June 18, 1929. A. F. BEMIS 1,717,546

METHOD OF BUILDING CONSTRUCTION AND RESULTING PRODUCT

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Fig. 1

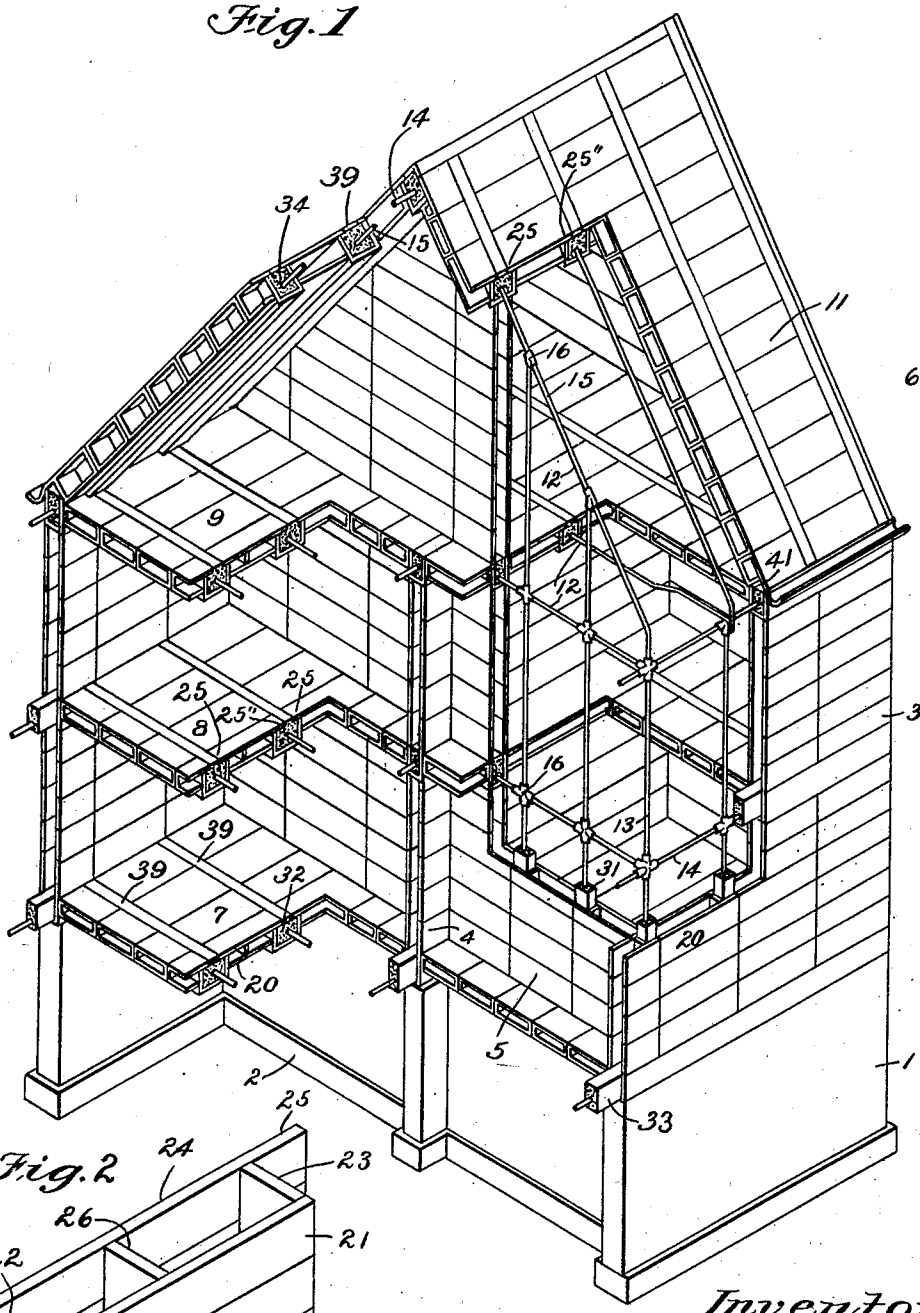
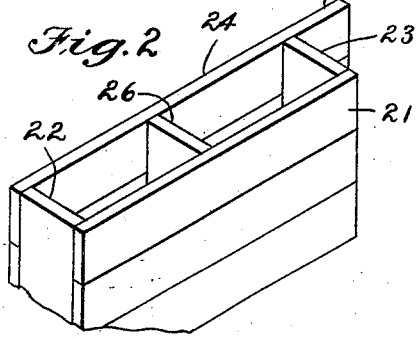


