Aug. 27, 1940. R. C. VOKES 2,212,906

BUILDING CONSTRUCTION

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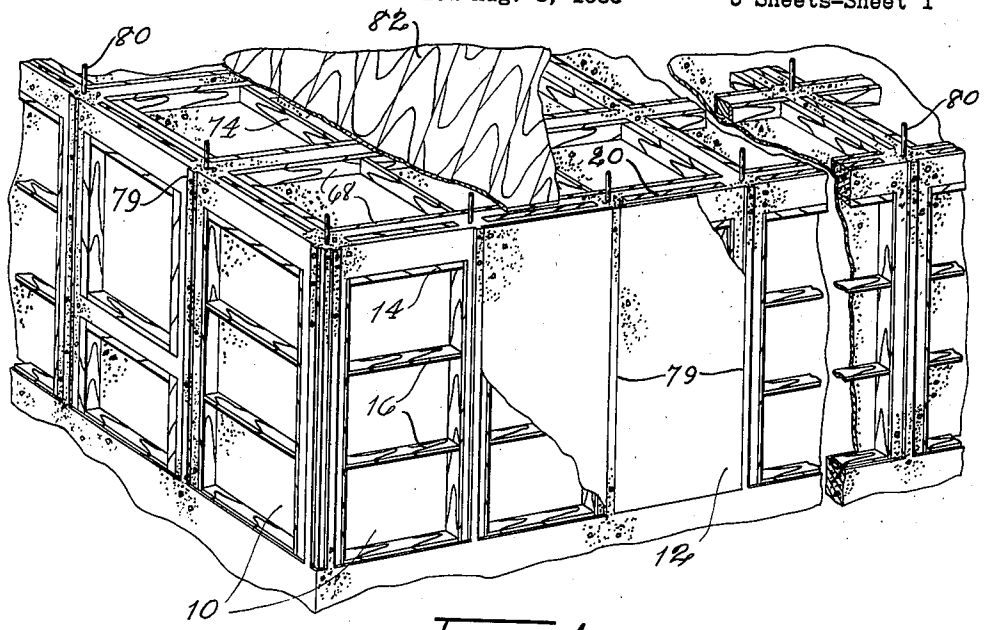


Fig. 1

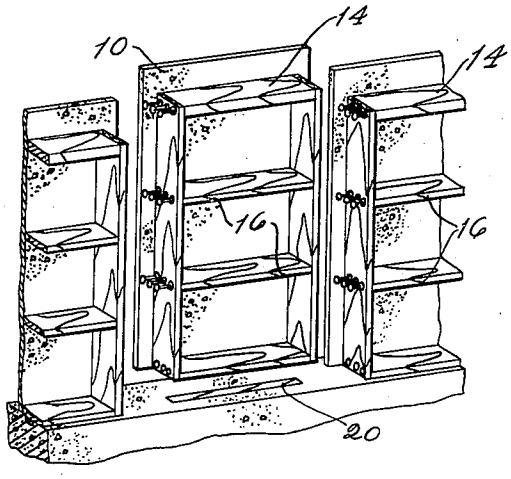


Fig. 2

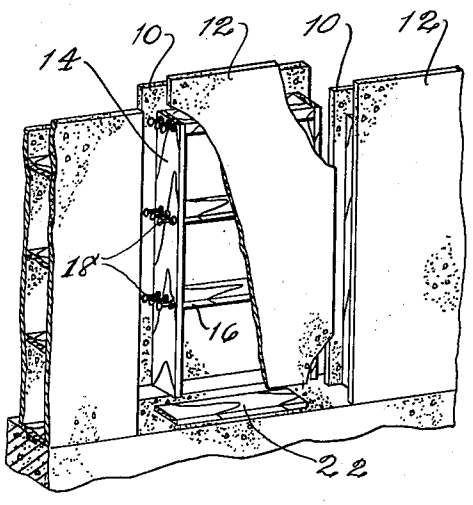


Fig. 3

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BUILDING CONSTRUCTION

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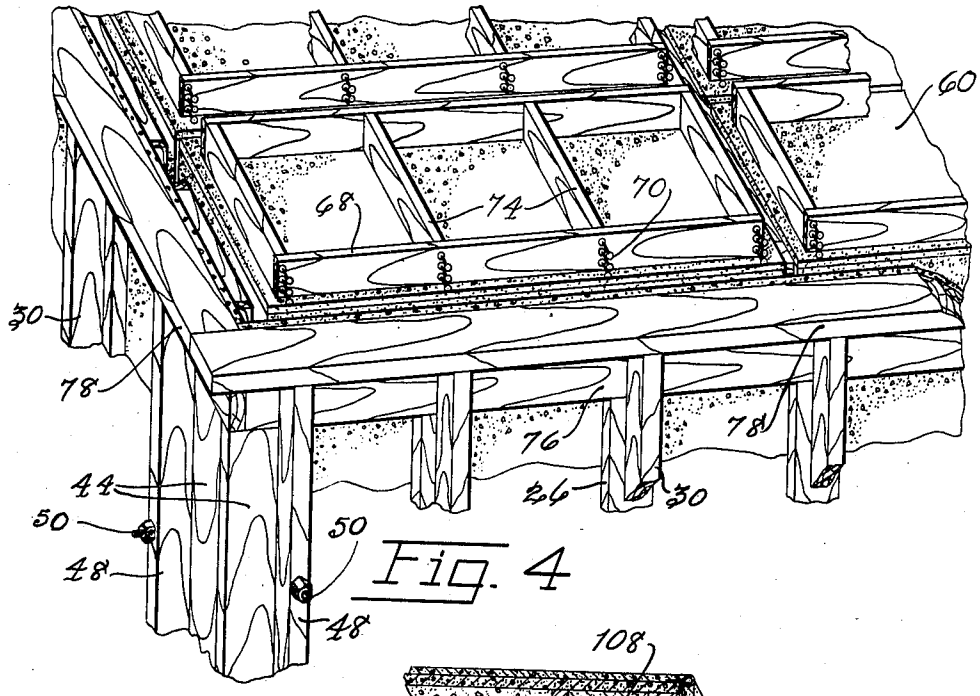


