United States Patent [19]

Wilson

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[45] **Jan. 7, 1975**

[54] **DEMOUNTABLE BUILDING**

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[21] Appl. No.: **406,556**

Related U.S. Application Data

[63] Continuation of Ser. No. 215,034, Jan. 3, 1972, abandoned.

[52] **U.S. Cl.** ..... **52/81,** 52/615, 52/656, 52/DIG. 4, 52/753 K, 52/589

[51] **Int. Cl.** **E04b 1/32**

[58] **Field of Search** ..... 52/616, 588, 81, 615, 82, 52/656, 753 K

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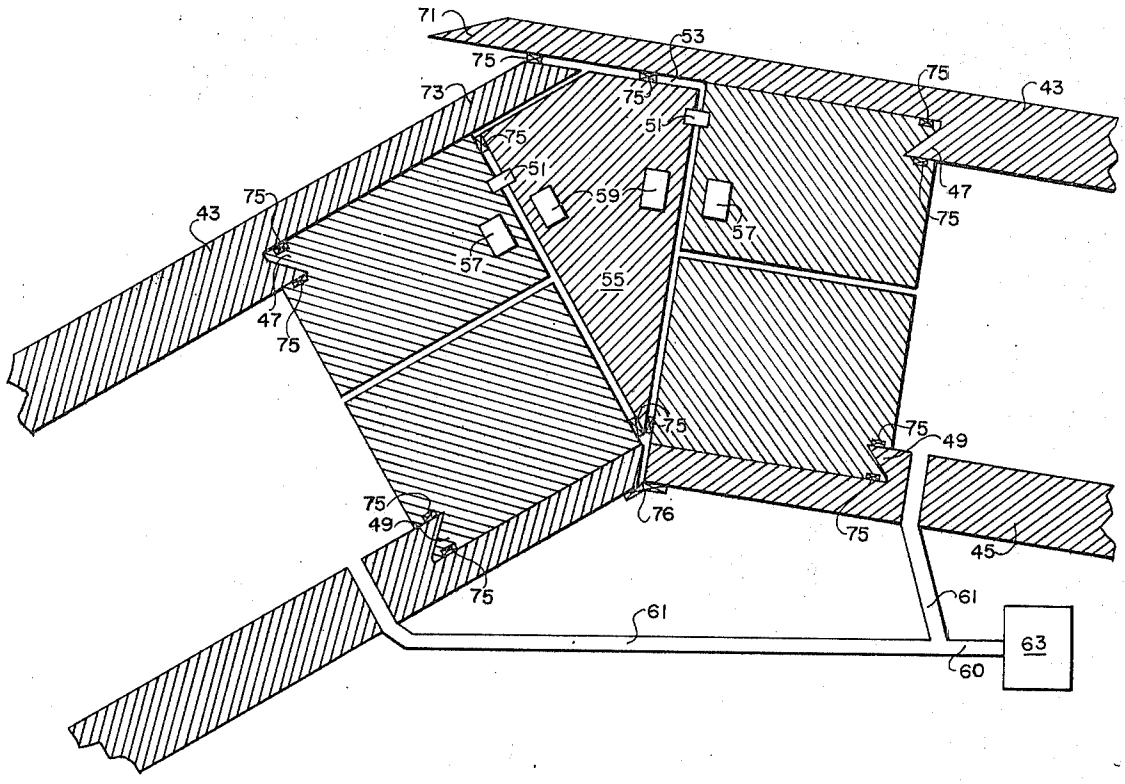
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Assistant Examiner—Henry Raduazo
Attorney, Agent, or Firm—Warren F. B. Lindsley

[57] **ABSTRACT**

A demountable modular dwelling structure formed of individual detachably interlocking panels. Each panel is formed by joining at least three frame members end-to-end to define a framework. Each of the framing members has a cutaway part and an overhanging part at each end. The cutaway and overhanging parts mate with like parts of the adjoining framing member defining a cavity within the joint. Pin means restrain lateral movement between the joint members. The frame members are grooved to receive siding panels which lock within the grooves and maintain the frame members in proper angular relationship.