Fig. 2



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Fig. 3

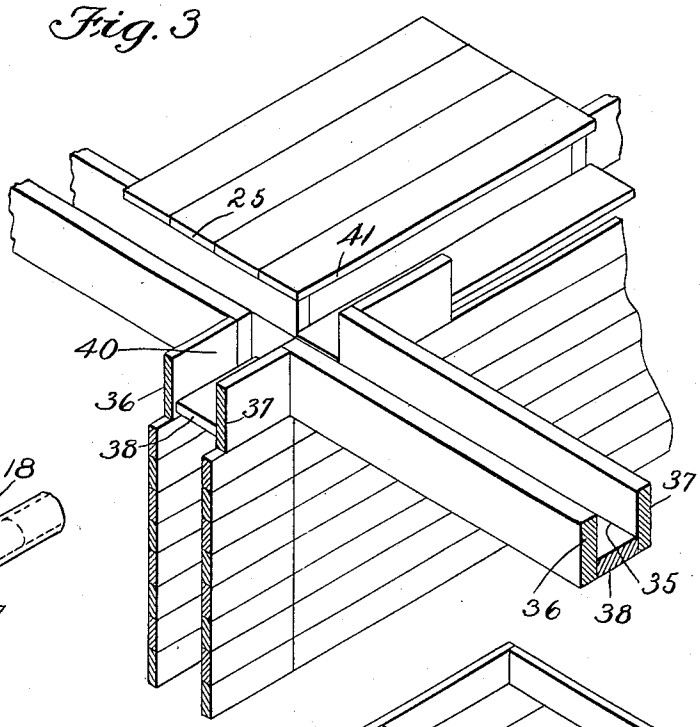
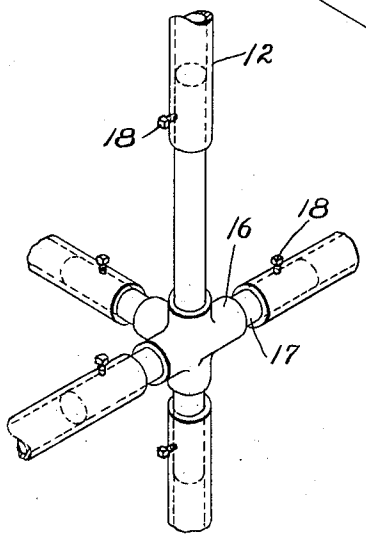


Fig. 6



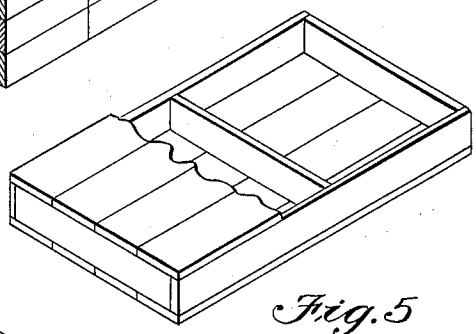
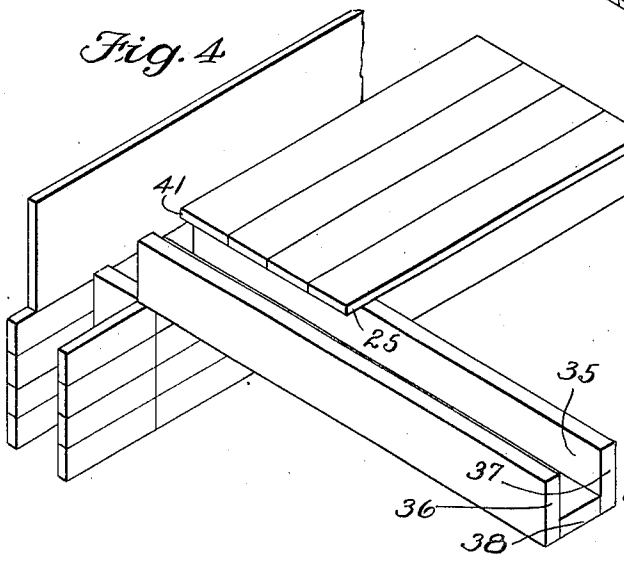


