Jan. 31, 1967 S. W. OWENS 3,300,943

BUILDING SYSTEM

Filed April 29, 1964 2 Sheets-Sheet 1

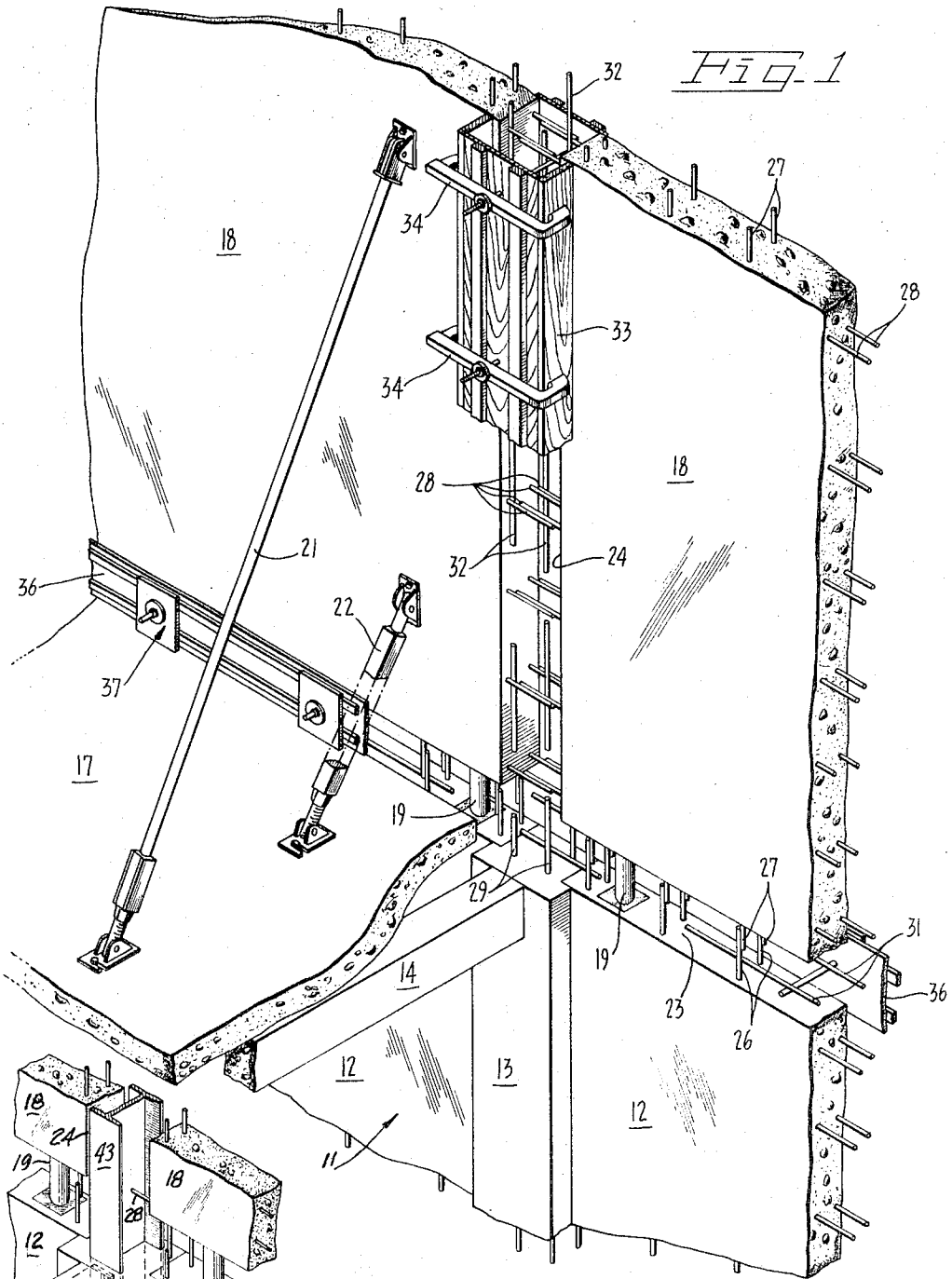

