March 28, 1967 S. A. SIMON 3,310,917

BUILDING CONSTRUCTION AND MODULAR PANELS THEREFOR

Filed April 13, 1964 2 Sheets-Sheet 1

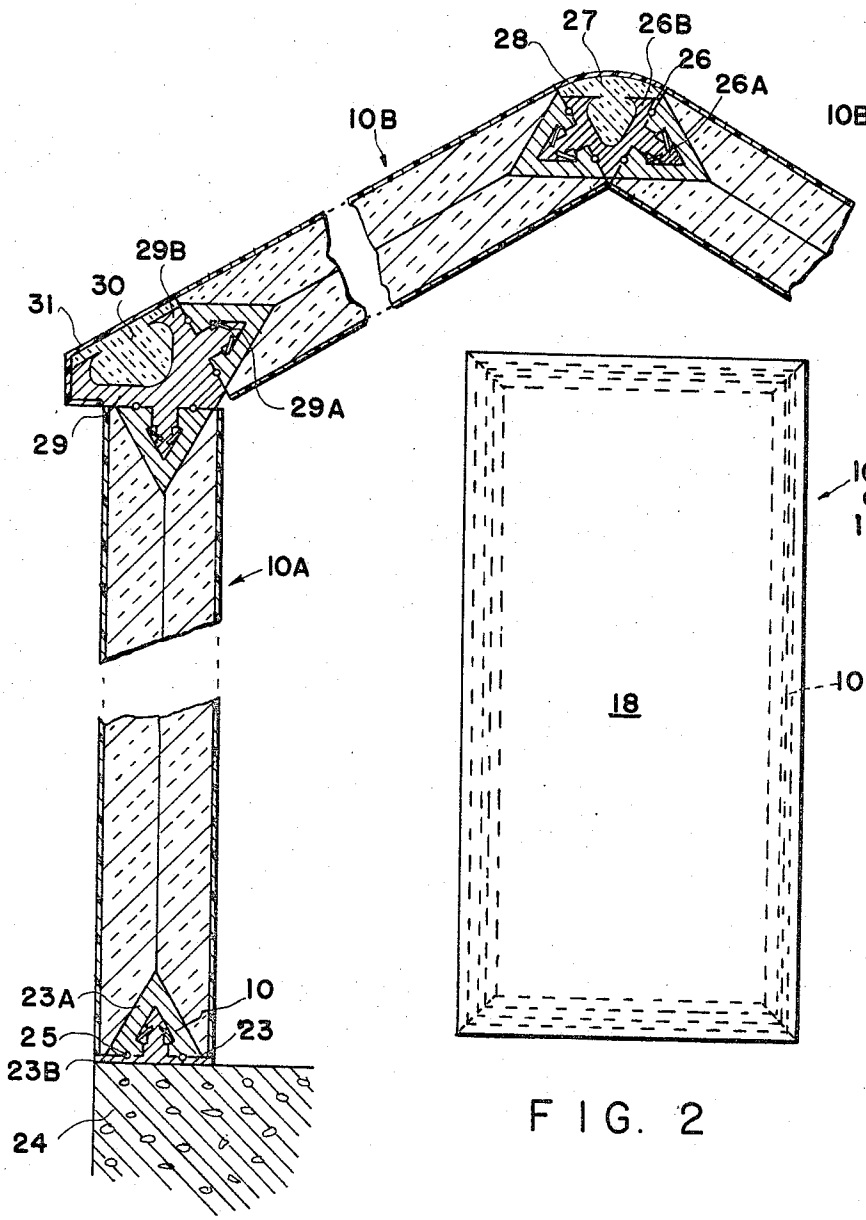

FIG. 1

FIG. 2

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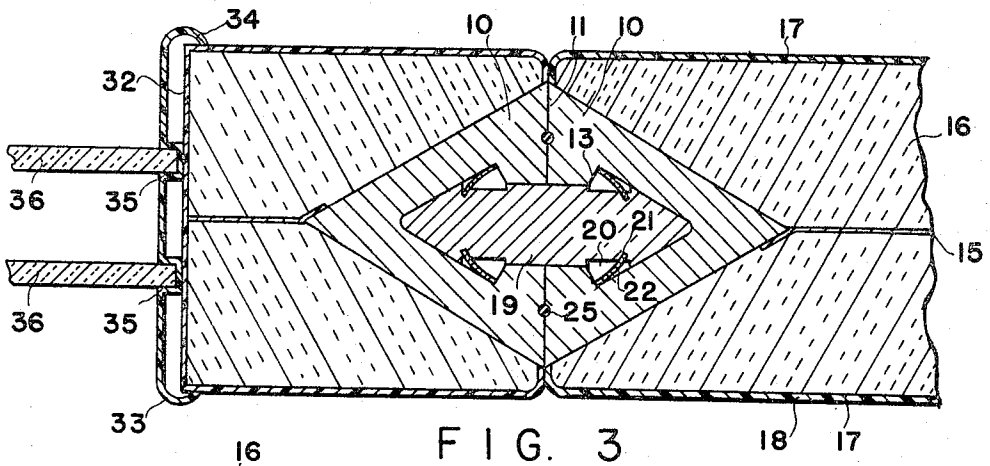

FIG. 3

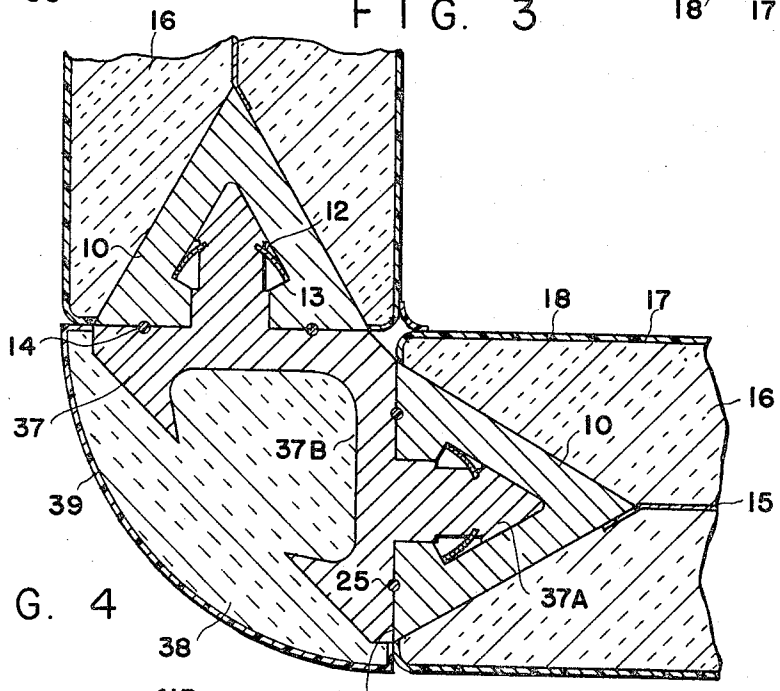

FIG. 4

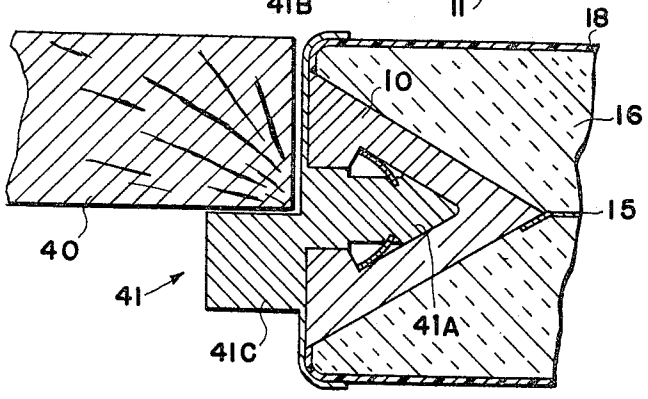

FIG. 5

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BUILDING CONSTRUCTION AND MODULAR PANELS THEREFOR

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This invention relates to the art of building construction and has as its principal object the provision of improved modular components for building structures and of improved method and means for securing the components together in an efficient and rigid manner in erecting the structure. More specifically, the invention seeks to provide modular building components such as wall and roof panels which while being low in cost are yet vastly improved as to characteristics regarding strength, close dimensional tolerances, insulation, finish, and ability to be readily and rigidly interlocked together in assembling the building structure. An ancillary but yet important object of the invention is to provide a system having the above designated features which in the case of simple structures such as garages and small houses enables the assembling to be accomplished without the use of any tools and by persons who may have had only limited experience in erecting such structures.

