Sept. 26, 1961 R. K. McBERTY 3,001,613

INTERLOCKING METAL BUILDING PANEL

Original Filed July 24, 1952 2 Sheets-Sheet 1

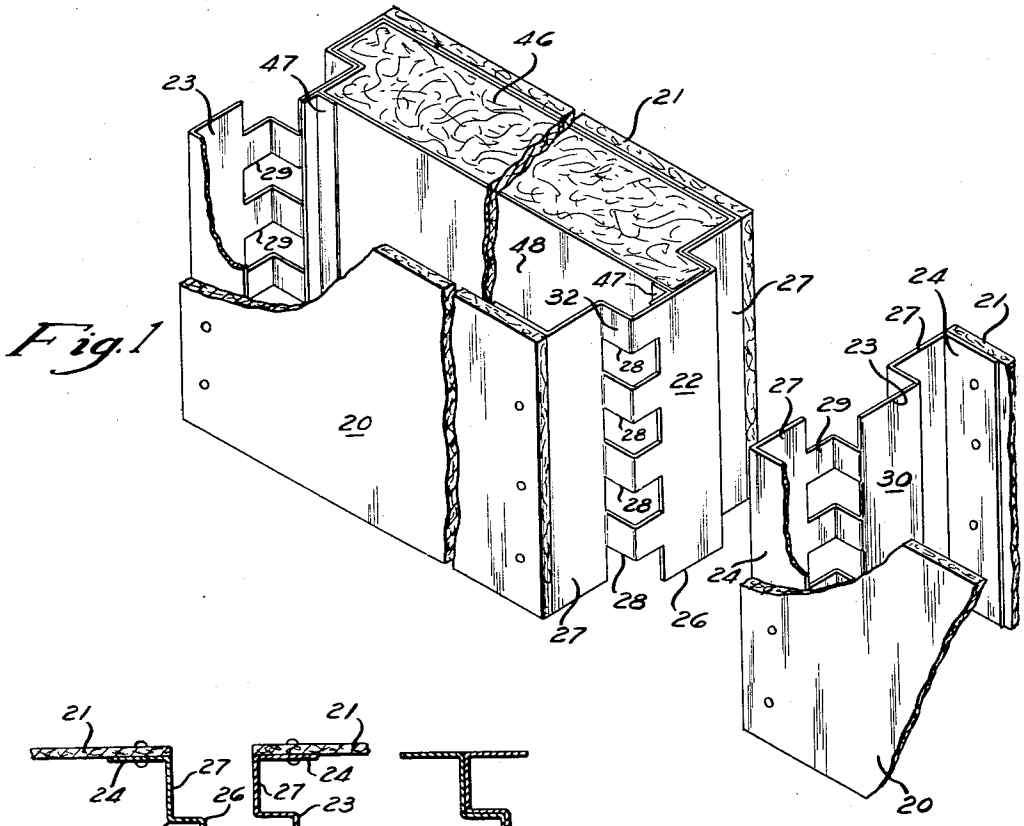


Fig. 1

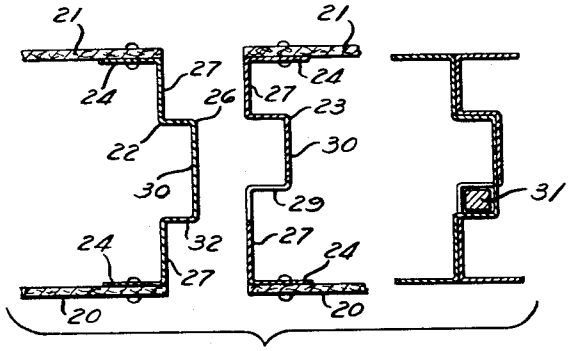


Fig. 2

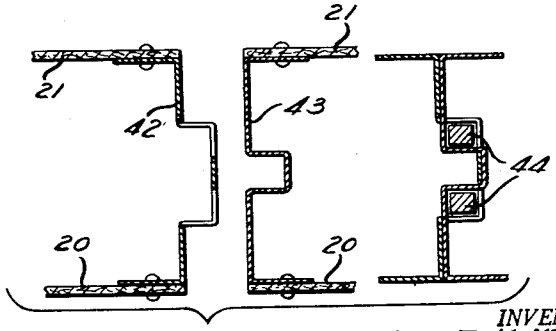


Fig. 3

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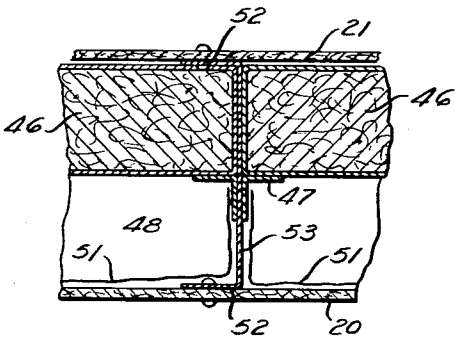


