. 11, the wall units each have their plates 13 terminating on a line with the faces of a row of wall matrix cubes. The walls extending in one direction, however, have their tongue portions 11 projecting ½ M into the row of modular cubes which is disposed at the wall intersection, while the wall units extending at right angles to the first-named wall have the end faces of their tongue portions spaced ½ M from this row of cubes. It is evident that such a construction permits the units extending in both directions to have modular dimensions. The square filler members 29 are disposed at the ends of the tongues 11 of the members at the right-angled corner at the left of Fig. 11 and cooperate with the stiles 10 in affording a solid post assembly.

At the right of Fig. 11 the ends of tongues 11 of aligned wall units abut each other, while the third wall unit at this intersection has its end face spaced ½ M from the matrix cube which is included in the wall intersection, the filler member 29 being disposed at the end of this tongue and between the stiles 10 at either side thereof.

It is furthermore evident that a four-way connection could be provided having a construction analogous to that shown at the right of Fig. 11. The arrangements shown in this figure illustrate one advantage of providing the members, such as the stiles 10, in modular dimensions, it being evident that if the stiles were less than one M wide, there would be gaps between certain edges of stiles and faces of adjoining stiles, while if the stiles were more than one M wide, special stiles or odd-shaped members would have to be employed upon an exterior corner such as shown at the left of Fig. 11.

Corner or wall jointing arrangements of the type shown in Fig. 11 may sometimes be conveniently employed where interior partitions join exterior walls, while other post constructions of a type which will now be described may be employed for the connections between load bearing walls. Thus, for example, a wall construction such as shown at the right of Fig. 11 could be arranged where a partition joins an exterior wall either at any stiled joint thereof, such as the vertical joint shown in Fig. 5. or at a region an integral number of modules from such a joint.

Fig. 12 is a broken isometric view of a portion of a building such as shown in Fig. 1, employing wall units of the type illustrated in Fig. 5. As is evident from Fig. 12, the jointing means between the posts at corners and wall intersections may include modular stiles 10 of the character already described, having modular dimensions with openings and pins spaced at intervals ½ module both transversely and longitudinally of the stiles. In so far as modular analysis of this construction is concerned, it is evident that jointing matrices are provided where the wall units join the posts and that the tongue portions of the posts have outer faces upon the secondary planes of the modular cubes of such jointing matrices.

One important advantage of such a construction is the arrangement of the various parts of the wall units and posts so that they may be formed of one or more layers of a single thickness of material. For example, a single thickness of material, such as a single layer of wood or a single layer of plywood, may be employed for the panels 13, while the stiles 10 may be formed of a single layer of such material, the tongue members 11 being formed of two layers of such material which may be glued or otherwise secured together and the posts also being formed of a plurality of layers of material of this character. Thus the right-angled post 20, shown at the left of Fig. 12, may be made of four layers of the material arranged as illustrated, while the post 21, which affords a T-shaped connection, may be similarly constructed. The fastening elements 12 may be dowels which are glued in place or held by a friction fit.

Fig. 13 illustrates the jointing arrangement which may be provided with this type of construction between a horizontal wall or floor and a vertical wall. The floor units 25 may be similar to the wall units, but the tongue portions 26 thereof may be thicker, including six layers of material ¼ M thick, and they may include two face plates 13a corresponding to the plates 13. Thus the horizontal wall matrix is two M thick, as diagrammatically illustrated in Fig. 4, but has its faces coinciding with the faces of the wall. Stiles 10, similar to those already described, may be disposed at the ends and sides of the floor units to aid in connecting them to each other and to the girt 30 which, as shown, may also be built up of layers of material ¼ M thick. The girts preferably are provided with upper and lower tongue portions 30a which register with the tongue portions 11 at the tops and bottoms respectively of wall units, being connected thereto by horizontal stiles 10 which are disposed in the manner illustrated in Fig. 5 and have their openings similarly arranged.

It is evident therefore that the construction at both the ends and sides of the wall units may be similar and that the openings may be similarly disposed. The floor units 25 are of similar construction with similarly disposed openings except that the tongue portions 26 are of 1½ M thickness rather than ½ M thickness, and the total thickness of these units is two M rather than one M. Such an arrangement not only permits the various units to be made up of parts having uniformly spaced openings, but permits great flexibility in design by the employment of stock parts having modular dimensions. Thus, for example, referring again to Fig. 5, it is evident that the spacing of the openings in the vertical and horizontal stiles is uniform and that the ends of the vertical stiles are spaced ½ M from the faces of modular jointing cubes so that these stile members not only have modular widths and thicknesses, but also modular lengths.

Fig. 14 shows that the same general type of construction with similar modularly dimensioned members is arranged to provide a girt 30' for an intermediate wall.

