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Hill

(54) **MODULAR STRUCTURE**

(76) Inventor: **Don A. Hill**, Burlington (CA)

Correspondence Address:
GOWLING, LAFLEUR HENDERSON LLP
ONE MAIN STREET WEST
HAMILTON, ON L8P 4Z5 (CA)

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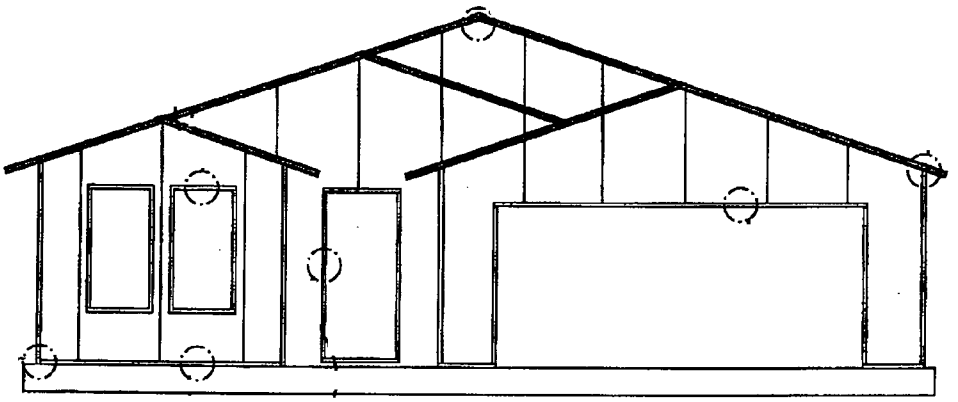
(57) **ABSTRACT**

A modular building system including methods and kits is provided. The system comprises C-channels anchored to a base. Structural insulated panels are slid into the channels to form walls. Adaptors are provided to provide channels at an angle for the insertion of roof panels. The building system provides for the rapis construction of a building without the need for framing or the use of roof trusses.



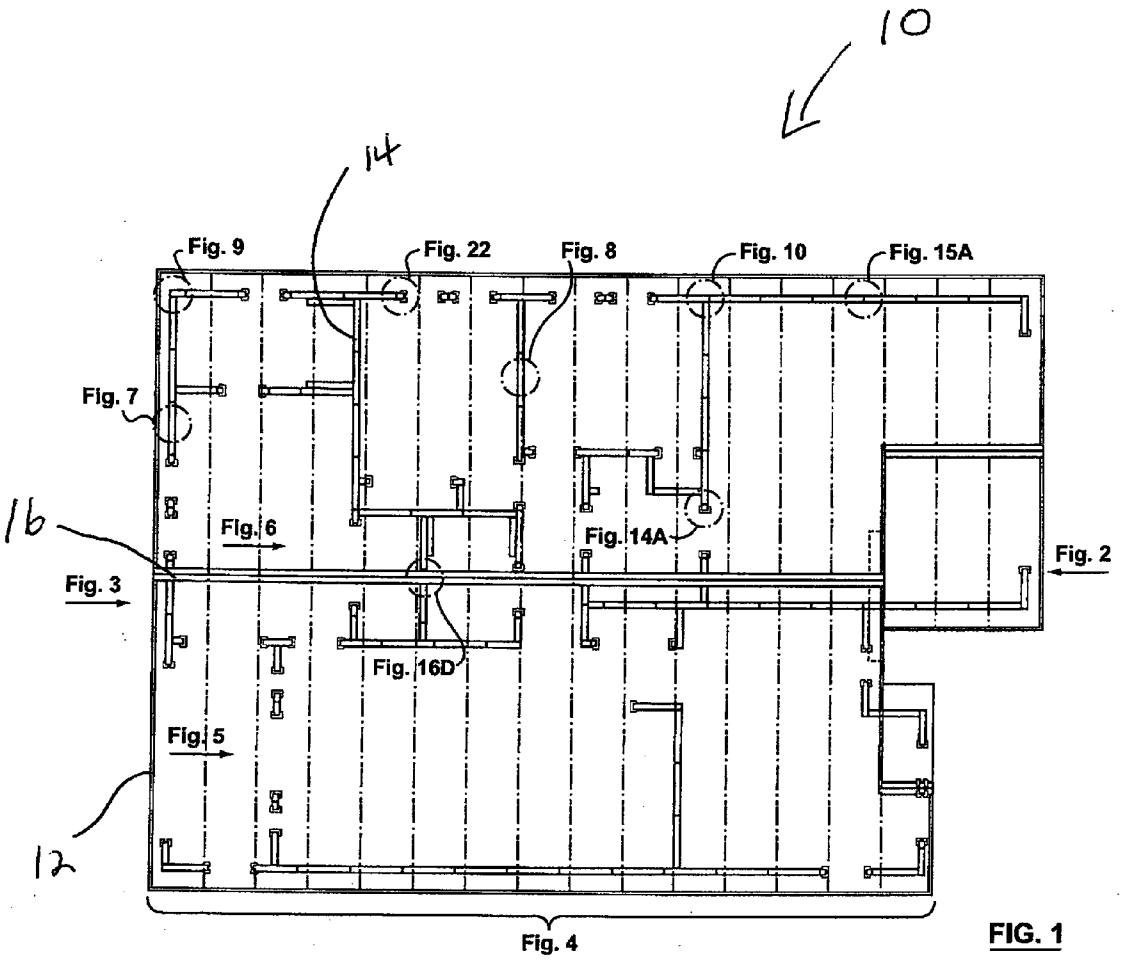

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Fig. 9
Fig. 22
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Fig. 3
Fig. 16D
Fig. 5
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Fig. 4