Fig. 4

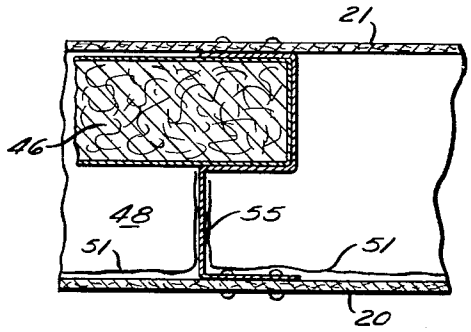


Fig. 5

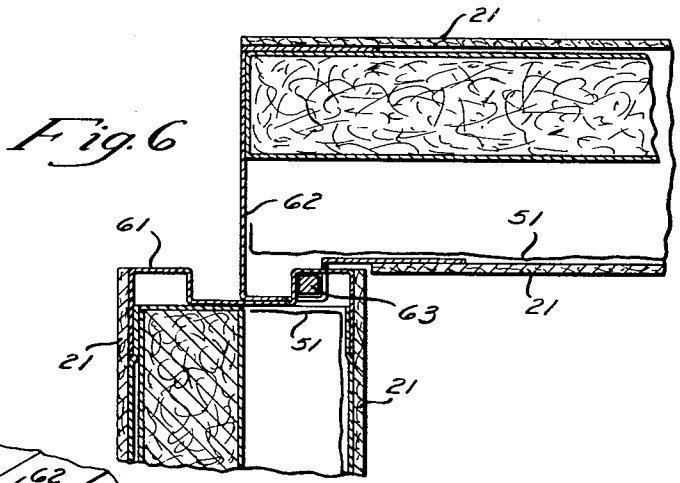


Fig. 6

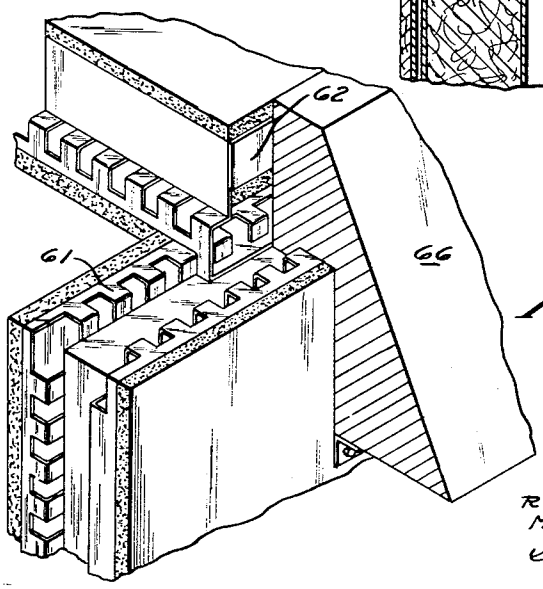


Fig. 7

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INTERLOCKING METAL BUILDING PANEL

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5 Claims. (Cl. 189—34)

This invention relates to building structures and more particularly to an interlocking panel device and this is a divisional application directed to the interlocking panel construction shown and described in my copending application Serial No. 300,663, filed July 24, 1952, now Patent No. 2,845,150.

For some time there has been a great deal of work directed toward developing building structures wherein mass production and prefabricated construction could be utilized to reduce the cost of the resulting structure. In the past it has been found necessary to employ heavy material to provide wall panels having the strength necessary to satisfy the requirements of building structures and which are lasting and adequately insulated. It is an important object of this invention to provide a panel having a relatively large surface area which is light in weight, easy to assemble, low in cost, and which provides adequate strength and serviceable characteristics without additional framing.

These panels are composed of relatively thin sheet metal frames of a size convenient for walls, roofs, or partitions surfaced with suitable sheets of organic or inorganic materials having durable properties. By utilizing thin metal for the frames there is a substantial saving in the cost of the metal as well as a saving in the initial cost of the production equipment; however, most important is the influence on the design of the panel itself. The thin metal angles and channels formed in the various shapes contemplated for the frames have comparatively little strength unless their flanges are prevented from buckling. In this invention the wall surface material is securely fastened to the flanges by any suitable means and by virtue of the stiffness of the wall surface material the thin sheet metal flanges are materially strengthened so it is another object of this invention to provide building panels wherein the strength of the sheet metal frame is materially increased due to the stiffness of the surface sheet.