Fig. 5

Fig. 4



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METHOD OF BUILDING CONSTRUCTION AND RESULTING PRODUCT

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Fig. 11

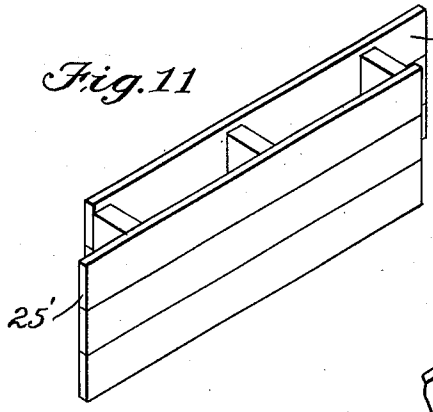


Fig. 7

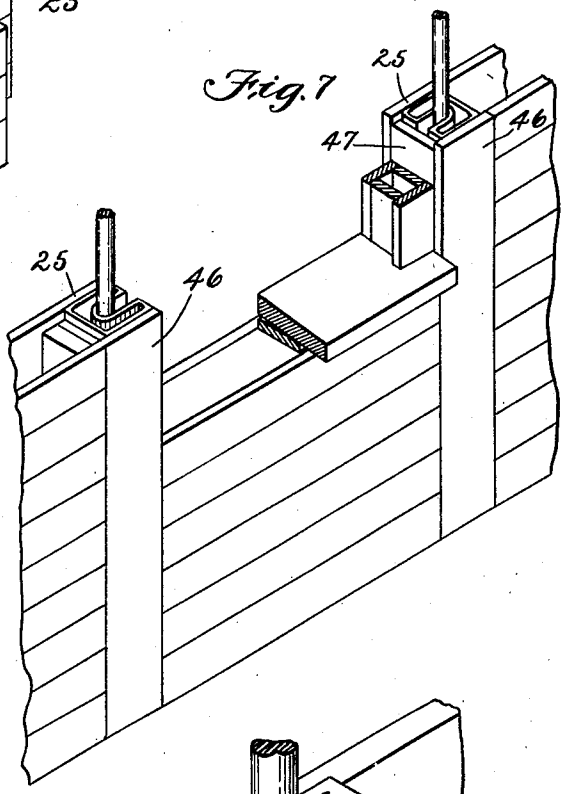


Fig. 10

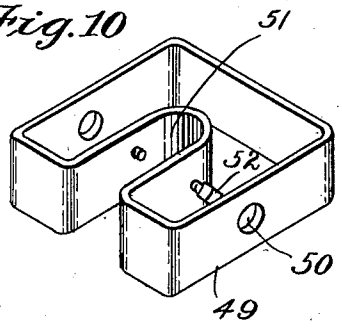
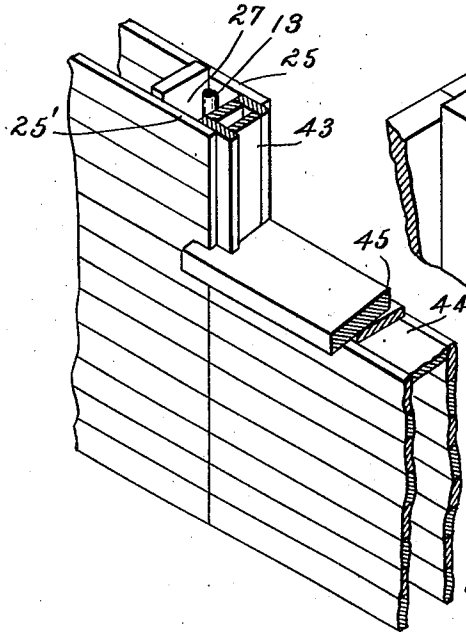