Fig. 5

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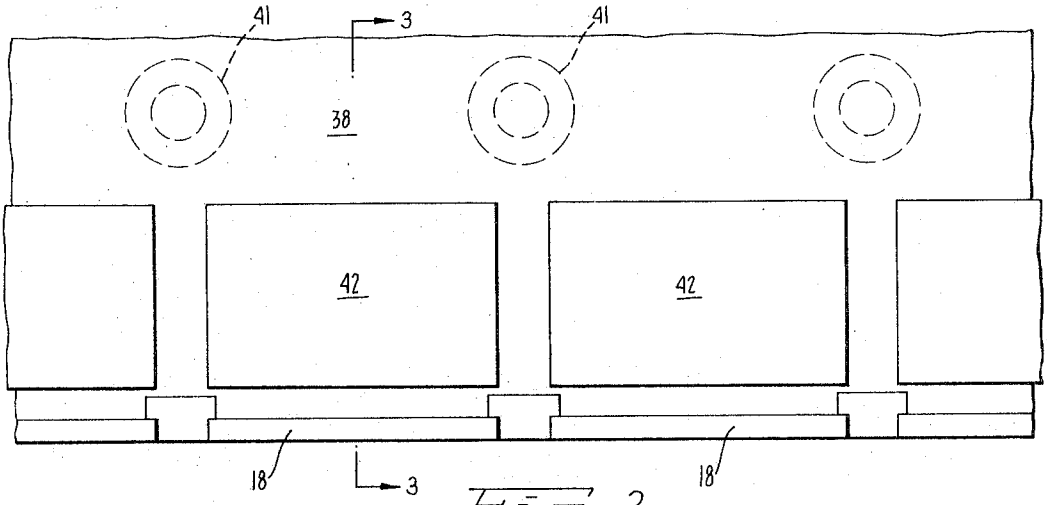

