March 31, 1936. F. M. CROWE 2,035,595

FABRICATED BUILDING CONSTRUCTION

Filed Jan. 11, 1935

FIG. 1.

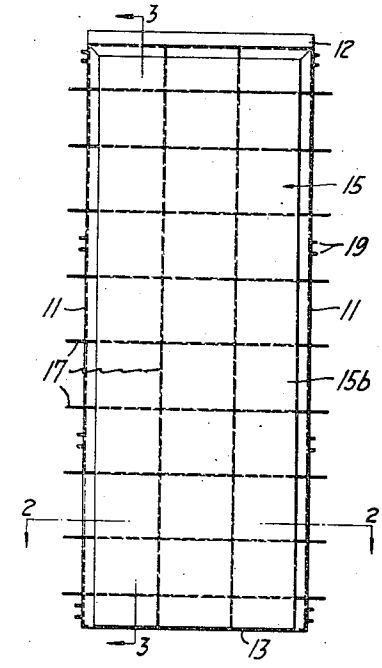


FIG. 2.

FIG. 3.

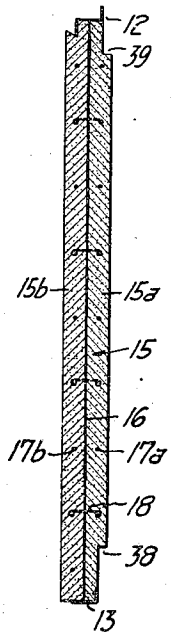


FIG. 4.

FIG. 5.

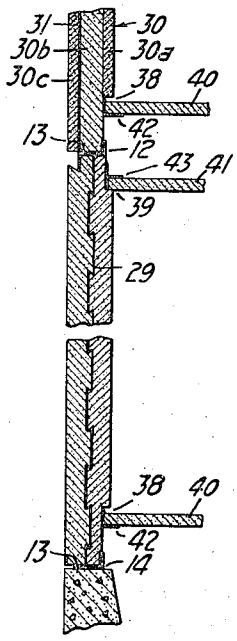


FIG. 6.

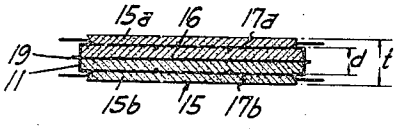


FIG. 7.

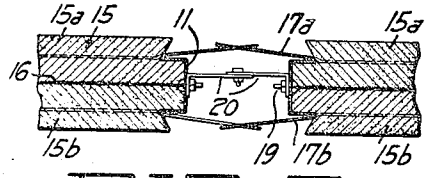


FIG. 8.

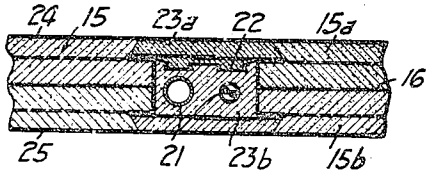


FIG. 9.

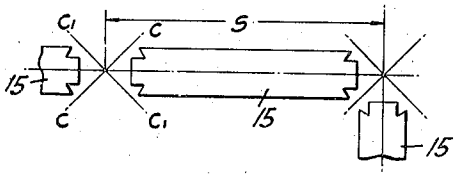
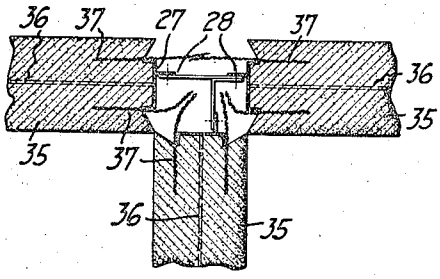
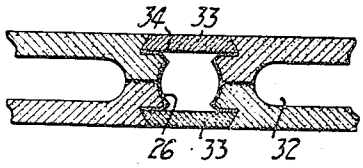


FIG. 10.





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2,035,595

FABRICATED BUILDING CONSTRUCTION

Francis Malcolm Crowe, Burlingame, Calif.

Application January 11, 1935, Serial No. 1,280

9 Claims. (Cl. 72—16)

This invention relates generally to the construction of houses and other buildings, and particularly to the fabrication and erection of the exterior and interior walls thereof. The present application is a continuation in part of my copending Patent No. 1,998,448.

In the aforementioned application is described an arrangement or system of wall construction wherein a variety of standardized panel units may be shop fabricated, upon a quantity production basis, and may be assembled in houses of varied floor plans and of varied architectural appearance, thereby effecting a reduction of cost while retaining a high degree of individuality. The system reduces to a minimum the number of different types of panel units required, because all units are structurally interchangeable and are not affected by the necessary installation of pipes, conduits and the like, nor by the color or texture of wall finish desired.