Fig. 8



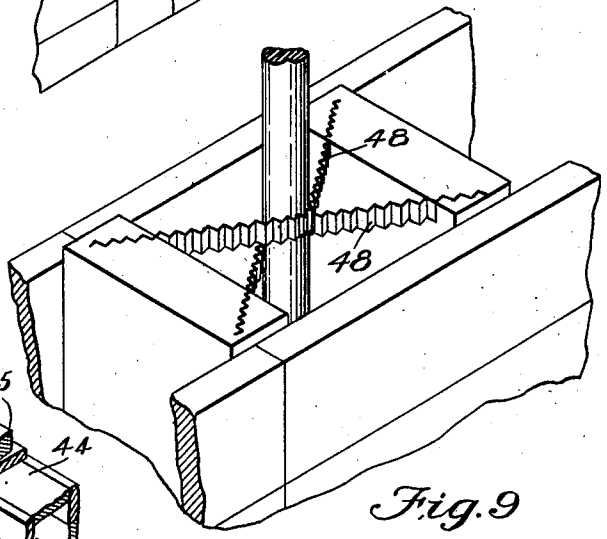


Fig. 9

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Fig. 12

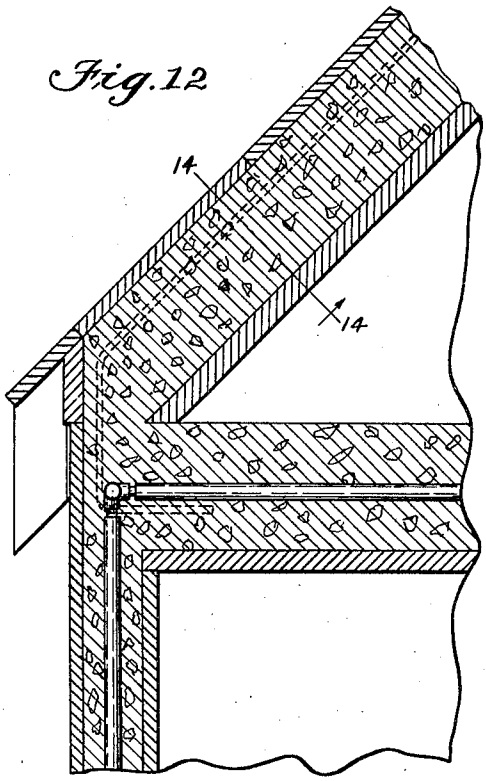


Fig. 13

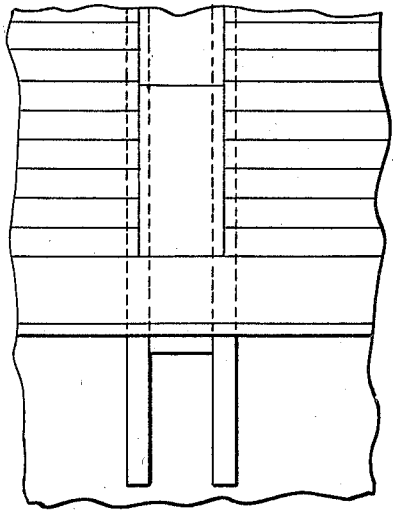


Fig. 14

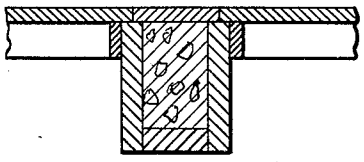


Fig. 15

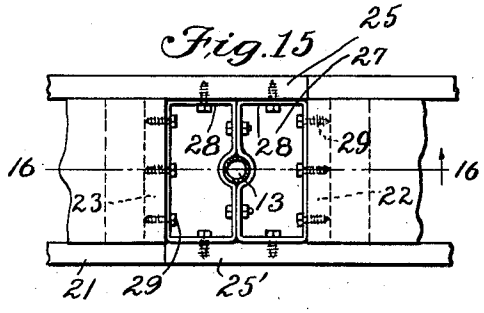


Fig. 16

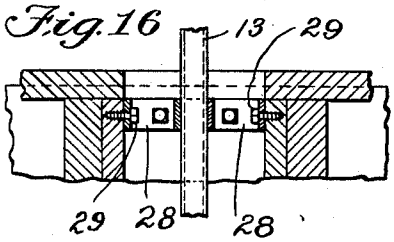
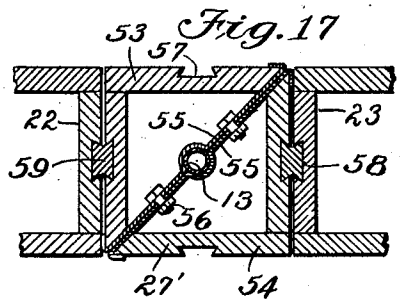


Fig. 17



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UNITED STATES PATENT OFFICE.

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METHOD OF BUILDING CONSTRUCTION AND RESULTING PRODUCT.

Application filed June 13, 1925. Serial No. 36,852.

The present invention relates in general to buildings, and more particularly to a method of building construction employing standardized units, constructed from wood or tough fabricated sheet materials, associated with a structural framework of concrete or the like, and to the units and completed structures resulting from the application of the same.

In accordance with present day practices of the building art, any given structure may be the subject of a distinctive and unique design or it may be substantially identical with a great number of other constructions intended for similar purposes. In the first instance, all of the materials required must be specially fashioned in order to conform to the necessary specifications, which results in a costly expenditure of time, labor and materials, and involves a considerable amount of unavoidable waste. On the other hand, in the case of group constructions, while quantity production may effect appreciable savings in materials, the finished buildings are limited to identical or similar designs and the individual parts for each building must still be fashioned and finished individually.

Moreover, in the construction of buildings, or of the structural framework thereof, from cement or like material, it is common practice to first make molds or forms, usually of wood, corresponding to those structural elements of the building which are to be cast. The cementitious material in fluid condition is then poured into these forms and allowed to set. The wooden forms are then taken down, but are usually not suitable for further use except as waste lumber, and the adjoining walls, woodwork, etc. of the building are then constructed from other and less accurately fitting materials.

It is accordingly an object of the present invention to afford a method of building construction which shall avoid the large expenditures and wastes involved in the usual course of individual construction work and which shall at the same time permit of variety of design, ease of assembly and improved structural solidarity, both during the assembly operations and in the completed building itself. It is also an object to provide standardized or complementary structural units, with which to carry out the method of the invention in actual practice. Other and more specific objects of the invention will appear from the following disclosure.

In its broader aspects the invention comprehends a mode of building construction employing standardized interfitting units which are not only adaptable to provide the walls (that is, inclusive of the floors and roof) but also to constitute complemental parts of forms, which are adapted to receive and engage re-inforcing elements and are suitable also for receiving and retaining a fluid cementitious material, such as those customarily used for the casting of the structural framework of the building therein.

The invention accordingly includes the provision of a completed structure or selected portions thereof having a framework (preferably re-inforced) of concrete or the like, formed in situ, and standardized wall units, complemental with respect to each other and capable of interfitting engagement with respect to the structural framework to complete the enclosure. The units are preferably so constructed and assembled as to surround the framework and they may also constitute the finished walls etc., or a part thereof only, in which latter case the outer or surface portions of the walls may be composed of any suitable materials. When concrete or other cementitious material is employed for the structural framework, the corresponding units adjacent thereto serve as forms in which the material may be molded and, in some instances, as supports to retain in position the re-inforcing elements thereof.