9 Claims, 8 Drawing Figures



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3 Sheets-Sheet 1

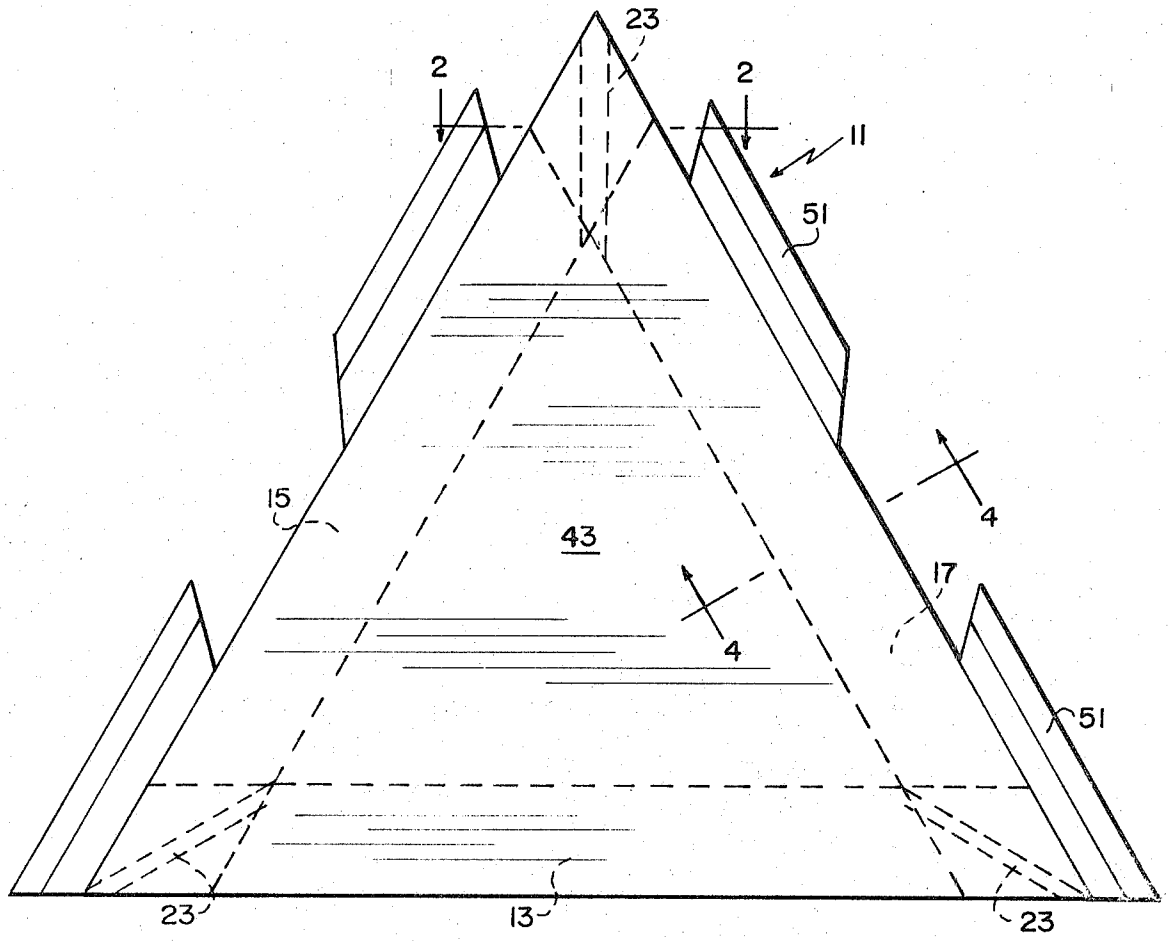


Fig - 1

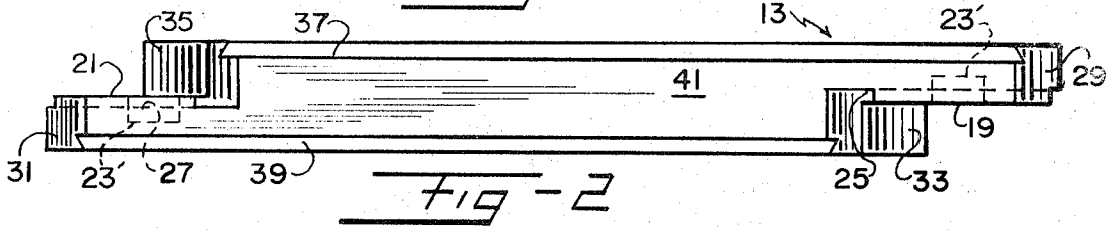


Fig - 2

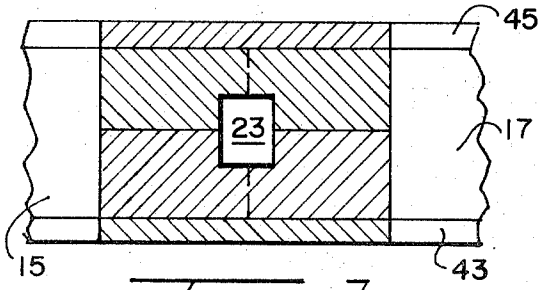


Fig - 3

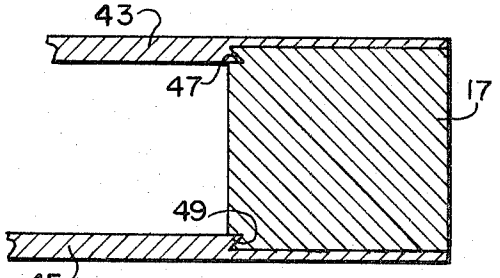


Fig - 4

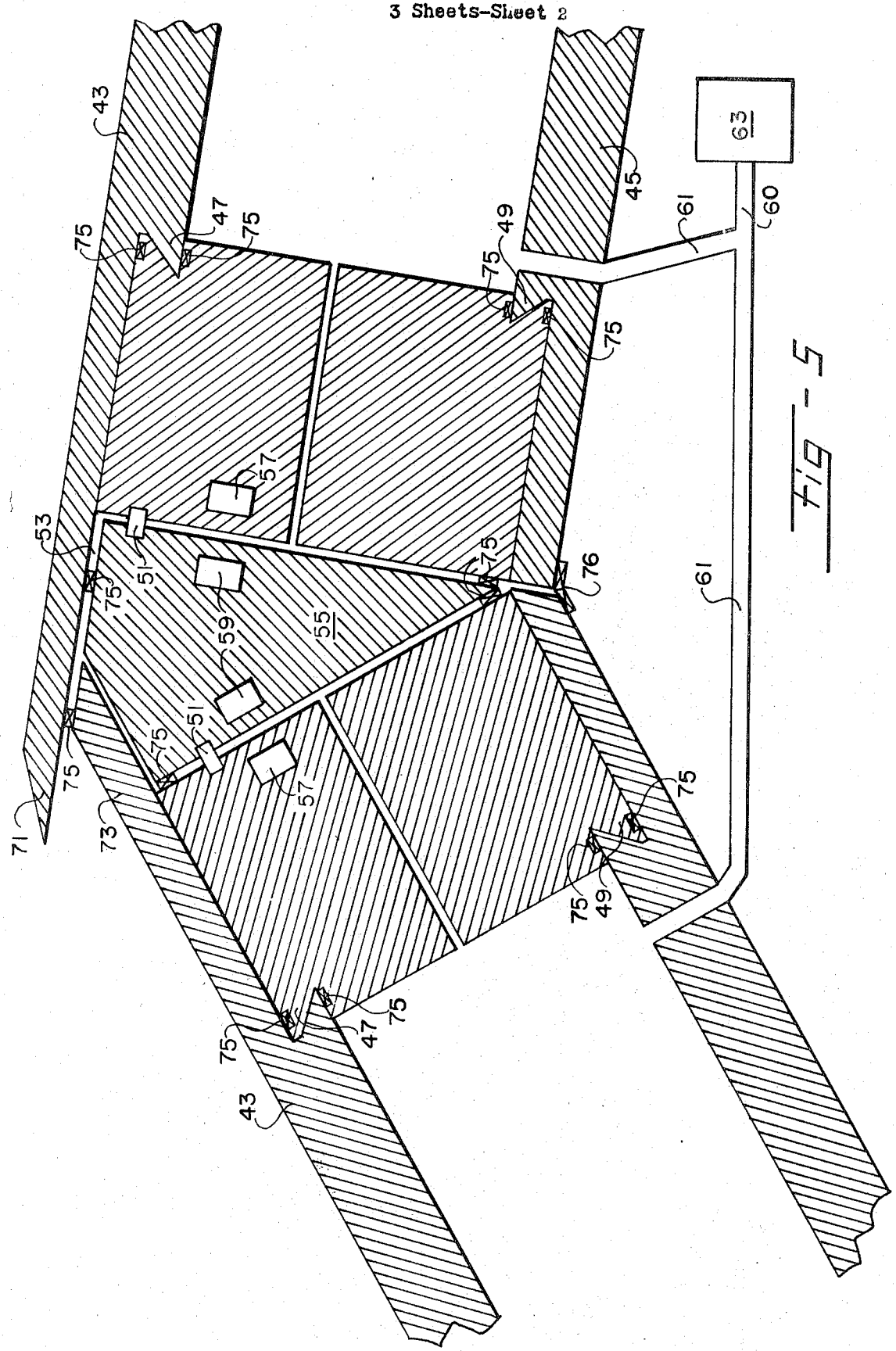


Fig - 5

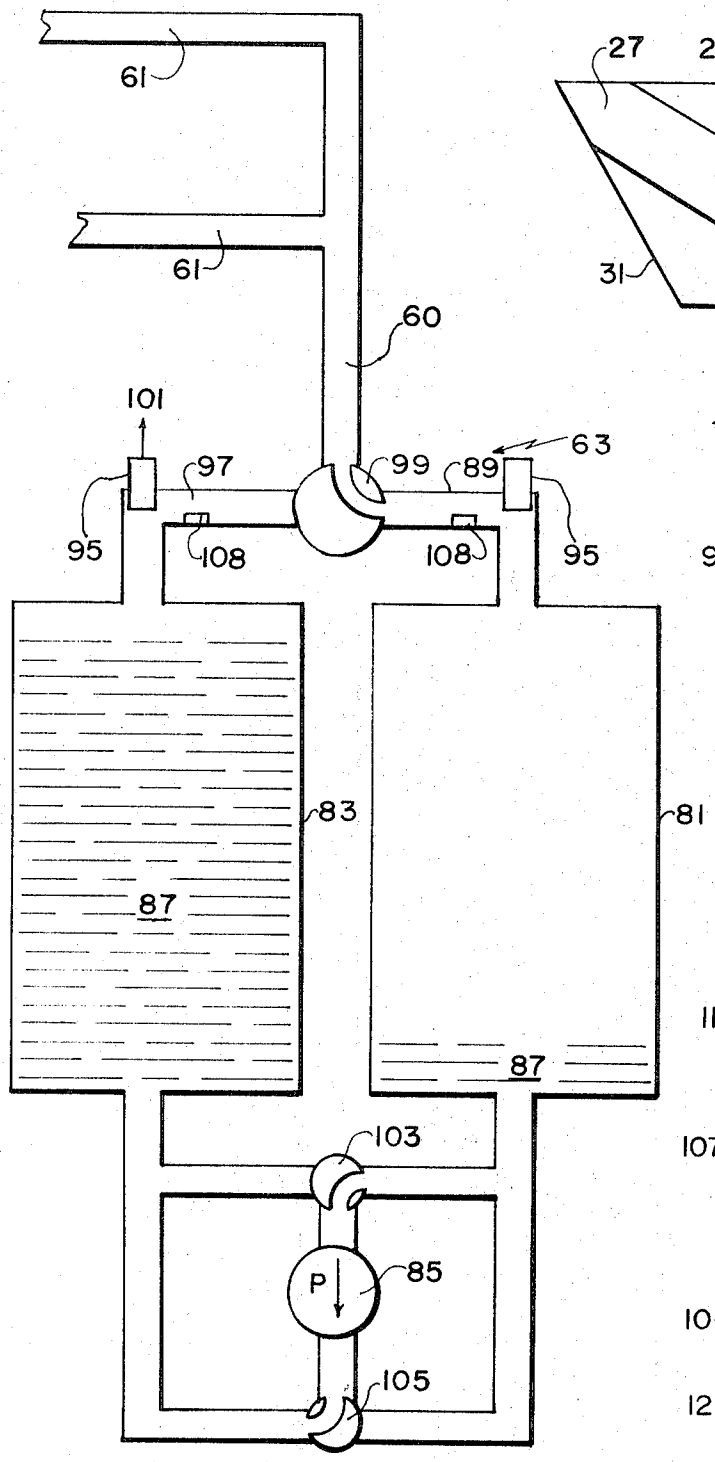


Fig - 6

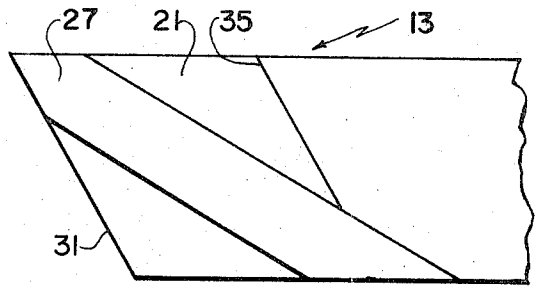


Fig - 7

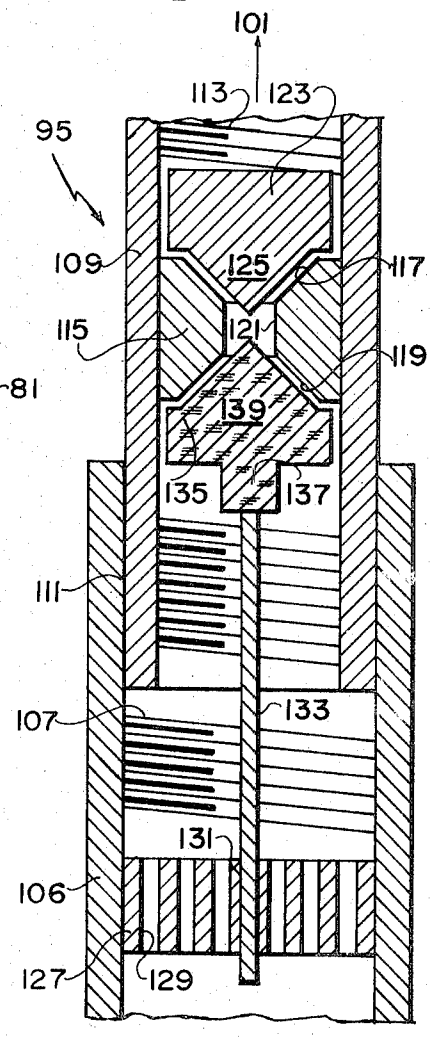


Fig - 8

DEMOUNTABLE BUILDING

