# United States Patent

**Zimmerman**

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[54] **CONCRETE BUILDING CONSTRUCTION AND COMPONENT PARTS USED THEREWITH**


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[52] **U.S. Cl.** .....**52/274,** 52/125, 52/583, 52/587

[51] **Int. Cl.** .....**E04b 1/04,** E04b 1/40, E04c 1/10

[58] **Field of Search**.....52/274, 293, 295, 125, 583, 52/587, 585, 267



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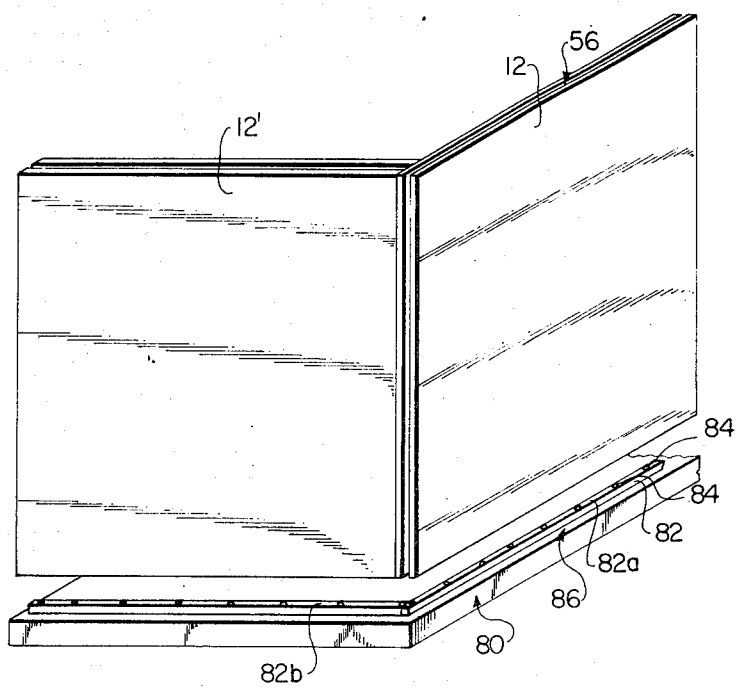
*Primary Examiner*—Price C. Faw, Jr.
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[57] **ABSTRACT**

There is disclosed a concrete building arrangement wherein the walls and roof are formed by insulated concrete panels. The wall panels are aligned by cooperating guide means on the base of the panels and on the foundation with which the panels cooperate. The panels preferably comprise outer concrete layers with an insulating layer sandwiched therebetween, and also preferably incorporate reinforcing frame means having segments extending transversely between respective layers. Moreover, securing means are provided which preferably include at least one exposed bar member carried by each panel and anchoring arms extending from the bar member into respective outer concrete layers of the panel for anchoring the bar member in position. While alignment at the base of the wall panels is provided by the cooperating guide means, alignment at the upper portion of the panels is preferably achieved by bolt means cooperating with the bar members. Modified securing means are also provided for joining together edgewise roof panels to form a roof unit, the roof panel securing means similarly comprising at least one exposed bar member carried by each roof panel and anchoring arms extending from the bar member into the outer concrete layer of the respective roof panel, and bolting means connecting the bar members of adjacent panels. The overall building, the cooperating guide and aligning means, the securing devices and the reinforcing frames individually and separately constitute parts of the invention.