A further object of the invention is the provision of improved components and methods for the above purposes whereby improved end results as to appearance, weatherproofness, stability, and longevity may be achieved at low cost.

The above and othher objects and advantages of the invention will become apparent upon consideration of the following specification and the accompanying drawing wherein there is disclosed a preferred embodiment of the invention.

In the drawing:

FIGURE 1 is a transverse section through a hipped-roof building construction made in accordance with the principles of my invention;

FIGURE 2 is a plan view of one of the panels used in the assembly of FIGURE 1;

FIGURE 3 is a fragmentary horizontal section of a wall which may be used in the structure of FIGURE 1 to incorporate therein a double-glazed window;

FIGURE 4 is a fragmentary horizontal section through a corner assembly which may be used in the structure of FIGURE 1; and

FIGURE 5 is a fragmentary horizontal wall section to illustrate a door jamb which may be utillized in the structure of FIGURE 1.

The gist of this invention is that both the basic and finish aspects of the outer enclosure walls and roof of the building to be erected is made up primarily of prefabricated standardized panels which are not only inherently rigid and insulating but also have incorporated along their edges provisions for being rigidly interlocked with other panels and with other structural elements of the system. One such panel is shown more or less schematically in flat form in FIGURE 2 but it should be understood at the outset that the individual panels may be suitable curved and/or shaped in outline to fit properly in structures having curved or geodesic shape, for example.

In accordance with the principles of this invention the above mentioned panels or modules are each built up on a rigid peripheral frame which may either be made from rolled steel sections or, more preferably, from aluminum extruded sections shown at **10** in the drawing. In either case the frame is built by mitre-cutting appropriate lengths of the formed metal sections and thereafter welding these cut sections together at the corners of the frame. As shown in the drawing, the members **10** are generally V-shaped in cross-section and each has an outer face **11** which is coincident with the outer peripheral edge of the panel to be constructed.

Extending inwardly from the face **11** of each of the members **10** is a deep slot **12** which is arrow-shaped in cross-section to provide a pair of outwardly splaying surfaces **13**, one on either side wall of the slot. Completing the structure of the members **10** is a pair of longitudinally extending semi-circular grooves **14** in the face **11**, one groove on either side of the slot **12**. It will be apparent to those familiar with the metal extrusion art that the elongated sections which make up the members **10** may be readily extruded at practical speeds by the use of relatively simple and uncomplicated extrusion dies.

Ridigdly connected, preferably by welding, to the inwardly directed apieces of the triangular-shaped frame members **10** are the peripheral edes of a unitary expanse of screening or expanded metal **15** made either of steel or aluminum, depending on the material selected for the members **10**. Expanded metal, such as used for plastering, is preferred for the elements **15** since the longitudinal ribs conventionally formed therein lend strength and rigidity to the assembly while the sharp barbs thereof facilitate the adherence of the insulating filler which is applied thereto in the next step of making the modules or panels. This filler material, designated therein by reference numeral **16**, may be of a wide variety of substances so long as the chosen one have the characteristics of adequate strength, lightness, adhering qualities, and insulation qualities. Thus, foamensced cellular plastic or lightweight acoustical gypsum plaster may be used for this purpose. Regardless of what is used and however applied this filler material is left with smooth parallel surfaces **17** on opposite sides of the panel with the peripheral edge portions of these surfaces being inturned to meet the members **10** as shown in the drawing. To finish the panels, both inside and out, the surfaces **17** are coated with a fairly heavy thickness **18** of plastic material having a desired color and which hardens into a dense permanent waterproof layer. The finish **18** may be applied by spraying or by other methods known in the art and in some instances, depending on the composition used, may be fired in the finall stage of manufacture.