FIG. 1

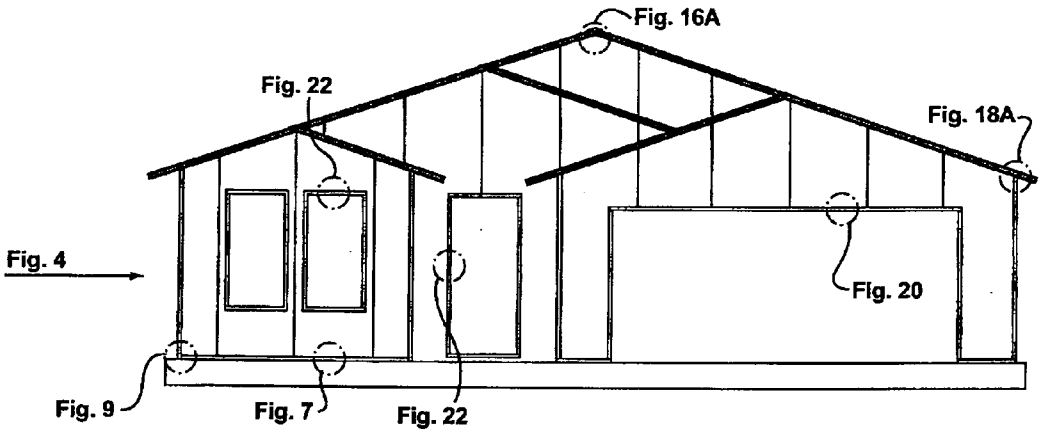


FIG. 2

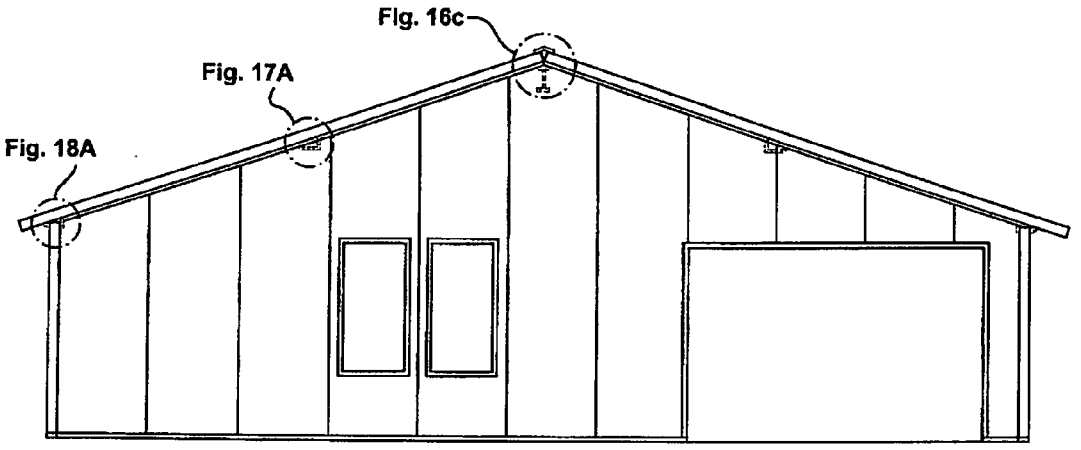


FIG. 3

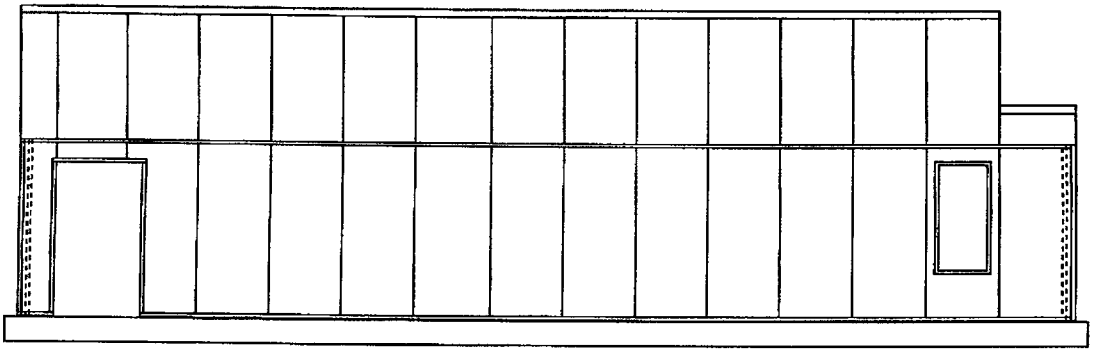


FIG. 4

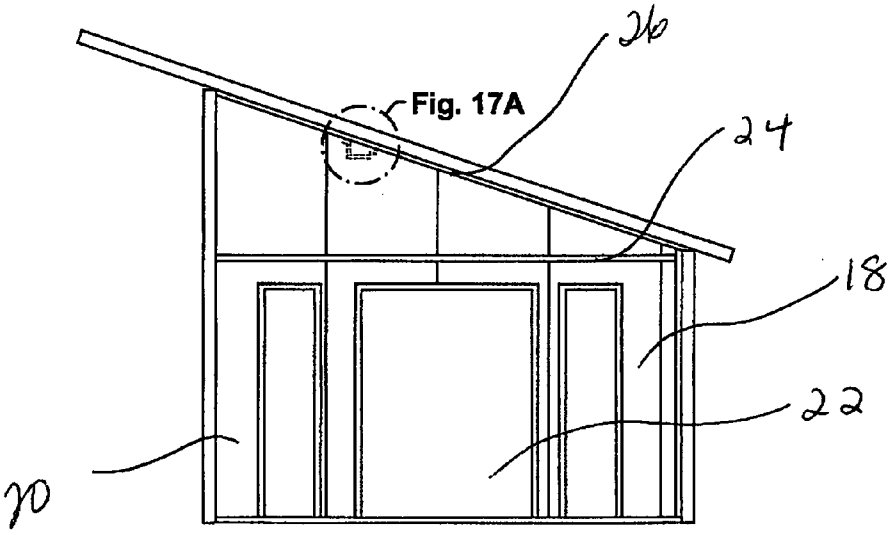


FIG. 5

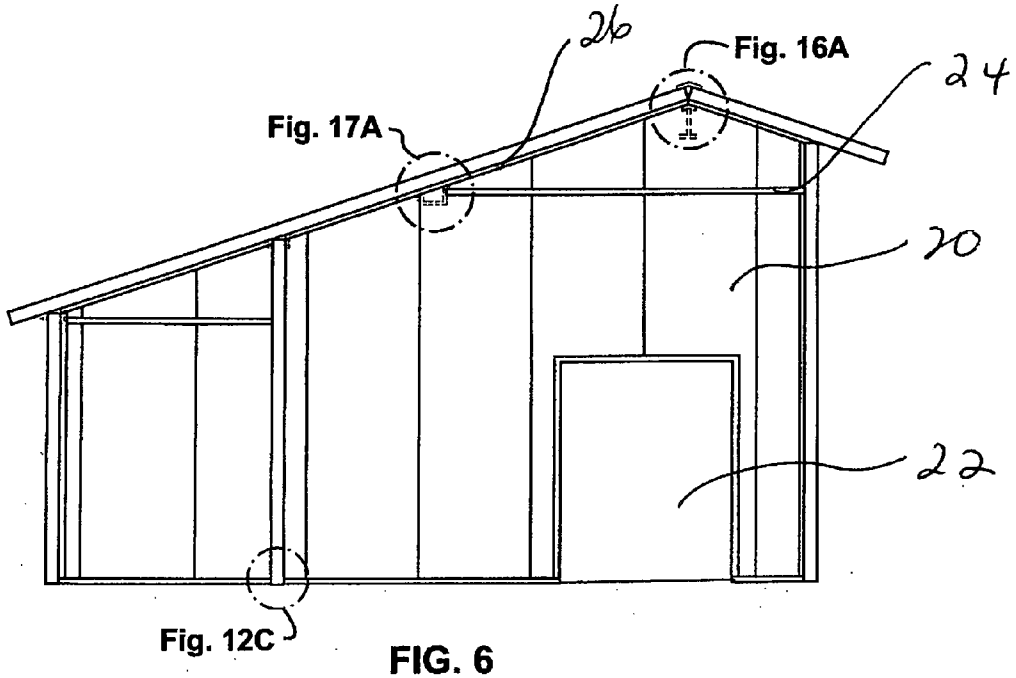


FIG. 6

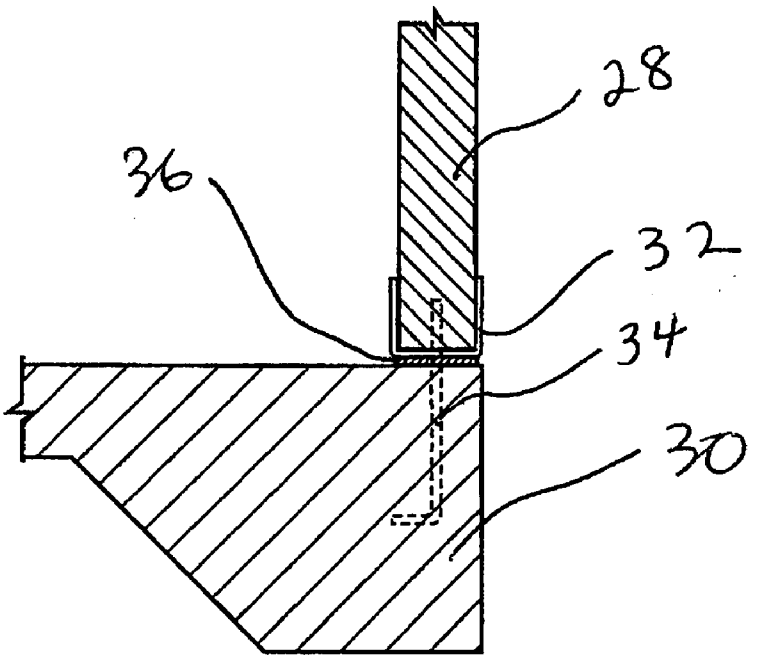


FIG. 7

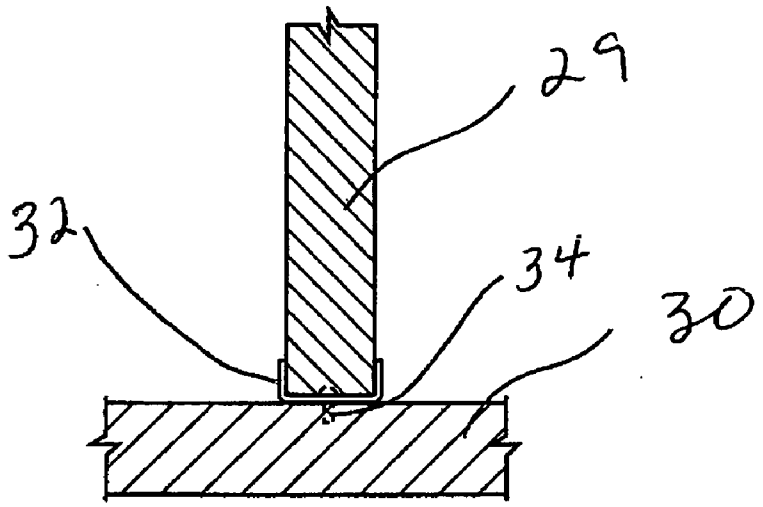


FIG. 8

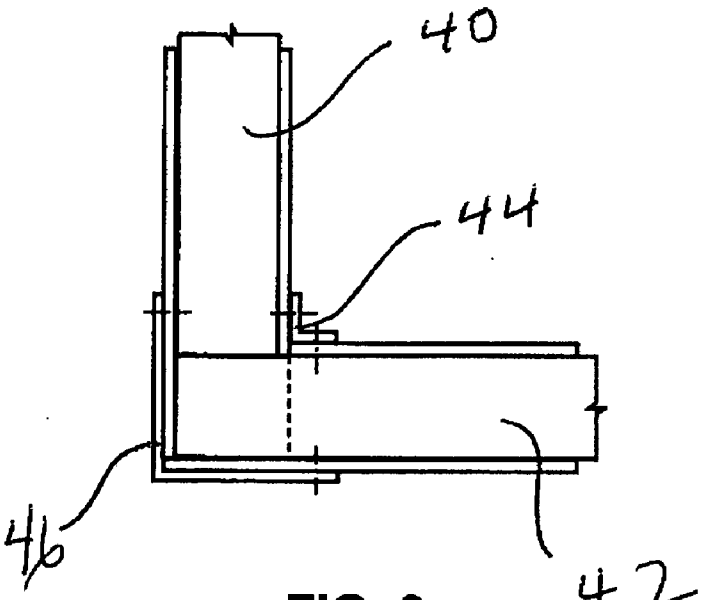


FIG. 9