Fig. 2

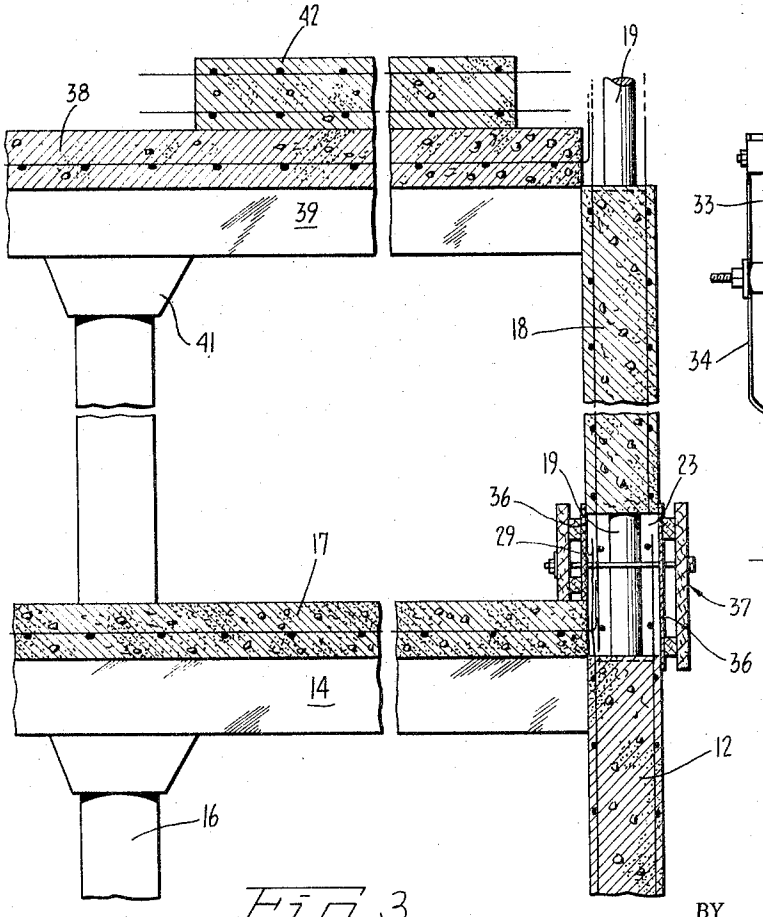

Fig. 3

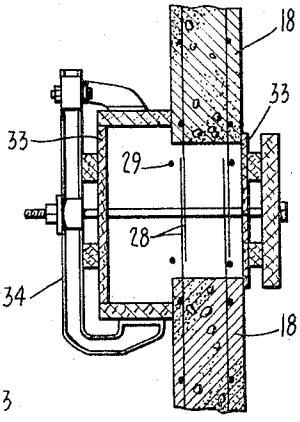

Fig. 4

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3,300,943

BUILDING SYSTEM

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The present invention relates to the erection of buildings in general, and is particularly directed to an improved system of tilt-up building construction in accordance with which multi-story buildings may be erected having heights far in excess of the limit presently imposed upon buildings erected by existing tilt-up construction practices.

Tilt-up building construction is frequently employed in the erection of buildings having relatively few stories. This method of building construction is advantageous from the standpoints of the relative ease and speed with which a building can be erected and the material saving which is realized in the amount of forms and other auxiliary elements required. However, tilt-up practices have been heretofore limited to use in the construction of buildings having no more than about four stories. This limitation has been imposed by the strength of the joints between the panels of adjacent stories being inadequate to withsand the various substantial loads which would be applied by additional stories of the building. More particularly, in accordance with existing tilt-up building construction, reinforced concrete wall panels are prefabricated in horizontal position, preferably at the building site. The panels are then raised, as by means of a derrick, to vertical longitudinally aligned spaced apart positions and are suitably braced therein. The panels of the ground story are placed directly on the footing and anchored by suitable integrally provided brackets or the like. Vertical reinforcing rods are placed in the spaces between longitudinally adjacent panels and tied to lapped horizontal rods projecting therefrom. Pilaster forms are positioned to enclose the gaps between longitudinally adjacent panels and concrete is poured into the resulting voids to thus form pilasters between the panels. In the construction of the second and subsequent stories, prefabricated wall panels are again raised to vertical positions, but are now placed directly atop the panels of the immediately subjacent story. The upper story panels are anchored to the lower story panels by suitable integrally provided brackets, or the like. Thereafter, the pilasters are constructed in the previously described manner and the process repeated for each successive story. It will be thus appreciated that the resulting construction is not monolithic, there being purely mechanical joints between the panels of adjacent stories. The relatively low strength of these mechanical joints makes it impractical to erect buildings of more than about four stories by existing tilt-up construction practices. In order to erect buildings having a greater number of stories a monolithic form of construction is required. Heretofore monolithic construction of tall buildings has entailed the pouring of vertical walls in place with the attendant disadvantages of the amount and complexity of the forms required and the time consumed in form erection. Material advantages are therefore to be gained where a system is provided to extend existing tilt-up construction practices to the erection of relatively tall buildings.

It is an object of the present invention to provide a tilt-up building system in accordance with which a monolithic construction is obtained having sufficient strength for tall buildings of forty stories or more.

Another object of the invention is the provision of a building system of the class described in accordance with which a longitudinal reinforced concrete belt between prefabricated panels of an upper story and subjacent panels of a lower story is poured simultaneously with the pilasters between longitudinally adjacent panels of the upper story.

Still another object of the invention is to provide a tilt-up building system of the class described whereby the panels of an upper story to be constructed may be precast upon the floor of a completed lower story and subsequently braced in vertical position from the floor of the lower story.