A distinguishing feature of the aforementioned system lies in the fact that wall panel units are assembled with spaces intervening between adjacent units, instead of being erected with vertical edges in contact. The panel units utilized each comprise a semi-finished one-piece section of wall, usually one story in height, some of which contain a window, door, or other opening. Adjacent panel units are connected by spacers, the latter being so arranged that vertical pipes, conduits and the like may be installed in the intervening space. Such space also facilitates structural connection of floor joists and other supplementary framing members to the wall. Subsequently, such joint spaces are covered over or filled, flush with surfaces of the adjacent panel units, and finally a finish coating or covering may be applied over each wall surface as a whole. In this way, any objectionable paneled appearance is avoided.

In utilizing such prefabricated or precast wall units, a convenient dimension is selected as the standard distance between centers of successive joint spaces, and all wall units are formed to fit this spacing or a multiple thereof, double or triple width units being required to accommodate the wider window and door openings. In preparing the floor plan of a building, if all wall centerlines be located so that the distances between the same are exact multiples of this specified dimensional increment, then standard panel units may be used throughout.

A practical system of panel type wall construction having been thus defined, the present invention is particularly concerned with the form of the wall units utilized therein, with the arrangement of joints between the same, and with the selection of materials therefor. It is an object of the invention to utilize durable and preferably fire-resistant materials, but to so simplify the form and arrangement of wall units and joints that final cost will be at a minimum. Likewise, it is an object to provide moistureproof and insulative characteristics in exterior wall construction.

It is a further object of the invention that the form and arrangement of wall units and joints shall permit installation of vertical pipes, conduits and the like in spaced joints between panel units without effect upon the latter, that all wall units shall be structurally interchangeable, and that joints may be filled or covered over flush with surfaces of adjacent panel units so that smooth, unbroken wall surfaces may be provided.

Further objects of the invention will appear from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the accompanying drawing. It is to be understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawing:

Fig. 1 is a side elevation of one form of panel unit utilized in my invention, being of solid wall type without window or other opening.

Fig. 2 is a horizontal cross-sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is a vertical cross-sectional view taken along the line 3—3 of Fig. 1.

Fig. 4 is a diagrammatic horizontal section showing several panel units aligned on wall center-lines.

Fig. 5 is a vertical section through an erected wall, similar to Fig. 3 but showing horizontal joints at the foundation sill and at an intermediate floor level, and also showing certain modifications in panel structure.

Fig. 6 is an enlarged horizontal section through a joint at a level at which a structural spacer occurs, this section being illustrative of an early and incomplete stage of erection.

Fig. 7 is a similar section through a joint after completion of the wall, and shows certain incidental pipe installations.

Figs. 8 and 9 are horizontal sections, at joints, showing modifications in framing and body structure of wall units, the latter figure also being varied to show a typical T intersection of walls.

One very practical form of the invention is

shown in Figs. 1, 2 and 3 of the drawing. In this embodiment, the wall unit comprises a rectangular steel frame and a filler slab of aerated concrete or similar material, together with reinforcing steel for the slab. A moistureproofing membrane divides the slab into two layers, and bolts projecting from the frame provide means for making structural connections when erected. Such a unit, designed for exterior walls, may contain a window, door or other opening and, being substantially one-story in height, constitutes a semi-finished, one-piece section of wall. Obviously, a similar wall unit of lesser height may be provided for basement walls and, conversely, a unit of greater than story height may include a roof parapet wall. In two-story or higher structures, successive tiers of single story wall units will usually be preferable to double story units.

In the standard wall unit shown in Fig. 1, the rectangular steel frame consists of vertical members 11, and top and bottom horizontal members 12 and 13. Such frames usually will be shop assembled with welded corner connections, although corner gusset plates or clip angles with riveted connections may be substituted. The vertical members 11 consist of steel channels, being either standard rolled sections or lighter pressed sections. Such channels are positioned with flanges toeing inward so as to engage the filler slab. Top and bottom members are of male and female sections so as to nest perfectly, forming tight horizontal joints. Thus the top member may be an angle, or a Z section, as shown, with a vertical leg near the inner face of the frame, this leg toeing upward to serve as flashing. The bottom member 13 can be a round-backed angle section, arranged to nest inside the top member of a lower tier of wall units, as shown in Fig. 5, and also to nest in a sill angle 14 which may occur at the top of a foundation wall, as also shown in this sectional view of an erected wall. The top and bottom members 12 and 13 may be of either rolled or pressed steel sections and can be of light weight as they are not stressed structurally.