Figs. 15 and 16 illustrate the corner construc-

tion where the girts meet at a convex corner, the exterior view of such a corner being shown in Fig. 15 which again illustrates the advantage of the disposition of the fastening means on the secondary foci so that the ends of horizontal stile members may abut a vertical edge of a vertical stile member. At the inside of the corner the stile pieces of the floor may be cut back from the corner portion and a special corner section 10c (shown in Fig. 16) may be arranged with fastening means to engage the corresponding corner of the floor unit and the tongues projecting from the girts 30. These girts terminate one M short of the vertical row of one-M cubes at the corner so that the post 20 extends through from one story to the next. With such a construction an opening 35, preferably one M square, may be provided inwardly of the corner of the wall to receive ducts for heating, lighting and the like. Suitable hollow corner members of modular dimensions may be disposed at the vertical corners of the rooms to conceal these openings and to receive the ducts extending between successive floors.

At such a corner the horizontal stiles 10 in the vertical walls may extend beneath and above the ends of vertical stiles 10, thus having the two fastenings at their extremities connected to the corresponding posts, or, if desired, the vertical stiles may extend past the ends of the horizontal stiles at these corners. In such a case the girts 30 may be notched to receive the stiles.

Fig. 17 shows a similar corner connection where an interior wall extends at right angles from an exterior wall and it is evident that a similar construction can readily be provided at the intersection of four walls.

It will now be apparent that all of the necessary parts required for the walls of a building may be made of a small number of simple modularly dimensioned elements, and that these elements preferably may be formed of stock ¼ M thick, such stock and the fastening pins which are either one M or two M long being the basic materials from which the wall parts are constructed.

At this point it may be noted that the ordinary clearances necessary in a building construction of this character may be afforded by the thickness of material removed by cutting the stock, and that when various elements are adhesively secured together, as by gluing, the adhesive layer may be of such a slight dimension as to be negligible. Therefore, when a part is stated, for example, to be one M thick, it is meant that the part has a dimension which is within a very small fraction of an inch of this dimension, ordinarily having a dimension slightly under the precise modular dimension to allow for clearances and allow for the waste due to sawing or the like.

Most of the parts necessary for the structural walls of a building of this character may be fully symmetrical so that they may be disposed with either face outward and with either end in either position. The arrangement of the openings for fastening means at uniform distances from each other and from the ends and edges of members permits standardization of manufacturing operations and of jigs, indexing and gauging devices. Obviously a building having walls constructed in the manner described may be formed of material such as wood or ply wood, which is itself suitable for interior and exterior finish or, if desired, suitable finishing material may be applied to the interior or exterior or both.

Figs. 18 and 19 illustrate a stile arrangement where the posts do not project beyond the cubical intersection matrix which is common to two intersecting walls. Thus, for example, Fig. 18 shows two walls meeting at a right-angled corner, each wall being one M thick so that a cubical matrix one M square is defined at the intersection. The post 36 is entirely located within this cubical matrix and the jointing means includes a special angular stile 37 upon the interior of the corner, stiles 10 of the type which have been described being disposed upon the outer sides of the corner. It is evident that the stiles 10 are disposed within a jointing matrix which is offset horizontally ½ M from the cubes in which the post is included and that the fastening means for these stiles, as well as for the angular stile 37, are disposed upon the secondary foci of these jointing matrices.

Fig. 19 illustrates a similar construction at a corner where the interior wall meets an exterior wall, the arrangement of the angular stiles and connecting means being similar to that described with reference to Fig. 18, except that upon the exterior surface of the wall two stiles 10 are located in direct side-by-side juxtaposition.

Figs. 20 to 26 show a building having jointing means comprising splines and having its parts formed of stock material which preferably is ¼ M thick and having dimensions which are modular.

The wall shown in Figs. 20 and 21 is built up of units having outer plates 40 which preferably may have widths and heights that are exact multiples of M. Suitable spacers 41 consisting of two layers of material are disposed between the plates 40 and spaced inwardly from the edges thereof to cooperate with the plates in defining grooves which are ½ M deep and ½ M wide. The spacers 41 preferably may be one M wide. The jointing means in this form of the invention may consist of splines 42 which, for convenience of illustration, are shown as consisting of a single piece of material but which in practice may be conveniently made of two layers of stock material in the same manner as the spacers 41. As shown, the splines 42 have a width equal to one M and a thickness equal to ½ M, and these splines as well as the plates 40 may be provided with openings and connected by fastening means 12 which are disposed on the secondary foci of the jointing matrices in which the splines are included.

In general it may be noted that the wall shown in Figs. 20 and 21 has parts corresponding to the wall shown in Fig. 5 but with the relationship reversed. Thus, rather than providing two stiles, each ¼ M thick, one M wide, and an integral number of modules long with its openings on the secondary foci, spline members each ½ M thick, one M wide and an integral number of modules long are arranged with their openings on the secondary foci. Thus the general modular principles illustrated in Figs. 12 to 17 may be employed with the type of wall units and jointing means illustrated in Figs. 20 and 21.