It is a further object of the invention to provide a tilt-up building system of the class described in accordance with which building construction may be conducted in a direction from inside the building towards the outside.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

FIGURE 1 is a perspective view with portions broken away of a typical section of wall in an intermediate stage of construction in accordance with the tilt-up building system of the present invention.

FIGURE 2 is a fragmentary plan view of a building depicting another stage of construction in accordance with the building system.

FIGURE 3 is a sectional view taken at line 3—3 of FIGURE 2.

FIGURE 4 is a fragmentary transverse sectional view through a pilaster form positioned at the gap between longitudinally adjacent wall panels.

FIGURE 5 is a fragmentary perspective view illustrating the application of the building system to frame steel buildings.

Considering now the invention in some detail and referring to the illustrated form thereof in the drawings, there will be seen to be generally provided a tilt-up building system for producing a monolithic construction having the requisite strength for tall buildings of many stories. In accordance with the basic aspects of the system, prefabricated reinforced concrete wall panels for the first story of a building are tilted-up, or raised, as by means of a derrick to vertical positions of support upon vertical spacer members positioned upon a continuous footing at longitudinally spaced intervals. The panels are suitably braced in vertical longitudinally aligned positions with gaps between longitudinally adjacent panels. There are also, of course, gaps between the panels and footing by virtue of the vertical spacer members. Vertical reinforcing rods are then positioned in the vertically extending gaps between longitudinally adjacent panels and secured, as by tying, to lapped ends of horizontal reinforcing rods oppositely longitudinally projecting into the gaps from the adjacent panels. Similarly, horizontal reinforcing rods are positioned in the longitudinally extending gaps between the panels and footing and tied, or otherwise secured, to lapped ends of vertical reinforcing rods projecting into these gaps from the panels and footing. The vertically and longitudinally extending gaps are next formed-in to thereby define pilaster voids between longitudinally adjacent panels which communicate at their lower ends with a longitudinally extending void between the panels and footing. Concrete is now poured into the upper ends of the pilaster voids. The concrete flows in opposite longitudinal directions from the base of each pilaster void into the longitudinal void at the bases of the panels. The concrete hence, ultimately fills the longitudinal void, as well as the pilaster voids. As a result a reinforced concrete belt is provided between the panels

and footing, and this belt is integral with reinforced concrete pilasters which are provided between longitudinally adjacent panels.

With the first story wall completed in accordance with the foregoing procedure, the second story is next constructed. Flooring is erected adjacent the top of the first story wall. Preferably, only a partial floor is constructed adjacent the inner periphery of the first story wall with an interior opening being left centrally of the building. The peripheral floor may be constructed as by securing prefabricated floor panels upon beams which are tied into the first story wall and supported upon pillars. Alternatively the peripheral floor may be poured in place subsequent to the construction of suitable floor forms. Wall panels are then provided in horizontal position upon the peripheral floor. Although these wall panels may be hoisted from the ground level to the peripheral floor of the next story to be constructed, the wall panels are more preferably poured in horizontal forms which are positioned upon such peripheral floor. After the panels have cured and the forms removed, the panels are tilted-up to vertical positions of support upon vertical spacer members which have been previously positioned at longitudinal intervals upon the upper edges of the first story wall panels. As in the case of the first story wall, the second story wall panels are longitudinally aligned in spaced-apart relation to thereby provide vertically extending gaps therebetween. The second story wall panels are braced in position from the second story peripheral wall. Reinforcing rods are secured in position within the vertically extending gaps between the longitudinally adjacent second story wall panels and within the longitudinally extending gap between the second and first story wall panels in a manner analogous to that previously discussed in connection with the construction of the first story wall. Similarly the vertically extending gaps and longitudinal gap are formed-in, after which the resulting voids are filled by pouring concrete into the upper ends of the vertically extending pilaster voids. The second story wall panels are thus secured to each other by reinforced concrete pilasters and to the first story wall panels by an interposed longitudinal reinforced concrete belt. The third and subsequent stories are thereafter successively constructed in an analogous manner to that of the second story. The over-all wall of the building is thus a monolithic structure wherein the wall panels of each story and of adjacent stories are interconnected by a grid work of reinforced concrete pilasters and longitudinal belts. Such a structure is of course extremely strong at the joints between wall panels and may be extended to a height of over forty or fifty stories while being capable of withstanding the loads imposed thereon. As a further advantageous feature of the building system outlined hereinbefore it is to be noted that the building may be constructed from the inside out. This results from the employment of peripheral flooring such that an opening is provided centrally of the building. Materials, etc., may hence be raised through the central opening and moved outward to positions on the peripheral flooring. When the uppermost story has been completed, the roof may be constructed and the flooring and all interior walls, heating and other installations thereafter completed under sheltered conditions.