The body 15 of the wall unit can be formed of a substantially solid or laminated slab of aerated concrete or of any similar material that possesses insulative properties and that will be unaffected by moisture. The slab thickness is greater than the depth of the panel frame, as is shown in Fig. 2 by comparison of the dimensions *t* and *d* respectively. Therefore, the plane of each slab surface passes wholly outside of the panel framing members, with shoulder offsets occurring along the toe edges of framing channels 11. This feature is of importance since it allows subsequent enclosure of the framing members wholly within the finished wall.

Where the body slab 15 of wall units is composed of a material that is not impervious to moisture penetration, it is desirable to incorporate a waterproofing membrane into the slab. Thus, using aerated concrete, or a similar material, the panel frame may be laid horizontally on a flat form, the latter fitted with lips to form the shoulder offsets previously described, and with the frame serving as a form around slab edges. About one-half thickness of the body filler slab is then poured, denoted by numeral 15*a* in Figs. 2 and 3. When this layer has set, a coating of asphalt, emulsified asphalt or other waterproofing material is applied to the top surface thereof to serve as a moistureproofing membrane 16 within the finished slab, the final half-thickness 15*b* of the slab being poured thereafter.

Filler slabs usually will be reinforced with steel bars or wire fabric 17. This reinforcing can extend outwardly through the shoulder offsets, past and beyond the vertical framing members, such exposed portions serving subsequently to reinforce the material placed at vertical joints between adjacent wall units. When the membrane construction previously described is adopted, such reinforcement may occur in separate layers 17*a* and 17*b* (Figs. 2 and 3) to reinforce each layer of the slab. Metal ties 18 (Fig. 3) can be provided to bond the two slab layers together. The reinforcing steel can be tack welded to the framing members to prevent movement of the latter with respect to the filler slab. Such welds should be placed near the toes of the flanges of the channels 11, so that reinforcement extending past such flanges may be bent slightly out and away from contact therewith, permitting such reinforcement to be wholly embedded in material to be placed subsequently at joints.

When bolted connections are desired for erection procedure, in preference to welding on the job, provision therefor must be made during fabrication of the wall units. This may be done, prior to pouring the filler slab, by inserting bolts 19 (Fig. 1) through holes punched in framing channels 11. These bolts project outwardly at proper locations for top and bottom connections, for intermediate spacers, and for supplementary structural framing at floor and ceiling levels.

It should be noted that standard wall units, as hereinabove described, may be completely shop fabricated, including precasting of the filler slab and installation, in some types, of a window or door. Such wall units require, after erection, only surface finish treatment.

As previously mentioned, and as described in detail in the aforementioned co-pending application, my wall units are intended primarily for erection with spaced joints occurring at regular intervals. Several such wall units are shown in Fig. 4, aligned on intersecting wall center-lines. The distance from center to center of joint spaces, denoted by dimension S thereon, usually will be the predetermined dimensional increment or a multiple thereof. Clearance lines *c*—*c* and *c*1—*c*1 have been drawn through joint centers at 45° with respect to wall center-lines. It will be noted that no rigid portion of the wall unit extends beyond such clearance lines. Thus, wall units are structurally interchangeable and can be used at intermediate locations in a straight wall, adjacent to a corner intersection as in Fig. 4, or adjacent to a T intersection, as in Fig. 9. While projecting portions of slab reinforcing steel may extend beyond the 45° clearance lines, such reinforcement is comparatively flexible and will not interfere with so positioning the wall units. Of course, standard wall units, devoid of bolts projecting from channel webs, can be erected with vertical members in contact and will retain the advantage of flush type joint finish. In this case, structural connection of adjacent panel units will be by welding or by plates connecting abutting flanges of adjacent channels, and piping must be installed elsewhere.

The preferred type of spaced joint, occurring between wall units of the type described, is shown in section in Figs. 6 and 7. Adjacent wall units are erected with a predetermined distance intervening between their opposed vertical framing

members 11, and are rigidly connected by pairs of clip angles 20, the latter being of short length and occurring at top, bottom and certain intermediate points along the framing members, using the bolts 19 provided for this purpose. Where welded connections are adopted for erection, the spacers may consist of short lengths of channel section. In either event, it should be noted that the space between wall units is substantially unobstructed at the stage of erection indicated in Fig. 6.