In a building structure all forces can be resolved into three fundamental forces or stresses to which any element of the structure is subjected. Two of these forces are in the plane of the wall or roof elements and the third force is perpendicular to the plane of the elements. If the structure is unable to support any one of these three fundamental forces the entire resulting structure is completely unsatisfactory so it is another object of this invention to provide building panels which may be easily assembled and which provide adequate strength both in the plane of the panels and perpendicular thereto.

In the design of the panels the metal thickness should be held to a minimum compatible with the expected load since the metal frame engages both the inside and the outside wall of the resulting structure thereby providing a path for heat dissipation between the two walls. In the past it has been quite common that walls containing metal elements develop cold spots on the wall adjacent to the metal causing condensation at these points.

It is a further object of my invention to provide a panel interlocking wherein one edge of a rectangular panel is provided with a re-entrant channel parallel to the edge and an opposite edge of the same panel is provided with a projecting rectangular channel wherein the re-entrant channel is narrower by a predetermined amount than the projecting channel and wherein one edge of the re-entrant channel is notched and a complementary edge of the projecting channel is notched so that a portion of the re-entrant channel is encompassed by the projecting channel and wherein the embraced portion receives a locking bar whereby the abutting end edges of such panels reinforce each other to resist bending forces. The metal framing must pass through this relatively warm space so the temperature of that portion of the metal frame in contact with the inner surface is relatively close to the room temperature so no condensation takes place on the inner wall surface. It, of course, follows that a thinner metal frame will conduct less heat so it is extremely important to use metal which is as thin as possible while still meeting the requirements of strength and stiffness.

It is of primary importance that the panels may be assembled into a complete structure with as much ease as possible while still providing versatility of building design, so it is a still further object of this invention to provide building panels which may be easily assembled and combined in a variety of ways while still satisfying the above objects.

To prevent moisture condensation on the insulating material a moisture or vapor barrier is placed along the inner panel surface adjacent to the air space. This structure will prevent the flow of vapor from the warm room into the air space preventing any condensation within the panel itself.

The relationship between the metal thickness, the insulation thickness, and the air space width may all be varied so as to provide a panel which will meet all the climatic conditions to which the building structure might be exposed.

A preferred method of interlocking adjacent panels is to insert metal rods through metal loops disposed along one panel edge projecting through holes properly spaced to receive them in the adjacent panels. Roof panels are fastened to the tops of the wall panels in the same way by sliding rods through the metal loops in the roof panel after they have been projected through holes in the wall panel. Similar frames with interlocking loops and rods are used between the individual roof panels.

The wall, roof, and partition panels of this design are intended to be used without any supporting frame other than that within the panels. The sheet metal members of the frame consisting in general of channels, angles or U-shaped members constitute the sides, top, and bottom of the frame and are securely fastened to each other at their point of contact thereby providing greater strength. Additional thin metal reinforcing members may be placed between the side sheets to increase resistance to the stresses to which the panels may be subjected. These internal reinforcing members may also be employed to hold the insulating material in place within the panel.

The wall panels are constructed with their two major surfaces substantially parallel to each other while the roof panel may be formed with the outer surface diverging from the inner surface to provide a slope to assist the shedding of water. Alternatively, a false top surface may be superimposed on a relatively flat roof surface to give greater slope and to eliminate the flat roof appearance. The particular shapes of the frames and the reinforcing members found most satisfactory will be discussed in detail later.

The foregoing and other objects and advantages will become apparent in view of the following description taken in conjunction with the drawings, wherein:

FIG. 1 is a perspective view of a panel with portions cut away for clarity of illustration;

FIG. 2 is a plan view of one embodiment of the interlocking frame members;

FIG. 3 is a plan view of another embodiment showing one alternative form of the interlocking frame members;

FIGS. 4 and 5 are plan views of a portion of a panel

showing two embodiments of the thin metal reinforcing members;

FIG. 6 is a vertical view showing a method of attaching a wall panel to a roof panel; and

FIG. 7 is a perspective view of an assembled wall and roof panel showing a preferred eave member for use in conjunction with the panels.