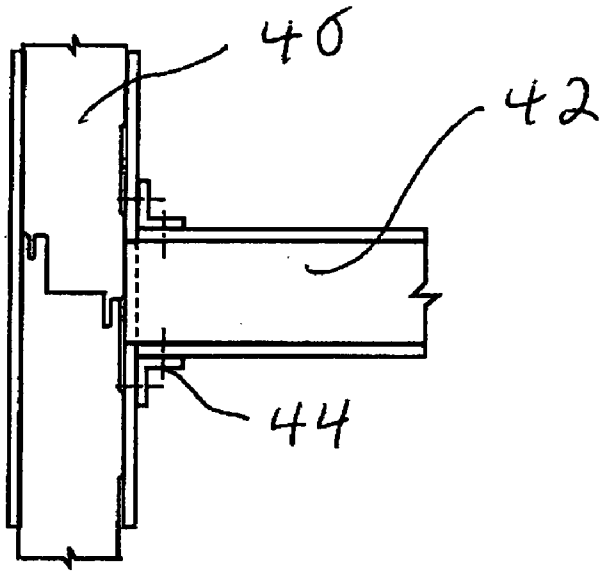


FIG. 10

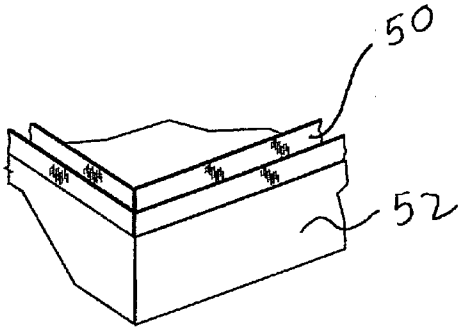


FIG. 11A

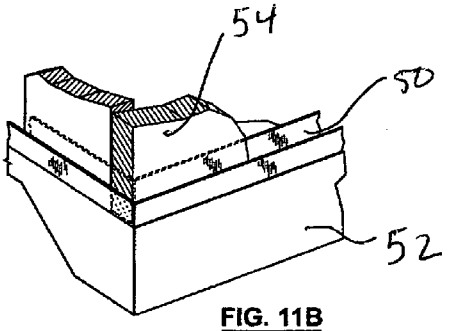


FIG. 11B

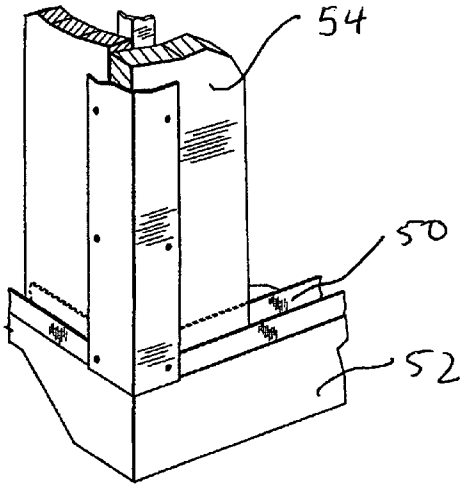


FIG. 11C

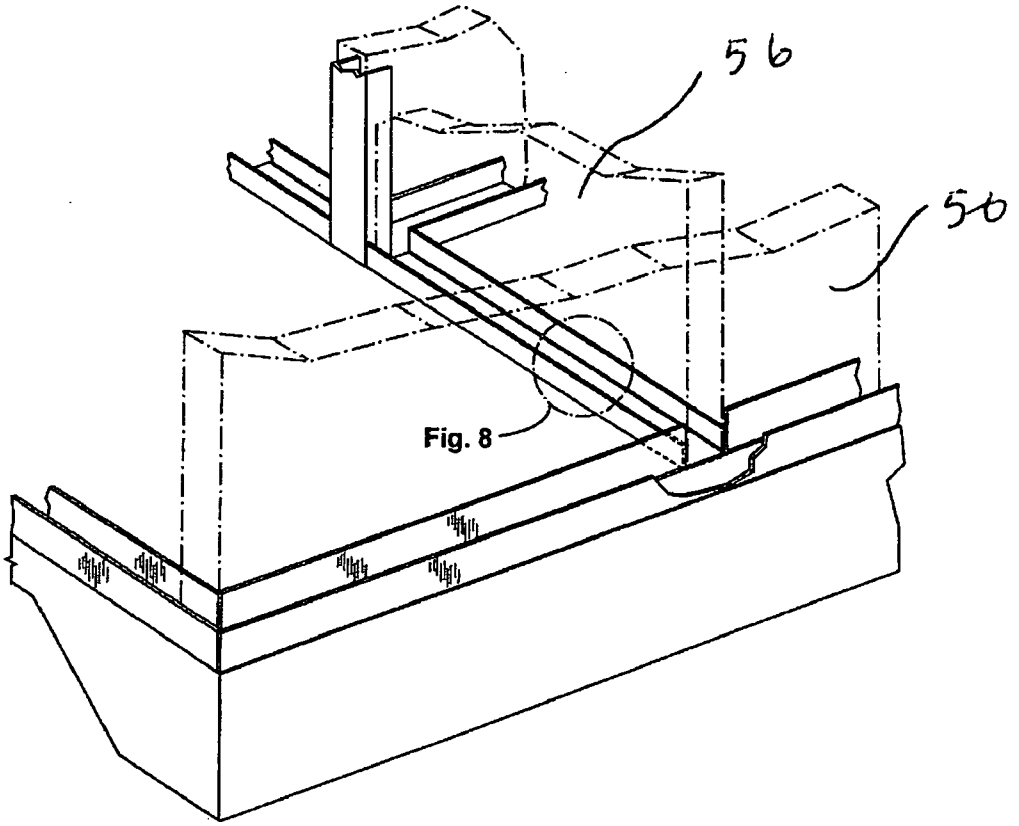


FIG. 12

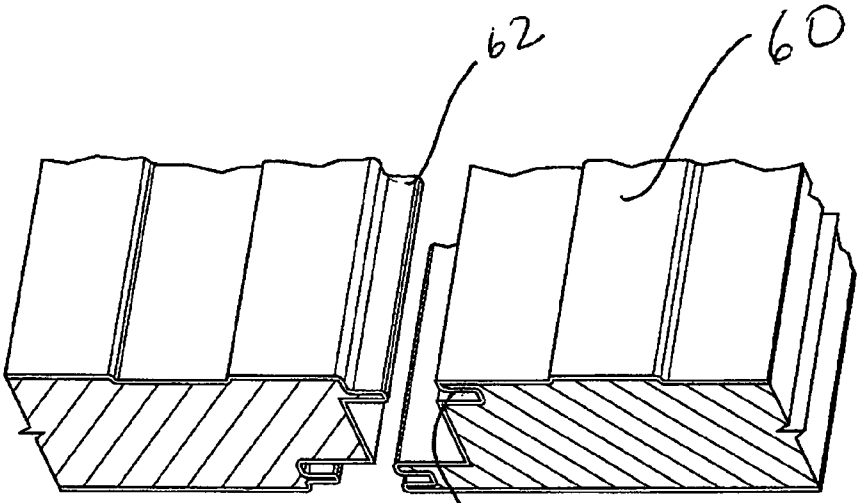


FIG. 13A

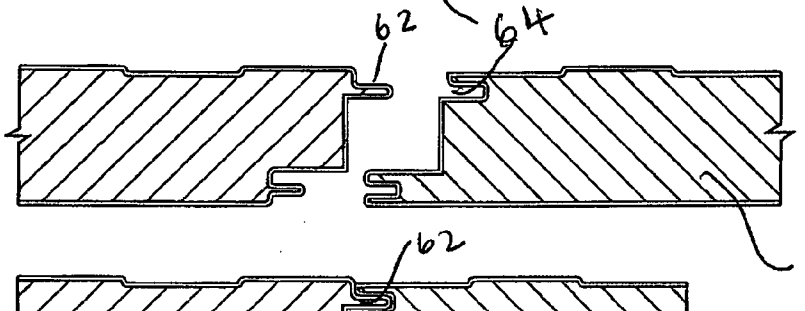


FIG. 13B

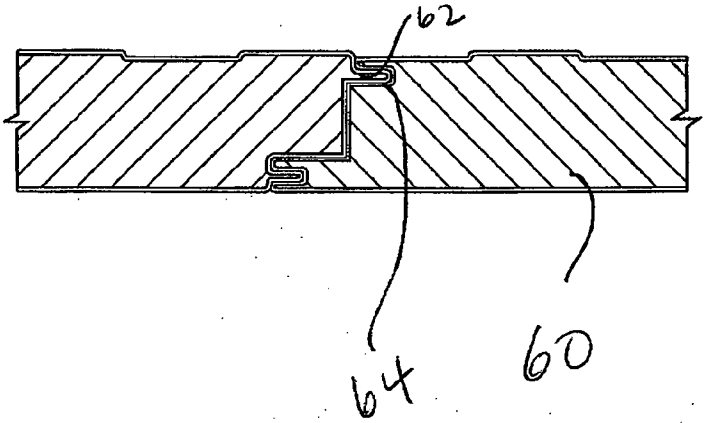


FIG. 13C

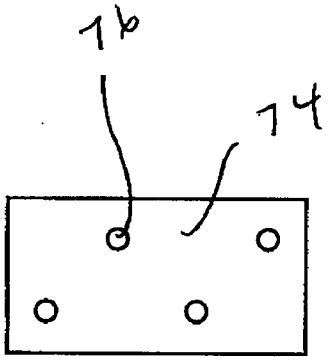