**10 Claims, 23 Drawing Figures**



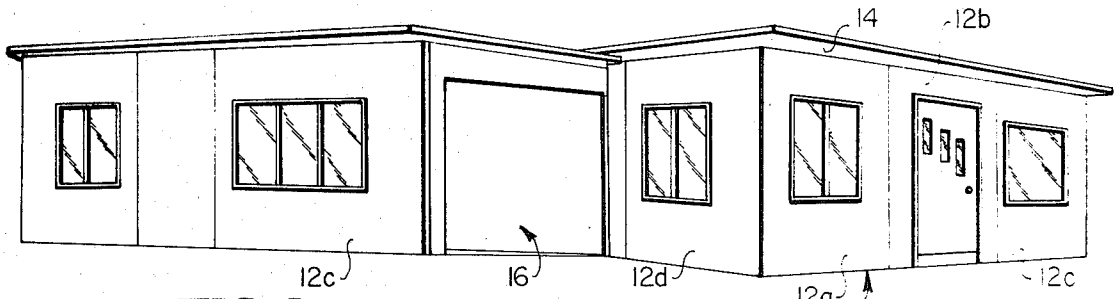



FIG. 1

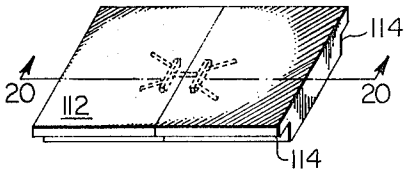



FIG. 19

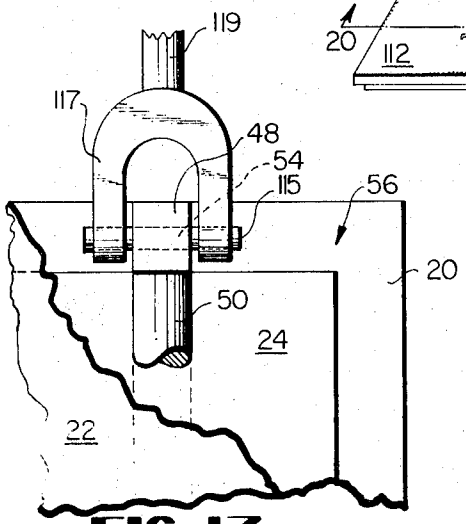



FIG. 17

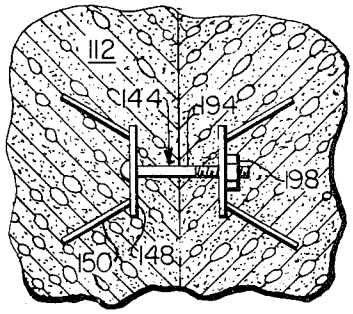



FIG. 20

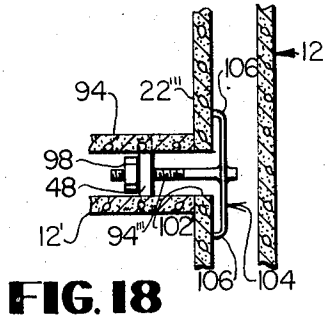



FIG. 18

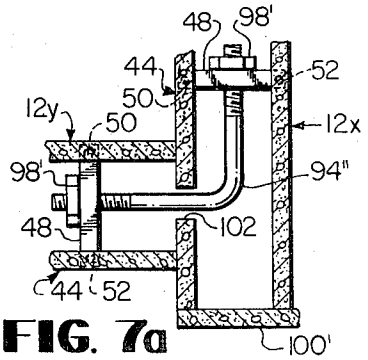



FIG. 7a

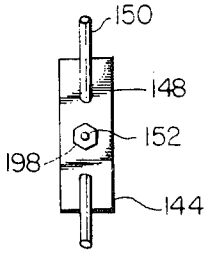



FIG. 21

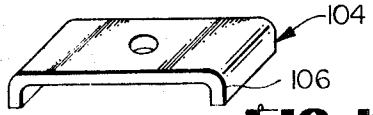



FIG. 18a

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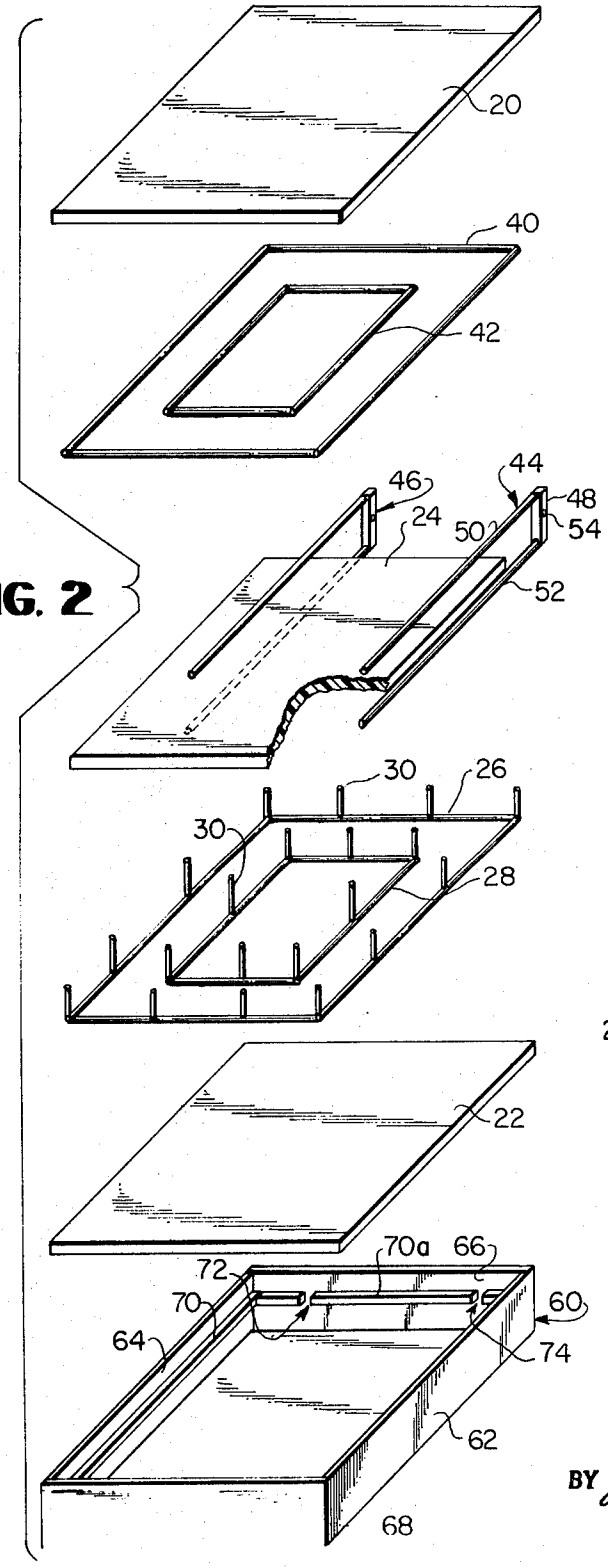



FIG. 2

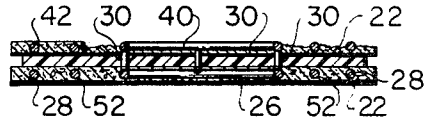



FIG. 9




FIG. 10

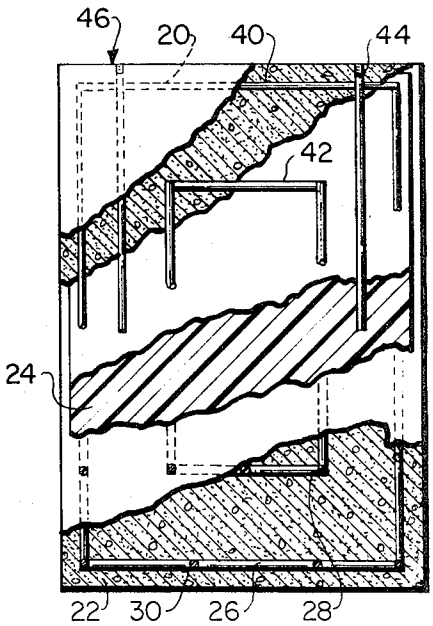



FIG. 4

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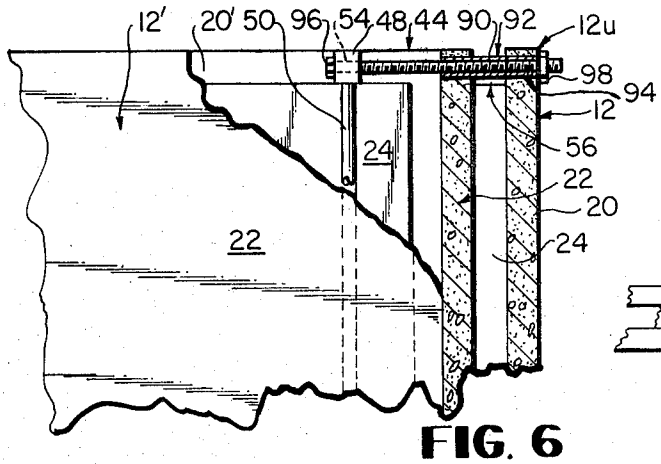