A clearer and more comprehensive understanding of the invention and its adaptation in practice will be derived from the following description of a specific structure made in accordance therewith, and from the accompanying drawings, in which:

Fig. 1 is an orthograph, showing a gable roofed house with sections removed;

Fig. 2 is an orthographic detail view of a unit section;

Fig. 3 is an orthographic view of the intersection of a floor and a supporting inner partition;

Fig. 4 is an orthographic view of the intersection of a floor and a supporting outer wall;

Fig. 5 is an orthographic view of a modified unit with parts broken away;

Fig. 6 is an orthographic view of an ad-

justable union for intersecting re-inforcing rods;

Fig. 7 is an orthographic view of a section of an assembled wall and a window casing therein, with remaining parts removed;

Fig. 8 is an orthographic view of a modification of the assembly of Fig. 7;

Fig. 9 is a detail view of means for retaining re-inforcing rods in the forms for molding the framework;

Fig. 10 is a detail view of a clamp for positioning a re-inforcing rod;

Fig. 11 is an orthographic view of a modified form of sectional unit;

Fig. 12 is a cross sectional view of a rafter, its supporting side wall and floor;

Fig. 13 is a plan view of a rafter, corresponding to Fig. 12 and of roof sections adjacent thereto;

Fig. 14 is a cross section on line 14—14 of Fig. 12;

Fig. 15 is a plan view of retaining means associated with the re-inforcing elements of the framework;

Fig. 16 is a section on line 16—16 of Fig. 15; and

Fig. 17 is a horizontal section of an independent framework casing or form, and means for engaging the same with adjacent sections, in abutting relationship thereto.

Referring to Fig. 1, numeral 1 indicates foundation walls and numeral 2 interior retaining walls for supporting the outside walls 3 and intersecting partition walls 4, 5 respectively of a building 6 having the floors 7, 8, 9 and a gable roof 11. Resting upon or embedded in the top surfaces of the foundation walls a metal framework 12 is provided, corresponding to the walls etc. of the entire structure, the framework comprising re-inforcing elements such as upright steel rods or tubular members 13, horizontal members 14, and inclined members 15, corresponding to the side and partition walls, the floors and roof, respectively, and interconnected by three- four- or five-way connecting unions 16, as may be appropriate in the several locations. Such unions may be of the construction shown by Fig. 6 in which the arms are adapted to receive the ends of the several tubes of the framework, or to be connected by rods 17 telescoping therewith, and locked in position by nuts or screws 18.

The outer walls 3, (Fig. 1) and also the partition walls, floors and roof are constructed from standardized sectional units, such as shown in Figs. 2, 5, 11, etc. which may be made from matched boards or other suitable material, forming a body portion which is preferably substantially rectangular in shape. The wall units shown in Fig. 2 each consists of a side 21, ends 22, 23 flush with and joined to the ends of the side 21, a side 24 projecting beyond the end 23 as at 25, and a cross-stay 26. The corresponding ends of two of such units are complementary each to each and accordingly the projections 25, 25 on two adjoining units and the corresponding ends 23, making a substantially rectangular or square form 27, as shown by Figs. 15, 16, surrounding the upright member 13 of the framework, therein. The relative position of the form with respect to the enclosed element of the framework is secured by spacing clamps 28, which are fastened to the opposed wall members by screws 29. As thus supported, the form serves to receive and retain the cementitious material of the columns 31. The units may also surround the horizontal cross rods 14 and enclose cement cross beams 32 and wall beams 33 and, in a similar manner enclosing cement rafters 34 of the roof, with the framework members 15 embedded therein, all as shown in Fig. 1.

However, if desired, the cement cross beams or rafters, or the upright columns may not be completely enclosed by the use of standard units alone, but may have the enclosures therefor supplemented by channel members 35, comprising side boards 36, 37, and a bottom 38. In this case the projections of the wall units overlap the channel members and enclosed beam, and the enclosure may conveniently be completed by superposed strips 39 (Fig. 1).

For the purpose of support, the units used for flooring adjacent the wall and cross beams may be additionally provided with a side projection 41 extending longitudinally thereof as well as end projection 25, as in the modifications shown by Figs. 3 and 4.

Likewise, both sides of the unit may project, as at 25 and 25′ in Fig. 8, showing a window opening in one of the walls, a single unit thus constituting two sides of the form, the fourth side being closed as by the window casing 43. The open top of the adjacent unit forming the lower portion of the window may contain a liner 44, and the window sill 45.

Again, the unit may have but a single projecting side 25, as in Fig. 7, a separate panel 46 being placed opposite thereto, in the construction of the upright rectangular form 27, while the fourth side is closed by the window casing 47.