After erecting the wall units and supplementary structural framing, including floor and roof beams and the like, the necessary plumbing and wiring should be installed, with all vertical pipes, conduits, wall outlet boxes and the like located in joint spaces, as indicated by numeral 21 in Fig. 7. Such spaces usually will accommodate all vertical piping, with the possible exception of large diameter soil pipe or heating ducts.

Joints between wall units, where the latter embody an aerated concrete filler slab of membrane construction, will be finished as shown in Fig. 7. A waterproofing membrane 22 is installed across the joint space, such membrane being of sheet metal or waterproof paper and being flat, or, as indicated, with crimped corrugations. The joint space remaining on each side of this membrane is then filled with aerated concrete 23*a* and 23*b* poured on the job, the outer surfaces of such fill being flush with surfaces of adjacent wall unit slabs. The joint membrane can be installed in short lengths so that small flat forms can be placed across each side of the joint, bearing against adjacent wall unit slabs, the filling of each joint space therefore being performed in several lifts. It will be noted that projecting ends of wall unit slab reinforcement serve to reinforce such joint fills and that the wall unit framing members are completely embedded within the wall so formed.

After thus filling joints between adjacent wall units and after troweling in similar material at horizontal joints, smooth wall surfaces are provided, unbroken by any offset, depression or opening. To finish the wall requires only an application of surface coating or covering. Exterior finish 24 in Fig. 7 may be a thin coating of stucco, gunite, cement paint or similar material, the thickness of which need be sufficient only to give the desired color and texture of finish. Such coatings bond perfectly on the aerated concrete slab surfaces, and no extra thickness of finish need be applied for waterproofness since this feature is cared for by the membrane construction of the wall itself. Similarly, interior wall finish 25 can consist of a minimum thickness of plaster, plastic paint, wall paper, or similar coating.

Considering now the alternative embodiments of this invention, it should be noted first that the filler slabs and joint fills may be composed of any light-weight concrete possessing adequate insulative properties. In addition to aerated concrete, for which several processes of manufacture are available, concrete made with pumice, "Haydite", rice hulls, wood bark or fiber or other light-weight coarse aggregates can be used in the construction as hereinabove described. Likewise, various so-called "composition" materials may prove to be practicable in the solid slab design. Obviously, if such composition slab be waterproof, then the moistureproofing membrane may be omitted.

Many modifications in the form of wall unit are possible, and only a few of the more feasible will be set forth herein. First, it should be observed that a wide variety of sections may be selected for framing members. For example, as shown in Fig. 8, the vertical members may be of a pressed steel channel section 26 having a concave web. Such a section is advantageous where welded erection connections are adopted, in which event spacers will consist of short lengths of pipe, the outside diameter of which matches the curvature of the concave web so that the connection will be self-aligning. Another alternative is shown in Fig. 9, in which the framing members are in the form of a special rolled steel channel section 27 having an outstanding leg 28 to which bolted connections may be made, thus eliminating need for the projecting bolts 19. In this case, spacers can be flat plates or may be a continuous plate serving also as joint membrane. Either of these two and other alternatives may be substituted in the wall unit described, without other modification. Similarly, many alternative pairs of male and female sections are available for use as top and bottom framing members.

An alternative moistureproofing membrane for the solid type of wall unit filler slab is shown in the lower wall unit in Fig. 5. This consists of a sheet 29 of waterproof paper or metal having crimped corrugations, as shown, so that the two slab layers are interlocked, thereby eliminating need for the ties 18 previously described. Of course, flat sheets of waterproof paper or metal also may be substituted for the membrane coating aforementioned.

Solid slab construction of wall units is not limited to use of a single homogeneous material, one alternative being to fill the wall unit frame successively with three or more laminations. Thus, with the frame placed upon a horizontal form as previously described, a layer of dense concrete may be poured first to form one slab surfacing layer, then a layer of light-weight insulating material, and finally the other concrete surfacing layer. In this alternative, wire mesh reinforcement can be provided for the surfacing layers, as well as cross ties similar to those previously described. The outer layer should be moistureproof or be backed by a membrane coating or sheet. Such construction is indicated in the upper wall unit 30, shown in Fig. 5, wherein the body is formed of layers 30*a*, 30*b* and 30*c*, with the intervening membrane 31.