The building system of the present invention will be better understood upon specific reference to the particular embodiment thereof illustrated in the drawings. Referring first to FIGURE 1, the wall of a previously constructed story of a building is depicted at **11**. Wall **11** includes a plurality of prefabricated concrete longitudinally aligned vertical wall panels **12**, adjacent ones of which are joined by interposed reinforced concrete pilasters **13**. In the stage of construction illustrated, cross beams **14** have been secured to the pilasters **13** and supported upon pillars **16** (see FIGURE 3). These cross beams may of course be steel beams, concrete reinforced by steel beams, etc., in place of the steel rod reinforced concrete beams illustrated in FIGURE 1 (e.g., note FIGURE 5). A peripheral floor **17** has likewise been constructed of prefabricated reinforced concrete floor panels, or poured in place, and supported upon the beams **14** adjacent the upper edge of wall **11**. The peripheral floor **17** forms a portion of the floor of the story which is next to be erected.

In the construction of the next story, prefabricated reinforced concrete panels **18** are tilted-up from the floor **17** to the vertical positions depicted in FIGURE 1. These panels are supported upon pipes **19** or equivalent spacer members vertically disposed upon the upper edges of the panels **12** at longitudinally spaced intervals. The pipes **19** are preferably filled with concrete so as to anchor same. To hold the panels **18** in place conventional long and short tilt-up braces **21** and **22** are secured between the side face of each panel and the floor **17** adjacent the opposite ends of the panel. As so braced in position there is a longitudinally extending gap **23** between each panel **18** and an immediately subjacent panel **12**. Moreover, the panels **18** are longitudinally spaced-apart so as to define vertically extending gaps **24** therebetween in alignment with the pilasters **13**. It is to be noted that vertical reinforcing rods **26** project upwardly from the panels **12** into the gap **23**. In addition, the panels **18** have vertical reinforcing rods **27** which project downwardly and upwardly from the bottom and top edges thereof, and horizontal reinforcing rods **28** which project longitudinally from the opposite side edges thereof. The downwardly projecting rods **27** extend into the gap **23** and lap the rods **26**, while the rods **28** from adjacent panels **18** are lapped in the gap **24** therebetween. Vertical rods **29** also extend into the gaps **23** from the subjacent pilasters **13**.

In the next step of construction, additional reinforcement is provided in the gaps **23**, **24**. More particularly, horizontal rods **31** are positioned in the gap **23** and tied, or otherwise secured to the vertical rods **26**, **27**, and **29**. Vertical rods **32** are similarly positioned in the gaps **24** and tied, or otherwise secured to the horizontal rods **28**.

Now with suitable steel reinforcement thus provided in the gaps **23**, **24**, these gaps are formed-in. Vertically extending forms **33** of wood, or the like, are secured to the opposite side faces of the panels **18** in bridging relation to the gaps **24**. Securance of the forms **33** in position is facilitated as by means of conventional pilaster clamps **34** as best shown in FIGURES 1 and 4. Longitudinally extending forms **36** are similarly secured to the opposite side faces of the panels **12** and **18** in bridging relation to the gap **23** therebetween. Securance of the forms **36** in position is facilitated as by means of conventional form clamps **37** as best shown in FIGURES 1 and 3.