A preferred panel made according to this invention embodies two side sheets of rigid material held in a space relationship by thin metal framing, insulation material positioned adjacent to the outer side sheet and spaced from the inner side sheet providing dead air space between the insulation and the inner side sheet, and a suitable moisture or vapor barrier located adjacent to the inner side sheet to prevent vapor from passing from a room formed by the panels into the panels. When necessary thin metal reinforcing elements may be added to the panel to increase the strength and stiffness and to help secure the insulation material. The interrelationship of these elements may be varied considerably to provide panels for a variety of types of structures.

The inside sheet member **20** and the outside sheet member **21** may be formed of any suitable material which is characterized by rigidity, durability, and light weight. Such materials as plywood, pressboard, or asbestos cement have all been found satisfactory; however, the preferred sheeting material is asbestos cement sheets.

A thin metal frame is secured to the side sheets **20** and **21** along their edges to hold the sheets in a fixed space relationship. In the preferred embodiment these frame elements are formed with interlocking means to provide for the attachment of adjacent panels in the completed building. These thin metal frames which may have a variety of shapes are positioned around the edges of the sheets **20** and **21** and in a preferred embodiment are composed of a male frame member **22** and a female frame member **23** formed so they may be interlocked with the mating frame member of the adjacent panel. It should be understood that in a complete panel the frame elements are positioned along all four edges but for the sake of illustration only the end frame members are disclosed in FIG. 1.

FIG. 2 is a plan view of the frame elements shown in FIG. 1 wherein the flanges **24** are attached to the side sheets **20** and **21** by any suitable means. By securely fastening the flanges to the side sheets the frame members are substantially strengthened and thereby prevented from buckling under load. The male frame element **22** is formed with a rectangular projection **26** connected to the flanges **24** by the webs **27**. Openings **28** are formed along one edge of the rectangular projection **26** to provide for interlocking with the female frame element **23**. The female frame element **23** is formed with a rectangular recess having a depth substantially equal to and narrower than the projection **26**. Openings **29** are formed in the female frame element **23** with an intermediate relationship to the openings **28**. When the male frame element **22** and the female frame element **23** are moved axially together as shown in FIG. 2, loops are formed by the portion of the respective elements which project through the respective openings **28** and **29**. A locking bar **31** is then inserted through these loops securing the two frame elements and preventing any relative motion.

In practice it has been found that by fabricating the panels from sheets having a thickness from 3/16 to 1/4 inch and thin metal frame elements of a thickness of approximately 20 gauge that a panel having surface dimensions of 10 feet by 2 feet will support a load up to 1 ton in the middle of the panel when the panel is supported at its ends. This phenomenal strength is due to the fact that the sheets prevent buckling of the frame elements, and the frame elements prevent bending of the sheets with the result that the strength of the resulting panel far exceeds the strength of either of the elements alone.

By referring to FIG. 2 it can be seen that this method of locking the two frame elements together provides a joint rigid in the plane of the panels and a plane perpendicular thereto. Vertical stresses within the plane of the panels are absorbed by the interlocking loops which prevent anly relative vertical motion between adjacent panels. Horizontal compression stresses within the plane of the panels are absorbed by the webs **27** and the end walls **30** of the extensions and recesses which engage corresponding surfaces on adjacent panels preventing any relative horizontal movement therebetween. Any horizontal tension force between adjacent panels is, of course, absorbed by that portion of the webs **27** and the walls **30** which engage the locking bar **31**. Forces perpendicular to the plane of the panels are absorbed by the side walls of the male extension and the female recesses.

Forces perpendicular to the plane of the wall have always been most troublesome in the type of construction employed herein but, as mentioned above, the forces perpendicular to the plane of the panels are absorbed by a surface contact between side walls of the male and female extension and recesses, so the resulting joint has satisfactory strength to resist these stresses.

A panel fabricated according to this invention is therefore capable of withstanding all forces to which it may be subjected without the need of reinforcing skeleton structure or framing other than that contained within the panel itself.

In another embodiment of the frame elements disclosed in FIG. 3 the male frame element **42** is interlocked with the female frame element **43** so that two sets of loops are formed. In this embodiment, two locking bars **44** are inserted through the respective loops to permanently attach the two frame elements. The structure of this embodiment is quite similar to the one disclosed in FIG. 2 so it is not necessary to give a detailed description of the interlocking means. This embodiment provides a stiffer joint between the adjacent panels and it should be used when the added strength is necessary.

Insulating material **46** is placed adjacent to the outer side sheet **21** and may be secured in place by a variety of methods. If sheet insulation is used flanges **47** may be attached to the frame members to assist in holding the insulating material in place. It is important when making a panel according to this invention that the insulating material be spaced from the inner side sheet **20** to provide an air space **48** adjacent to this side sheet. If loose insulating material is used a suitable thin restraining wall may be provided to hold the insulation in place and prevent it from filling the air space **48**.