Within the vertical form 27 the relative positions of the side walls and of the re-inforcing member 13 may be determined by cross strips 48 driven into the wall members as in Fig. 9, or by iron bands 49 recessed at 51 to receive the re-inforcing rod or tube, and carrying a nut and bolt 52 to secure it thereto (Fig. 10) and openings 50 to receive means for fastening the same to adjacent wall units.

An alternative mode of assembling the units is shown in Fig. 17 in which the form 27′ for the cement columns and re-inforcing member is independent but permanently con-

structed and consists of complementary angle sections 53 and 54, each formed of two boards, having diagonal cross straps 55 recessed to receive the re-inforcing member 13 therebetween and secured together by nuts and bolts 56. The outer surfaces of the form, as thus constructed, are mortised as at 57, and likewise the side walls of the adjacent wall sections at 58 to receive mutually interfitting key members 59, thus locking the adjacent wall sections in permanent position with respect to re-inforced column.

It will be obvious that minor modifications and substitutions of the several elements specifically shown by the drawings in the instant case may, and ordinarily will be resorted to in practice. Such changes, however, will not necessarily be of such character as to involve a variety of shapes or the provision of complicated or special parts and will usually be within the scope of a mere matter of selection from well known and standardized fittings, customarily employed in the building art and of general availability.

In the practice of the invention, in accordance with the specific and representative construction shown by the drawings, the foundations 1 and 2 are constructed in any usual and suitable manner, and may be of any appropriate material desired.

A framework of steel tubes or rods, or other equivalent re-inforcing material is then set up upon the foundation walls, corresponding to the side walls 3, partition walls 4, 5 and floors 7, 8, 9 of the building to be constructed. This framework may be initially assembled to correspond to the completed building but ordinarily its erection is conducted in step with the other operations involved. For example, horizontal rods 14 are first laid upon the tops of the foundation walls, and cross-wise to define the supporting members for the first floor. Upright rods 13, corresponding to the walls of the first story of the building are set in their several locations with respect to the walls to be constructed, their lower ends being preferably joined to the horizontal rods 14, while their upper ends are connected by other cross bars 14, being joined together by unions 16. Channels 35, as shown in Figs. 3 and 4, corresponding to the cross-beams 32 for the first floor, are constructed with side walls 36, 37 and a bottom 38, in appropriate positions, surrounding the corresponding horizontal re-inforcing rods 14 above referred to, and resting at their ends upon the side or interior foundation walls. If the floor is to be fashioned independently of the wall columns, the cement or concrete mixture is then run into these channels, completely embedding the re-inforcing rods 14 therein, and forming re-inforced concrete cross-beams 32, upon hardening. The lower ends of the upright rods 13 are by this process embedded in the cement of the side wall beams 33 which thus serve as a part of the foundation upon which the rest of the structure is built.

Either before or after thus pouring the cement into the floor channels 35, the units 20 (shown as having a projection 25, 25'' at both ends) may be set in position as shown by Fig. 1, with their projections overlapping the channels 35 for the cross-beams 32 and thus forming a continuous and permanent flooring at an early stage of the operations.

The wall units (including also those which are employed in the floors and roof as hereinafter to be described) are preferably constructed from wood, or other suitable material adapted to be shaped and joined in a manner similar to the usual operations in the working of wood, and may be provided with a finish or not, as desired.

The outer walls may be of a suitable material and so finished as to withstand weather conditions, to conform to the architectural design of the house, and so forth, while the inner walls may be unfinished and adapted to receive the interior portions of the wall, or may be finished to constitute or correspond to the general interior decoration and woodwork to be provided. As shown, these units may be made up from individual boards, or from matched boards, composition boards of various kinds, or other equivalent sheet materials suitable to be joined together, as by nails, screws, dovetailing or the like without cracking or crumbling. Typical examples of such units are made up from matched boards to form a hollow substantially rectangular body portion, having one or more marginal projections thereon, lying in the plane of the corresponding side or sides which may conveniently be formed integral therewith. Such projections, with the side or end walls of adjacent units, make possible numerous combinations and arrangements, and constitute complementary elements, as will be more fully described, in the construction of the floors, as well as of the walls and roof of the building in which they are incorporated. In the floor, as already described, the projections of adjacent units are laid in such a manner as to overlap the corresponding side members 36, 37 of the channels 35, and also a portion of the beams 32 which are formed or to be formed therein. These units may abut each other at the ends as well as upon their longitudinal edges, and their upper surfaces thus unite to form the floor, or a space may be left therebetween and filled with cement as at 30 or with a board 39, as shown in the flooring of Fig. 1. Likewise those units adjacent the wall beams are preferably provided along their lateral margins with a lateral projection 41 as well as the projection 25 at the ends which lap over the wall beams 33 and cross beams 32, respectively, as shown in Figs. 1, 3 and 4. A similar arrangement

occurs at the intersection of cross beams or channels 35, 40 (as in Fig. 3) corresponding to the inner partition walls 4 and 5 (not shown).