This application is a continuation of U.S. application Ser. No. 215,034 filed Jan. 3, 1972 and now abandoned.

CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to applicant's copending U.S. application Ser. No. 12,173, filed Feb. 19, 1970, for Prefabricated Modular Building now U.S. Pat. No. 3,660,952.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to in situ construction of structures, and more particuarly to a prefabricated modular structures constructed from a plurality of modular panels which are forced into engagement by their weight and which utilize additional vacuum or magnetic securing means to secure or enhance the stability and strength of an assembled panel and structure.

This invention also relates to the practical application of controlled vacuum to panels and structures, to both hold the structure together, and insulate the panel member.

2. Description of the Prior Art

Many prefabricated structures such as homes or buildings utilize panel members or the like which are constructed at a factory and assembled in situ to form the structure. In particular, applicant's copending application, Ser. No. 12,173 now U.S. Pat. No. 3,660,952 discloses a self-supporting prefabricated building constructed from a plurality of substantially identical, triangular-shaped panel members. Each of the members is interlocked with adjacent members by interfitting means comprising a plurality of mating surfaces abutting each other along the adjacent edges of the panels. In this manner, the weight of the panels applies a wedging effect between the mating surfaces. Each of the panel members includes a frame with a sheet covering at least one side thereof, and the sheet is fixed to the frame by gluing, stapling, or the like.