Fig. 4

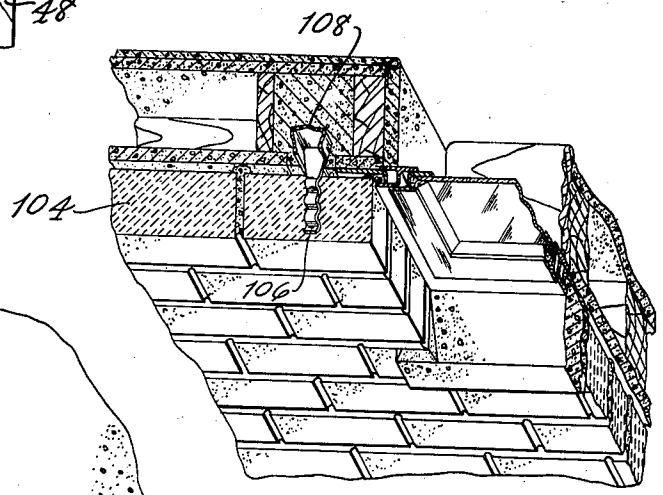


Fig. 5

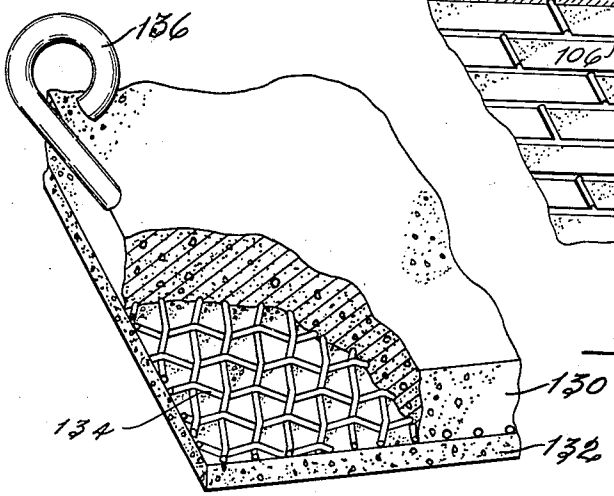


Fig. 6

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BUILDING CONSTRUCTION

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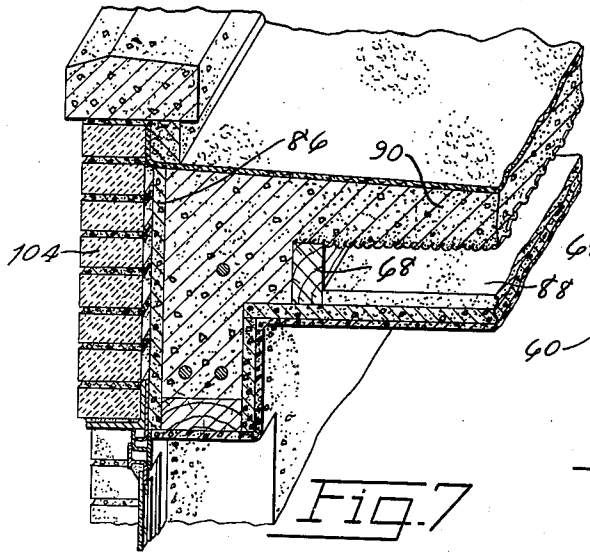


Fig. 7

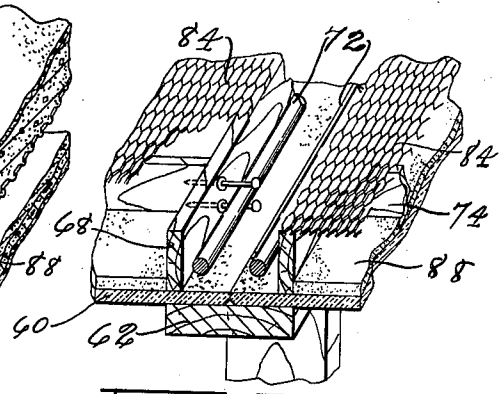


Fig. 8

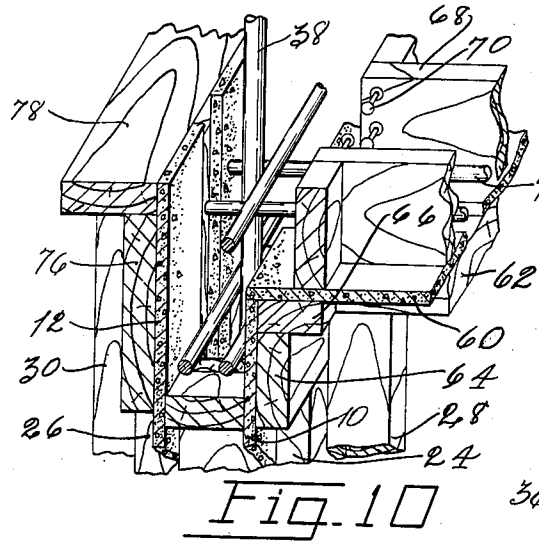


Fig. 10

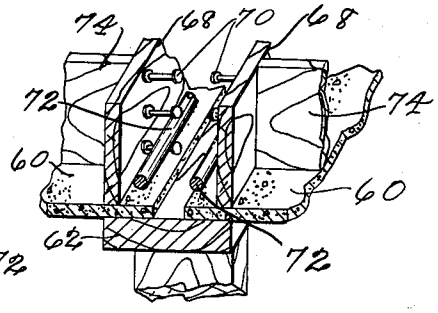


Fig. 9

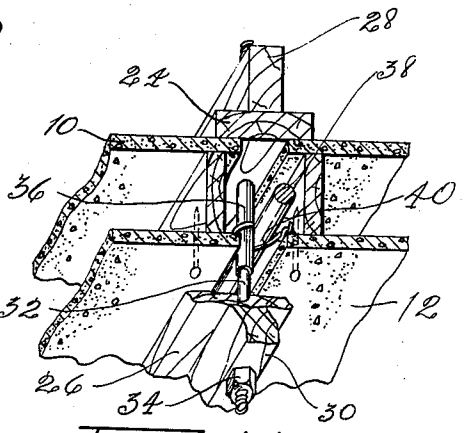


Fig. 11

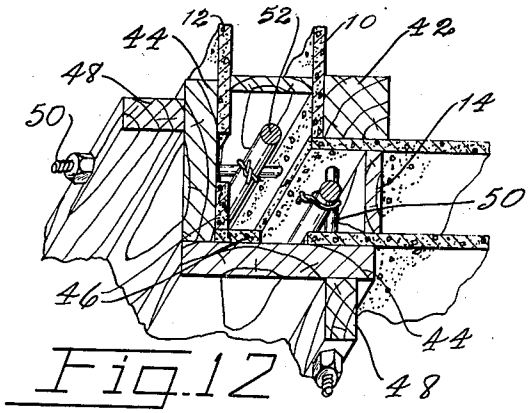


Fig. 12

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BUILDING CONSTRUCTION

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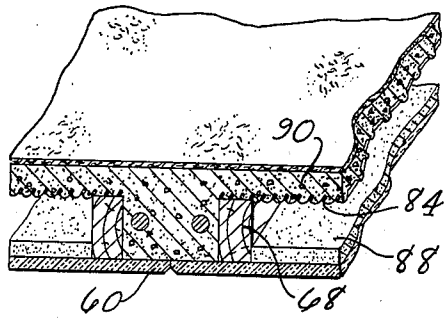