FIG. 14B

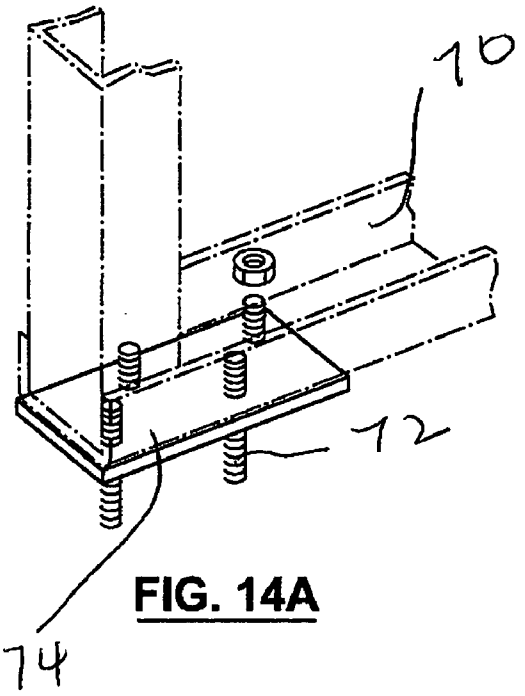


FIG. 14A

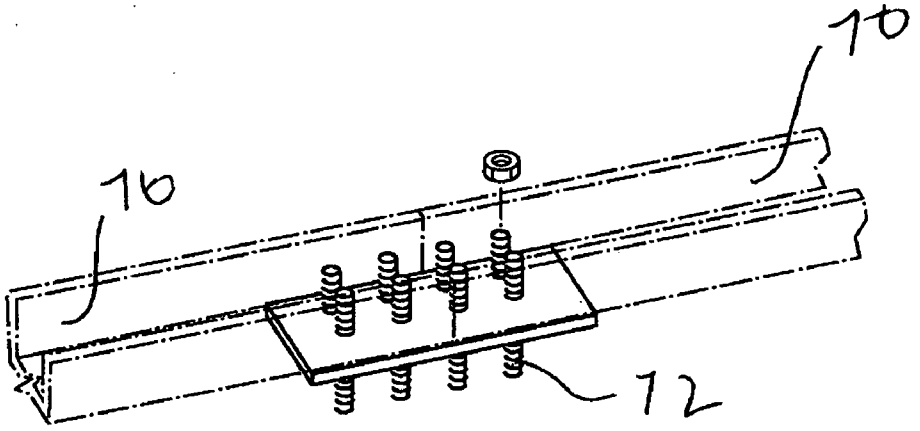


FIG. 15A

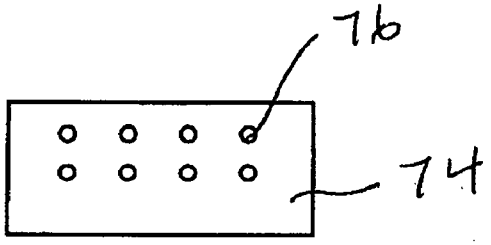


FIG. 15B

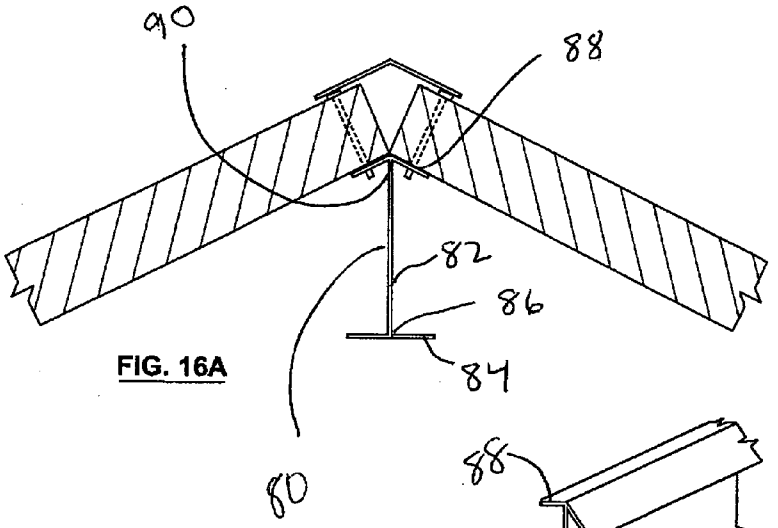


FIG. 16A

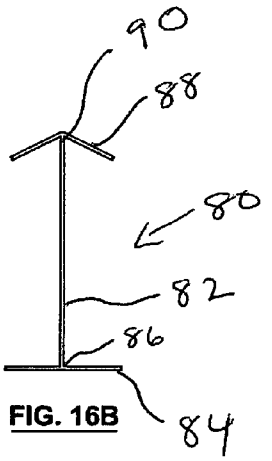


FIG. 16B

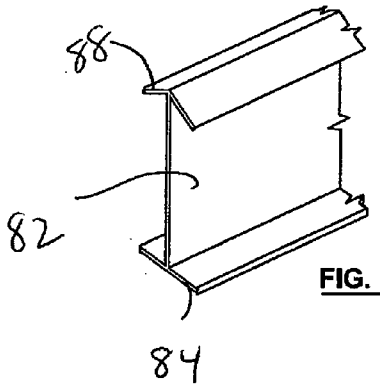


FIG. 16C

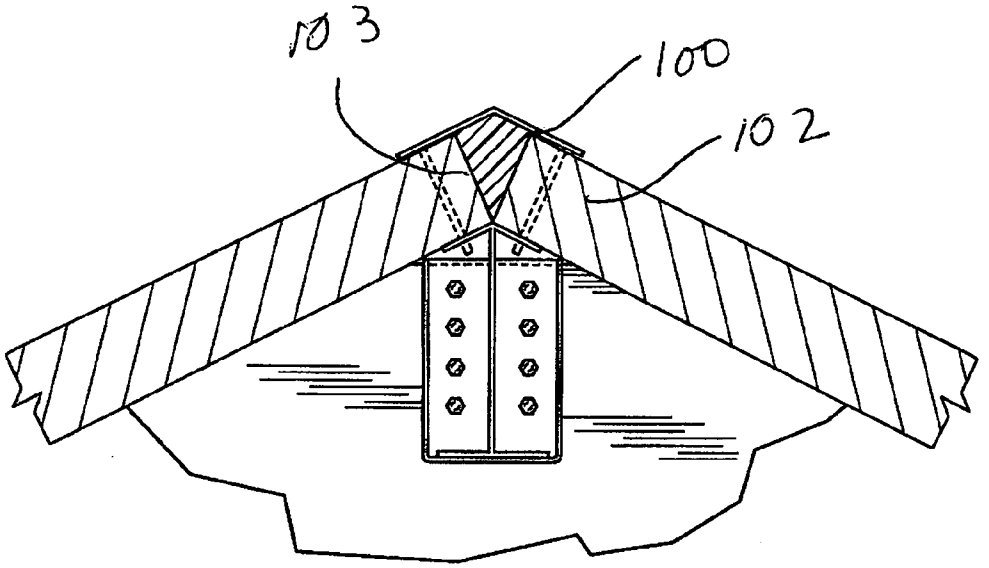
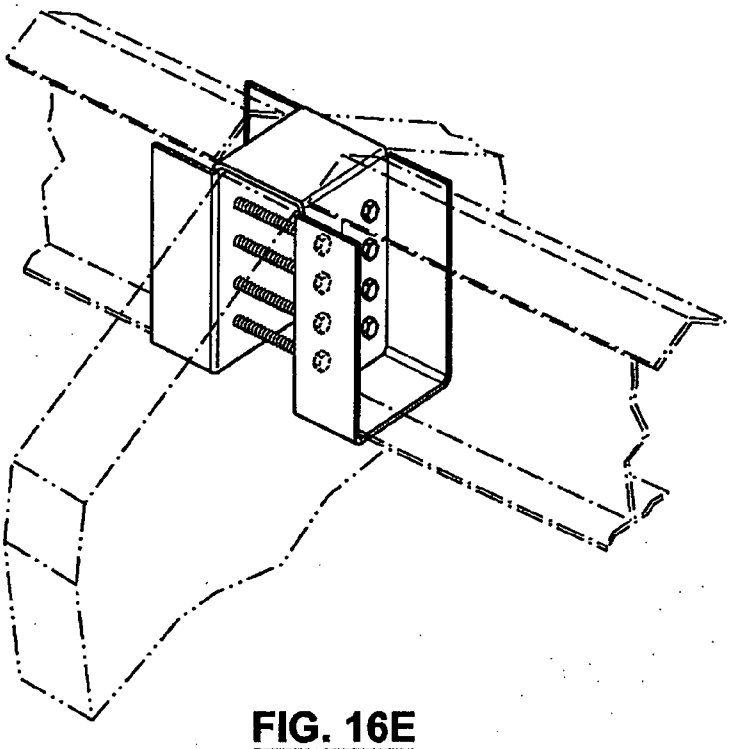