Fig. 22 shows the arrangement of a right-angle corner at the intersection of two walls such as are illustrated in Figs. 20 and 21, the post 50 being built up of a plurality of layers of stock material and having outer plates with openings disposed on the modular foci and having grooves which are ½ M wide by ½ M deep to receive splines 42 connecting the wall units to the post.

Fig. 23 illustrates a similar construction with a three-way post 51 with the various parts modu-

larly dimensioned and disposed in the general manner which has been described, while Fig. 24 shows a four-way construction of a similar type.

Fig. 25 shows a girt 52 which may be employed with a building, including splines 42 such as are illustrated in Fig. 20. Preferably the floor may be two M in thickness and two splines 42 may be arranged as shown, two of the spacing layers 53 of the floor units being extended to cooperate with their upper and lower plates 40a in defining two grooves, each of which are ½ M deep and ½ M wide.

Fig. 26 is a view of a girt construction where a post extends through between successive stories, the girts being cut back to provide corner openings 60 of the general type which were described in connection with Fig. 16 and splines being provided in the form of special corner units 61 shown in dotted lines in this figure. It is evident that this construction also permits the employment of simple modularly dimensioned pieces to afford practically any desired construction, and that they may be assembled of stock ¼ M thick.

It may now be evident that some of the parts disclosed in Figs. 20 to 26 are very similar to those disclosed in Figs. 12 to 19. For example, the splines 42 are similar in dimensions to the tongue members 11 and may each similarly be formed of two pieces of stock material that are one M wide, such as are employed for the stiles 10. It therefore is possible readily to combine the constructions of this character in various ways so that, for example, the stile joints may be used in vertical walls and the splined joints in horizontal walls. Fig. 27 illustrates a girt joint employing an arrangement of this character, the girt being provided with tongue portions to engage splines 10 in the vertical walls and being provided with grooves to receive splines 42 in the horizontal wall or floor. It is thus apparent that a building can be provided having horizontal floors and jointing means therefor similar to those illustrated in Figs. 25 and 26 and having vertical walls with jointing means similar to those illustrated in Figs. 12 to 18.

Fig. 28 illustrates a construction wherein wall units of the type illustrated in Fig. 5 may be joined to a post 65, the stiles 10 of the jointing means in the walls which are connected to the post being disposed in matrices which are directly juxtaposed to the row of cubes at the intersection. The wall units may be regarded as included in wall matrices in the manner illustrated in Fig. 5, but the transverse faces of wall matrix cubes are spaced at odd multiples of ½ M from the parallel faces of the matrix of the transversely extending wall rather than at multiples of M therefrom as is the case with the construction shown in Fig. 12. With the arrangement shown in Fig. 28, the wall units may have modular dimensions such as previously described, and the parts will fit together to afford walls and rooms of modular dimensions.

It is of course evident that tongued and grooved units rather than units having splines may be connected in the general manner illustrated in Figs. 20 to 26, the openings for fastening means being disposed upon the secondary foci of the jointing cubes in the general manner which has been described and the jointing parts as well as the parts connected thereby being provided by modular dimensions.

It is furthermore evident that the general arrangement of jointing parts in jointing matrices which are definitely related to the median planes of the walls and the arrangement of the fastening means upon secondary foci can be employed with a variety of structural materials. For example, metal units may be provided in modular dimensions and may be connected by jointing means and fastening elements provided with the general modular relationships which have been described. Furthermore, constructions having such modular relationships may be employed when the walls do not have thicknesses which are integral multiples of M, e. g., thicknesses equal to one M or two M. Thus, for example, again referring to Figs. 12 and 13, it is evident that the general modular disposition of the jointing means could be retained if the walls did not have a one-M or two-M thickness. If this were true, for example, the angular portions of the posts between stiles 10 at the interior corners would not have surfaces equal to an aliquot part of M, namely ½ M, as now shown. Similarly with such constructions the corresponding portions of girts 30, such as shown in Fig. 13, might have widths somewhat greater than the ½ M dimension shown. Certain advantages of the invention may also be obtained, as pointed out above, when the jointing members have lengths which differ only by integral multiples of M rather than lengths which are equal to integral multiples of M.

As suggested above, it is generally advantageous to have the openings arranged in pairs of rows so that the rows of each pair are spaced at ½ M distances and the openings in each row are spaced at ½ M distances, while spaced parallel rows of openings are spaced at integral multiples of the ½ M distance. It is possible, however, and may be desirable when the module is rather large, to arrange the openings and rows of openings at aliquot parts of the ½ M spacing, and in other constructions it is sometimes desirable to arrange the openings so that they are spaced one M apart. Thus the general arrangement of openings disclosed herein may involve spacing at ¼ M or an even multiple thereof not greater than one M, namely, ¼ M, ½ M or M.