Fig. 13

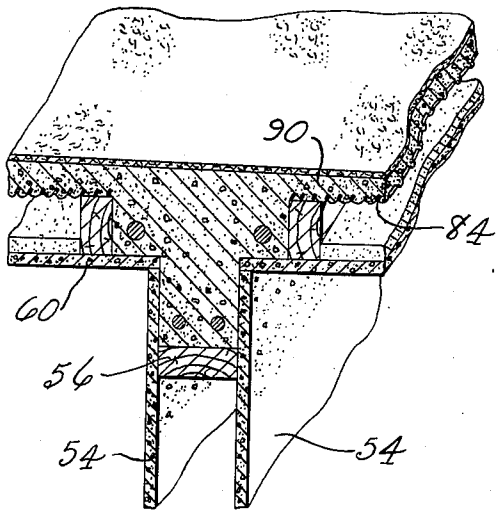


Fig. 14

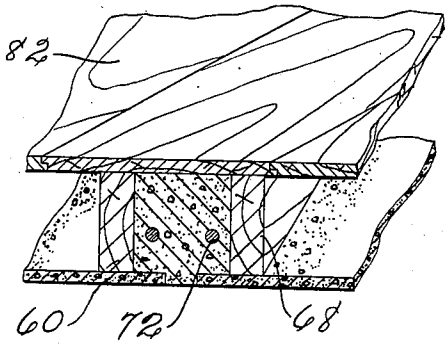


Fig. 15

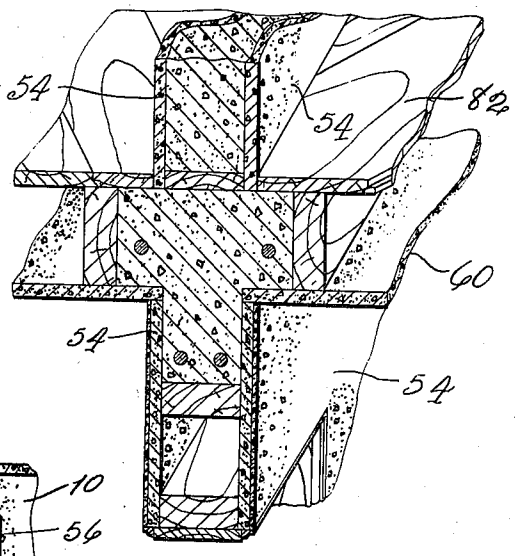


Fig. 16

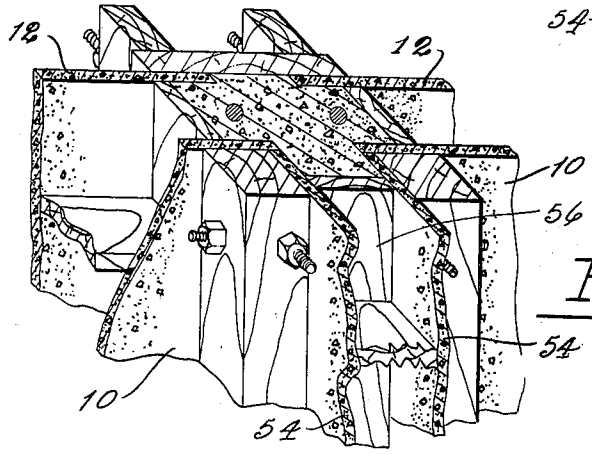


Fig. 17

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BUILDING CONSTRUCTION

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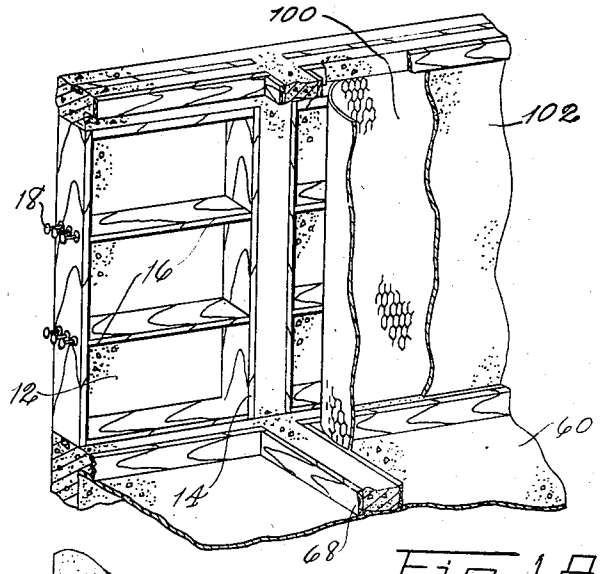


Fig. 18

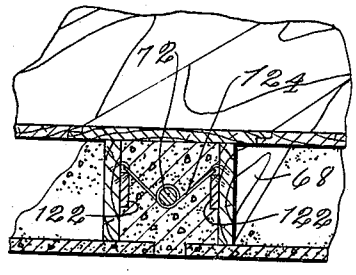


Fig. 23

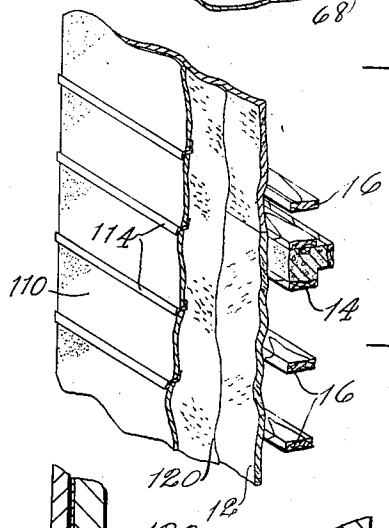


Fig. 19

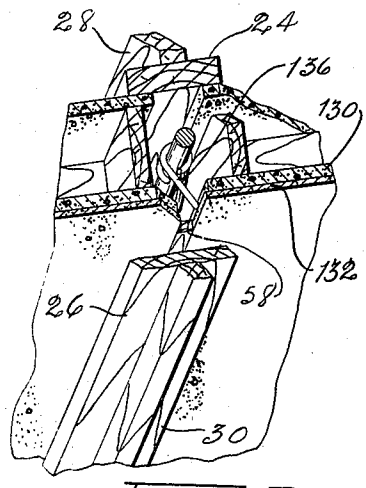


Fig. 24

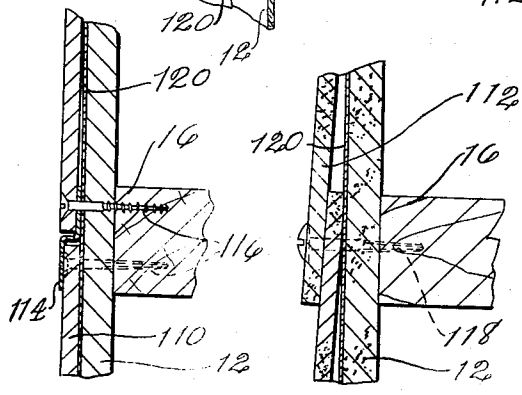


Fig. 21 Fig. 22

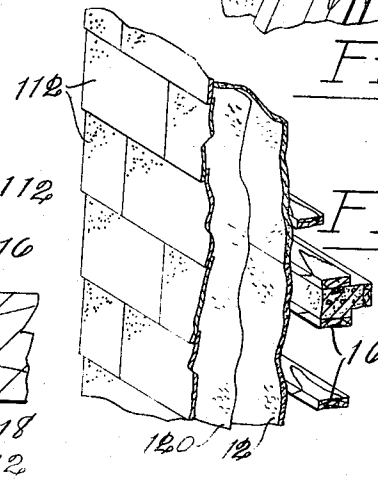


Fig. 20

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Patented Aug. 27, 1940 2,212,906

UNITED STATES PATENT OFFICE

2,212,906

BUILDING CONSTRUCTION

Ralph C. Vokes, Detroit, Mich.

Application August 8, 1938, Serial No. 223,612

15 Claims. (Cl. 72—1)

This invention relates to the construction of buildings and more particularly to a novel method of and means for employing hardening plastic material in the erection of buildings. Reference is made to my copending application, now Patent No. 2,154,590, wherein certain features of construction relating to the present invention are described and claimed.

An important object of this invention is to provide a novel, economical method of constructing a building wherein reinforced hardened plastic material constitutes the supporting structure thereof. A building constructed in accordance with this invention economizes in time, labor and material yet provides a building which is durable, fire proof and well insulated against the transmission of heat and sound. The invention is particularly adaptable for the erection of dwellings but may be applied to the erection of larger buildings such as apartment and office buildings. The invention is architecturally flexible. The dimensions of the parts may be varied to suit different conditions and accurate shaping of the parts requiring expensive processes or skilled labor is not essential. It compares favorably in price with all frame or all concrete types of buildings.