FIG. 16D



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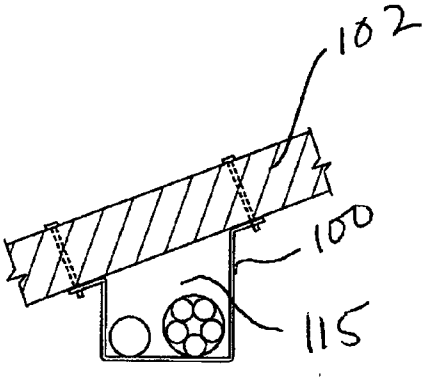


FIG. 17A

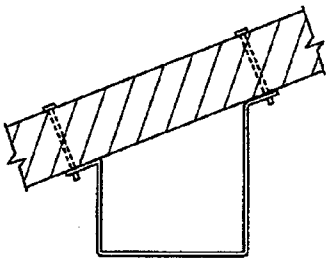
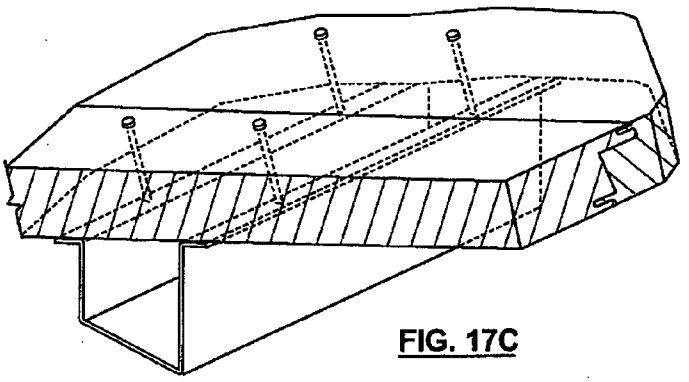


FIG. 17B



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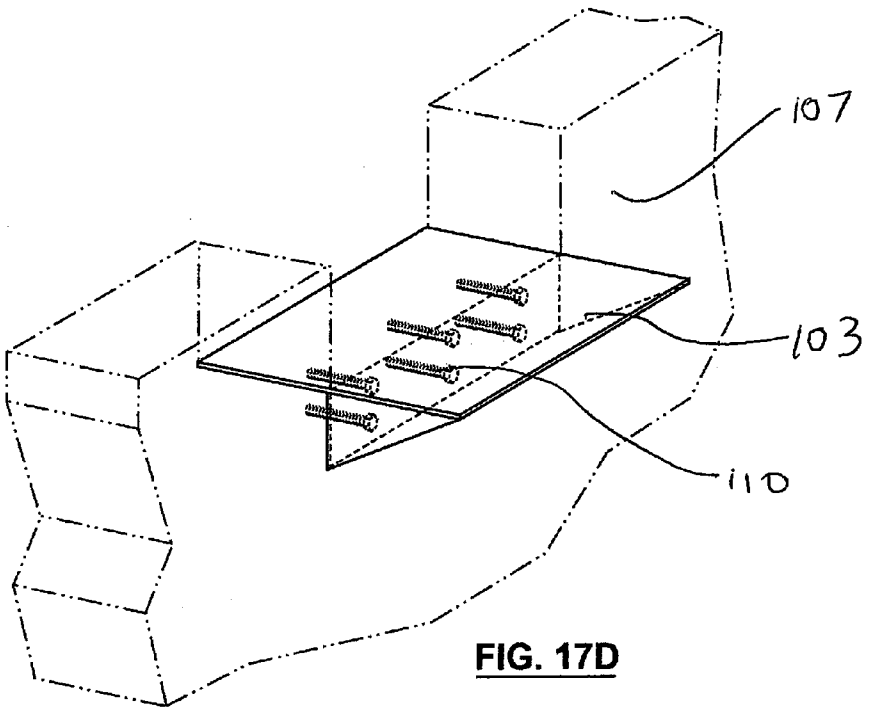