The rigid and finished panels or modules described above may be readily connected together, in a manner to be described below, for the making of large expenses and, also, these panels may be readily interlocked in edge relation to other structural members which will also be described below.

Referring first to FIGURE 3 which illustrates how two panels may be interlocked in edge-to-edge relation, reference numeral **19** designates a flat bar of such cross-sectional shape end dimensions as to fit snugly within the two slots **12** of the two adjacent frame members **10** of the two panels to be joined. Again, the bar **19** is preferably an aluminum extrusion although it should be understood that this member may be rolled from a steel bar or from a steel strip. In any embodiment, the bar **19** is integrally formed with four recesses **20** in its side walls and with longitudinally extending slots **21** extending further inwardly from these recesses. Snugly received in each recess **21** is an edge portion of a longitudinally extending spring steel spline **22**. As shown, the splines **22** are splayed outwardly toward the transverse midplane of the bar **19**, and it should be obvious that as the edges of the bar are forcibly injected into the slots **12** of members **10** the splines **22** will first fold into the recesses **20** but after passing the oppositely splayed surfaces **13** of the grooves **12** will spring outwardly thereby rigidlly and tightly locking the member **10** and the bar **19** together. Since the slot **12**

as well as the bar **19** and the splines **22** are continuous the resulting holding force is enormous. Also, it should be apparent that due to the continuous nature and close interfitting of the members **10** and the bar **19**, any waviness or misalignment of the adjacent panel edges will be corrected upon assembly so that the combined panels will present a smooth planar surface both inside and out.

In a manner to be now described, the above explained connecting method may be employed to connect the panels of the invention to other structural elements of a building assembly. Referring now to FIGURE 1 wherein panels **10A** are to form the side walls of a building assembly and similar panels **10B** are to form the roof structure of the assembly, reference numeral **23** designates a sill member which, in actual practice, may be lagged onto a foundation wall **24**. Sill member **23** may again be an aluminum extrusion or be otherwise suitably formed, and in any embodiment has an upwardly extending rib **23A** which is precisely of the cross-sectional shape of one-half of the bar **29** previously described above. The rib **23A** is formed with recesses on its opposite sides and provided with retained spring steel splines as shown at **20–22** on the bar **19**. Sill member **23** has flat upper surfaces on opposite sides of the rib **23A** in which are formed longitudinally extending semicircular grooves **23B** which are located to face the semicircular grooves **14** of the members **10**. In the process of assembly round continuous beads **25** of compressible plastic are laid in the grooves **14** and **23B** to effect weather-tight and water-tight seals, as will be understood. It should be obvious that the sill member or members **23** serve to anchor the bottom ends of the side wall panels of the building structure to the available foundation in accurately aligned and water-tight relation.

For producing a hipped-roof structure as shown in FIGURE 1, I provide a structural ridge member which consists of a continuous metal section **26** which is triangular in section, as shown, to provide two faces which are normal to the planes of the roof panels **10B**. Extending outwardly from each of these faces is a rib **26A** which is identical in shape and equipment with the rib **23A** of the still member **23**. These faces of member **26** are also provided with small grooves for receiving the sealing beads as shown and as previously described. The member **26** is preferably an aluminum extrusion but however constructed serves as a means to rigidly connect the panels **10B** on opposite slopes of the roof in a weather-tight manner.

To facilitate extrusion, if such process is used, and to anchor filler material the section **26** is deeply grooved and recessed as shown at **26B**. Applied to this groove and to the adjacent space outside of the section is a quantity of insulating filler material **27** which may be identical with the filler **16** of the panels previously described. The outer surface of the filler **27** is appropriately contoured to provide the desired ridge line, and to this outer surface there is adhered a hard plastic coating **28** which may be identical with the coatings **18** of the panels above described. As shown in FIGURE 1, the composite filler **27** and the coating **28** is so spaced from the section **26** that the outer surface or surfaces of the coating **28** matches with the outer coatings of the panels **10B**.