More specifically, the walls and floors of a building constructed in accordance with this invention are formed in general of panels of relatively large rectangular shape. These panels may be fabricated in predetermined sizes before the erection of the building and transported to the building site and erected in place on the building construction. These panels may be slabs of concrete or similar plastic material or they may be composed of a lighter material such as fiber or asbestos. The latter form of panel is desirable for small home dwellings where economy is one of the principal factors involved.

In the erection of a building in accordance with this invention the panels are assembled and the concrete poured in a manner similar to that described in the aforesaid patent application but differing in many particulars. In general, the panels are temporarily shored in vertical position to form the walls of the building for one story height and in horizontal position to form a portion of the floor of the next succeeding story of the building. Novel forms are associated with the wall and floor panels which provide a series of communicating vertical and horizontal channels capable of being filled in one operation with hardening plastic material. When hardened, this material forms an integral, interconnected supporting framework of hardened plastic material for the building.

In particular, the present invention provides a novel method of erecting the wall and floor panels and their associated forms for casting the studdings and joists of each story of the building. The improved method of casting the studs comprehends the use of bolts extending through the stud forms from one side to the other and the provision of means on the bolts for drawing the assembled parts together into a sealed self-supporting relationship. Novel means is provided which shelters the bolts from the poured plastic material and enables the same to be removed without difficulty after the plastic material has hardened.

Another important object of this invention is to provide novel shaped concrete casting frames and to associate the same with the wall and floor panels in such a way that they create interconnecting channels for casting the studs and joists. These frames are preferably formed of wood or any composition which will permit nailing operations. The frames are employed in the walls and floors of the building and in either case they are arranged substantially in one plane in a spaced edge-to-edge relationship. In both the floor and wall construction the panels are larger than the frames and are arranged in a single plane against one side of the frames and in such a manner that the marginal portions of the panels project beyond the side members of the frames. In the floors, the panels are arranged below the frames and temporarily support the frames until the joists of hardened plastic material are formed. A flooring may be laid over the top of the frames and thus conceal the frames from sight. In the walls, oversized panels may be arranged along one side or upon opposite sides of the frames. The projecting marginal portions of these panels will form in cooperation with additional form members a series of spaced vertical columns in which hardened plastic material may be cast to form studdings for the building.

In both the floor and wall structure, the frames are provided with transverse girts dividing the frame into sections which when the building is erected form relatively small dead air spaces in the walls and floors limiting any convection of air to a negligible amount and reducing the fire hazard by confining any fire in the wall to a small closed space. Novel means is provided for securing the girts to the frame and at the same time anchoring the frames to the concrete studs or

joists with which it is associated. Such means may comprise nails, such as double headed nails, projecting beyond the side or end members of the frame and serving to secure the girts to the frames. When the plastic material of the joist and studdings have hardened, the frames are rigidly anchored thereto by the projecting portions of the nails.

Various other objects, advantages and meritorious features will appear more fully from the following specification, appended claims and accompanying drawings wherein:

Figure 1 is a perspective view of one story of a building partially completed in accordance with this invention and partially broken away to show interior constructions,

Fig. 2 is a perspective view illustrating one form of wall panel assembly and manner of erecting same to form a wall section,

Fig. 3 is a perspective view illustrating another form of wall panel assembly and manner of erecting same to form a wall section,

Fig. 4 is a top perspective view of one story of a building constructed in accordance with this invention showing the casting forms in position to receive and cast the studs and joists of the building,

Fig. 5 is a top perspective view of a completed building wall constructed in accordance with this invention and showing the manner of securing the brick veneer and a window frame to the supporting wall structure,

Fig. 6 is a detail perspective view of one form of wall panel,

Fig. 7 is a view of the top portion of a completed wall erected in accordance with the invention showing how the concrete roofing is cast to provide an insulating air space above the room therebeneath,

Fig. 8 is a perspective view of a part of the ceiling construction adjacent to the roof showing the manner of casting the joist therealong,

Fig. 9 is a perspective cross-sectional view through one of the forms for casting a concrete floor joist,

Fig. 10 is a perspective cross-sectional view through a wall section showing the forms for casting a joist, stud and cordon unit in one operation,

Fig. 11 is a perspective cross-sectional view illustrating the construction of the form for casting a concrete wall stud,

Fig. 12 is a perspective cross-vertical view through the corner of the building showing the form for casting the corner wall stud,

Fig. 13 is a perspective sectional view through the completed roof structure,

Fig. 14 is a perspective sectional view through the roof when an inner wall partition is connected thereto,

Fig. 15 is a perspective sectional view through a cast floor joist showing the ceiling panels and flooring associated therewith,

Fig. 16 is a perspective sectional view through a cast floor joist when an inner wall partition rises from the story therebelow to the story thereabove,

Fig. 17 is a perspective sectional view through a cast corner stud showing the temporary forms in place prior to removal.

Fig. 18 is an inside perspective view of the building wall showing a modified way of forming the inner wall surface of a room in the building,

Fig. 19 is a perspective view through a building wall illustrating the manner of securing siding to the wall panel of the frames,

Fig. 20 is a perspective view through a building wall illustrating the manner of securing siding in shingle overlapping relationship to the wall panel frames,

Fig. 21 is a cross-sectional view through adjacent parts of two pieces of siding showing the manner of securing the pieces to the girts of the wall panel frames,

Fig. 22 is a cross-sectional view through overlapping parts of two pieces of siding showing the manner of securing same to the girts of the wall panel frames,

Fig. 23 is a perspective sectional view through a cast floor joist illustrating a modified form of anchoring the frames to the joist, and

Fig. 24 is a perspective sectional view through the forms for casting a wall stud illustrating a modification thereof.

The building, constructed in accordance with this invention, is preferably erected in a floor-by-floor process similar to that described in copending application, now Patent No. 2,154,590. In proceeding in this method the wall panels of one story are preferably temporarily shored in vertical position and vertical forms of novel design are provided at spaced intervals in which to cast the wall supporting studs. After the wall panels have been erected for a given story in the building, the floor panels in the next succeeding floor are temporarily shored in horizontal position on a level substantially equal to the height of the wall panels. Forms of novel design are provided on top of these panels for casting the joists of plastic material. This structure of the wall panels is such that when the vertical forms for casting the studs and the horizontal forms for casting the joists are completed, a form is provided entirely around the building on a level with the floor panels. This last form opens into the vertical stud forms and horizontal joist forms of the wall and floor respectively and will cast a "cordon unit" or band of hardened plastic material around the building which is integrally connected to the cast studs and joists.

Referring to the drawings in detail, a series of wall panels 10 of rectangular shape and having a height substantially equal to the height of the story which is being erected are arranged in vertical edge to edge relationship. These panels are slightly spaced from one another as shown in Figs. 1, 11 and 12. They will form, as it is apparent from the drawings, the inner wall panels of the wall structure. The outer wall panels 12 are arranged in a plane parallel to the inner wall panels 10 but spaced therefrom. The outer wall panels are preferably spaced about 5 inches from the inner wall panel but this distance may be varied depending upon circumstances. Like the inner wall panels 10, the outer wall panels are slightly spaced apart from one another. The inner and outer panels 10 and 12 respectively are of substantially the same width and are arranged directly opposite one another as indicated in Fig. 3. The outer wall panels, however, are preferably constructed so that they extend to a greater height than the inner wall panels 10. The top edges of the outer panels 12 may be shown in Fig. 1 terminate on a level with the flooring for the next succeeding story of the building. The purpose of the difference in heights of the panels will be described hereinafter.