Although buildings constructed in accordance with the teaching of applicant's copending application are self-supporting and normally stand in position under their own weight, some type of fixing means is usually required between adjacent panels to insure structural stability in case of high winds or the like. Furthermore, each of the framing members used to form the triangular frames of the panels must be interlocked with the other framing members by utilizing some type of fastening means, such as glue, hinges, bolts, nails, or the like. These fastening members must be driven through the frame members, and usually cause weakening of the materials used. In particular, these weakened portions are susceptible to decay and rotting, and usually comprise the weakest areas of an assembled panel.

Applicant's present invention overcomes the above set forth disadvantages by providing a panel construction which is easily taken apart and which utilizes novel fixing means for fixing the framing structure and siding together. Applicant's invention further utilized magnetic or vacuum means to provide or enhance structural stability and strength to a structure formed with these panels.

SUMMARY OF THE INVENTION

A panel for use in constructing a demountable structure comprising at least three framing members having securing means holding the ends of the members together to form a modular panel. The securing means including at least one siding releasably held between the assembled framing members and attaching means provided between the corners of the framing members. In invention also includes magnetic and vacuum means for securing a demountable structure together, or strengthening the assembled structure. A novel vacuum pump is incorporated into the vacuum means.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of an assembled panel of the present invention;

FIG. **2** is a top plan view of one of the framing members forming the frame for the panel of FIG. **1**;

FIG. **3** is a cross-sectional view taken along line **2—2** of FIG. **1**;

FIG. **4** is a cross-sectional view taken along line **4—4** of FIG. **1**;

FIG. **5** shows a pair of panels of the instant invention in the assembled position with magnetic and vacuum means acting therebetween to strengthen the connection of the panel members;

FIG. **6** is a schematic diagram of a vacuum system for maintaining a vacuum within and between the panel members of FIG. **5**;

FIG. **7** is a side elevational view of one of the overlapping end portions of the framing member shown in FIG. **2**; and

FIG. **8** shows a novel two-way check valve for use with the vacuum system of FIG. **6.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is an improved panel for use in constructing prefabricated modular buildings of the type set forth in Application Ser. No. 12,173 now U.S. Pat. No. 3,660,952. The panels of the present invention are interfitted in accordance with the teaching of applicant's prior application, and normally rest in the assembled position by the wedging action of the panel members.

A preferred form of the panel of the present invention is shown in FIG. **1.** This panel is shown as triangular, but may take any desired shape. Each of the panel includes a frame **11** which is an equilateral triangle composed of three separate interfitting and interlocking framing members **13, 15, 17.** If the panel is of any other shape, it will comprise at least three framing members held together in the same manner.

The framing members may be formed from any material such as aluminum, wood, etc., and is provided with cutaway end portions **19, 21** at opposite sides on each end thereof (FIG. **2**). In this manner, the framing members may be secured to adjacent members by the overlapping of the respective end portions to form the triangular frame **11.**

In the assembled position, the framing members **13, 15, 17** are maintained in position by attaching means **23,** which may comprise magnets, a vacuum system, or elongated pins as shown. The pins are preferably wedge-shaped in cross section, and are slidably held within corresponding openings formed between the

mating surfaces of the cutaway portions at the corners of the frame. The openings are formed by the mating together of slotted portions **25, 27** formed at predetermined angles within the mating surfaces of the end portions **19, 21.** The slotted portions on any framing member bisect the angle at the corner to provide a slot which identically matches with the slot on a facing framing member. In this manner the grooves formed by the mating slots extend diagonally across the corners thereby providing a two-dimensional holding means in which the wedge-shaped pins are held.

As shown more clearly inf FIGS. **1** and **7,** the slots extend inwardly, commencing at the outer corner of the bottom surface of each framing member, at an angle that bisects the corner angle at 30° toward the opposite inner surface of the respective frame member.

To provide properly mating surfaces, and to enable a stable triangular frame to be secured together, the end of each of the framing members is cut-off at **29, 31** so as to slant inwardly at an angle of approximately 60°. In addition, the inner mating surfaces **33, 35** of each of the cut-out portions **19, 21** is formed parallel to the ends cut-off **29, 31.** These slanted portions provide the proper angle of 60° between the side framing members in their assembled position. In some situations, the ends **29, 31** may be extended to overlap ends of members of adjacent panels in other buildings.