To complete the construction of the particular story defined by wall panels **18**, concrete is poured into the upper ends of the pilaster voids defined between adjacent panels **18** and the forms **33**. These voids of course communicate at their lower ends with the longitudinal void encompassed by the top and bottom edges of panels **12** and **18** respectively and the forms **36**. Hence, the concrete flows into the longitudinal void to fill same while also filling the pilaster voids. There thus results a longitudinal concrete belt between the panels **12** of the lower story and panels **18** of the upper story which is reinforced by the rods **26**, **27**, **29**, and **31**. Concrete pilasters are likewise provided between adjacent panels **18** which are reinforced by rods **28**, **29**, and **32**, and these pilasters are tied to the pilasters **13** through the rods **29**.

Although the pouring of concrete into the pilaster voids may be variously accomplished, some benefits are to be gained where flowing is first provided adjacent the upper ends of the pilaster voids from which the concrete may be poured into these voids. Such an arrangement is best shown in FIGURE 4, wherein the panels **18** have been erected and the gaps formed-in, but the pilaster voids and the longitudinal void have not yet been poured. A peripheral floor **38** has been erected adjacent the upper ends of panels **18**. Such floor is supported upon beams

39 which are in turn supported upon pillars 41 extending upwardly from the lower floor 17. The floor 38 provides a platform from which the concrete may be poured into the pilaster voids of the lower story. In addition, wall panels 42 may be precast in horizontal forms upon the floor 38 preparatory to the construction of the next story. In this manner, it will be appreciated that the panels 42 may be conveniently poured during the same operation as the pouring of the pilaster and longitudinal voids of the immediately subjacent story.

The building system of the present invention is also applicable to frame steel buildings, and in this regard reference is made to FIGURE 5. As shown therein, a frame steel building construction has been provided which includes I beam columns 43 and I beam reinforced concrete cross members 44 secured thereto. In this case, the prefabricated wall panels 18 are raised to positions of support upon the spacer pipes 19 in longitudinally spaced-apart relation on opposite sides of the I beam columns 43. In other words, the panels are disposed such that the columns extend upwardly through the gaps 24 between adjacent panels. The longitudinal reinforcing rods 28 projecting into the gaps from the ends of adjacent panels are secured to the I beam columns 43, as by welding. Similarly the longitudinal reinforcing rods 31 positioned in the longitudinal gap 23 between the panels 18 and panels 12 of the subjacent story are secured to the I beam columns 43. Thereafter, the gaps are formed-in and the resulting voids filled with concrete in the manner previously described. There thus results a building construction wherein the I beam columns 43 of a frame steel building construction are contained in, and reinforced by concrete pilasters securing longitudinally adjacent prefabricated wall panels.

What is claimed is:

1. A method of building construction comprising positioning vertical spacer members at longitudinally spaced-apart intervals upon a concrete support surface having vertical reinforcing members projecting therefrom, providing a plurality of prefabricated reinforced concrete wall panels in horizontal position adjacent said support surface with each panel having reinforcing members projecting from the edges thereof, raising said panels to longitudinally aligned spaced-apart positions of support upon said spacer members and bracing said panels in said spaced-apart positions to thereby provide vertically extending gaps between adjacent panels and a longitudinally extending gap between said panels and said support surface, reinforcing members of each panel projecting vertically into said longitudinally extending gap and lapping said reinforcing members projecting from said support surface and reinforcing members of adjacent panels projecting longitudinally into said vertically extending gaps in lapped relationship, securing longitudinal reinforcing members to the lapped vertical reinforcing members in said longitudinally extending gaps, securing vertical reinforcing members to the lapped longitudinal reinforcing members in said vertically extending gaps, forming-in said vertically extending and longitudinally extending gaps to thereby provide vertically extending voids between adjacent panels communicating with a longitudinally extending void between said panels and support surface, and filling said voids with concrete by pouring concrete into the upper ends of said vertically extending voids.