Between each opposite inner and outer wall panel is a rectangular frame structure 14 which

cooperates with the panels and adjacent frames to provide a form for casting wall studs of hardened plastic material between the marginal portions of the panels. These frames are of novel design and preferably formed of wooden members of a size slightly less in length and width than that of the panels between which they are mounted. These rectangular frames, as shown in Figs. 1, 2 and 3, are each disposed between an inner and outer wall panel with the side and top edges of the frame spaced from the side and top edges of the panels but having the bottom edge substantially coextensive with the bottom edges of the panels. The reduced size of the frames and their location between the panels provides, when these are properly assembled into a wall, a series of hollow vertical enclosures along the projecting marginal portions of the panels and a horizontal channel between the top edges of the panels.

Each frame **14** is divided transversely by one or more members or girts **16**. Three such girts are shown in the frames used on the building structure in Fig. 1. Six girts are employed in the frames in the structure in Figs. 18 and 19. These girts not only strengthen the frames but because of the fact that they are anchored in a novel way in the hardened plastic material they resist transverse stress and prevent deformation of the panels or plaster that cover the walls or ceilings of the building. In addition, since the girts are of a width to abut the inner surfaces of the panels **10** and **12**, they form small sealed chambers in the walls of the building preventing circulation of air and heat and acting to snuff out any fire originating therein thus preventing the propogation of fire from floor to floor in case any portion of the building is set on fire.

To secure the girts to the outside members of their respective frames, projecting fastening elements such as double headed spikes or nails **18** are employed which are embedded in the plastic material of the studdings and anchored therein when the same has hardened. The double headed nails thus serve to secure the girts to their respective frames and anchor the frames securely to the concrete studs on opposite sides thereof.

It is preferred that the rectangular casting frames be secured to either one or both of the panels with which it is associated prior to assembly upon the building. Thus, as illustrated in Figs. 2 and 3, the frame and panel assembly forms a separate unit capable of erection one after the other to form a wall of the structure. Fig. 2 shows the manner of erecting a rectangular frame secured to a single inner wall panel **10**. A wooden sleeper or nailer **20** is preferably embedded in the concrete support for this particular story of the wall and after the frame is dropped thereon as indicated in Fig. 2 the bottom member of the frame may be nailed to the wooden sleeper for temporary support until the studdings are cast and hardened about the frame. This form of construction is particularly desirable when concrete slabs are used for the outside panels **12**.

In Fig. 3, both an inside panel **10** and an outside panel **12** is associated with each frame **14**. In this case, however, the panels prevent access to the inside of the frame and therefore it is necessary to leave off the bottom member **22** of the frame and instead first nail this member to the sleepers previously embedded in the concrete support. Then when the assembly of the frame and the two panels is dropped down upon all sides of the bottom member **22** it may be temporarily supported by nailing the side members of the frame to the bottom member **22**. This form of panel construction is desirable when the panels **10** and **12** are composed of softer nailable material such as fibrous boards.

After the panel and frame assemblies have been temporarily supported in upright position in slightly spaced relationship as indicated in Fig. 11, a series of vertically extending forming or casting boards **24** are erected in overlapping relationship upon the adjacent side edges of the inner panels **10** and similar boards **26** are positioned against the outer panels **12** in overlapping relationship to their adjacent side edges. These boards close the spaces between the edges of adjacent panels of the inner and outer wall series and thus provide sealed forms for casting the vertical wall studs. The forming boards **24** which abut the inner wall panels **10** extend to a height slightly less than the ceiling of the room as shown in Fig. 10. The outer forming boards **26** which overlap upon the side margins of the panels **12** extend to a height about equal to the inner wall boards **24**. Positioned against the outer sides of each of the forming boards **24** and **26** are wooden members **28** and **30** respectively which, as shown in the drawings, are preferably turned endwise to the boards against which they lie. These members are disposed opposite the spaces between the inner and outer panels. The sides of the rectangular frames **14**, the overlapping marginal portions of the panels **10** and **12**, the boards **24** and **26** and the members **28** and **30** form a hollow vertical form for casting a spaced series of studs of plastic material around each floor of the building.

To secure these parts together bolts **32** are provided which extend transversely through the stud forms from one side to the other. As shown in the drawings the opposite ends of these bolts project from the outer sides of the members **28** and **30** and removable nuts **34** are provided on the ends of the bolts. Upon tightening the nuts upon their respective bolts, the elements of the stud forms are drawn closely together into a tight, sealed, self-supporting relationship. The bolts are intended as a temporary expedient. After the plastic material has been poured and hardened in the stud forms, the bolts are removed and the forming elements **24**, **26**, **28** and **30** are dismantled.

In order to enable the bolts **32** to be removed after the plastic material has hardened, a hollow metal cylinder or furl **36** composed of inexpensive metal such as tin is placed around the exposed section of each bolt **32** between the forming boards **24** and **26**. These furls protect the bolts from the plastic matter so that when the latter hardens the bolts may be easily withdrawn from the stud forms. The furls **36** are left in the stud forms.

As the stud forms are assembled the reinforcing metal rod **38** may be positioned vertically in the stud substantially centrally therewithin. In order to hold these rods upright in the stud forms until the plastic material is poured and hardened, they may be tied to the furls **36** as indicated at **40**.

Fig. 12 is a cross-sectional view through a form for casting a corner stud of the building. The assembly is similar to the form for an intermediate wall stud shown in Fig. 11 but modified to conform to the desired corner construction. Against the inside corner formed by the inner wall panels **10—10** a rectangular wooden beam **42** such as a 4'' x 4'' may be erected as shown.

Upon the outer faces of the outside panels, wooden boards 44 corresponding to the outer wall board 24 in Fig. 11 are erected so that they extend beyond the panels 12 adjacent to the corner and abut one another as shown in Fig. 12. Two small wall panel sections 46 may be nailed together at right angles and dropped into the corner formed by the boards 44 as shown. Wooden members 48 are disposed against the wall boards 44 opposite to the beam 42 and like the wooden members 30 are secured to the beam by bolts 50 extending through the form from one side to the other. The exposed middle portions of these bolts may be sheltered from the plastic material by the furls previously described. The longitudinal reinforcing rods 52 may be tied to the furls to temporarily support them in upright position until the plastic material is poured and hardened. The sides of the frames 14 between the panels 10 and 12 complete the assembly for the casting form.

In Fig. 17 there is illustrated a slightly different form for casting a wall stud. In this view the plastic material is indicated as already filling the form. This form is particularly desirable for casting the studs opposite a wall partition in the house. The construction is similar to that shown in Figs. 11 and 12 but modified to accommodate the two inner wall panels 54 and the wooden frame 56 forming the adjacent part of the inner wall partition.

A modified form particularly desirable for casting a wall stud where the outer panels are of concrete or similar plastic material is illustrated in Fig. 24. The form is in every respect similar to that shown in Fig. 11 except that between the adjacent side edges of the outer panels a removable wooden strip 58 is inserted. After the plastic material has been poured into the form and hardened therein this strip is removed and into the groove or joint which it creates between the outer panels 14 caulking compound is forced. This allows the concrete panels to expand and contract in accordance with the temperature changes. A similar provision may be made if the inner wall panels are of similar material.