The walls are then constructed upon the foundation walls, or wall beams, and cross beams by assembling thereon a plurality of the units 20, which may be substantially identical with those employed for the floor or like the modified forms shown in Figs. 2, 5, 7 etc. For example, the first unit such as that shown by Fig. 11 may be placed with its longitudinal edge in alignment with and resting upon the foundation, with the end projection 25 lying outside of one of the upright tubes 13 of the framework. The next unit is placed in end to end relationship thereto (see Fig. 15) with its corresponding end projection 25′ meeting the end of side wall 21 of the first and forming with the ends thereof a square, enclosed form 27, with the rod 13, standing substantially in the center.

The two units may be secured together by placing a pair of clamps 28 therebetween, shaped to be centrally located about the tube 13, and fastening the same as by screws 29 to each other and to the opposed end faces 23, 22 and the lateral projections 25, 25′ of the units, respectively. Other means may be additionally provided for this purpose, or to replace the use of the clamps shown, as will be hereinafter more fully explained.

Successive rows of similar units 20 are placed, one upon the other, and in fixed relationship to the framework in the manner described to form the wall of a height equal to the first story of the building. Cross-rods 14 are then fastened in position, corresponding to the floor beams 32 for the second floor, and connected together and to the uprights 13 by means of unions 16 therebetween. Channels 35 are then placed around the cross-rods 14 to form floor beams and also about the horizontal wall members of the framework to form the wall beams. These channels may rest upon the wall already constructed or may be additionally supported by temporary means of any sort, or both. As with the first floor, the flooring units 20 may also be put into position at this stage, with their end portions overlapping the side members of the channels 35.

This permits the use of a continuous flooring surface during the process of construction and materially lessens or avoids the necessity of staging, both inside and outside of the building and also facilitates the more perfect adjustment and alignment of the wall and floor beams, as well as of the wall and floor surfaces before actual pouring of the cement or concrete framework. It also is of great importance in making possible the conduct of other operations upon the building, simultaneous with the assembly of the framework itself, which ordinarily must be delayed until a much later stage of the operations and which in some instances can not be commenced until the whole is substantially complete, for example, plumbing, electric wiring, and the like.

The cementitious mixture is next poured into the upper ends of the forms 27, surrounding the upright members 13 of the framework, thus embedding such members and fashioning cement columns or wall beams 31, conforming to the units adjacent thereto. It will be clear that the fluid cementitious mixture will to an appreciable extent flow into irregularities or spaces in such surfaces and partially penetrate into the porous structure of the wood, making an intimate or adhesive association therewith. Upon setting of the cement, the resulting column will fit accurately with all of the various elements of the building units which may be in juxtaposition therewith. As a result, not only are these members firmly and snugly joined, but also structurally more solid and resistant to strains and disruptive shocks than is possible in case of subsequent assembly.

It is also to be noted that in some instances it may be preferable to cast the vertical column 21 in sections corresponding to the assembly of the form or forms 27. Thus, the cementitious mixture may be charged into that portion of the form 27 which is formed by each successive row or tier of units 20, as they are assembled in position and joined together.

The cement or concrete for the second floor is then poured into channels 35 through the upper openings as between the opposed projections 25 of the floor units 20, and may be finished off level therewith as at 30, or at such depth as to receive a cover board 39 placed therebetween to make a continuous wooden floor surface.

The cross-beams 32 may be fashioned integral with the wall beams 33 and columns 31, or each may be formed independently as desired, depending upon whether the cementitious material is poured into adjacent forms simultaneously or whether it is allowed to set in one section before pouring into the next section thereto.

In like manner, the side and partition walls for the second story may be set up and the third floor 9, constructed.

For supporting the roof 11, the re-inforcing rods 15 may be inclined and joined to the vertical rods by the unions 16, in the manner already described, and those from each side may in turn be connected to another horizontal rod 14 at the ridge pole of the roof, where they come together.

Channels 35, similar to those used in the floor constructions already described, are placed in position to surround the several members of the roof framework, defining the

ridge pole, beams, or rafters corresponding thereto and serving to receive and retain the cementitious material from which the latter are to be made. These channels are made up of side walls 36, 37 and a bottom wall 38, which engage and support the projecting portions 25, 25'' of the units 20. The latter are fastened to and overlie said channel, while cover boards 39 are placed therebetween and serve to close the top of the channel space.

The units 20, used in the construction of the roof, may be identical with those used for the walls and floors. The first unit to be put in position at the eaves is preferably provided with a lateral projection 41 which overhangs the upper edge of the side wall, and end projections 25, 25'' overlapping the rafter channels in a manner analogous to the floor construction already set forth, except that they will, of course, assume an inclined position as initially determined by the pitch of the rafter rods. Cement is then poured into the channels and the cover boards 39 are placed in position thereover. Alternatively the channels surrounding the rafter elements of the framework and the ridge pole rod 14 may be completely enclosed before the fluid concrete mixture is poured. When this is done, all of the channels may be filled simultaneously from the top.