Prior reference has been made to the use of filler slabs containing hollow, inaccessible cores, and such construction is illustrated in the wall units shown in Fig. 8. Such interior spaces 32 may be formed by stiff paper form cells positioned in the panel frame prior to pouring the slab; by deferring the assembly of one member of the rectangular frame until after the slab has been cast and the core forms withdrawn; by assembling the frame around a previously formed slab; or by precasting the slab in half layers which are locked together by framing channel flanges after assembly of the frame. In the latter alternative, an aluminum foil membrane may be installed between such half slabs, serving both insulating and moistureproofing purposes.

Relative to joint spaces, an alternative method of completing the wall is shown in Fig. 8. In this case, cover tiles 33 are placed across the joint opening, the thickness of such tiles being equal to the shoulder offsets to the wall unit surfaces.

These tiles may be backed by sheet metal or paper 34 to prevent moisture penetration. Interiors of joint spaces so covered may be left hollow or may be filled with loose insulating material. A second alternative, similar in result, involves the provision of projecting wire fabric or metal lath at the shoulder offsets of the wall units and the application thereon of stucco or plaster to cover over the joint space.

Most of the foregoing remarks apply to interior bearing wall and non-bearing partition construction as well as to exterior walls. There being no risk of moisture penetration, interior walls do not require the inclusion of a membrane, either in wall units or across joint spaces. Selection of materials for interior use may include gypsum and other alternatives in addition to those aforementioned. As shown in Fig. 9, when using a monolithic filler slab 35, the reinforcement may be concentrated in one layer 36, and the projecting reinforcement at the slab shoulder offsets may be strips of wire fabric or metal lath 37. Furthermore, top and bottom framing members of the interior wall units usually will consist of channels, rather than the sections previously described, and will not necessarily be of male and female type, since such units may rest upon floor beams instead of upon a continuous foundation.

In conclusion, it should be noted that the inner face of the exterior wall units and both faces of the interior bearing wall units may be formed with shoulders 38 and 39 (Fig. 5) at the levels of floor deck 40 and ceiling slab 41. In Fig. 5 supplementary steel framing is also indicated, there being shelf angles 42 and 43 shown at both floor deck and ceiling slab levels. It will be observed from Figs. 6, 7, 8 and 9 that opposed pairs of vertical framing members in adjacent wall units, rigidly connected by spacers, constitute structural columns at each joint space. Thus such columns, together with floor and roof beams, shelf angles and bracing, constitute a steel framed structure which may be fully as rigid and equally as strong as any steel framed structure assembled of separate framing members by conventional methods. However, in sheathing the frame, in providing the complete building, great simplification has been achieved through panel type construction. The saving in cost of fabrication and erection appears to be more than ample to offset the higher basic cost of the superior materials used, so that my invention makes possible not merely better but actually cheaper houses.

I claim:

1. In a building construction, a prefabricated panel unit for walls, comprising members forming a rectangular frame, and a rigid body filling the space within said frame, the thickness between the surfaces of said body being greater than the depth of the members comprising the rectangular frame, shoulder offsets occurring along the juncture of said framing members with the body, thereby permitting the subsequent application of material to cover the exposed portion of said marginal framing members and allowing the outer surface of said covering material to be flush with surfaces of the body portion of the panel unit.

2. In a building construction, a prefabricated panel unit for walls, comprising members forming a rectangular frame, and a rigid body filling the space within said frame, the thickness between the surfaces of said body being greater than the depth of the members comprising the rectangular frame, shoulder offsets occurring along the juncture of said framing members with the body, thereby permitting the subsequent application of material to cover the exposed portion of said marginal framing members and allowing the outer surface of said covering material to be flush with surfaces of the body portion of the panel unit, said rigid body being formed of cementitious material and containing metallic reinforcement extending through said body between opposite members of the frame and attached thereto, metallic reinforcement extending outwardly from the interior of said body through the shoulder offsets therein, such projecting reinforcement to serve subsequently to bond the covering material to be applied at the joint between two such panel units.

3. In a building construction, a prefabricated panel unit for walls, comprising members forming a rectangular frame, and a rigid body filling the space within said frame, the thickness between the surfaces of said body being greater than the depth of the members comprising the rectangular frame, shoulder offsets occurring along the juncture of said framing members with the body, thereby permitting the subsequent application of material to cover the exposed portion of said marginal framing members and allowing the outer surface of said covering material to be flush with the surfaces of the body portion of the panel unit, said rigid body formed of two layers of cementitious material, metallic reinforcement for said cementitious material, a moistureproof membrane between said layers, and means for securing said layers together.