The erection of the forms for casting the floor joists is similar to that for casting the wall studs but with certain differences to which particular reference will be made hereinafter. Similar to the walls, the floors of the building are formed in part of panels 60 laid in substantially the ceiling plane of each story of the building. Each panel is preferably of rectangular shape and supported in slight spaced apart relationship. These panels may be formed of fibrous material or of precast concrete slabs whichever may be desired in the building. For home dwellings the former is preferred.

These panels are temporarily shored in the positions which they will assume in the building by members or boards 62 which bear against the undersides of the panels and overlap upon the adjacent edges of the panels much in the same manner as the boards 24 and 26 in the stud casting forms. It is desirable though not essential that these shoring members be erected on a level slightly below the top edges of the inner wall panels 10 so that the edges of the floor panels 60 may rest upon the top edges of the wall panels 10 as shown in Fig. 10. The panels 60 are preferably shored so that their edges are disposed substantially in alignment with the edges of the wall panels 10 upon which they rest. The temporary wooden members 28 are fore shortened to act as supports for the boards 62 where these boards abut the inner wall panels. In addition to these supports, temporary beams 64 are mounted endwise upon the upper ends of the boards 24 and secured in such upright position by the overlapping upper end section of the members 28. The beams 64 thus extend across the opening between the wall panels 10 and around the room walls of the building at this height. Between each stud, short horizontal beams 66 may extend and temporarily carry the major weight of the floor panels where they contactually bear upon the wall panels 10.

Associated with the floor panels 60 are rectangular frames 68 preferably formed of wooden members, which are so disposed that they form on top of the floor panels a series of intercommunicating channels into which plastic material will be poured and hardened to form the floor joists. Each frame is of slightly less dimension than the panel with which it is associated and is secured to the panel by nails or otherwise in substantially the center thereof so that the margins of the panel project around all sides of the frame. When all these frames are assembled on their respective floor panels in this way they form, as shown in Fig. 4, the communicating channels for casting the floor joists referred to above. Because of the manner in which the edges of the floor panels are aligned with the wall panels, the channel formed by the frames opens above and opposite the forms for casting the wall studs.

As in the case of the wall frames 14, the floor frames 68 are provided with a series of spaced elements 70 which project into the form for casting the floor joists and anchor the frames to the joists after the latter have hardened. These elements are preferably double headed nails as in the case of the wall frames 14. Certain of these double headed nails 70 on each side of the floor frames are arranged in a horizontal alignment so that they may support a metal rod 72 on their outer extremities as shown in Fig. 9. Two such rods are thus supported between adjacent sides of each frame. When plastic material is poured into the joist forms these rods are deeply embedded therewithin and like the rods 38 form a reinforcement for the hardened plastic material.

The double headed nails 70 like those associated with the wall frames 14 also act to secure one or more girts 74 to the frames as shown in Fig. 9. Thus not only do the double headed nails 70 act to support reinforcing rods in the joist forms until the plastic material is poured and hardened and anchor the frames to the concrete joists, but they also serve to secure the girts to the frames. The association of these parts in this manner is important in this case as in the construction of the wall frames 14. The girts as well as the side members of each frame are anchored to the reinforced concrete skeleton structure of the building. Not only does this form of construction economize in labor and material but also strengthens the frames to resist the usual and unusual strains and stresses to which the building may be subjected. In addition, the anchoring effect of the nails prevents the frames from shrinking and becoming loose in the building.

As previously explained, the outside wall panels 12 extend to a greater height than the inner wall panels 10 or substantially to the level of the floor of the next succeeding story of the building. The member 26 of each stud form does not as in the case of member 24 extend to the full height of the

panels against which it bears. As shown in Figs. 4 and 10, this enables each member to support a series of beams 76 mounted endwise thereon and functioning similar to the beams 64 previously described. The beams 30 through which the bolts 32 project to the outside extend higher than the beams 26 and act to support the horizontally extending beams 76 in place against the outside of the panels 12. Both the beams 30 and 76 terminate short of the upper edges of the panels 12 and support on their upper ends flat horizontal beams 78 which as shown in Fig. 4 may encircle the building.

The upper end section of the panels 12 and the beams associated therewith form as a result of this construction a bulkhead or retaining wall opposite the open ends of the joist forms. Thus it is possible to pour hardening plastic material such as concrete into the wall stud forms and the floor joist forms of the next story thereabove in one pouring operation and integrally cast the studs and joists together in this manner. When the plastic material is poured in the forms for casting the wall studs and floor joists it first fills the vertical stud forms of the story below. As more material is poured, the height of the material will rise in the stud forms until it overflows the top sections of the wall frames 14. As the pouring operation is continued, the material will commence to fill the floor joist forms, the upper end section of the wall panels 16 acting to retain the plastic material from flowing outside of the structure. When the joist forms are completely filled and all the plastic material has hardened, a band or ring of hardened plastic material extends around the building at the juncture of the wall and floor casting forms.

Fig. 4 shows a portion of one story of the building with the forms erected for casting the studs, joists and "cordon unit" of one story of the building in one pouring operation. Fig. 1 shows a portion of one story of the building after the plastic material has hardened to form the studs, joists and encircling "cordon unit" and after the temporary parts of the casting forms have been removed. It will be noted that the hardened plastic material completely surrounds the rectangular frames 14 and 68 and forms a reticulated supporting structure for the building. It embeds the projecting nails carried by the frames and as a result anchors the frames solidly to the concrete. At the same time the frames form a series of dead air spaces in the walls and floors of the building effectively insulating the same from the transmission of sound and heat. The forms for the studs and joists create ridges 79 between the panels which act as seats for holding the panels in place against the frames to which they are attached. The ridges terminate flush with the outer surfaces of the floor or wall panels as shown in Fig. 1.

After the pouring of the studs and joists of each story of the building but prior to complete hardening of the same it is desirable to sink the sleepers 20 in the concrete where the wall panel units of the next succeeding story will be erected. At the same time dowel pins 80 may be forced into the concrete above each stud and thereby be interlocked with the studs of the next upper story of the building. When flooring 82 is laid down it will extend over the concrete joists and the rectangular frames 68. It may be nailed to the frames and to the girts thereof as it is laid down.

If it is desired to erect a flat topped concrete roof on the building, a sheeting such as a perforated metal screen or lath 84 may be laid over the concrete joists and the frames 68 prior to the filling of the joists and "cordon unit" at this height with plastic material. This asssembly is shown in Figs 7, 8, 13 and 14. Either the outside panels 12 at this height, or additional panel sections 86, may be erected to extend the outside wall height above the level of the floor frames 68 as shown in Fig. 7. On top of the surface of the panels 60 which form the ceiling of the rooms below the roof and in the rectangular frames 68, a layer of insulation material 88 such as fine powdery rock may be deposited. Concrete is then poured into the studs and joist and continued until it overflows upon the metal laths 84. Thus when it hardens it forms a concrete roofing 90 integral with the studs and joists of the story therebelow. In addition, the metal lath forms sealed air chambers in the frames 68 under the concrete roof 90 which acts to insulate the roof from the rooms therebelow.

For wall partitions inside the building the construction heretofore described in connection with Fig. 17 may be followed. As shown in Figs. 14 and 15, the wall panels 54—54 are associated with rectangular frames 56 of the type used in the outside wall structure. The concrete is poured into the channels provided and allowed to take a permanent set. The resulting construction is shown in Figs. 14 and 15.