Referring particularly to FIG. 2 of the drawings, it will be noted that one vertical edge of the panel **20** is provided with a projecting channel with its side walls normal to the plane of the metal frame member **27** and that this channel has a width which exceeds the width of a complementary re-entrant channel in the next adjacent panel. The projecting channel is notched along one edge as at **28** by cutting out the corner portions of the channel and such notches receive complementary portions of the re-entrant channel on the next adjacent panel. The result is a sort of paradox in that by this arrangement a reentrant channel receives a projecting channel which is wider than the re-entrant channel. The difference in the width of the channels is taken up by the complementary interlocking portions so that portions **29** of the re-entrant channel enter and are embraced within the chamber formed by the projecting channel. Similarly the portions of the projecting channel extend into the chamber between one wall **20** of the panel and the re-entrant channel. The complementary interlocking portions form a square pocket parallel to the faces of the panel and thus the locking bar **31**, arranged to extend through this square pocket, locks the panels to

each other and provides a mutual reinforcing of the two panel edges.

It will be noted that any bending force applied to one panel is transmitted through the locking bar **31** so as to transfer a part of the bending load to the frame **27** of the next adjacent panel. This is to be distinguished over prior art panel interlocking devices, many of which resemble a piano hinge in construction, and wherein all of the bending portions must be taken by the interlocking bar. According to my invention the nesting of the rectangular edge portions, particularly wherein a wide projecting channel is housed within a narrow re-entrant channel, distributes all of the bending forces so that each frame member is required to carry half of the bending load. This results in the thin sheet metal of the frame members being fully stressed and provides a low cost, efficient assembly.

The form of interlocking shown in FIG. 3 corresponds generally to the structure and mode of operation of the form of FIG. 2 except that the re-entrant channel is about one-third the width of the projecting channel and both sides of the re-entrant channel are notched so that both sides of the projecting channel may be accommodated. This form permits the use of two locking bars **44** and thus provides spaced lock means resisting turning movement of one panel with respect to its adjacent panel along an abutting edge.

Since the air space **48** is insulated from the outer side sheet **21** and adjacent to the inner side sheet **20**, the air space tends to assume a temperature closely associated with the temperature of the inner side sheet **20**. Again, since the frame elements pass through the air space **48** that portion of the frame element adjacent to the inner side sheet **20** tends to assume a temperature closely associated with the temperature of the air space **48** and consequently of the temperature of the inner side sheet **20**. This is very important for if the flange **24** which is in engagement with the inner side sheet **20** were too cold it would cause cold spots on the inner side sheet resulting in condensation. By employing the construction having insulation and an air space through which the metal frame elements pass, it is possible to eliminate condensation on the inner side wall which has been troublesome in the past in walls containing metal elements.

A vapor barrier **51** is placed along the surface of the inner side sheet **20** to prevent the flow of moisture through this sheet into the panel thereby preventing any condensation within the panel itself. Any suitable material may be used for this vapor barrier but aluminum foil or plastic sheeting has been found very satisfactory.

When the size of the panels is such that added rigidity is necessary, reinforcing elements formed of thin metal may be added. FIGS. 4 and 5 show two embodiments of these reinforcing elements wherein the flanges **52** are attached to the side sheets by any suitable means. In FIG. 4 the reinforcing element **53** is provided with intermediate flanges **47** which assist in the securing of the insulating material **46** and also serve the second function of providing fins on the reinforcing element which are exposed to the air space **48** thereby assisting in bringing the temperature of that portion of the reinforcing element **53** within the air space **48** into close relationship with the temperature of the air space **48**. The exact shape of the reinforcing elements is not critical to this invention so long as the element adds support to the side sheets and has a substantial area within the air space **48**. In FIG. 5 an alternative form of reinforcing element is shown wherein the element **55** is formed roughly in the shape of an **S**. It is important that both the frame elements and the reinforcing elements be made from metal as thin as possible compatible with the load and stresses to be encountered by the completed panel, since a thin element will present more resistance to heat flow through the element itself thereby reducing heat loss in the panel.