The pins **23** hold the ends of the triangular frame in alignment, and prevent separation of the framing members in the plane of the drawing. Or magnets **23'** may be aligned at the corners to prevent separation. To prevent separation of the frame in a direction perpendicular to the plane of the drawing, each of the framing members is provided with at least one groove **37, 39** extending along the length of the inner surface **41.** EAch framing member is preferably provided with a pair of grooves which may take any desired shape. As shown in FIG. **4,** each groove is slanted inwardly from the side edge of each framing member and receives similarly formed edges **47, 79** secured on the inner surface of covering sidings or sheets **43, 45.** This securely holds the sidings within the frame and prevents their separation therefrom. The sheets may be formed from any material, such as aluminum sidings, plywood or the like.

As shown, the sidings are substantially the same shape as the frame and include narrowed or reduced inner portions of the same shape fixed to or laminated on the inner surface to form the edges **47, 49.** These edges extend into and mate with the grooves **37, 39.** In this manner, it can be seen that when the frame members are assembled with the sheets fixed therein, the sheets will be prevented from being pulled away from the frame by the coaction of the edges **47, 49** in the grooves **37, 39.** At the same time, the triangular or other shape of the inner portion coacting with each of the grooves, will prevent the framing member from being pulled apart in the direction perpendicular to the drawings, and will also support a portion of any load applied to the panel member, to further strengthen the same.

After the construction of the panels, a plurality of these panels are assembled in accordance with the teaching of the application Serial No. 12,173 now U.S. Pat. No. 3,660,952 to form a building or other enclosure. As described in applicant's previous application, the panels are provided with interfitting means **51,** to secure each panel to adjacent panels at a predetermined angle relative to each other.

For illustrative purposes only, FIG. **5** shows the side framing member **17** of one panel slipped into and secured to the side framing panel **15** of an adjacent panel member. A space **52** if formed between the side framing members of abutting panel members. Depending on the angle of contact between the panel member, which is in turn determined by the size and angle of the interfitting means **51,** space **53** will vary in size.

As shown in FIG. **5,** securing means and/or additional reinforcing means to increase the strength of the connection between the panel members is provided. This securing or reinforcing means may take any number of forms and in the preferred embodiments shown, comprises magnetic and vacuum means.

An insert **55,** substantially filling the space **53** is provided between the adjacent panel members. This insert, is preferably separate, but may be made a portion of either of the adjacent framing members, **15, 17.** For reasons of simplicity, the interfitting **51,** more clearly described in applicant's pending application, are shown as simple tongue and grooves on the mating surfaces.

To maintain the insert **55** in place, and to securely hold the panel members together, a plurality of pairs of facing magnets **57, 59,** of any desired size, are placed in the abutting frame members and the insert. The magnets may be of the permanent or electro-magnetic type. If electromagnetic, they will be preferably controlled by releasable electric circuit means extending into space **53,** to facilitate the release of the same, if it is decided that the structure should be taken apart for moving or storage.

In addition to the magnetic coupling means, a further embodiment of the invention envisions the use of a vacuum joining and insulating means. This means is formed at the joints between adjacent panel members and, if desired, in the space enclosed by the frame and the outside sheeting.

One embodiment of a vacuum system for producing the desired result is shown in FIG. **5,** and includes a plurality of conduits **60, 61** connected between a vacuum pump or source **63,** and a space **65** lying between the frame and the sheeting **43, 45.** If no interior sheeting **45** is utilized, conduits **61** will be connected directly to passages **79** for connecting to space **53.** Exterior sheeting **43** is shown formed with end portions **71, 73** which extend outwardly beyond the frames **11.** One of these end portions, such as **71** extends beyond the end portion **73** and the other end portions **73** contacts the under surface thereof.

To prevent the leaking of any vacuum formed in the spaces between the frames and the sheeting **43, 45** and to add further insulation to a building formed therewith, the sheeting **43, 45** is made impervious to the passage of fluids, as by being coated or impregnated with a sealant. The sealant may be a resin, rubber coating, or the like. In addition, a plurality of sealing members **75** are strategically placed so as to insure the sealing of any vacuum formed in the spaces **53** and **65.**

As shown, the inner sheeting **45** of adjoining panels come into contact adjacent to ends of the framing members **15, 17,** and a weather stripping or other rubber-like tape **76** is provided to further seal the spaces at this point.