2. A method of building construction comprising erecting a partial floor adjacent the upper edge of a completed story of a multi-story wall, providing prefabricated reinforced concrete wall panels in horizontal support upon said floor in longitudinally spaced-apart relation to each other, positioning vertical spacer members upon the upper edge of said completed story in longitudinally spaced-apart relation, tilting said wall panels upward from said floor to longitudinally aligned spaced-apart positions of support upon said spacer members to thereby provide vertically extending gaps between adjacent panels and a longitudinally extending gap between said panels and upper edge of said completed story, bracing said panels in said positions of support upon said spacer members from said floor, securing vertical reinforcing members to lapped longitudinal reinforcing members projecting into said vertically extending gaps from adjacent panels, securing longitudinal reinforcing members to lapped vertical reinforcing members projecting into said longitudinally extending gap from said panels and the upper edge of said completed story, erecting forms at the opposite side faces of said panels in bridging relation to said vertically extending gaps and longitudinally extending gap to thereby define vertically extending voids communicating at their lower ends with a longitudinally extending void, and pouring concrete into the upper ends of said vertically extending voids to thereby fill these voids and the longitudinally extending void.

3. A method of building construction according to claim 2, wherein said wall panels are prefabricated in horizontal forms upon said partial floor.

4. A method of building construction according to claim 2, wherein a second partial floor is supported from said first partial floor adjacent the upper edges of said wall panels, and said concrete is poured into the upper ends of said vertically extending voids from said second partial floor.

5. A method of building construction comprising

(a) positioning vertical spacer members at longitudinally spaced-apart intervals upon a continuous concrete footing having vertical reinforcing members projecting therefrom,

(b) providing a plurality of prefabricated reinforced concrete wall panels in horizontal position adjacent said footing with each panel having reinforcing members projecting from the edges thereof,

(c) raising said panels to longitudinally aligned spaced apart vertical positions of support upon said spacer members and bracing said panels in said spaced apart positions to thereby provide vertically extending gaps between adjacent panels and a longitudinally extending gap between said panels and said footing,

(d) securing vertical reinforcing members to longitudinal reinforcing members projecting into said vertically extending gaps from adjacent panels,

(e) sceuring longitudinal reinforcing members to vertical reinforcing members projecting into said longitudinally extending gap from said panels and said footing,

(f) erecting forms at the opposite side faces of said panels in bridging relation to said vertically extending gaps and said longitudinally extending gap to thereby define vertically extending voids communicating at their lower ends with a longitudinally extending void,

(g) pouring concrete into the upper ends of said vertically extending voids to thereby fill these voids and the longitudinally extending void and complete a story of a multi-story wall,

(h) erecting a peripheral floor adjacent the upper edges of the panels of the last completed story of said multi-story wall,

(i) providing a plurality of prefabricated reinforced concrete wall panels in horizontal position upon said floor adjacent the upper edges of the panels of the last completed story with each panel having reinforcing members projecting from the edges thereof,

(j) positioning vertical spacer members at longitudinally spaced intervals upon said upper edges of the panels of the last completed story,

(k) raising said panels from said floor to longitudinally aligned spaced apart vertical positions of support upon said spacer members to thereby provide vertically extending gaps between longitudinally adjacent ones of these panels and a longitudinally ex-

tending gap between these panels and the subjacent panels of the last completed story,

(l) securing vertical reinforcing members to longitudinal reinforcing members projecting into said last named vertically extending gaps,

(m) securing longitudinal reinforcing members to vertical reinforcing members projecting into said last named longitudinal gap,

(n) erecting forms at the opposite side faces of said panels in bridging relation to said last named vertically extending and longitudinally extending gaps to thereby define vertically extending voids communicating at their lower ends with a longitudinally extending void,

(o) pouring concrete into the upper ends of said last named vertically extending voids to thereby fill these voids and the last named longitudinally extending void and complete another story of said multi-story wall, and

(p) repeating steps (h)–(o) for each subsequent story of said wall.

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