To interconnect the upper ends of the panels **10A** of the side wall of the building with the lower ends of the panels **10B** making up the roof and ceiling of the building, I provide a continuous structural section **29** which again may be an aluminum extrusion and which has the cross-sectional shape illustrated. This section has faces which are normal to the planes of the panels **10A** and **10B**, and from each of these faces there projects an integral rib **29A** which is identical in shape and equipment to the rib **23A** of the sill member **23**. Again, provision is made, as shown, for the retention of the sealing beads, and it should be obvious that the section **29** very rigidly and tightly interconnects the panels **10A** and **10B**.

Section **29** is also formed with an enlarged longitudinal recess **29B** to receive and retain a mass of filler material **30** which may be the same as the filler material **16** of the panels **10A** or **10B** as previously described. Overlying the filler **30** is a hard plastic coating **31** suitably contoured to give the desired gutter line or shape to the building, and it should be noted that the coating **31** matches up accurately with the outer coating of the panels **10B**.

The triangular shape of the section **29**, as well as of the section **26**, makes for substantial strength and rigidity and thus keeps the gutter line as well as the ridge line of the building true and parallel. Further, the section **29** provides an excellent anchorage for gutter brackets and the like (not shown herein).

Referring now to FIGURE 3, which illustrates how a window may be incorporated in one of the sidewall panels **10A** of the building, the reference numeral **32** represents a side edge of an appropriate opening which is formed in one of these panels. I provide a continuous frame **33** of suitable resilient plastic material which snugly fits into such opening and is held therein by flanges **34**. The frame **33** is, of course, made of strip-like material, and has continuous grooves **35** opening toward the center of the window opening. Reference numeral **36** designate panes of glass which are cut to precise dimensions, and in the assembly of the building these panes are simply snapped into position in the grooves **35**, the plastic material of the frame being such that the frame simply snaps back into its original shape shown after installation of the glass.

FIGURE 4 illustrates a possible corner structure made in accordance with the principles of the invention, and it will be observed that the corner assembly is made possible by a corner structural member built up on the metal section **37**. This section **37** is again preferably an aluminum extrusion and has faces disposed at 90° to each other from each of which extends an integral rib **37A** having the same shape and equipment as the rib **23A** of the sill member **23**. Section **37** is longitudinally recessed as shown at **37B** to anchor a mass of filler material **38**, this filler material being the same as used for the structural insulation **16** of the panels **10A** and **10B**. The exposed surface of filler **38** is contoured to the rounded corner, as shown, and is coated with a hard plastic layer similarly to the outer layers **18** of the panels **10A** and **10B**.

FIGURE 5 illustrates how an opening for a door **40** may be provided in a side wall of the building structure of the invention. This opening provides both the door jambs and stops and is made up of a frame consisting of the section **41** which, again, is preferably an aluminum extrusion. Section **41** has an integral rib **41A** of the same shape and equipment as the rib **23A** of the sill member **23**, an integral jamb portion **41B**, and an integral stop portion **41C**. The door frame consisting of the section **41** is, of course, prefabricated from lengths making up the side jambs and top rail of the frame, and this assembled frame may be shipped installed in the particular side wall panel in which it is located. The appropriate opening in such side wall panel is, of course, framed with the section **10** as shown in FIGURE 5. The illustrated combination of interlocking framing members makes for an exceedingly solid mounting and stop for the door.

While not illustrated herein, the end wall for a building of the style suggested in FIGURE 1 would be made up of an appropriate number of panels **10A** connected to the building side walls by the corners as illustrated in FIGURE 4. Triangular shape panels would be positioned above the horizontal top line of the rectangular panels **10A** and be connected to the roof panels **10B** by corner structures shown in FIGURE 4.