Corner posts or abutting connections of wall members may be joined together by means of an independent form such as the modification shown in Fig. 17 in which the form 27' consists of angular side members 53 and 54 which are provided with diagonal cross straps 55 (recessed to receive the vertical rod or tube 13 therein) and then clamped together by nuts and bolts 56. As thus constructed the form may be filled with cement or left hollow as desired. The adjacent wall units 22, 23 are in this instance mortised as at 58 which, with mortised channels 57 in the outer surfaces of the side members, are adapted to receive key members 59, which are inserted longitudinally therebetween to permanently lock the wall units to the column 27.

While in some instances cross strips 48, as shown by Fig. 9, are sufficient to retain the wall units in position with respect to the framework it is not infrequently desirable to employ a clamp which may be inserted after the form in which it is to be used has been constructed. Such a clamp is shown in Fig. 11 consisting of an iron band 49, adapted to fit the form and having a recess 51 at one side adapted to fit around the corresponding element of the framework 13 therein. A nut and bolt 52 is then inserted across the recess, thereby retaining the rod of the framework securely and the band is then attached to the adjacent wall units as by screws through the openings 50 to thereby hold them in position.

The formation of windows or other openings in the walls such as doorways and the like is conveniently effected by merely omitting units from that portion of the wall in which they are to be provided, as shown in Figs. 7 and 8. The lower portion of the opening, as defined by the upper longitudinal edge of the unit 20, is finished by inserting a liner 44 between the side walls 21 and 24 which retains the latter in their relative positions and prevents subsequent distortion and warping. Above the liner there is placed the finished sill 45. The sides of the opening are in part defined by the projections 25, 25' of the adjacent units. Where the units 20 have but a single projection adjacent the opening the opposite side of the space 27 may be enclosed by inserting a separate panel 46 therein, which may be on the inside or outside of the window and serve to carry out the decorative motif of the building accordingly. The window casing 43 is received between the projections 25, 25'', (Fig. 8) or between projection 25 and panel 46 (Fig. 7) and may be of any desired construction. The upper portion of the opening is closed in the same manner as the bottom, already described.

In this manner, a building of rugged construction may be rapidly erected and will be substantially complete at the successive stages of operations involved. This permits the progress of other operations simultaneously with those of putting up the structural framework and enclosing walls, and accordingly eliminates the inhibiting factor of climatic conditions to a very marked extent. As already suggested, the necessity of providing temporary constructions, such as staging and cement forms, is avoided, and the materials employed (for example concrete, metal tubing and wall units) are standard products and do not require any appreciable amount of fabrication but fit together readily and with precision.

It is not necessary that buildings erected in accordance with the invention shall be alike either in plan or design and obviously any desired combination of sizes and shapes of construction units may be effected by suitable modifications in the application of the principle of the invention in actual practice.

I claim:

1. A method of building construction which comprises erecting metal uprights, connecting these uprights with each other by metal members to comprise a rigid metal framework, locating interfitting hollow units in complementary relationship intermediate the uprights to comprise forms thereabout, interconnecting each hollow unit with said rigid frame as the units are progressively positioned, and pouring cementitious material in said forms to provide a structure with a reinforced concrete frame.

2. A method of building construction which comprises erecting a structural steel framework to comprise a substantially rigid

metal skeleton, locating interfitting hollow units about said skeleton with spaces formed between the units and the skeleton to constitute forms, interconnecting each hollow unit with said rigid frame accurately to align the units as they are progressively positioned, and pouring cementitious material into the forms.

3. In a building construction, a wall portion comprising spaced, rigid, structural elements, a plurality of standardized hollow wall units between said elements, projections on said units interfitting to make forms which enclose the structural elements adjacent thereto, rigid aligning members in said forms projecting from the units in abutting relation with said elements, and cementitious material poured into said forms about the structural elements and locking the aligning members against the elements.

4. In a building construction, a wall portion comprising spaced, rigid, structural elements, a plurality of standardized hollow wall units between said elements, projections on said units interfitting to make forms which enclose the structural elements adjacent thereto, and rigid aligning members in said forms projecting from the units in complementary relationship to each other and substantially encircling the elements, and cementitious material poured into said forms about the structural elements and locking the aligning members against the same.

5. A building construction, comprising a wall portion having spaced cementitious elements therein, a floor portion intersecting with said wall portion, said wall and floor portions meeting at an angle, rigid vertical reinforcements in certain of said cementitious elements, and a wall beam of cement coincident with the line of intersection of said floor and wall and integral with the cementitious elements of said wall portion, respectively, and a metal reinforcement in said wall beam connected to said vertical reinforcements.

6. A building construction, comprising a wall portion having spaced cementitious structural elements therein, a floor portion having cementitious structural elements therein, said wall and floor portions intersecting at an angle, a cementitious beam coincident with the line of intersection of said wall and floor portions and integral with said cementitious structural elements, respectively.

Signed by me at Boston, Massachusetts, this 21st day of May, 1925.

ALBERT F. BEMIS.