FIG. 6

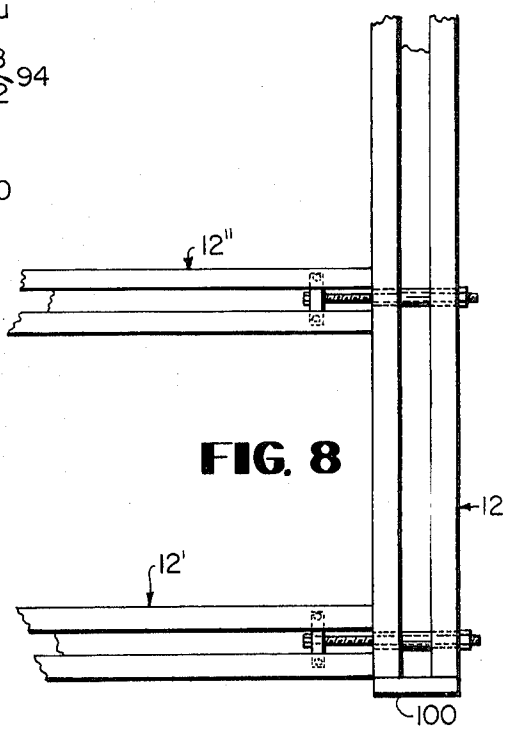



FIG. 8

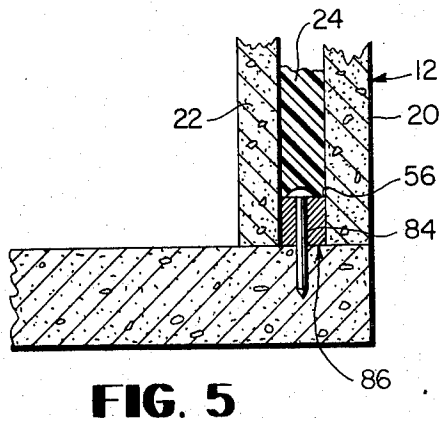



FIG. 5

FIG. 7

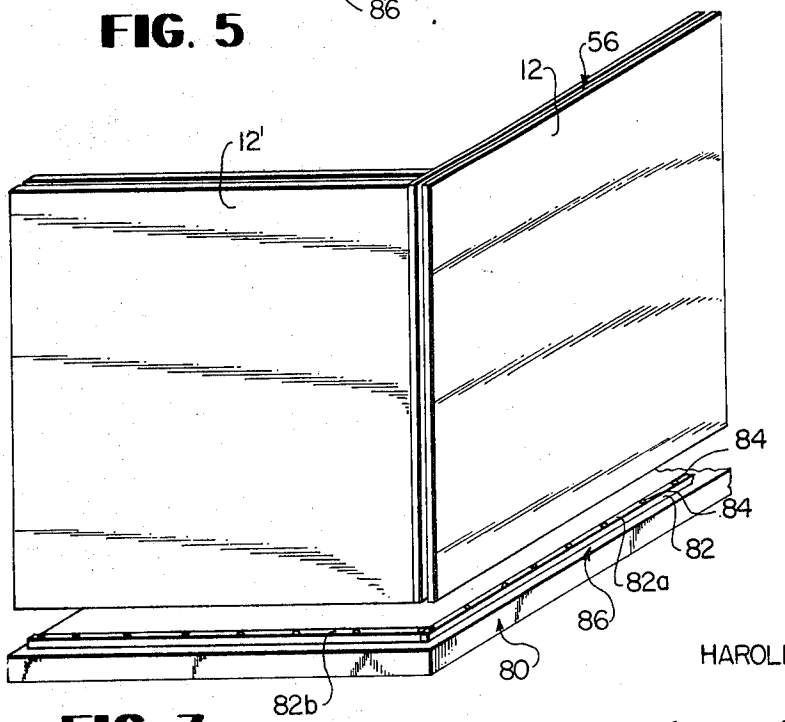
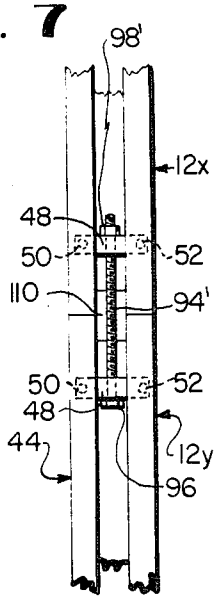



FIG. 3




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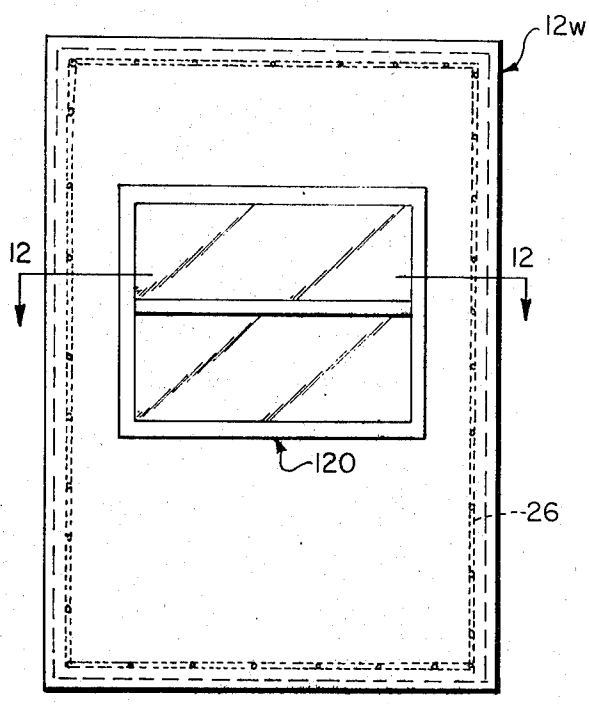



FIG. 11

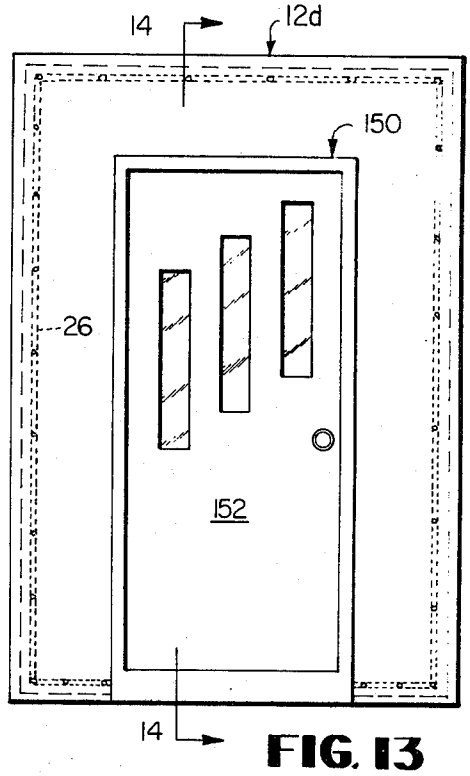



FIG. 13

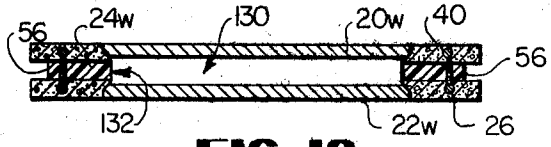



FIG. 12

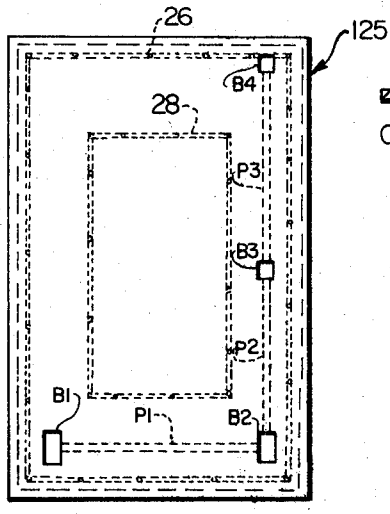



FIG. 15

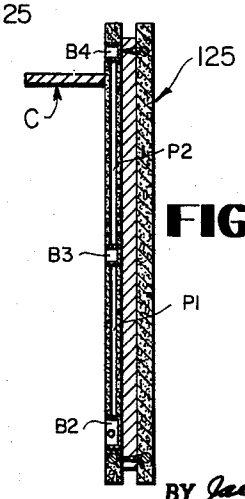



FIG. 16

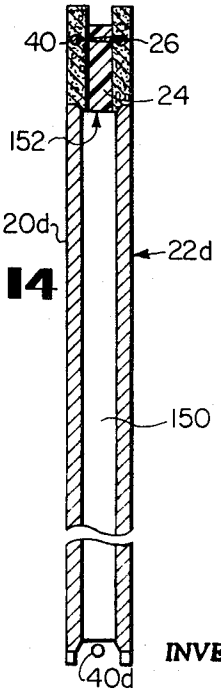



FIG. 14

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# CONCRETE BUILDING CONSTRUCTION AND COMPONENT PARTS USED THEREWITH

This invention relates to concrete building arrangements, and also to component parts used in association therewith such as building panels, reinforcing frames, securing means, and the like.