Instead of utilizing panels such as 10 for forming the inner walls of the building, and plastering over these panels, a perforated sheeting such as the metal lath previously described may be employed for taking the plaster. This is shown in Fig. 18. The metal lath 100 is fastened by nails or otherwise to the room side of the wall frames 14. Plastic material 102 may be there spread upon the lath and allowed to harden thereto. Plaster which forms an extremely hard coating and capable of being washed without damage is particularly desirable for this construction.

The exterior finish of the building may be a brick veneer 104 as illustrated in Figs. 5 and 7. The brick veneer may be tied to the supporting concrete framework in any desirable manner such as by the anchoring device 106 illustrated in Fig. 5. As shown, this device comprises a corrugated metal strip adapted to extend into the filler material between two adjacent bricks. It is widened on its inner end and dove-tailed into a tubular member 108 mounted in the stud form prior to filling the same with concrete. Any number of these anchoring devices may be secured to the wall of the building at spaced points to securely anchor the brick to the building.

Instead of a brick veneer, the outside finish of the building may be formed of panel sections of reduced size forming a siding for the structure. Underneath the siding, the sheets or panels 10 composed of insulation material secured to the wooden frames 14 form a base foundation for the siding. The siding may be of various kinds. Two kinds are illustrated herein. The siding illustrated in Fig. 19 is composed of panel sections 110 of relatively small width laid in a vertical plane with the top and bottom edges of each section substantially abutting one another. The siding illustrated in Fig. 20 is composed of panel sections 112 of similar dimensions as sections 110 but arranged in overlapping shingled relationship.

The members of the frames 14 including the

girts 16 may serve in an improved manner as supports to which either type of panel section may be secured. The girts 16 are preferably spaced apart in their respective frames in such a way that after the siding composed of panel sections has been erected the adjacent edges of the sections are disposed opposite to the girts. All that is then necessary to do is to fasten the edges of the panel sections to the girts by screws or nails extending through the insulation sheets 12. In Fig. 21 a desirable way of securing the type of siding shown in Fig. 19 is illustrated. Long L-shaped metal brackets 114 are placed between the adjoining edges of the sections 110 with one half under one section and the other half over the other section. Screws 116 extend through the sections, bracket and insulation panel to the girts 16. As shown in Fig. 22, the overlapping shingled type of siding may be secured by screws or nails 118 extending through the overlapping parts of the panel sections and through the insulation to the girts. In either form of construction, water proof paper material 120 may be secured to the outside face of the insulation panels 12 as shown in Figs. 21 and 22.

A modified form of joist construction is illustrated in Fig. 23. Instead of the projecting double headed nails for anchoring the floor frames 68 to the concrete joists, small strips of wood 122 may be nailed to the outside surfaces of the members forming the frames. These strips will become embedded in the concrete of the joist and lock their respective frames to the joists. This type of construction will support unusually heavy loads imposed vertical on the floor frames. The reinforcing rods 72 in this construction may be suspended in the middle of the joist form prior to the pouring operation by flexible elements or wires 124 strung from one frame to the other.

The modified panel construction illustrated in Fig. 6 forms a particularly desirable exterior wall section. It is a laminated structure composed of two layers 120 and 132 of cementitious material separated by a wire mesh 134. The inner layer 130 is composed of porous nailing cement. The outer thinner layer 132 is composed of hard waterproof cement. The provision of the wire mesh will prevent crazing or cracking of the concrete facing 132 due to differences in the expansion and contraction of the two layers. The concrete facing 132 in combination with the wire mesh is so much stronger than the inside porous insulating layer 130 that it can expand and contract without crazing.

The panel or slab illustrated in Fig. 6 is preferably cast in one operation in a horizontal form of the type described in my aforesaid copending application, now Patent No. 2,154,590. The layer of waterproof cement is first poured into the form. The wire mesh is then laid on top of this layer before the latter hardens. The composition forming the porous nailable section is then poured before the base layer hardens so that two cementitious layers are integrally joined together through the interstices of the wire mesh. Reinforcing rods 136 of the type described in my aforesaid copending application may be cast in the panel with their turned over projecting edges superimposing the sides of the panel.

In order to allow for expansion and contraction of the outer layer 134 of this panel, the stud forms with which these panels are associated may be constructed as shown in Fig. 24 to prevent the concrete of the stud from penetrating between the outer layers 132 of two adjacent panels of this type. Fig. 24 shows laminated panels of this type with the waterproof layer on the outside of the building. If desired, these panels may form the exterior finish of the wall with the waterproof layers serving as the outer facing.

No costly materials or operations are required for erecting a building in accordance with this invention. The paneling for the walls and ceilings may be of prefabricated fibrous material easily cut to the desired dimension either on the premises of the building or before delivery thereto. When any panels are cast they are of the simplest design so that no expensive molds are required. The wall and floor units comprising the panels and the rectangular frames secured thereto constitute part of the forms for casting the studs, joists and the "cordon unit." The additional temporary members needed to complete the casting forms are easily assembled together and quickly removed when the plastic material has hardened. The manner of anchoring the frames to the surrounding concrete material increases the strength of the building without adding appreciatively to the cost. The multifunctional character of the double headed nails employed in the erection of the building increases the strength and solidity of the building and provides savings in material and labor which aids in keeping the total cost of the building down to a minimum. Special tools or highly skilled help is not essential for the erection of the building. The procedure in erecting the building coordinates many simple operations heretofore separately utilized in erecting all frame and all reinforced concrete structures.

The interior of a building erected in accordance with this invention is substantially insulated against outside temperature and sound conditions. It is also substantially fire proof. It not only will resist attack by fire from an outside source but will also prevent spread of a fire originating in the building. This is highly important particularly when the building is erected in an isolated section remote from fire prevention service. If desired, the fire hazard may be even further reduced by spraying the wooden rectangular frames with a fireproof paint at the time of their assembly or erection on the building.

What I claim:

1. In a building structure, a reticulated supporting framework composed of hardened plastic material forming a series of rectangularly shaped openings therein, a plurality of panels of a size slightly larger than said openings secured to one side of said framework with each panel thereof entirely closing an opening in the framework and overlapping upon the hardened plastic material on at least three sides thereof, a rectangular frame in each opening of the framework having an outside dimension sufficient to closely fit the opening, elements fixed in said frames on different sides thereof and projecting outwardly therefrom and embedded in the hardened plastic material therearound for support, and means fixed against the side of said framework of hardened plastic material opposite to said panels and closing the opening therein so that the frames are concealed between the panels on one side and the said means on the other side.

2. In a building structure, a pair of rectangular panels of substantially the same size disposed opposite to another in spaced parallel planes, a rectangular wooden frame of a size slightly less than that of said panels disposed between said panels in engagement with the in-

ner side surfaces of the panels, hardened plastic material extending around said frame and engaging the marginal portions of the panels which project beyond the sides of the frame, and nails partially driven into the outer sides of the frame leaving a projecting part thereof deeply embedded in hardened plastic material to thereby interlockingly secure the panels together.

3. In a building structure, a series of panels assembled in the same plane in edgewise relationship to one another, a similar series of panels of substantially the same size assembled in edgewise relationship to one another in a plane parallel to but slightly spaced from the plane of the other assembled panels in such a way that each panel of one assembled group is disposed opposite one of those of the other assembled group, a rectangular wooden frame arranged between each oppositely disposed pair of panels in engagement with the inner side surfaces thereof, said rectangular frames being of a size slightly less in length and width to the panels with which it is associated and so arranged between these panels that a marginal edge of each panel extends beyond the frame on at least three sides thereof, hardened plastic material extending around each of the rectangular frames and in contact with the inner sides of the marginal portions of the panels projecting beyond the panels, and elements nailed into the outer sides of said rectangular frames and projecting into the hardened plastic material extending therearound to interlockingly secure the parts together.