For building structures of curved and geodesic designs, for example, the make-up panels which correspond to **10A** and **10B** illustrated would be suitably curved, trun-

cated, etc. to arrive at the desired surface or surface and, of course, the connecting bars corresponding to section 19 illustrated would be suitably curved complementary to the lines of jointure. It should be noted that in accordance with this invention the framing sections (corresponding to illustrated elements 10) of such curved and angled panels could be suitably cut and bent and welded together before the mesh (15) and filler and surfacing is applied. Since the system herein disclosed is intended specifically for standardized structures, the necessary sections would be cut, bent and joined to precise tolerances with the aid of suitable fixtures as is well understood in the metal fabricating arts.

Having thus described my invention what I claim is:

1. A building structure formed of discrete panels each having a rigid peripheral frame, said frame having longitudinal grooves extending inwardly from the outer peripheral face thereof and said grooves being arrow-shaped in cross-section, an apertured metal sheet spanning the inner periphery of said frame intermediate the side faces of said frame and being rigidly secured to said frame, lightweight insulating structural material adhered to the opposite sides of said sheet within the confines of the frame and having outer surfaces spaced from said sheet at least as far as the outer edges of said frame, said outer surfaces being coated with a hard adherent layer of weatherproof plastic material, and means to secure said panels in proper positions in said building structure comprising elongated connecting members having integral ribs fitting tightly within said arrow-shaped grooves, said ribs being fitted with outwardly expanding splines whereby said ribs are securely locked within said arrow-shaped grooves.

2. Structure according to claim 1 further including a corner assembly for joining angular related panels comprising an elongated metal section having angular related surfaces from which protrude said integral ribs for entry into the contiguous grooves of the adjacent and angular related panels, the outer corner face of said section having applied and bounded thereto a thickness of said structural material which is formed on its outer surface to give the desired corner curvature, and said outer surface being coated with a hard adherent layer of waterproof plastic material.

3. A building structure according to claim 2 further characterized in that the same is an enclosure of the hipped-roof style, said panels forming the side walls and roof thereof, one of said corner assemblies forming the ridge of the roof and another of said corner assemblies interconnecting top ends of at least some of said side wall panels and the bottom ends of the roof panels and also providing a gutter support, and further including an elongated sill member adapted to be lagged down onto a foundation wall, said sill member having a flat plate-like portion for resting on said wall and an integral upwardly extending rib portion for entering into the lower grooves of said side wall panels.

4. A building structure formed of discrete panels each having a rigid peripheral frame, an apertured metal sheet spanning the inner periphery of said frame intermediate the side faces of said frame and being rigidly secured to said frame, lightweight insulating structural material adhered to the opposite sides of said sheet within the confines of the frame and having outer surfaces spaced from said sheet at least as far as the outer edges of said frame, said outer surfaces being coated with a hard adherent layer of waterproof plastic material, and means engaging the outer peripheral faces of the frames of said panels to secure said panels in proper positions in said building structure.

5. A modular panel for building construction comprising a rigid frame made from lengths of metal section and having a continuous groove extending inwardly from the outer peripheral face of the frame, an apertured metal sheet spanning the inner periphery of said frame intermediate the side faces of said frame and being rigidly secured to said frame, lightweight insulating structural material adhered to the opposite sides of said sheet within the confines of the frame and having outer surfaces spaced from said sheet at least as far as the said side faces of said frame, and said outer surfaces being coated with a hard adherent layer of weatherproof plastic material.

6. A modular panel for building construction comprising a rigid metal frame, an apertured metal sheet spanning the inner periphery of said frame intermediate the side faces thereof and being rigidly secured to said frame, lightweight insulating structural material adhered to the opposite sides of said sheet within the confines of the frame and having outer surfaces spaced from said sheet at least as far as said side faces of said frame, and said outer surfaces being coated with a hard adherent layer of weatherproof plastic material.

7. A building structure comprising a plurality of discrete modular panels, each having a rigid peripheral frame with continuous grooves extending therein from the outer peripheries of the frames, and means to interconnect said panels edgewise to each other and to other structural elements of the building assembly, comprising members having ribs to tightly enter said grooves in a direction normal to said outer peripheral edges of said frames, and said ribs carrying means to prevent withdrawal of said ribs from said grooves.

8. A building as recited in claim 7 wherein said last mentioned means comprises one-way acting splines.

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