There have been various prior attempts made to provide a relatively easily assembled and relatively inexpensive building that could be used, for example, for low-cost housing projects. One of the objects of the present invention is to provide such a building which is not subject to the limitations of the prior attempts.

While the present invention is not limited to homes, as such, it is described in connection with the building of homes so as to facilitate an understanding thereof. Still, it is to be recognized from the outset that the invention can be applied in various different environments, including industrial environments, educational environments, etc. Specifically, the invention is described herein in relation to a low cost house, but it can be utilized in building schools, factories, stores, or any other buildings without departing from the scope and spirit of the invention.

Recognizing that the invention has such universal application, let us look initially at some of the problems which were faced with prior prefabricated component arrangements. First, many of the prior constructions required that at least basic horizontal and vertical structural components be utilized before preformed panels could be connected therewith. In turn, this meant that even after the foundation had been laid, vertical columns had to be poured and set so that the panels essentially served to give inside and outside facing, rather than complete walls. With respect to this prior type of arrangement, the invention is directed to eliminating the need for establishing vertical structures prior to utilization of preformed panels.

In another type of prior arrangement, preformed structural columns were utilized in association with preformed structural blocks. The columns were essentially arranged to provide side guides with the blocks being vertically stacked and maintained in position by such guides. With this type of arrangement, handling problems were not particularly difficult since the preformed elements were comparatively small, but still the degree of fabrication was limited and in turn substantial assembly time was required at the building site. The present invention, when viewed with respect to this last mentioned type of prior arrangement, eliminates the need for excess handling and assembly operation in that the present invention has as one of its objects the provision of wall panels which in and of themselves form a complete vertical wall segment, both interior and exterior from floor to ceiling of at least one story.

A further type of prior construction contemplates the provision of preformed complete walls of a given building unit. This type of arrangement presents unusually difficult handling problems because of size and weight, and, moreover, in addition to other factors, presents a significant transportation problem by virtue of the size of the preformed elements. Considered in this relation, the present invention provides preformed building panels, and means of coupling the same together, whereby reasonable size wall segments can be handled, whereby handling problems are not severe, and whereby transportation problems are essentially non-existent.



The foregoing discussion is not intended to be exhaustive and instead is presented to illustrate types of prior constructions and the disadvantages associated therewith. Undoubtedly, there are numerous prior suggestions as to the manner in which prefabricated buildings can be provided, but to the best of my knowledge, with all of the prior arrangements, there is some significant difficulty which has precluded the particular arrangement from achieving widespread commercial acceptance. The principal object of the present invention is to provide a prefabricated building arrangement and components for use therewith which cooperatively provide a concrete building arrangement which is commercially acceptable, whether considered from the production standpoint, the assembly standpoint, the durability standpoint and/or the aesthetic standpoint.

A very significant further object of the invention is to provide, in a prefabricated building arrangement, strong and insulated preformed concrete panels, and easily useable and operable means for aligning and joining the panels in desired relation to one another. Even further in this regard, it is an object of the invention to provide such panels which can incorporate windows and/or doors and which can be easily prefabricated with inexpensive equipment such as simple concrete forms.

Although the invention, in its basic aspects, is directed to providing a concrete building construction which conforms with all of the preceding objects, one should not overlook some of the subsidiary objects of the invention, and specifically some of the sub-combinations provided by the invention which ultimately result in being able to achieve the overall building. In this regard, further important objects of the invention include (a) the provision of a relatively simple and easily useable cooperating guide system which co-acts between a concrete slab and wall panels formed consistent herewith to facilitate the alignment, disposition, and securing of adjacent panels; (b) the provision of reinforcing frame means which can be utilized within each building panel constructed in accordance herewith not only to provide vertical support in a given plane, but also to provide lateral support between respective layers of given panels; (c) the provision of preformed concrete wall and roof panels which have insulation built therein, and in particular, the provision of wall and/or roof panels including inner and outer concrete layers with an insulating and preferably plastic foam layer therebetween; (d) the provision of securing means to be utilized in aligning and joining adjacent wall and/or roof panels extending along the same axis and/or in joining adjacent wall and/or roof panels extending along different axes; (e) the provision of such securing means and a system for anchoring the same in any given wall or roof panel so that the desired alignment and joining can be made sufficiently strong to preclude subsequent mis-alignment and/or deterioration; (f) the provision of a system for constructing a building formed of prefabricated concrete panels, which system permits the panels to provide complete exterior vertical walls of the building, a complete flat or peaked roof, and additionally, if desired, associated in-

terior walls; and (g) the provision of an arrangement conforming with all of the preceding objects that additionally permits the utilization of various different facings which can be, if desired, formed integrally with the respective panel.

Although it should be apparent, a further object of the present invention is to provide an overall building system which allows for the use of a properly supported concrete slab as a foundation and also for the use of a roof of any desired type.

Basically, and as indicated previously, the invention resides in the provision of a building or building system which essentially utilizes preformed concrete panels. However, the component parts of the building and/or of the slabs which are made consistent herewith are significant aspects of the present development.

The invention itself, and various inventive concepts related thereto, will be better understood after reading the foregoing detailed description. Such description refers to preferred and illustrative embodiments of the invention presented in the annexed drawings in which:

FIG. **1** is a perspective view of a prefabricated building constructed in accordance with the present invention;

FIG. **2** is an exploded view of a form and segments of a wall panel constructed in accordance herewith;

FIG. **3** is a fragmental illustrative corner view of panels and an associated foundation, FIG. **3** presenting the base alignment cooperation between such elements according to the preferred embodiment hereof;

FIG. **4** is a plan view, partially broken away from a panel including the elements shown in FIG. **2**;

FIG. **5** is a fragmental detailed sectional view taken through a base corner of a building constructed according to the invention, FIG. **5** showing the specific guide means preferably utilized at the panel bases;

FIG. **6** is a fragmental top view of intersecting panel members, FIG. **6** being partially broken away to show the cooperating securing means and fastening means between respective panels;

FIG. **7** is a fragmental top plan view of a junction between axially aligned panels in a building utilizing the invention;

FIG. **7***a* is a fragmental top plan view similar to FIG. **7** showing a junction between perpendicularly aligned panels;

FIG. **8** is a top plan view of a section of a building wall arrangement constructed according to the invention and wherein the securing means and fastening means cooperate to secure intersecting inner and outer wall panels to another outer wall panel;

FIG. **9** is a sectional view taken through a panel such as shown in FIG. **4**;

FIG. **10** is a partially sectional and partially diagrammatic view of a panel such as shown in FIG. **4**, FIG. **10** illustrating the transverse disposition of stub shafts projecting from a lower base reinforcing frame;

FIG. **11** is a front view of a panel made according to the invention and incorporating a window therein;

FIG. **12** is a sectional view taken on the line **12;12** of FIG. **11**;

FIG. **13** is a front view of a panel made according to the invention and incorporating a door therein;

FIG. **14** is a sectional view taken on the line **14;14** of FIG. **13**;

FIG. **15** is a plan view of a panel incorporating an electrical conduit and boxes therein;

FIG. **16** is a sectional view through the vertical conduit portion of the panel of FIG. **15** with the addition of a section of part of a false ceiling that can be used according to FIG. **16**;

FIG. **17** is a fragmental detailed corner view showing the manner in which a fork member can be utilized with a connecting pin for purposes of lifting a panel;

FIG. **18** is a top plan view of a section of a building wall arrangement similar to that of FIG. **8**, wherein a modified form of cooperating securing means and fastening means for adjacent panels is shown;

FIG. **18***a* is a perspective view of the clip or bracket member of FIG. **18**;

FIG. **19** is a perspective view showing a pair of roof panels in assembled relation;

FIG. **20** is an enlarged partial horizontal section along line **20—20** of FIG. **19** showing the manner of joining the roof panels; and

FIG. **21** is a side elevational view of a single securing element of FIG. **20**.