Not only do the above-described arrangements permit the modular dimensioning of parts and the registration of openings in the parts of a single wall, but they also involve modular relationships of parts and openings in one wall with transversely extending or intersecting walls, thus permitting symmetry in arrangement of parts and proper fitting at intersections. The transverse faces of matrix cubes of one wall are spaced at multiples of ½ M from the parallel faces of transversely extending wall matrices and the median planes of such walls; while the axial planes of jointing matrices which coincide with such transverse faces are similarly spaced at multiples of ½ M from the parallel faces of the matrices of and the median planes of transverse walls, and the openings are disposed in rows which are preferably spaced at ¼ M from the axial planes of the corresponding joints and at odd multiples of this distance from the median planes of transversely extending walls.

The principles of this invention may be employed to facilitate the application of interior and exterior finish to the modularly disposed walls of buildings. Fig. 29 shows the corner of such a building which has a metal frame including a corner post 70, metal studs 71, girts 72 and joists 73. The studs 71 are disposed within jointing matrix cubes, and are provided with openings on the secondary foci of these cubes. As shown,

the floor may be included in a layer of matrix cubes which is two M thick, and the frame members, such as posts, girts, studs, and joints, may also be provided with parts having openings spaced at ½ M from each other in the general manner which has been described.

Finish panels 75 may be disposed upon the interior surfaces of the walls, these panels being of modular dimensions and being connected to the studs by fastening means such as pins or screws located at the secondary foci. In Fig. 29 certain fastening means, e. g., screws, are shown, the remainder being omitted for convenience and clarity of illustration. As shown, such fastening means are arranged to hold battens 76 against the panels 75, thus concealing the joints between the panels. The battens preferably may have a width of one M and may have lengths equal to integral multiples of M. Similar battens or finishing strips may be arranged on the ceiling surfaces.

At the corners where vertical and horizontal walls join each other and where vertical walls intersect, special angular corner strips may be employed. Such angular strips 77 are arranged so that one flange of each of the same affords a marginal surface of the floor while the other flange thereof affords a finish for the lower part of the wall. Preferably both flanges of this member may be one M wide, and it may be provided with openings disposed upon secondary foci to facilitate its connection with the studs 71 and floor joists 73.

At the regions where two of these corner strips extend toward a corner between two vertical walls, a corner unit 78 may be arranged providing a horizontal wall aligned with the horizontal flanges of the strips 77 and two vertical walls aligned with the corresponding flanges of the strips. This unit may have each of its three dimensions equal to one M and may be provided with openings at the secondary foci, each of these openings being common to the rows of openings extending in two directions therefrom. Thus the openings in the vertical walls of the units are aligned with the horizontal rows of openings in the vertical flanges of the members 77 and with the vertical rows of openings in batten members 76, while the horizontal flange of this member is provided with an opening which is common to the rows of openings in the two horizontal flanges of the two strips 77 which extend at right angles to each other. Between the studs and the floor joists the openings in flanges of corner strips 77 may be omitted if desired, or these openings may be filled with suitable plugs, or suitable bridging strips may be located in modular relationship to the girts to extend between the studs and joists respectively, so that the portions of the strips 77 which extend between studs or joists are connected to such bridging strips. Since the walls of the unit 78 are each one M square, the strips may be provided in modular lengths, i. e., they may be equal multiples of the module if the structural wall thickness is one M or two M, it being understood that in Fig. 29 the thickness of the vertical structural wall is one M and the thickness of the horizontal wall is two M.

At a vertical corner special right angular finish panels 75a are provided, these angular panels having flanges which are one M wide and which are aligned with the panels 75 in the respective vertical walls.

The arrangement of the paneling upon the exterior walls is generally similar to that which has been described, the panels 75b, as shown, being somewhat thicker than the panels 75 but having similar widths and being retained in place by battens 76, which may be similar to the interior battens. At the exterior corners of the building, however, a special angular corner panel 75c is provided having each of its walls two M in width.

At the corners between the finish panels for the vertical walls and the ceiling, angular corner strips 77 and corner units 78, similar to those which have been described, may be provided, these members 77 and 78 having their openings arranged in the same manner that has been described.

Arrangements of this character may also be employed where the walls do not have thicknesses which are exact integral multiples of the module. Thus, for example, assuming that the vertical walls are less than one M thick, the corner unit 78 and the angular paneling member 75a may have dimensions which are somewhat greater than one M, the arrangement of the panels and strips, as well as the battens, being similar to that shown, so that these parts may all have the same modular dimensions.