4. In a building structure, a horizontal rectangular panel, a rectangular frame disposed upon the top side of said panel, said frame being of a less size than the panel so that the margins of the latter project beyond the side members of the frame, elements projecting laterally from the outer sides of the frame in alignment with one another and spaced from the top surfaces of the projecting marginal portions of the panel, rods bearing upon the top of said projecting elements in spaced relationship to the other sides of the frame and the top surface of the projecting marginal portions of the panel, and hardened plastic material surrounding the frame above the marginal portions of the panel and embedding therein the projecting elements and the rods bearing thereon.

5. In a building structure, a horizontal rectangular panel, a rectangular wooden frame mounted on the top side of said panel, said frame being of less size than said panel and arranged thereon so that margins of the latter project beyond the frames, one or more wooden girts traversing the frame and dividing the same into sections, nails extending through the frame from the sides thereof securing said girts to the frame, said nails projecting from said frame in spaced relationship to the margins of the panel, rods bearing upon the top side of said nails in spaced relation to the frame and the projecting margins of the panel, and hardened plastic material surrounding the frame and embedding the rods and the projecting portions of the nails therewithin.

6. In a building structure, a rectangular wooden frame surrounded by hardened plastic material, one or more wooden girts extending across the frame and dividing the same into two or more sections, nails with heads on them extending through the frame from the outside and securing the girts to the frame, the heads of said nails embedded in said hardened plastic material and also acting to anchor the frame thereto.

7. In a building structure, a rectangular wooden frame surrounded by hardened plastic material, one or more wooden girts extending across the frame and dividing the same into two or more sections, nails with heads on them driven through the frame from the outside and securing the girts to the frame, the heads of said nails embedded in said hardened plastic material and also acting to anchor the frame thereto, and means secured to the opposite sides of said frame and the girts therein and enclosing the same therewithin.

8. In a building structure, a rectangular wooden frame surrounded by hardened plastic material, one or more wooden girts extending across the frame and dividing the same into two or more sections, nails with heads on them driven through the frame from the outside and securing the girts to the frame, the heads of said nails embedded in said hardened plastic material and also acting to anchor the frame thereto, and means secured to the opposite sides of said frame and the girts therein and enclosing the same therewithin, one of said means comprising metallic lath upon which is surfaced a layer of hardened plastic material.

9. In a building structure, a rectangular wooden frame surrounded by hardened plastic material, one or more wooden girts extending across the frame and dividing the same into two or more sections, nails with heads on them driven through the frame from the outside and securing the girts to the frame, the heads of said nails embedded in said hardened plastic material and also acting to anchor the frame thereto, and means secured to the opposite sides of said frame and the girts therein and enclosing the same therewithin, one of said means comprising a siding formed of panel sections of less size than the size of the frame secured to the girts thereof.

10. In a building structure, a pair of rectangular frames mounted in the same plane but spaced from one another, a panel associated with each frame mounted on the same side of each frame with the adjacent marginal portions projecting beyond the frame toward one another but terminating short of each other to provide a slight space therebetween, hardened plastic material between the adjacent sides of said frame and contactually bearing against the inner surface of the projecting marginal portions of said panels, said hardened plastic material having a ridge integral therewith entering into the space between the adjacent edges of said panels and terminating substantially flush with the outer surfaces of the panels.

11. In a building structure, a pair of rectangular frames mounted in the same plane but spaced from one another, a panel associated with each frame mounted on the same side of each frame with the adjacent marginal portions projecting beyond the frames toward one another but terminating short of abutment to provide a slight clearance therebetween, said panels each formed of an inner layer of porous insulating cementitious material against which the frame with which it is associated bears and an outer layer of harder waterproof cementitious material, hardened plastic material between the adjacent sides of said frame contactually bearing against the projecting marginal portions of the panels, said hardened plastic material having a ridge entering into the space between the adjacent edges of the panels but terminating short of the outer harder layers of the panels so as to provide clear-

ance for the expansion and contraction of the latter.

12. In the construction of a building, a series of rectangular panels arranged in the same plane in slightly spaced side-by-side relationship, a removable form member for each pair of said panels having a width slightly greater than the space between the two adjacent panels with which it is associated and disposed on one side of the panels in overlapping engagement with the adjacent edges of these two panels, a series of rectangular frames one for each panel each having a size slightly less in length and width than that of the panel with which it is associated, said frames disposed against the sides of their respective panels opposite to that engaged by said form members in such a way that marginal portions of the panels project beyond the sides of the frames, said frames, members and projecting marginal portions of said panels serving as a form into which hardening plastic material can be poured and allowed to harden.

13. In the construction of a building, a form into which hardening plastic material can be poured to form a series of spaced wall studs comprising, in combination, a series of rectangular wall panels of one story height arranged in a vertical plane in side-by-side slightly spaced apart relationship, a similar series of wall panels arranged in a vertical plane parallel to but spaced from the other series of wall panels with the individual panels thereof disposed directly opposite the individual panels of the other series, a plurality of relatively long vertical form members disposed on the opposite outer sides of the panels in overlapping engagement with the vertical marginal portions of adjacent panels to close the space therebetween, a rectangular frame between each pair of oppositely disposed panels and engaging the inner side surfaces thereof, said frames being of a size smaller than the pair of panels with which it is associated so that the margins of the latter project beyond the frame on the opposite sides thereof and forming with the cooperation of the overlapping form members and the outer sides of the frames between adjacent pairs of panels a series of vertical hollow columns for receiving and retaining hardening plastic material.

14. In the construction of a building, a form into which hardening plastic material can be poured to form a series of spaced wall studs comprising, in combination, a series of rectangular wall panels of one story height arranged in a vertical plane in side-by-side slightly spaced apart relationship, a similar series of wall panels arranged in a vertical plane parallel to but spaced from the other series of wall panels with the individual panels thereof disposed directly opposite the individual panels of the other series, a plurality of relatively long vertical form members disposed on the opposite outer sides of the panels in overlapping engagement with the vertical marginal portions of adjacent panels to close the spaces therebetween, a rectangular frame between each pair of oppositely disposed panels and engaging the inner side surfaces thereof, said frames being smaller in size than the pair of panels with which it is associated so that the margins of the latter project beyond the frame on the opposite sides thereof and forming with the cooperation of the overlapping form members and the outer sides of the frames between adjacent pairs of panels a series of vertical hollow columns for receiving and retaining hardening plastic material, metallic rods extending longitudinally through the vertical hollow columns thus formed, tubes extending transversely through the hollow columns at vertically spaced points along the hollow columns thus formed and extending as far as the form members on opposite sides of the hollow columns, bolts extending through the tubes and through the form members beyond the opposite ends of the tubes, and means associated with the bolts for drawing the panels and the frames therebetween into a tight, self-supporting structure.

15. In the construction of a building, a form into which hardening plastic material may be poured and cast to form an integral part of the building, a pair of rectangular frames mounted in the same plane in spaced relationship to one another, relatively rigid means on opposite sides of said frames extending across the space between said frames, a bolt extending transversely through the space between the frames, means associated with the bolt for tightening said first mentioned means against the frames to seal the space therebetween, and a tube loosely mounted on the section of said bolt in the sealed space between the frames enabling the bolt to be withdrawn after the plastic material has been poured into said space and hardened therewithin.

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