FIG. 17D

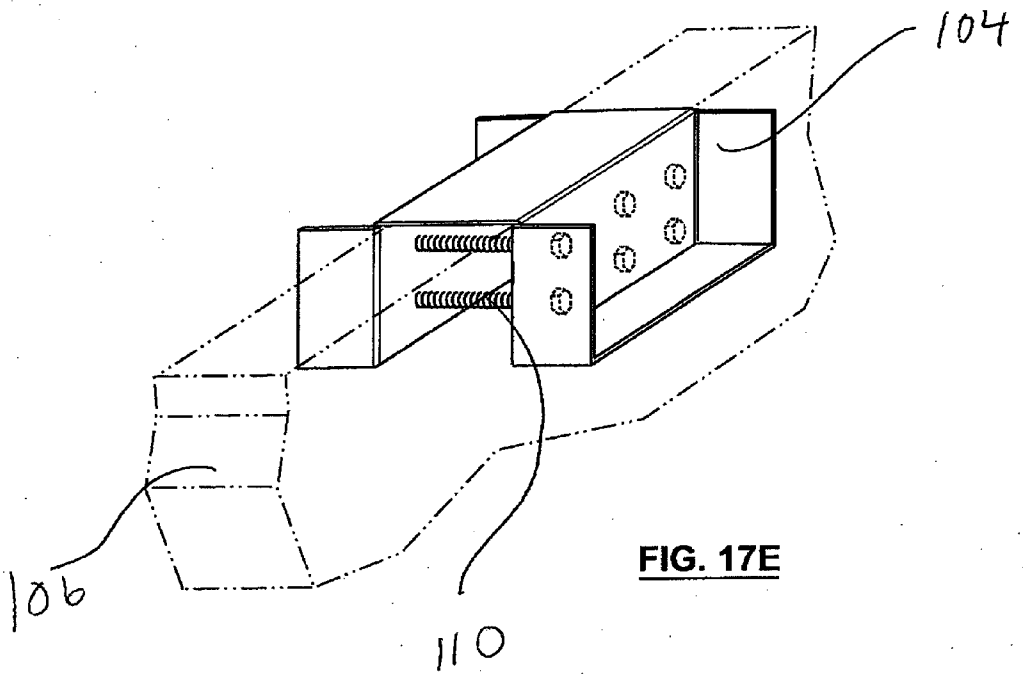

FIG. 17E

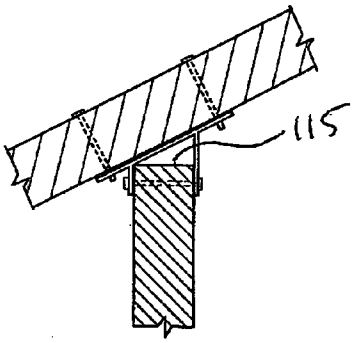

FIG. 18A

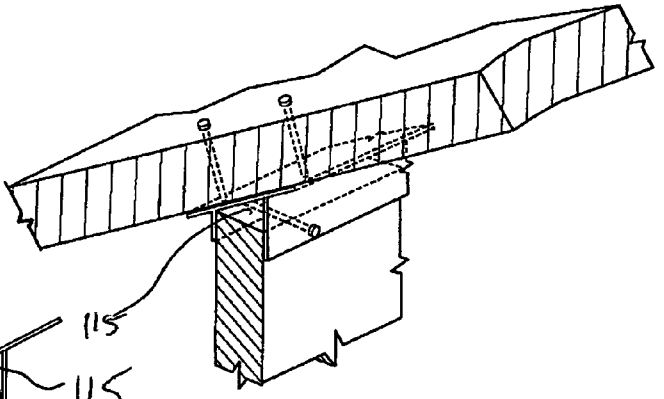

FIG. 18B

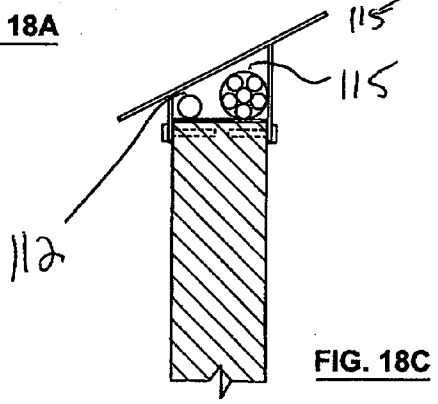

FIG. 18C

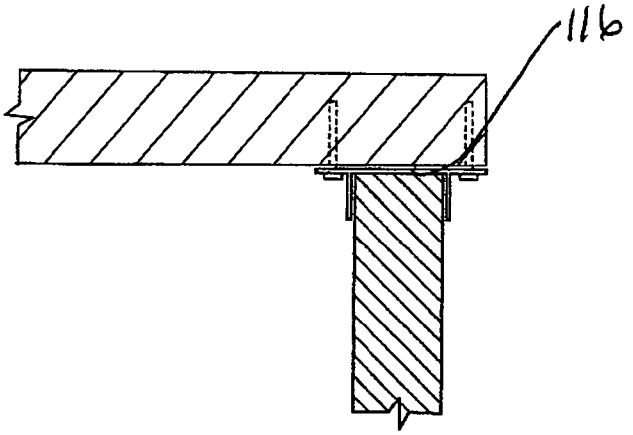

FIG. 19

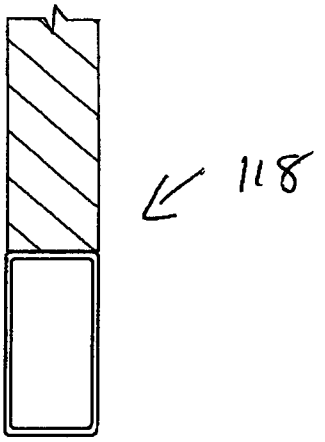

FIG. 20

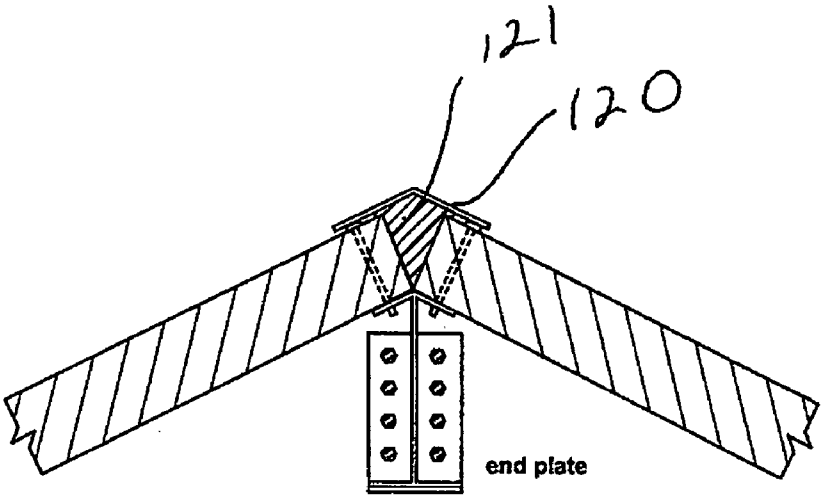

FIG. 21

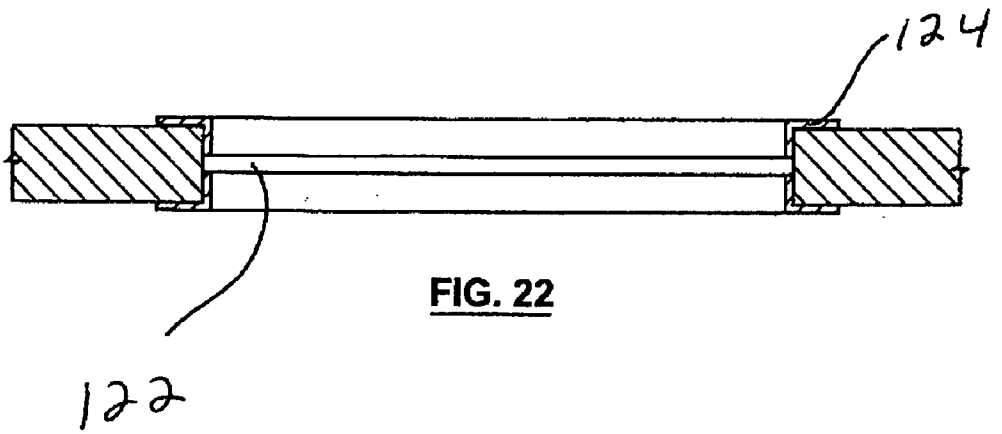

FIG. 22

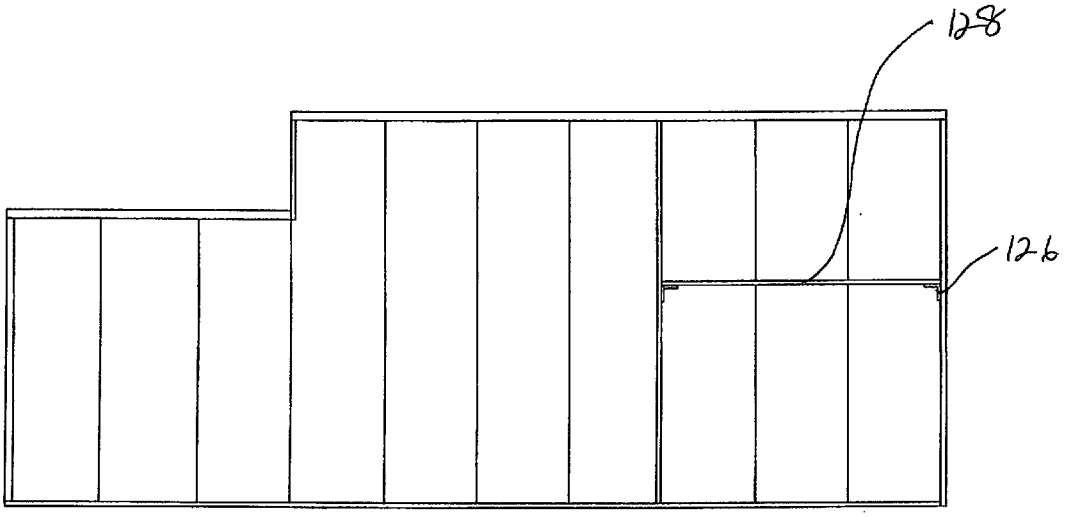

FIG. 23

MODULAR STRUCTURE

FIELD OF INVENTION

[0001] The present invention relates to a modular construction system. In particular, the invention relates to modular homes comprising prefabricated elements that can be quickly assembled.

BACKGROUND OF THE INVENTION

[0002] There is an increasing demand for affordable housing that can be constructed quickly. This is particularly true in some areas that have been hit by natural disasters. However, the need high quality homes at an affordable price extends to all areas. Most standard homes are made of brick, stone or wood on a wood frame. Framing a house is time consuming and often requires specialized equipment to, for example, lift heavy roof trusses. A major cause of delay in home construction is coordinating the work of various trades. Particularly in view of several recent natural disasters, there is an increasing demand for homes that can be constructed

[0003] To try and overcome some of the costs and time involved in on-site construction, various attempts have been made to prefabricate certain components of the house off-site and to use them to assemble a modular house.

[0004] For example, U.S. Pat. No. 6,349,509 discloses a prefabricated wall and roof unit. United States patent application 2007/0051059 describes a structural building system that uses standard material in a configuration that provides for high wind resistance.

[0005] There still remains a need for high quality modular homes that are indistinguishable from custom built homes and yet are affordable. Most previous modular homes have few architectural features and tend to be limited in options customized to a particular buyer.

SUMMARY OF THE INVENTION

[0006] The present invention addresses the need for an improved modular construction system by providing an alternative to wood or metal-framed structures.

[0007] According to an aspect of the present invention there is provided a modular construction system for housing, retail sites, offices and the like.

[0008] The system comprises a series of prefabricated wall and roof panels and a channel and beam system for assembly. The number of walls, the location of pre-cut windows and doors can be varied depending upon the model of home desired. The slope and orientation of the roof can also be varied and the appropriate channels can be provided as part of the building system. This represents an advantage of the present invention over previously known modular construction units, such as container type units that have a pre-set design.

[0009] In the present invention, the walls are load bearing and thus there is no need for wood framing. In addition to the advantages of cost saving and ease of construction, the elimination of a wood frame removes the possibility of mold and termites.

[0010] The modular system of the present invention comprises wall and roof structural insulated panels (SIP) and channels for receiving those panels. The panels may be from about 2 to 8 inches thick, preferably about 3 to 6 inches.

[0011] In a preferred embodiment, the panels are insulated metal panels. More preferably, the panels have a tongue and groove configuration for easy joining.

[0012] The shape of the channels depends on the role they play. The channels may include C-channels, L-channels, eave channels, gable channels, etc.

[0013] In a preferred embodiment the channels are galvanized steel channels.

[0014] C-channels typically form the floor channels, while L-channels are used at corners. In addition to channels, fastening systems such as brackets and adhesives may be used to secure panels in position.

[0015] At least one roof beam is also included.

[0016] At least two hat section beams are also typically included.

[0017] In one aspect of the invention, there is provided a modular building comprising: i) a foundation; ii) a plurality of C channels anchored on said foundation; load bearing panels inserted in said channels; at least one ridge beam; at least one set of hat beams; and connectors for connecting the various components.

[0018] In another aspect of the invention, a kit for the construction of a building is provided. The kit comprises prefabricated load bearing panels, a series of C channels for receiving the panels, at least one roof beam, a roof assembly set of adaptors, and instructions for assembly. In a preferred embodiment, the roof assembly set includes an eave channel, an exterior gable channel, a channel for attachment to the exterior walls, a ridge beam and at least one set of hat beams. In another preferred embodiment, the panels are prefabricated insulated panels. The panels are about 2 to 8 inches thick, more preferably about 5 inches thick. The kit typically further includes securing fasteners.