If reference is first made to FIG. **1**, it will be noted that the building **10** shown therein includes a series of panels **12***a*, **12***b*, **12***c*, **12***d*, etc., which form the vertical exterior surface thereof. These panels, in the arrangement of FIG. **1**, support a flat roof **14** of conventional design. The various panels are so joined together as to essentially define a home, which in the embodiment presented, has a garage **16** to one side thereof.

Although each of the panels specifically referred to by number in FIG. **1** has a window, door, or the like therein, these panels are essentially basically the same, and in this regard, attention is now directed to FIG. **2**. FIG. **2** shows in exploded form, various component parts which are preferably utilized to make a panel **12**. In this regard, it is to be noted that each panel includes inner and outer concrete layers **20** and **22** with an insulating layer **24** therebetween. The insulating layer is preferably formed of a rigid plastic foam material with the preferred embodiment of the invention contemplating forming the layer **24** of styrofoam.

In the actual construction of plain panels (i.e., panels without windows or doors) base frames such as both the base frames **26** and **28** of FIG. **2** are imbedded within the concrete layer **22**, and each of these base frames carries projecting elements **30** that extend in laterally upstanding relation thereto. The base frame **26**, as well as the base frame **28** are preferably made of rigid metal, and in particular, bar steel stock and each of the upstanding projecting elements **30** is similarly made of the same material so that such elements take the form of spaced apart stub shafts. These stub shafts are joined to the base frame in spaced relation to one another, and in any suitable manner, although welding is certainly the easiest and cheapest technique.

Each of the panels preferably also includes additional rectangular frame elements such as the rectangular frames **40** and **42** also shown in FIG. **2**. These latter mentioned rectangular frames are normally formed in the same manner and from the same materials as the base frames **26** and **28**, but the frames **40** and **42** do not necessarily carry projecting elements extending laterally therefrom. These latter mentioned frames are imbedded within concrete layer **20** as explained more fully hereinafter.

In addition to including the inner and outer concrete layers, the interposed insulating layer, and the frames just described, each panel also preferably includes a pair of securing means such as the securing means **44** and **46** shown in FIG. **2**. Each such securing means in turn, and as shown, comprises an upper bar member **48**, preferably of rectangular cross-section, and a pair of anchoring arms **50** and **52**. The anchoring arms are joined to the opposed end portions of the bar **48** in any suitable manner, although welding is preferred for the same reasons as given above, and these respective anchoring arms **50** and **52** have a length which is substantially greater than the length of the bar element **48**. The respective arms **50** and **52**, moreover, are anchored in the inner and outer concrete layers **20** and **22**, as also explained more fully below.

Even though the details of construction of the securing means **44** have been described in the immediately preceding paragraph, it should be apparent from FIG. **2** that the construction of the securing means **46** is identical to that of the securing means **44**. Accordingly, repetition of the details of the securing means **46** appears unnecessary. Suffice it to say to complete this discussion, the bar **48** of each securing means includes an aperture or bore **54** therethrough. This aperture or bore serves to permit desired fastening in the ultimate building construction.

Having considered the basic components incorporated in a building panel constructed in accordance herewith, let us look for a moment at the edge configuration of such panels. For this purpose, consider FIG. **3**. In this figure, each panel **12** is shown as having a generally rectangular recess or channel **56** which extends along the opposed side edges thereof and the opposed top and bottom edges thereof. This channel **56**, as discussed in connection with the building assembly in following portions of this specification permits, along the bottom or base edge of each panel, proper alignment of the panel, and permits along the top edge, exposure of a component of the securing means or in particular the bar **48** thereof. Along the side edges, the recess or channel permits a grout joint to be formed rather easily, once desired alignment is obtained.

Referring again to FIG. **2**, it will be noted that at the bottom of the figure there is shown a form **60** which has opposed side walls **62** and **64** and opposed end walls **66** and **68**. These respective walls are presented in illustrative form, and it suffices for purposes of this description to understand that the walls provide a mold or form which is utilized to pre-cast each building panel **12**. For this purpose, each of the walls **62**, **64**, **66**, and **68** carries a projecting rib **70**, preferably of square or rectangular cross-section, which rib extends into the form itself. The rib portion **70*a*** carried on the inside of the wall **66** is interrupted or recessed at **72** and **74** so that the form will accommodate the securing means, as bars **48** thereof, as referred to previously.

Assume that one wished to form a building panel consistent with this invention. It would merely require the provision of a form such as the form **60**, and the availability of the required components and materials. Specifically, once the form had its walls disposed as shown in FIG. **2**, a fluid concrete layer, preferably about two inches thick, would be poured into the form thus eventually providing the concrete layer **22**. When this layer of concrete had been poured, the respective frames **26** and **28** would be placed in the form with the base of the frames imbedded within the layer of concrete.

Either before the frames were inserted, or thereafter, the securing means **44** and **46** would be placed in the form with the bars **48** of the respective securing means being disposed in the recesses **72** and **74** in the rib portion or section **70*a***. Thereafter, the styrofoam layer **24** as preformed and preferably having about a two inch thickness would be inserted in the mold. This may require bending the top arm **50** of each securing means upwardly and/or slightly tilting each securing means, but in any event, it has been found that the styrofoam layer can be easily inserted. The upstanding stub shafts **30** will punch through the styrofoam if one pushes down on the styroform, or alternatively, pre-cut apertures can be formed in the styrofoam. After the styrofoam layer has been poured, an additional layer of concrete, also preferably about two inches thick is poured into the form, and the frames **40** and **42** are then submerged in this layer.

The concrete is then permitted to set, and after the concrete has set, the form walls **62**, **64**, **66** and **68** are separated, having been previously joined in any suitable manner, and the resultant panel is ready for use consistent with the invention.

It should here be noted that if a particular facing is required on the outside of the concrete layer **20** or on the outside of the concrete layer **22**, it is only necessary to contour and/or provide the facing in the form **60**. For example, the base of the form could have some grain contour to which the outer surface of the layer **22** would conform when poured, and/or again by way of example, some type of pebble or stone facing could be achieved on the upper surface of the layer **20** merely by sprinkling or otherwise covering such face, when wet, with the desired material. Of course, pebbles could be used in the base of the form so as to provide a facing on the layer **22**.