It is evident that arrangements of this character permit the employment of finishing members, such as upper and lower corner strips, battens and finish panels, which may be provided in a range of sizes which differ only by integral multiples of the module M, while stock corner units 78 and corner pieces 75a and 75c may be provided having fully modular dimensions, if the walls are of modular thickness, and having certain dimensions which are not exactly modular if the walls do not have a thickness equal to the integral multiple of the module.

Figs. 31 and 32 illustrate the principles of this invention which may be employed when the fastening means are disposed at the primary foci of jointing cubes, such as the foci F^1 of the cube shown in Fig. 6. A further illustration of such an arrangement of fastening means is also provided by my copending application Serial No. 649,158, filed December 8, 1932.

Fig. 31 illustrates a row of vertically disposed and an adjoining row of horizontally disposed cubical matrix cubes with the positions of their primary foci indicated by the symbol F^1.

Fig. 32 shows a wall provided with studs 120 and with plates 121, such plates differing from each other by modular dimensions but conveniently having dimensions which are less than a module. Retaining strips 122 may be provided with outer plate portions 123 and with intermediate inwardly extending flanges 124 to be interposed between the edges of the plates 121 and to engage the faces of the studs 120. With such a member the fastening means, such as screws 125, may be received in openings or apertures that are disposed upon the primary foci of the cubes of the jointing matrices, such fastening members extending through the parts 124 of the retaining strips and into the studs 120. A similar construction may be used for both vertical and horizontal joints so that the strips 123, when used for either of these joints, may be cut out of long uniform stock to modular lengths and will have their openings to receive fastening means properly disposed, the strips being arranged so that the edges of adjoining vertical and horizontal strips are juxtaposed in close fitting relation.

Figs. 33 to 44 illustrate a building in which modular principles are employed in conjunction with the arrangement of composite wall units and modular main frame members. The vertical wall units **129** may comprise similar face sheets **130** of sheet metal, while the edges of the sheets may be secured by a suitable adhesive to marginal strips **131** of wood or the like. These strips are connected to each other to define a rectangular core frame; if desired, insulating panels **132** may be secured against the inner faces of sheets **130** that are to be disposed at interior wall surfaces. Preferably the units **129** may be provided in widths which vary by multiples of the module M but which are equal to multiples of the module M minus a small clearance *c*. Thus the adjoining edges of the units are spaced from each other by the clearance *c*, as shown in Fig. 33. The vertical dimensions of such units preferably may be exact multiples of the module. These units preferably are associated with suitable posts **134** and girts **135** to define the vertical walls of the building. As shown, each post **134** may have a wooden core portion enclosed in a sheet metal shell, the entire post being square and having a dimension of one M upon each side (Fig. 38). Preferably the posts do not extend through from story to story, the end of the girt assembly resting upon a lower post at each corner and supporting an upper post.

The exterior girts **135**, as shown in Figs. 35 and 36, may conveniently have one large channel portion **136** providing upper and lower flanges **137** and **138**, while smaller channels **139** may be connected to the upper and lower parts of the bight portion of the large channel **136**, one flange of each of the channels **139** being aligned with a flange **137** or **138** of the large channel **136**. The girt preferably may have a vertical dimension equal to three M and the channels **139** may have a corresponding dimension equal to ½ M so that the faces of their adjoining parallel flanges are spaced two M apart.

Suitable registering openings **140** may be provided in the bight portions of the channels **136** and **139**, these openings being arranged in rows which are ¼ M from the outer faces of the flanges of the channels and being spaced ½ M from each other, thus being disposed at secondary foci of matrix cubes. Suitable fastening means **141**, such as bolts, may extend through the registering openings **140** of the channels so that the girt in effect forms a single unit of the type illustrated in Figs. 35 and 36. For purposes of convenience of illustration the openings **140** are shown without the connecting bolts **141** in Figs. 35 and 36, while the bolts are shown in Figs. 39 and 42. Preferably both of the horizontal flanges of each of the girt channels are provided with openings **143** (Fig. 37) which are spaced ½ M from each other and ¼ M from the adjoining edge of the flange.

At corners angular girt members **135a** are provided (Figs. 40, 41 and 44). These members have portions which are aligned with the straight sections **135** and which have a similar cross section and have similarly spaced openings, but these members are also provided with angular splicing plates **136a**. The ends of these plates extend from the members **135a** and may be connected to the girts **135** by fastenings extending through openings **196** in the ends of the girts (Fig. 36). The ends of the posts **134** receive fastening means **197** (Fig. 44) which extend through the openings **143a** in the top and bottom flanges of the corner members.

The wall units **129** are conveniently secured to the girts by fastenings **145** which extend through the openings **143** in the upper and lower flanges of the girts and are received in preformed openings in the horizontal core elements **131** of the wall units (Fig. 39).

The floor units **150** may conveniently be of the same general type as the wall units, having lower metal face sheets **151** and having marginal core pieces **152** which cooperate in affording a rectangular frame. However, the upper faces of these units **150** may conveniently be formed of rigid paneling **154** of wood or the like, the panels **154** and the sheets **151** being secured to the core strips **152** by suitable adhesive.