FIGS. 6 and 7 disclose a method of attaching the roof panels to the wall panels wherein a frame element **61** having projecting loops and openings similar to the female frame element **43** shown in FIG. 3 is attached to the top edge of the wall panel. A roof panel frame element **62** is attached to the roof panel as disclosed in FIG. 6 providing interlocking engagement with the frame element **61** and, in conjunction with the frame element **61**, provides loops through which a locking bar **63** is inserted in the same manner as the locking bar **31** shown in FIG. 2. Similar loops are formed along the surface of engagement between adjacent roof panels and locking bars are provided within these loops to secure the adjacent roof panels. It is desirable to provide an interlocking means between adjacent roof panels which can be assembled by motion perpendicular to the plane of the panels as shown in FIG. 7. The roof panels may include insulating material, air spaces and vapor barriers and may have reinforcing elements if added strength is necessary. An eave member **66** may be provided having a frame element similar to the frame element **62** for locking the eave in place.

It is desirable when assembling a structure incorporating panels of the nature disclosed herein to stagger the joints between adjacent panels to increase the strength of the resulting structure. Since all of the panels employed are interlocked on all edges, the resulting roof and wall surfaces effectively become large unitary surfaces and any force on a given surface is distributed over the entire surface, thereby creating a structure of satisfactory strength. It can be seen that a building may be erected easily and quickly from panels disclosed herein without the need of separate framing and the structure will have sufficient strength to resist any stresses to which it might be subjected.

Windows and doors may be incorporated in the building structure fabricated according to this invention by either forming panels with integral doors or windows or by assembling a building structure wherein appropriate panels are eliminated to provide the necessary openings. Since the interlocking elements described above provide support capable of withstanding all forces to which the joint might be subjected, the panels located above the window and door openings have adequate strength even though they do not rest on the foundation of the building.

Having completed a detailed description of a preferred embodiment of the present invention so that others skilled in the art may be able to understand and practice the same, I state that what I desire to secure by Letters Patent is not limited by said preferred embodiment but rather is defined in what is claimed.

What is claimed is:

1. A panel for building structures comprising spaced inner and outer walls secured to each other by means of metal frames secured to the edges of said walls, one edge of said panel having a metal frame with edge portions immediately adjacent each of the panel walls disposed normal to the panel walls and an intermediate portion in the form of a rectangular projecting channel spaced from said inner and outer walls, said panel having a frame member at its opposite edge provided with edge portions normal to the panel walls and an intermediate portion in the form of a re-entrant rectangular channel spaced from said inner and outer walls, said re-entrant rectangular channel having a web normal to the panel walls that is narrower than the corresponding web on the projecting channel, one edge of said re-entrant channel being notched to provide a series of openings extending parallel to the panel walls and the corresponding edge of the projecting channel being notched to provide portions adapted to enter the openings in the re-entrant channel in a similar adjoining panel whereby the projecting channel is embraced by and housed within said last-mentioned re-entrant channel and defines therewith a pocket for receiving a locking bar.

2. In a building panel an outer wall sheet member, a spaced parallel inner wall sheet member, a metal frame secured along one edge of the inner and outer sheets and maintaining said sheets in spaced relation, a second metal frame member secured to said inner and outer sheets parallel to the first frame member and along an opposite edge of the sheets, said first frame member having a channel projecting therefrom beyond the edges of the sheets, said second frame member having a re-entrant channel disposed inwardly of the edges of the said inner and outer wall sheet members, said projecting channel having a width exceeding the width of the re-entrant channel, and means to secure the projecting channel along the edge of one panel within the re-entrant channel along the edge of an adjoining panel comprising spaced slots along a corner of the projecting channel which is spaced from both said outer and inner wall sheet members and alternately spaced slots along the corresponding corner of the re-entrant channel which is spaced from both said outer and inner wall sheet members, whereby said corners are adapted to interfit with each other so as to define a pocket spaced from both said outer and inner wall sheet members for receiving a locking member extending parallel to the channels.

3. A building panel as defined in claim 2 wherein the projecting and re-entrant channels are both spaced from said outer and inner wall sheet members and are rectangular and of the same depth.

4. A building panel in accordance with claim 2 wherein both the projecting and re-entrant channels are spaced from said outer and inner wall sheet members and are rectangular and the width of the projecting channel exceeds the width of the re-entrant channel by an amount corresponding to the depth of the channels.

5. A building panel according to claim 2 wherein both the projecting and re-entrant channels are spaced from said outer and inner wall sheet members and are rectangular and the width of the projecting channel exceeds the width of the re-entrant channel by an amount corresponding substantially to the depths of the channels to provide a square opening in the overlapping slotted portions of the channels for receiving a square locking member extending parallel to the channels through said overlapping slotted portions.

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