Regardless of the manner in which the facings are applied, the panel shown in FIG. **2**, when completed, and as shown in FIGS. **4** and **9**, has a first outer concrete layer **20**, a second and inner concrete layer **22**, with an interposed styrofoam layer **24**. Imbedded within the inner layer **22** is a base frame **26**, and preferably also a base frame **28**. Each of these frames carries projecting stub shafts **30** which extend between the layers thereby affording lateral support. Additionally, the upper layer **20** preferably has imbedded therein a pair of frames **40** and **42**. Even further, and of particular significance, is the fact that such panel has a pair of securing means **44** and **46** anchored therein, which securing means have an exposed element, namely, bar **48**.

Leaving aside for a moment the manner in which doors and windows are provided in the respective panels, attention is again directed initially to FIG. **3** and then to FIGS. **5** through **7**.

Reference has previously been made to FIG. **3** with respect to the basic panels **12** provided in accordance herewith and also in connection with the provision in such basic channels of a peripheral recess generally designated by the numeral **56**. This recess **56**, as indicated above, serves several purposes. In FIG. **3**, however, we are concerned basically with a single purpose served thereby, namely, the use of the channel or

recess **56**, as it extends along the bottom of the panel, for purposes of a guide means.

Note in FIG. **3** that the base of the structure, generally designated by the numeral **80**, has secured thereto an elongated strip **82**. Preferably, the base **80** is in the form of a concrete slab such as provided in the ordinary foundation for a building. The strip **82** is secured to the slab **80** by means of nails **84** driven at spaced locations through the strip and into the concrete slab. The strip **82** can be segmented so as to include, for example, a section **82***a* extending in one direction and a section **82***b* extending in another direction. Obviously, other segments can be utilized, and thus it is to be understood that the strip **82** and/or segments thereof provide a projecting bar means generally designated by the numeral **86**, which projecting bar means essentially defines a further guide means.

Specifically, the projecting bar means **86** has a cross-sectional configuration adapting the same to be received in the portion of the recess **56** on the panel **12** extending thereover. Accordingly, as the panels **12** are lowered into position, the bottom recesses thereof matingly engage the projecting bar segment therebelow, thus aligning respective panels **12** longitudinally with respect to one another, and additionally aligning the panels **12** in angular relation to one another as shown specifically in FIG. **3**. In essence, the bar means **86** serves as a first bar means on the foundation, and the recess on the base or along the base of each panel **12** serves as a second guide means, with the first and second guide means cooperating to align the bases of the panels in desired position.

By referring to FIG. **5**, it will be noted that the bar means **86** there shown is disposed between the inner and outer layers **20** and **22** of a panel **12** having a styrofoam or insulating layer **24** between the respective outer layers **20** and **22**. The nail **84** which projects through a suitable aperture in the bar means **86** is a standard cement nail adapted to secure members to a cement foundation. The recess **56** essentially is defined on its side by the inner faces of the respective walls **20** and **22** and on its top by the bottom edge of the styrofoam or insulating section **24**. From FIGS. **3** and **5**, it should therefore be apparent that a very simple technique is utilized for providing first and second cooperating guide means to align the base of the panels, the technique being based on the use of a tongue and grooved type arrangement with the tongue preferably being provided by the projecting bar means and the groove preferably being provided by the recess in the panel.

Although an important aspect of the invention resides in the construction of the panels themselves and a further important aspect of the invention resides in the provision of the cooperating base guide means, the technique utilized for securing the upper portions of the panels in position can be regarded as equally significant. Thus, reference is now made to FIGS. **6**, **7** and **8**.

FIG. **6** shows an end upper joint between two panels such as the panels **12** and **12'** shown in FIG. **3**, namely, panels which are abutting at a corner location. Note that the panel **12** has an outer concrete layer **20**, a central insulating layer **24** and an inner concrete layer **22**, whereas the panel **12'** similarly has an inner concrete layer **22'**. a central insulating layer **24'** and an outer concrete layer **20'**. The panel **12'** further includes a securing means **44**, which as explained above, comprises a bar member **48** having an aperture **54** therein and a pair of anchoring arms **50** and **52** that serve to anchor the bar **48** in the panel. The panel **12**, on the other hand, has a modified upper corner section generally referred to by the numeral **12***u*. This section includes a tubular member **90** extending through the panel from the outer face of the outer layer **20** to the inner face of the inner layer **22**, the tubular member or sleeve **90** preferably being provided in the corner section **12***u* during the forming operation by inserting the tube **90** into the mold prior to pouring the various layers therein.

Extending through tube **90** is part of a fastening means **92** that includes a threaded shaft **94**, a head **96** on one end thereof and a nut **98** on the opposite end thereof. The threaded shaft **94** passes through the aperture **54** in the bar member **48** with the head **96** serving as an abutment against such bar. The shaft further extends to the outer side of the outer layer **20** of the panel **12**, thus permitting the nut **98** to be tightened thereon and thereby secure the respective panels **12** and **12'** together in the upper portions thereof.

The outwardly projecting exposed end of the shaft **94** can be cut-off. Moreover, the tube **90** need not extend through the area of the recess **56** and through the outer concrete layer **20**. It can be cut short so that the tubular member **90** terminates adjacent the inner face of the concrete layer **22**, and so that in turn the nut **98** can be screwed on such shaft adjacent the inner face of the layer **22**, with access to the nut **98** being provided by virtue of the provision of the recess **56**.

FIG. **8** presents a top view of an arrangement such as shown in FIG. **6**. In FIG. **8**, the panel **12'** is shown as being joined to the panel **12** by means of a corner connection identical with that shown in FIG. **6**. However, in FIG. **8**, there is further provided a corner board covering member **100** which serves to seal the exposed end of the recess **56** at the corner location.

Also in FIG. **8**, it is presumed that another wall section **12''** is coupled to the wall section **12** in the same manner, thus illustrating in FIG. **8** the manner in which an interior building wall, such as the wall **12''** can be easily connected with an outer wall building panel such as the panel **12** in generally the same manner that the outer wall panel members are connected together, as at corners. In all probability, in the normal instance, the interior walls would be spaced further from one another as indicated in FIG. **8** — that is, they would be spaced more than the width of one panel apart. However, FIG. **8** serves to illustrate the adaptability of the invention to provide inside as well as outside walls. In this latter regard, it should also be noted that the wall **12''**, if desired, can be substantially thinner than the outside walls **12** or **12'** since the interior walls need not necessarily include the insulation. This being the case, as distinct from using six inch walls on the outside, the interior walls can have a thickness of, for example, four inches with the insulating layer either being eliminated or, if desired, with all of the layers being made somewhat thinner than is the case with the outside layers.

Having explained the corner or right angle joints which are made in the upper section of walls consistent

herewith, attention can now be directed to FIG. 7. In this figure, the mating edge portions 12*x* and 12*y* of respectively different but aligned panels are shown. In the edge portion 12*x*, there is provided a bar 48 which is anchored within the respective inner and outer layers of its associated panel by the anchor arms 50 and 52. Similarly, in the edge portion 12*y* of the lower panel in FIG. 7, there is included a further securing means 44 having a bar 48 and a pair of anchoring arms 50 and 52. These respective bars each have apertures 54 therein and extending through such apertures is a threaded shaft 94′ having an enlarged head 96′ at one end thereof and having a nut 98′ screwed on the other end thereof. The shaft thus extends between respective adjacent panels, or in particular, the upper corner sections thereof, cooperating with the respective bars 48 in each section, and causing, upon tightening of the nut 98′, an alignment of the respective panels in desired location. When such alignment has been achieved and the nut is tightened, there still remains a vertical recess 110 formed by the facing portions of the respectively opposite recesses 56. Into this open area, a grout is preferably poured so as to fill the space between the respective panels created by the recesses therein, and in turn, this grout serves to sealingly position the respective panels thus eliminating any direct air passage in the crack therebetween and thus further insuring that proper alignment is maintained without deterioration.