Preferably the units **150** may have a thickness approximately equal to two M so that these units are received between the inner flanges of the smaller channels **139** of the girts, as shown in Figs. 33 and 39. Thus, when the building is being constructed, the upper channel **139** of each girt may conveniently be assembled in place after the horizontal wall units or the floor units have been disposed upon the upper flange of the lower channel. Suitable fastenings **155**, similar to the fastenings **145**, may extend through the openings in the inner flanges of the channels **139** and into preformed openings **160** in the marginal portions of the floor units **150**.

Preferably the openings **160** in the margins of the floor units **150** are spaced ½ M from each other and spaced at distances from the nominal edges of the units which are equal to ¼ M, it being understood that in practice the actual widths and lengths of the units are less than their corresponding nominal modular widths by a small clearance. The openings **160** (Fig. 41) are thus adapted to register with the openings **143** in the small girt channels **139**, and such registration will be provided at the corner of a building, it being evident that the openings in the corner members **135a** are spaced from each other and the adjoining straight sections **135** at distances of ½ M (Fig. 40).

The ceilings may be provided with batten finish strips **163** (Fig. 33) which are provided with openings spaced at ½ M both longitudinally and transversely of the strips to register with the openings **160** in the adjoining margins of the units **150**. A suitable covering material **165** may be disposed upon the upper surface of the floor to conceal the openings **160** upon the intermediate parts of the margins of the units, such cover material conveniently being linoleum or the like.

At the lower corners between vertical and horizontal walls (Figs. 33 and 39) finish strips **170** of sheet metal or the like may be arranged, these strips being secured in place by rows of fastenings **171** extending into certain of the marginal openings in the wall units. As shown, these fastenings extend into alternate openings **128** of the units **129**. The openings **128** are spaced ½ M from each other, being arranged in rows which are ¼ M from the ends of the units and from their nominal side edges; thus the adjoining vertical rows of openings provided by two juxtaposed units are ½ M apart. At vertical corners angle strips **174** may be connected to the margins of the units by similar fastenings. At the ends of the strips **170**, corner units **175** may be provided, such units having transverse dimensions equal to ½ M and each having a vertical dimension

which may equal that of strips 170 and may conveniently be one M. The corner units 175 may be secured to the adjoining wall units by screws which are aligned with the rows of screws provided for the adjoining strips 170 and 174. Similar finish members 170 (Fig. 39) may be provided at upper horizontal corners, suitable corner units 175 being provided at the ends of these strips, i. e., where horizontal corners meet vertical corners.

While the illustrated finish members have dimensions which are multiples of the module or aliquot fractions thereof, in practice, it may often be desirable to depart from such exact relationships, for example, the members 170 may be provided in ranges of standardized lengths which differ by multiples of the module M, but which are not exact multiples thereof, the horizontal dimensions of the corner units 175 being correspondingly varied. Similarly the lengths of the members 174 might not be multiples of the module although differing from each other by the module, the vertical dimensions of the members 175 being correspondingly varied. It is furthermore to be noted that the cross-sectional forms of finish members for corners may be varied widely in accordance with aesthetic preferences and requirements of individual design. Thus in some cases cornice chase members may be provided for vertical and horizontal corners, while different finish members might be provided for the lower horizontal corners than for the upper horizontal corners.

The vertical joints between the wall units may be covered by batten strips 190 (Fig. 38) having suitable fastening means to connect them to the marginal openings 128 in the units in the same general manner as has been described above and in the same general manner that the battens 163 for the ceilings are arranged.

Upon the exterior walls suitable flat finish panels 180 and angular finish panels 180a may be provided, these panels including outer sheet metal portions 181 and body portions 182 of insulating board. The sheet metal portions may conveniently be extended inwardly and provided with laterally projecting continuous flanges 183 (Fig. 34) which are received by retaining strips 184 secured on the outer surface of the wall. The vertical retaining strips 184 (Fig. 43) extend along the edges of wall units and/or posts and are provided with openings to register with openings in these members, being held in place by screws 198 extending through the registering openings which are spaced ½ M apart. The horizontal strips 184 are provided with fastening means where they cross the vertical rows of openings, such fastening means being designated 198a (Fig. 43).