4. In a building construction, a prefabricated panel unit for walls, comprising members forming a rectangular frame, and a rigid body filling the space within said frame, the thickness between the surfaces of said body being greater than the depth of the members comprising the rectangular frame, shoulder offsets occurring along the juncture of said framing members with the body, thereby permitting the subsequent application of material to cover the exposed portion of said marginal framing members and allowing the outer surface of said covering material to be flush with the surfaces of the body portion of the panel unit, said rectangular frame being of metal, the vertical members thereof being channels positioned with flanges toeing inwardly toward the interior of the frame to engage the body filling the space therein.

5. In a building construction, a plurality of vertical prefabricated panel units aligned on a wall center-line, said panel units each comprising members forming a rectangular metallic frame, and a body composed of cementitious material filling the space within said frame, the frame forming a margin for the body, the thickness between surfaces of said body being greater than the depth of said frame so that shoulder offsets occur along the juncture of said marginal frame with the body, metallic reinforcement extending through said body and attached to opposite side members of the frame and metallic reinforcement projecting outwardly from said body through said shoulder offsets, means for connecting the opposed vertical members of the frames of adjacent panel units, the projecting reinforcement from adjacent panel units overlapping at joints between said units, and cementitious material applied upon said exposed reinforcement, the thickness of said material being sufficient to provide outer surfaces which complete the con-

tinuity of wall surfaces established by body portions of the aligned panel units.

6. In a building construction, a plurality of vertical prefabricated panel units aligned on a wall center-line, said panel units each comprising members forming a rectangular metallic frame substantially one story in height, and a rigid body filling the space within said frame, said body being formed of two layers of aerated concrete with a moistureproof membrane between said layers and with metallic reinforcement extending through the body between opposite members of the frame and attached thereto and continuing to project outwardly through shoulder offsets, said shoulder offsets occurring at the juncture of vertical members of the frame with the body, the thickness of said body being greater than the depth of said frame members; said panel units being so positioned that space intervenes between the opposed vertical frame members of adjacent panel units, metallic spacers connecting said pairs of opposed vertical members, the spacers being arranged so as to permit installation of vertical pipes and the like within the space between adjacent panel units, a moistureproof membrane extending across the interior of said space between adjacent panel units, and aerated concrete filling the remainder of said space on each side of the joint space membrane, embedding reinforcement projecting from adjacent panel units, the surfaces of said joint fill being flush with the body surfaces of the panel units adjacent thereto.

7. In a building construction, a plurality of vertical prefabricated panel units aligned on a wall center-line, said panel units each comprising a rectangular frame and a body filling the space within said frame, the thickness between the surfaces of said body being greater than the depth of members comprising the rectangular frame so that a shoulder offset to one outer surface of the body occurs along the juncture of said framing members with the body, the opposed vertical members of frames of adjacent panel units connected in pairs to form a structural load supporting column within the wall, and a covering over the exposed portions of said vertical framing members the thickness of said covering being substantially equal to the depth of the shoulder offsets so that the outer surface of said covering will lie in the wall surface plane established by surfaces of body portions of adjacent aligned panel units, thereby completing the continuity of a wall surface.

8. In a building construction, a plurality of vertical prefabricated panel units aligned on a wall center-line, said panel units each comprising members forming a rectangular frame substantially one-story in height and a body filling the space within said frame, the thickness between outer surfaces of said body being greater than the depth of members comprising the rectangular frame so that shoulder offsets occur along the juncture of said framing members with the body and so that outer surface planes of said body lie outside of lateral edges of framing members, said panel units being so positioned that a space intervenes between the opposed vertical members of frames of adjacent panel units, spacers connecting pairs of said opposed vertical framing members to form load supporting structural columns within the wall, said spacers being arranged so as to permit installation of vertical pipes and the like within the joint spaces between adjacent panel units, and means for completing the continuity of wall surfaces established by the outer surfaces of body portions of aligned panel units, said means extending between opposed shoulder offsets of adjacent panel units and concealing the joint space, the exposed portions of frame members and any pipe installed within said joint space.

9. In a building construction, a prefabricated panel unit for walls comprising members forming a rectangular frame and a rigid body filling the space within said frame, the thickness between outer surfaces of said body being greater than the depth of members comprising the rectangular frame, shoulder offsets occurring along the juncture of said framing members with the body, thereby permitting the subsequent application of material to cover the exposed portion of said marginal framing members and allowing the outer surface of said covering material to be flush with outer surfaces of the body portion of the panel unit, said rigid body being formed of two layers of material, each layer being formed inwardly around its periphery so that the said two layers meet in contact near and engage the inner face of marginal framing members, thereby enclosing a hollow interior within said rigid body.

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