Referring now to FIG. 7*a*, a modified form of fastening and aligning means is shown similar to that of FIG. 7, which finds particular utility in joining two wall panels to each other at an angle wherein the panels define a corner and both walls terminate at the corner, e.g., at an exterior building corner. In this figure, reference numerals are the same as those in FIG. 7 for like parts. Mating edge portions 12*x* and 12*y* are shown abutted at an angle to each other, each edge portion having a securing means 44 comprising a bar 48 and a pair of anchoring arms 50 and 52, as already described above. An access opening 102 is formed in the inner concrete layer of edge portion 12*x* to receive therethrough a curved or bent threaded shaft or bolt 94″, which bolt adjacent its opposite ends passes through apertures in the respective bars 48 and is secured to the bars by means of nuts 98′ screwed onto each end of the bolt 94″. A corner board covering member 100′ is provided to seal the exposed end of the recess at the end of edge portion 12*x* in a manner similar to the corner board covering member 100 shown in FIG. 8.

A second modified form of fastening and aligning means, shown in FIGS. 18 and 18*a*, is generally similar to the corner construction of FIGS. 6 and 8 but eliminates protrusion of the securing bolts through to the exterior of wall panel 12. In this modified form, the interior wall panel 12′ has embedded therein a securing means 44, which, as previously described, comprises a bar member 48 having an aperture therein to receive a bolt 94‴ therethrough, which bolt has a nut 98 screwed onto the end thereof to secure the bolt to bar 48. The inner concrete layer 22 of wall panel 12 has an access opening 102′ formed therein of any suitable dimension greater than the diameter of bolt 94‴ but less than the thickness of panel 12′. Bolt 94‴ does not extend completely through panel 12 in this modification, but terminates intermediate the inner and outer concrete layers of panel 12 and has rigidly secured thereto adjacent its outer end, as by welding or other suitable means, a wall-engaging clip or bracket 104 of generally U-shaped configuration, which clip has its ends bent at substantially right angles to the central body portion thereof towards inner layer 22 to form a pair of spaced wall-engaging legs 106, which legs engage the inner surface of inner concrete layer 22 of panel 12 and thereby secure panel 12 to panel 12′. The length of clip 104, i.e., the distance between legs 106, is preferably sufficiently greater than the thickness of panel 12′ so that the legs 106 engage inner layer 22 of panel 12 at points spaced outwardly from the exterior faces of panel 12′, rather than immediately adjacent the access opening 102′. In this manner the legs 106 engage a comparatively strong and rigid portion of inner concrete layer 22, and hence undue cracking of the concrete adjacent the access opening 102′ is avoided.

Although from the above discussion someone reading this specification will undoubtedly have a basic idea as to the structure provided hereby, there are certain detailed aspects which need possibly some further consideration. First, even though mention has been made of moving the panels 12, there has been no discussion of the manner in which this movement is achieved. Accordingly, attention is now directed to FIG. 17. This broken away view shows the inner concrete layer 20 of a panel having disposed between it and the outer concrete layer 22 an insulating layer 24. Further, the area of the recess 56 is rather clearly shown as having a bar 48 extending thereacross, which bar is anchored in position by means of anchoring arms such as the anchoring arms 50. The aperture 54 in the bar 48 is shown as receiving a short shaft 115 that cooperates with a bifurcated coupling member 117 carried at the end of a lifting cable or other device 119. The bifurcated coupling member 117 has suitable apertures therethrough whereby when the coupling member is disposed in the position shown in FIG. 17, the bar or pin 115 can be inserted in position thereby immediately providing a coupling for use with a lifting crane or the like so that the panel can be moved to desired location. FIG. 17 and this discussion therefore illustrate the creative manner in which the securing means discussed previously are utilized not only for purposes of obtaining proper alignment in the upper section whether the joints be angular or aligned, but also for purposes of facilitating movement of the various panels during the actual assembly.

With respect to the panels themselves, there has been a description in considerable detail in connection with FIGS. 2 and 4, and in fact, in such figures all of the various elements preferably incorporated in a panel have been shown. In contrast, in FIGS. 3, 5, 6, 7 and 8, the panels have been presented rather schematically for convenience. Still, in each panel, as shown in FIGS. 9 and 10, the base layer 22 preferably has embedded therein the arms 52 of the respective securing means and the respective frames 26 and 28. The upstanding stub shafts 30 from each frame extend laterally through the respective layers and in the top layer 22, there is embedded the respective frames 40 and 42. The rela-

tive disposition of the stub shafts **30** is possibly best shown in FIG. **10**, and likewise, such figure more clearly illustrates the peripheral recess or groove **56**.

Even though the preferred embodiments contemplate the use of a pair of base frames in both the upper and lower layers of the ultimate panel, the use of such frames is not always practical, and this aspect of the invention must be somewhat modified in forming a panel having a door or window therein. Consider, for example, FIGS. **11** through **14**.

In FIG. **11** there is shown a panel **12***w* which is generally formed in accordance herewith but which has a window **120** disposed therein. This panel, as shown in FIG. **12** has the same peripheral channel or recess **56** therein and is otherwise dimensioned consistent with the other panels **12** discussed herein, particularly as outer panels. The panel **12***w* has an outer frame **26** and an outer frame **40** disposed respectively in the inner and outer concrete layers thereof, and moreover it has a styrofoam layer **24***w* disposed between such inner layer **22***w* and such outer layer **20***w*. However, at the time the panel **12***w* was being made, a window frame **130** was inserted in the mold, which window frame had an arcuate side contour **132** and a thickness corresponding to the thickness of the panel **12***w*. Thus, when the window frame **130** was placed in the mold and concrete was then poured therearound, with the styrofoam or insulating layer being cut out previously so as to accommodate the window frame, the window frame was essentially sealed in proper position with respect to the outer concrete layers, and in turn in proper position with respect to the insulating layer so as to yield an ultimate panel having generally the same characteristics as described above, but incorporating a window. Since the smaller base frames were not conveniently utilized, and since in any event the window frame essentially serves to perform the function thereof, the smaller frames **28** and **42** were not utilized in the panels of FIGS. **11** and **12**.

In the panel of FIG. **13**, we have a similar situation although we are specifically concerned with a door. Note that the panel **12***d* shown in FIG. **13** is dimensioned similarly to the panel **12***w* of FIG. **11**, and also in accordance with other panels discussed above. Such panel incorporates the respective frames **26** and **40** in the respective outer and inner layers **22***d* and **20***d* thereof. Moreover, an insulating layer **24** is incorporated. However, in the arrangement of FIG. **13**, a door frame **150** is provided which frame supports a door **152**. The door frame **150** has a dovetail type edge configuration as in **152**, thus adopting the door frame **150** to be fit within the form such as shown at the base of FIG. **2**.