The type of construction which has just been described involves the arrangement of rows of openings modularly related to the faces of wall matrix cubes and the median planes of walls in the manner which has been described. Thus the vertical wall units provide rows of openings 128 which are spaced at multiples of ½ M from each other and are spaced at ½ M distances in each row, while the rows of openings 143 are spaced at multiples of one-half of this distance or multiples of ¼ M from the median planes of transverse walls. The axial planes of joints between wall units 129 are spaced at integral multiples of the module M, the parallel rows of openings being spaced at multiples of ¼ M from these planes and, as here shown, at odd multiples of ¼ M from the median planes of transversely extending walls. The rows of openings 160 extending along the margins of the floor units 150 are similarly arranged. Thus this construction provides openings with axes perpendicular to the plane of the corresponding wall, which may be regarded as being disposed at the secondary foci of matrix cubes. In addition to such openings, the openings 143 in the girts are disposed with their axes in planes parallel to the median planes of the corresponding walls, these openings, however, being spaced at ½ M from each other both transversely and longitudinally of the girts and being arranged so that they may be regarded as being located at the secondary foci of matrix cubes, which are parallel to the plane of the wall and which extend at right angles to the foci defining the position of the openings 128.

Such an arrangement of the openings permits registration at the corner of the floor units, as has been described with reference to Fig. 41, and with openings punched in the upper and lower core strips 131 of the wall units. It is thus evident that it is sometimes advantageous to dispose openings and/or fastenings at secondary foci of matrix cubes which extend in directions at right angles to each other, i. e., directions either perpendicular to or parallel to the median plane of the wall.

It is evident that the present invention permits the provision of all of the important parts of building walls, such as frame members, wall panels or units, jointing members and accessories, such as finish panels, trimming strips or cornice chase members, in ranges of modular sizes with openings disposed so that they register when the parts are assembled, so that practically no special cutting or shaping is required in situ, the arrangement of the openings on the foci, and particularly the secondary foci of the matrix cubes, and the arrangement of surfaces of jointing means on such surfaces or in modular relation thereto being particularly important in facilitating the provision of such constructions.

I claim:

1. Building comprising horizontal and vertical structural walls separating and bounding a plurality of rooms, parallel walls having median planes spaced at integral multiples of a module M which is of the order of the structural wall thickness, said walls including rectangular wall parts with similar opposite margins, elongate jointing members each in overlapping relation with similarly shaped margins of two adjoining wall parts, certain of said members in one wall being parallel and having axial planes extending transversely of the wall which are spaced at multiples of M from each other and at multiples of ½ M from the median planes of walls parallel to said axial planes, said margins and members having registering openings spaced ½ M apart and ¼ M from the axial plane of the members, and fastening means extending through said registering openings to connect said members and margins, other jointing members in said wall extending transversely of said first-named members, the openings in the first-named members being spaced at multiples of ¼ M from the axial planes of said transversely extending members, said multiples being integers and odd numbers.

2. Building comprising horizontal and vertical structural walls separating and bounding a plurality of rooms, parallel walls having median planes spaced at integral multiples of a module M which is of the order of the structural wall

thickness, said walls including wall parts having similarly shaped margins, frame members disposed at the intersections of certain of said walls, said frame members having margins extending along the intersections similar to the margins of said wall parts, elongate jointing means extending parallel and at right angles to each other and each in overlapping relation with the similarly shaped margins of two adjoining wall parts or of a frame member and an adjoining wall part, certain of said jointing means having axial planes extending transversely of the corresponding walls, said axial planes being spaced at multiples of the module M and at multiples of ½ M from median planes of walls parallel to said axial planes, said margins and jointing means each having registering openings spaced ½ M apart and ¼ M from the corresponding axial plane of said jointing means, the openings in one of said jointing means being spaced at multiples of ¼ M from the axial plane of an adjoining transversely extending jointing means, said last-named multiples being integers and odd numbers.

3. Building comprising horizontal and vertical structural walls separating and bounding a plurality of rooms, parallel walls having median planes spaced at integral multiples of a module M which is of the order of the thickness of said walls, elongate jointing members in said walls, said members having lengths which vary by multiples of the module M, parts connected by said members, said parts and members having registering openings, said members in each wall being parallel and at right angles to one another, parallel members in each wall having parallel axial planes spaced at integral multiples of a module M, said members each having its openings arranged in a pair of similar parallel rows, the rows being symmetrically disposed relative to an axial plane of the member, each row being spaced at multiples of ¼ M from parallel rows in the same wall including the other row of the same pair, the rows being spaced from the median planes of walls parallel to said axial planes at distances which are multiples of the spacing of each row of a pair from the corresponding axial plane, said last-named multiples being integers and odd numbers, the openings in each row being spaced at distances equal to the spacing of the two rows of a pair, there being four openings common to two pairs of rows at regions where certain of said members extend at right angles to other of said members, and fastening elements connecting said members and parts and extending through said openings.