[0019] In yet another aspect of the invention, a method of building a modular unit is provided. The method comprises the steps of: i) laying a foundation; ii) anchoring a plurality of C-channels to the foundation; iii) sliding a series of load bearing panels along a C-channel; attaching a number of panels together to form a wall; securing intersecting walls with an L-bracket; installing a ridge saddle at the gable end and along interior walls; inserting a beam into the saddles and installing a hat saddle over the roof assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings wherein:

[0021] FIG. **1** is a plan view of a modular structure according to an embodiment of the present invention;

[0022] FIG. **2** is a view of one side of a modular structure according to an embodiment of the present invention;

[0023] FIG. **3** is a view of another side of modular structure according to an embodiment of the present invention;

[0024] FIG. **4** is a view of a third side modular structure according to an embodiment of the present invention;

[0025] FIG. **5** is a view of an internal wall of a modular structure according to an embodiment of the present invention;

[0026] FIG. **6** is a view of another internal wall of a modular structure according to an embodiment of the present invention;

[0027] FIG. **7** illustrates how an exterior wall of a modular structure can be attached to a foundation according to an embodiment of the present invention;

[0028] FIG. **8** illustrates how an internal wall can be attached to a foundation in a modular structure according to an embodiment of the present invention;

[0029] FIG. **9** illustrates a means for connecting corner walls in a modular structure according to an embodiment of the present invention;

[0030] FIG. **10** illustrates a means for connecting intersecting walls in a modular structure according to an embodiment of the present invention;

[0031] FIG. **11** is a perspective view illustrating connecting walls of a modular structure according to an embodiment of the present invention;

[0032] FIG. **12** is a perspective view illustrating how multiple walls can be connected in a modular structure according to an embodiment of the present invention;

[0033] FIG. **13** demonstrates how the load bearing panels join together;

[0034] FIG. **14** illustrates one type of fastening means for securing intersecting support channels and walls; in a modular structure according to an embodiment of the present invention;

[0035] FIG. **15** illustrates a fastening means for joining linear support channels and walls in a modular structure according to an embodiment of the present invention;

[0036] FIG. **16** A-C illustrate means for attaching a peaked roof in a modular structure according to an embodiment of the present invention;

[0037] FIG. **16** D-E illustrates one type of fastening means for attaching the roof support means;

[0038] FIG. **17** A-C illustrates how the roof is attached to the hat beam.

[0039] FIG. **17** D-E illustrates the hat saddles that supports hat beam on interior and exterior walls

[0040] FIG. **18** A-B illustrates the eave channel that attaches roof to exterior side walls and shows how they connect

[0041] FIG. **18** *c* illustrates how utility conduits can be formed in a modular structure according to an embodiment of the present invention;

[0042] FIG. **19** illustrates the exterior gable channel used to connect roof to gable end walls, similar to eave channel on exterior side walls

[0043] FIG. **20** illustrates the header to column and column to support header that carries load

[0044] FIG. **21** illustrates an embodiment of an end-plate for attaching a roof support;

[0045] FIG. **22** illustrates a window inserted into a wall of a modular structure according to an embodiment of the invention.

[0046] FIG. **23** illustrates the use of the 'L' channel being used to support an interior ceiling panel/or loft support.

DETAILED DESCRIPTION

[0047] The present invention provides a modular building system that is easy to assemble and avoids the cost and labor of framing and installation of roof trusses. While the description of a home building kit and its assembly is described below for exemplary purposes, it is apparent that the system can also be used to construct offices, stores and other buildings.

[0048] The modular building system comprises support channels, exterior and interior walls, structural & non-structural components, adhesives and fasteners. The components are preferably provided as a kit based on a pre-selected design. Alternatively, individual pieces may be selected to adapt to a particular consumers desires or requirements and to form a "custom" kit.

[0049] The walls comprise pre-fabricated panels. These panels are typically structural insulated panels that are load bearing when combined up to a length of about 15 to 30 feet or greater. Spans of about 16 to 18 feet are preferred. Each panel is preferably cut to a pre-determined specification including, for example, height, width, and openings for doors and windows. Of course, the panels can always be cut on site, but it is more efficient to provide standard models. The structural insulated panels typically range in thickness from 2 to 8 inches, more preferably from about 3 to 6 inches. A combination of panels having different thicknesses may be used on a single structure.

[0050] The support channels are preferably metal, although it is possible that other high strength materials may be used. Galvanized steel and aluminum channels have been demonstrated to be very effective. The channels may have various shapes depending on their location and function. These include C-Channel, L-Channel, Eave Channel, Exterior Gable Channel, Double Channel Section, Interior/Exterior Angle channels.

[0051] The modular building system also typically comprises an adhesive, a fastening system, usually bolts, and brackets or plates for securing the elements together. Galvanized steel and aluminum beams are also included.

[0052] The following is a description of a method for the assembly of a modular building system of the present invention. C-channels for both exterior and interior walls are affixed to a foundation. The exterior walls are formed by sliding a required number of prefabricated panels into the C-channels. The prefabricated panels typically have a tongue and groove construction to fit them together. Adhesive may also be used to seal the joints. At the corners, L-brackets are used to secure the two walls together. The exterior walls form a continuous perimeter. The interior walls meet up with the exterior walls and are supported by C-channel and L-channels. The panels for the interior walls are slid into the C-channels and affixed to each other. Next, a roof support is installed. This comprises beam that sits on plates in precut openings in the walls. A ridge hanger is installed at the gable ends. Hat hangers are installed over the interior walls. The roof support beams are then fitted into the ridge hangers and hat hangers. A more detailed description of the construction of an exemplary structure, a house, can be found in Example 1 below.

[0053] Referring now to the figures, a modular house in accordance with one aspect of the invention is shown. FIG. **1** is an overall top plan view illustrating exterior walls and interior walls fitted into anchored C-channels. The house **10** comprises exterior walls **12** and interior walls **14**. A roof beam **16** extends between two walls. FIG. **1** also indicates the locations of various features that are shown in subsequent figures.

[0054] FIGS. **2-4** show various sides of the house and indicate where further details can be found. As shown, the wall panels may include cut-outs for windows, doors, garage, etc.

[0055] FIGS. **5** and **6** show various aspects of internal walls. As can be seen, various cut-outs can be provided in the walls to obtain doors, columns, windows, etc, where desired. The wall **18** comprises a series of load bearing panels **20**. The wall panels may include pre-cut openings **22**. A ceiling support beam **24** spans the walls. A roof beam **26** is connected to

the top of the walls. The details of the connectors are shown in subsequent figures as indicated.

[0056] FIGS. **7** and **8** provide greater detail as to how the walls are installed. FIG. **7** illustrates attachment of an external wall and FIG. **8** illustrates an attachment of internal wall **29**. The house comprises a foundation **30**. This foundation may be a concrete slab, a wooden slab or any other suitable material. Alternatively, it may be a pre-existing basement. A C-channel **32** is attached to the foundation using an anchor **34**. Various types of fastening means, such as, but not limited to bolts, rods and threads, etc. may be used. A gasket **36** may be positioned between the c-channel and the foundation. This is particularly useful in exterior walls. A wall panel is slid into position along the C-channel **32**.

[0057] FIGS. **9** and **10** illustrate the securing of intersecting walls **40**, **42** in position using interior **44** and exterior **46** L-brackets. This provides for a very sturdy construction that is resistant to high winds.

[0058] The steps involved in forming the walls are shown in FIG. **11**. FIG. **11**A illustrates the installation of C-channels **50** on a foundation **52**, FIG. **11**B illustrates the positioning of wall panels **54** in the C-channels **50** and FIG. **11**C demonstrates the securing of walls. FIG. **12** illustrates the positioning of several walls **56**.

[0059] FIG. **13** illustrates how wall panels **60** fit together to form a single long wall. Each panel has a tongue side **62** and a groove **64**. Preferred wall panels are structural insulated panels such as those used for various commercial applications These type of panels have previously been used on large framed buildings, such as airplane hangars. Analysis in the course of the present invention provided the surprising result that these panels can be load bearing over significant lengths (i.e. up to more than 20 feet) in the absence of any external frame. A typical house according to the present invention comprises walls up to about 17 feet without the need for a frame.

[0060] FIGS. **14** and **15** illustrate how the channels **70** can be held in position. A plurality of bolts **72** are inserted through a plate **74** that spans two channels. Depending on the type and orientation of the channels to be joined, the configuration of the pre-cut holes **76** for the bolts may vary.

[0061] FIG. **16** illustrates the configuration for attaching the roof. The components include a ridge beam **80** as shown particularly in FIGS. **16** A-C. The ridge beam **80** has an elongated plate **82** that has a first set **84** of oppositely directed flanges at the lower end **86** and a second set **88** of oppositely directed flanges at the upper end **90**. The flanges **88** at the upper end **90** are downwardly projecting. As shown in FIG. **16** D, the ridge beam **80** that runs opposite to the roof pitch and its placement in 9 gable ridge hanger **92**. As shown in FIG. **16** E, illustrates the interior wall ridge hanger **94** that fit, over the interior walls. The ridge beam **80** fit between gable ridge hangers **92** and the interior ridge hangers **94** and are secured via fasteners **96**.