To such end, the frame **26**, for example, and the frame **40**, for example, have to be severed so that the central section of the lower leg of each frame is cut out to permit the door frame **150** to be accommodated. When all concrete is used to form the panel **12***d*, except for the door frame itself, then the frame **40***d* is imbedded in such concrete thus locking the respective concrete sections on either side of the door frame to one another under the base of the door frame or door jamb.

Means are provided for extending the basic construction previously described to include a roof formed of panels generally similar to those forming the walls of the building construction, such roof construction being shown in FIGS. **19** through **21**, inclusive. It will be seen from FIG. **19** that the roof comprises a plurality of roof panels **112**, which panels are substantially identical in construction to the wall panels **12**, with the sole exception being that the roof panels preferably have one horizontal dimension substantially equal to the horizontal span of the building, and also have an insulating layer of foamed material or the like which is substantially thicker than the insulating layer **24** of the wall panels. The roof panels are joined in edgewise relation to each other and are secured by means of securing means **144**, shown in FIGS. **20** and **21**, which securing means is rigidly embedded in the outer concrete layer of each roof panel **112**, or may be inserted into the roof panel **112** by gouging away sufficient concrete material from the panel, inserting the securing means **144** substantially flush with the upper surface of the panel and then plastering over the securing means or otherwise restoring a substantially planar surface to the panel **112**. The securing means **144** comprises a bar member **148** having an aperture **152** therein and having a pair of anchoring arms **150** secured thereto, as by welding, adjacent the ends of bar member **148**. The arms **150** extend outwardly from the bar member **148** in a generally horizontal and diagonally outward direction, and serve to lock the securing means immovably within the respective roof panel **112**. A threaded shaft or bolt **194** having a head on one end thereof is passed through the aperatures **152** in adjacent bar members and a nut **198** is screwed onto the other end thereof and tightened to lock and align the panels **112** in proper relationship to each other. In this manner a flat roof of any desired size can be assembled by combining an appropriate number of panels **112**; or by slight modification, a similar roof can be constructed having a peak or ridge at the center thereof.

The roof unit formed by panels **112** rests upon the top of the walls formed by panels **12**, and may be aligned therewith by means of interlocking guide and alignment means similar to those used between the walls **12** and the supporting foundation, or any other suitable aligning means may be employed.

The panels **112** forming the roof have a longitudinal recess **114** along one or more edges thereof on the lower side of the panels, thus forming one or more eaves. A conventional rain gutter may, if desired, be secured within this recess **114** in any suitable manner.

The above-described roof construction can also be used to form walls of greater vertical extent than the height of wall panels **12**, by aligning a plurality of wall panels **12** above one another vertically and securing adjacent panels by means of the particular securing means **144**.

A further feature of the present invention not explored above but which is of interest is shown in FIGS. **15** and **16**. The panel shown in FIG. **15** is designated by the numeral **125**. This includes the layers as described above with the outer frame such as the outer frame **26** and the inner frame such as the inner frame **28**, and although not shown, corresponding frames **40** and **42**. However, in the arrangement of FIG. **15**, there is further incorporated a series of box-type elements $B_1$, $B_2$, $B_3$, and $B_4$ interconnected by pipe sections $P_1$, $P_2$

and $P_3$. These boxes as shown in FIG. **16** open on one face of the panel **125**, preferably the inner face thereof, with the pipe sections interconnecting the same and thus permitting electrical wire or the like to be placed through the respective boxes and pipes to the desired one or group so as to readily provide outlets in the particular panel. Interestingly enough, the box $B_4$ as shown in FIG. **16** can be located near or adjacent the roof, so that if a dropped ceiling such as that designated by the letter C in FIG. **16** is utilized, all of the electrical wiring between panels of a building constructed in accordance herewith can be either fed through the preformed channels and boxes in the panels, or alternatively, run above the dropped false ceiling which would then serve to conceal the wiring.

Having shown and described various embodiments of the invention and having illustrated the versatility of the concepts incorporated therein, it should be apparent that the objects set forth at the outset of the present specification have been successfully achieved.

What is claimed is:

**1.** In a concrete building construction, having a foundation, the improvement comprising in combination

a. first guide means on said foundation being disposed along at least one elongated axis; and

b. a plurality of concrete panels, each of said panels having second guide means on the base thereof

said second guide means cooperating with said first guide means to align the bases of said panels along said axis, said panels comprising outer concrete layers with an insulating layer sandwiched therebetween,

c. securing means anchored in each of said panels, said securing means including a connector member and anchor members extending therefrom in respective concrete layers, and

d. fastening means cooperating with adjacent securing means to vertically align adjacent panels.

**2.** In a building the combination comprising:

a. foundation means having first guide means thereon extending along axes disposed in a position where walls will extend upwardly therefrom,

b. a plurality of building panels each having second guide means on the base thereof, said building panels being disposed along said axes in upstanding relation to said foundation means and with said second guide means cooperating with said first guide means, and

c. a plurality of coupling means cooperating between the upper portions of adjacent panels to secure the same in aligned position,

said first guide means comprising projecting bar means and said second guide means comprising recess means receiving said bar means,

said building panels having recesses extending along the respectively opposite side edges and top and bottom edges thereof, wherein said foundation comprises slab means, and wherein said projecting bar means comprises bars secured to the upper exposed face of said foundation, adjacent panels extending along the same axis having bar means exposed in the recess thereon along the top edge thereof, said bar means and said bolt means cooperating to comprise said coupling means.

**3.** The combination defined in claim **2** wherein two adjacent panels extending along intersecting axes have respectively bar means disposed in the recess along the top edge of one of the two panels and bolt means carried on and projecting at least partially through the other of said two panels for cooperation with said last mentioned bar means, the last mentioned bar means and bolt means also cooperating to comprise said coupling means.

**4.** The combination defined in claim **3** wherein said bolt means extends partially through said other of said two panels, and further including means rigidly secured to said bolt means and cooperating with said other of said two panels to comprise said coupling means.

**5.** The combination defined in claim **3** wherein said bolt means extends completely through said other of said two panels.

**6.** The combination defined in claim **5** wherein said means secured to said bolt means comprises a U-shaped bar having a pair of laterally spaced legs, said legs engaging said other panel and securing said other panel to said one panel.

**7.** In a building combination comprising:

a. foundation means having first guide means thereon extending along axes disposed in a position where walls will extend upwardly therefrom,

b. a plurality of building panels each having second guide means on the base thereof, said building panels being disposed along said axes in upstanding relation to said foundation means and with said second guide means cooperating with said first guide means, and

c. a plurality of coupling means cooperating between the upper portions of adjacent panels to secure the same in aligned position,

each of said panels comprising first and second outer concrete layers, an insulating layer sandwiched therebetween, and reinforcing means having a base disposed in one of said concrete layers and projecting elements extending from said base through said insulating layer and into the other concrete layer.

**8.** The combination defined in claim **7** wherein said coupling means comprise first and second securing means disposed in each of a plurality of said panels, said securing means comprising a bar member and first and second arms projecting from opposite end portions of said bar member, said arms being anchored in said first and second outer concrete layers.

**9.** The combination defined in claim **7** wherein said insulating layer is a rigid plastic foam.

**10.** The combination defined in claim **9** wherein said base comprises a rectangular bar frame and said projecting elements are stub shafts projecting therefrom.

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