4. Building comprising horizontal and vertical structural walls separating and bounding a plurality of rooms, parallel walls having median planes spaced at integral multiples of a module M which is of the order of the structural wall thickness, one of said walls having rectangular parts with juxtaposed edges, said parts having openings uniformly spaced in rows extending along their margins with one opening at a corner common to two of said rows, elongate members in overlapping relation with juxtaposed margins of said parts, said members extending at right angles to each other, said members each having a pair of rows of uniformly spaced openings registering with openings in said parts, four openings in one of said members being aligned with the rows of openings in another member, the rows of openings in one of said members being spaced from the median planes of transversely extending walls at distances which are odd multiples of one-half the spacing of the rows of a pair from each other, and fastenings extending through certain of said openings to connect the parts to said members.

5. A building construction comprising rooms separated and bounded by a plurality of vertical walls parallel and at right angles to each other, said walls having median planes spaced an integral number of modules M from the planes of other parallel walls, finish panels on said walls having widths and lengths which differ respectively only by integral multiples of a module M, angular panels having equal transverse dimensions and being disposed at corners between walls at right angles to each other, said angular panels having surfaces aligned with the surfaces of finish panels on walls meeting at said corners, and fastening means in pairs of rows extending along the vertical edges of adjoining finish panels and of finish panels and angular panels, the means in each row being spaced at distances which are multiples of ¼ M and not greater than M, the rows of each pair being spaced a distance equal to the spacing of the fastenings, the rows at opposite edges of a panel being spaced at odd multiples of said distance, and each of the rows being spaced from the median planes of transverse walls at distances which are multiples of one-half the spacing of the rows of each pair.

6. A building construction comprising rooms bounded and separated by horizontal and vertical structural walls with the median planes of parallel walls spaced at multiples of one-half a common module M, one of the walls of a room having elongate members extending at right angles to each other with the end of one member juxtaposed to the side of another member, parts connected to said members, said parts and members being disposed with adjoining surfaces parallel to the plane of the wall, and fastenings having portions extending transversely of said surfaces and connecting said parts and members, there being a pair of rows of fastenings extending along each member, the rows of each pair being spaced at ½ M from each other, said rows each being parallel to and spaced at odd multiples of ¼ M from the median planes of walls of the room which extend at right angles to said wall, the fastenings in each row being spaced at multiples of ½ M from other fastenings in the same row, a fastening in each row of one pair being disposed in alignment with a transversely extending row of fastenings.

7. A building construction comprising rooms bounded and separated by horizontal and vertical structural walls with the median planes of parallel walls spaced at multiples of one-half a common module M, one of the walls of a room having elongate members extending at right angles to each other with the end of one member juxtaposed to the side of another member, parts connected to said members, said parts and members being disposed with adjoining surfaces parallel to the plane of the wall, and fastenings having portions extending transversely of said surfaces and connecting said parts and members, there being a pair of rows of fastenings extending along each member, the rows of each pair being spaced ½ M from each other, the rows which extend in one direction being parallel to and spaced at odd multiples of ¼ M from the median planes of two mutually parallel walls of the room which extend at right angles from said wall, rows which extend trans-

versely of said last-named rows being spaced at multiples of ½ M from each other, the fastenings in each row being spaced at multiples of ½ M from other fastenings in the same row, a fastening in each row of one pair being disposed in alignment with a transversely extending row of fastenings.

8. A building construction comprising rooms bounded and separated by horizontal and vertical structural walls with the median planes of parallel walls spaced at multiples of one-half a common module M, one wall of a room having parts with adjoining faces substantially parallel to the median plane of the wall, fastening elements having portions extending transversely of said surfaces and connecting said parts, certain of the elements being disposed in parallel pairs of rows, the fastenings in each row of a pair being spaced at multiples of ½ M from other fastenings in the same row, the rows of each pair being spaced at ½ M distance from each other, other of the fastening elements being disposed in a row extending transversely to said first-named rows, the fastenings in the transverse row being disposed at multiples of ½ M from other fastenings in said row, each row of a pair having a fastening in common with the transversely extending row, the first-named rows being spaced at odd multiples of ¼ M from the median planes of parallel walls of the room which extend at right angles to the wall in which the fastenings are disposed and the transverse row being spaced at odd multiples of ¼ M from the median planes of parallel walls.

9. A building construction comprising rooms bounded and separated by horizontal and vertical structural walls with the median planes of parallel walls spaced at multiples of one-half a common module M, one wall of a room having parts with adjoining faces substantially parallel to the median plane of the wall, fastening elements having portions extending transversely of said surfaces and connecting said parts, certain of the elements being disposed in parallel pairs of rows, the fastenings in each row of a pair being spaced at multiples of ½ M from other fastenings in the same row, the rows of each pair being spaced at ½ M distance from each other, other fastening elements being disposed in a row extending transversely to said first-named rows, the fastenings in the transverse row being disposed at multiples of ½ M from other fastenings in said row, each row of a pair having a fastening in common with the transversely extending row, the rows of each pair being spaced at odd multiples of ¼ M from the median planes of parallel walls of the room which extend at right angles to the wall in which the fastenings are disposed.

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