[0062] FIGS. **17** A-C-illustrates the hat beam **100** and how the roof **102** is attached to the hat beam. The hat saddle **100** runs opposite to roof pitch and its placement in the gable end hat saddle **103** (exterior gable end wall) and into interior hat saddle **104**. FIG. **17** D-E illustrates the hat saddle for both interior walls **106** and at the end **107** gable. The hat saddle **103** (exterior wall gable end) fit into a pre cut area and attached by the proper hardware. The hat saddle (interior wall) **104** fit over the walls and they are attached by the appropriate hardware **110**.

[0063] As shown in FIGS. **17** and **18** illustrates how both the eave channels **112** and hat beam can act as a conduit **115** for utilities such as electricity, cable/internet, central vacuum, etc.

[0064] FIG. **19** illustrates gable channel **116** that fits on top of gable wall and attaches roof to wall. This channel supports the roof along the gable ends.

[0065] FIG. **20** illustrates a miscellaneous beam **118** used for a floor to roof tie-down beam, also used for certain span, such as a header beam for a garage door opening

[0066] FIG. **21** illustrates the ridge cap **120** that is placed over the joining of the roof panels at peak and filled with foam insulation **121**.

[0067] FIG. **22** illustrates how a thermal break channel **122** can be inserted in an opening such as a window or door to prevent the transfer of heat or cold from the metal components in situations where the climate is extreme.

[0068] FIG. **23** illustrates the use of an 'L' channel **126** that is able to support an interior ceiling panel **128** or loft support.

[0069] The above disclosure generally describes the present invention. It is believed that one of ordinary skill in the art can, using the preceding description, make and use the compositions and practice the methods of the present invention. A more complete understanding can be obtained by reference to the following specific examples. These examples are described solely to illustrate preferred embodiments of the present invention and are not intended to limit the scope of the invention. Changes in form and substitution of equivalents are contemplated as circumstances may suggest or render expedient. Other generic configurations will be apparent to one skilled in the art. All journal articles and other documents such as patents or patent applications referred to herein are hereby incorporated by reference.

EXAMPLES

[0070] Although specific terms have been used in these examples, such terms are intended in a descriptive sense and not for purposes of limitation. Methods of construction referred to but not explicitly described in the disclosure and these examples are well known to those skilled in the art.

Example 1

Construction of Modular House

[0071] Phase 1 involves the foundation & channel layout. The steps are as follows:

[0072] Step 1: Foundation is constructed—concrete slab, basement, wood slab

[0073] Step 2: Exterior Perimeter and internal wall c-channels Bolted to foundation.

Phase 2 is the erection of the exterior walls according to the following steps.

[0074] Step 1: First panel slides into c-channel into starting position. Starting position is in a corner.

[0075] Step 2: Slide opposing corner piece, along the c-channel, to meet the first panel to create squared corner.

[0076] Step 3: Screw 'L' bracket on interior of corner to each panel Step 4: Screw 'L' Bracket on exterior of each corner.

[0077] Step 5: Apply adhesive to exposed panel side (tongue & grove).

[0078] Step 6: Slide next exterior wall panel along the c-channel into position-tongue and grove—adhere to previous panel.

[0079] Step 7: repeat step 5 & 6 till the first interior wall c-channel.

[0080] Step 8: Insert interior wall panel into interior c-channel, slide into place flush against the interior side of exterior wall panel.

[0081] Step 9: Screw "L" Brackets on both side of the interior wall panel, for support, to the interior of the exterior wall panel

[0082] Step 10: Apply adhesive to exposed side of Interior wall panel

[0083] Step 11: Slide next panel along the c-channel into position-tongue and grove.

[0084] Step 12: Repeat 5 to 11

Phase 3 is the installment of the roof support as follows:

[0085] Step 1: Install ridge saddle (exterior gable wall) into precut opening. Bolt into place with specified hardware.

[0086] Step 2: Install Ridge Saddle (interior wall) into pre cut opening on interior walls. Bolt into place with specified hardware.

[0087] Step 3: Install ridge beam (beam#1 main beam) into ridge saddles, this beam runs through the middle of the house.

[0088] Step 4: Install hat Saddle (exterior gable wall) into precut opening. Attach with proper hardware.

[0089] Step 5: Install hat saddle (interior walls) place over top of interior wall.

[0090] Step 6: Install hat beam inot the hat saddle. Attach with proper hardware.

Phase 4 relates to securing the parts of the structure together as follows:

[0091] Step 1: Each seam (where panels fit together) is screwed together. Using designated screws and engineered approved distances.

Phase 5 relates to providing utility services as follows:

[0092] Step 1: Each panel has wiring conduit prefabricated. All wires are to be installed according to the wiring schematics. Also have cable/internet, phone, central vacuum and alarms installed. All installed prior to installing roof

Phase 6 relates to the Eave Channel Conduit Section. The steps are:

[0093] Step 1: Place eave channel on exterior sidewalls (custom design with roof pitch) built in electrical conduit.

[0094] Step 2: Run electrical wires in conduit before fastening eave channel permanently to wall panels.

Phase 7 involves installation of an Exterior Gable Channel.

[0095] Step 1: Place exterior gable channel to both gable ends of the house. Attach with proper fasteners.

Step 8 is the installation of roof panels and the ridge cap. The steps are:

[0096] Step 1: Slide roof panel into position and using the proper screws and specified bolts, attach the panels to beam support (Beam #1, 2, 3, 4)

[0097] Step 2: Apply adhesive/sealant to grove & tongue section on each roof panel

[0098] Step 3: Install foam insulation where the two roof panels meet at the exterior peak

[0099] Step 4: Place ridge cap into place and fix with the proper fasteners.

Step 9 is the installation of an interior corner angle and interior ceiling/wall connection as follows:

[0100] Step 1: Interior corner angles are attached to the interior wall to ceiling connection. These connections are support connections.

Step 10 is directed to installing interior corner angles around window & door openings.

[0101] Step 2: Install interior corner angle (L channel), one on the exterior and one on the interior side for window and door attachment.

[0102] Step 3: Place interior corner angles one to each side leaving a space of 1" (one inch), which eliminates the thermo, break.

Example 2

Insulation of a Thermo Break

[0103] 1. Base bottom channel running around the perimeter of the house. The base channel must be flashed. The flashing cavity is to be 1½" deep and must be insulated to minimum R-19. Flash per detail drawings.

[0104] 2. Eave channel/sidewalls to Roof. This area must be flashed as well, leaving a cavity of at least 1½" (one and one half inch) and insulated minimum R19.

[0105] 3. The exterior gable channel, this area also must be flashed using the same procedure and insulated to minimum of R-19.

[0106] One or more currently preferred embodiments have been described by way of example. It will be apparent to persons skilled in the art that a number of variations and modifications can be made without departing from the scope of the invention as defined in the claims.

What is claimed is:

1. A modular building comprising: i) a foundation; ii) a plurality of C channels anchored on said foundation; load bearing panels inserted in said channels; at least one ridge beam; at least one set of hat beams; and connectors for connecting the various components.

2. A building according to claim **1** wherein a plurality of load bearing panels are attached to form a plurality of walls.

3. A building according to claim **2** wherein the walls comprise both exterior and interior walls.

4. A building according to claim **2** wherein the walls comprise prefabricated insulated panels.

5. A building according to claim **2** wherein the panels are connected via a tongue and groove mechanism.

6. A building according to claim **2** wherein intersecting walls are supported at right angles using L brackets.

7. A kit for the construction of a building, said kit comprising prefabricated load bearing panels, a series of C channels for receiving the panels, at least one roof beam, a roof assembly set of adaptors, and instructions for assembly.

8. A kit according to claim **7** wherein the roof assembly set includes an eave channel, an exterior gable channel, a channel for attachment to the exterior walls, a ridge beam and at least one set of hat beams.

9. A kit according to claim **7** wherein the panels are prefabricated insulated panels.

10. A kit according to claim **7** wherein the panels are about 2 to 8 inches thick.

11. A kit according to claim **7** wherein the panels are about 5 inches thick.

12. A kit according to claim **7** wherein the kit further includes securing fasteners.

13. A kit according to claim **12** wherein the fasteners are bolts.

14. A kit according to claim **12** further comprising supporting brackets or plates.

15. A method of building a modular unit, said method comprising: I) laying a foundation; ii) anchoring a plurality of C-channels to the foundation; iii) sliding a series of load bearing panels along a C-channel; attaching a number of panels together to form a wall; securing intersecting walls with an L-bracket; installing a ridge saddle at the gable end and along interior walls; inserting a beam into the saddles and installing a hat saddle over the roof assembly.

16. A method according to claim **15** wherein the panels are attached via a tongue and groove mechanism.

17. A method according to claim **15** wherein the panels are affixed to each other with glue.

18. A method according to claim **15** wherein the wall has a length of about 15 to 30 feet.

19. A method according to claim **15** wherein the wall has a length of up to about 17 feet.

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