When a vacuum is drawn in the source **63,** the conduits **60, 61** withdraw the air from the space **65** and the

space 53 via the conduits 61 and the passages 79. The vacuum drawn within the spaces allows the outside air pressure to hold the panels together, and to secure the adjacent panel members together. The vacuum also insulates the walls against temperature changes.

The vacuum provides a structurally rigid and stable building, or may be selectively used with other means to stabilize or maintain a structure in its erected position. Check valves, release valves and other safety devices are provided in the vacuum system, to prevent any unnecessary leakage of vacuum therefrom.

When a vacuum is drawn in space 65 between the sheetings 43, 45 and within the space 53 formed between adjacent panels, no further insulation will be required in the strucutre, since the vacuum will prevent the passage of or transfer of any heat therethrough, in either direction. When transfer of heat is desired, the vacuum may be automatically regulated to enable a transfer of heat through the walls, in either direction. In addition, the vacuum will cause the materials used in constructing the enclosure to be less susceptible to temperature changes, thereby increasing the life thereof.

Although the vacuum system may be used alone, the use of this system with magnetic and pin means provides a failsafe safe system to insure structural rigidity in case the vacuum within the system is lost. In this manner the vacuum may be varied more widely to take full advantage of and changes in the environmental or outside temperatures without detracting from the building's rigidity.

The vacuum system of the present invention may be applied beneath any completed structure or flooring upon which the same rests for the elimination of squeaky floors and to more firmly anchor the structure to its foundation or the ground during storms, earthquakes, or the like.

When utilizing a double wall panel as shown in FIGS. 1 and 5, any vacuum drawn within the space 65 between the panels acts as an insulating layer to thereby allow a structure to be more economically heated or cooled. If a portion of either wall becomes ruptured or worn, repairs may be easily made by merely placing a patch or the like over the damaged portion and fixing this patch in place, in any suitable manner, as by the application of a resin.

If all of the walls and joints of the completed structure are subjected to a vacuum, some type of a positive vent, such as a direct passage through the walls to allow air to circulate within the structure, must be provided. The air entering the enclosure may be positively controlled by being passed through filters, air conditioning and the like. If safety demands it, the discharge from the vacuum system may be directed to the interior of the building, or some other safe discharge point.

If a large enough vacuum is drawn between the walls of the structure, density inciter means should be provided therein. These density inciter means restrict, restrain or oppose the vacuum and thereby provide a strengthened panel. For insulational value, the "density inciters" should contain at least one layer of material, such as asbestos.

With a large enough vacuum, it is also possible to operate vacuum tools, to provide positive ventiliation for the interior of the structure, or to provide tiny pinholes or the like in the interior walls, whereby a small vacuum may be drawn for holding pictures or other fixtures thereby.

As set forth above, all woods or other porous material used to construct a structure of the present invention may be coated with a resin or other sealant. If desired, the sealant may be hardened under a greater vacuum than that to which it normally would be subjected in everyday use. This would provide a stronger material adding still further insulating value to a structure.

By utilizing the magnetic and vacuum systems of the present invention, in conjunction with the novel panels disclosed herein, the frame and other portions of a structure are not pierced or punctured by securing means such as nails, staples, or the like. This lack of piercing will increase the length of life of the material used to construct the structure, by eliminating weak points where rot or other means of destroying the material commence.

In addition, any appliances contained in a home or the like constructed in accordance with the present invention may be adapted to be insulated or operated by the vacuum system.

Turning now to FIG. 6 of the drawings, there shown is a novel vacuum pump or source 63 for use with the vacuum system of the present invention. The source includes a pair of cylinders or reservoirs 81, 83. The reservoirs are connected between the conduits 60, 61 which draw the vacuum within the system described above, and a pump 85. In this manner, a vacuum is continuously drawn within the system by the action of a fluid 87 continuously pumped into and withdrawn from the reservoirs.

In the present invention, the amount of fluid pumped between the reservoirs is fixed, and additional fluid may be added, by a valve (not shown) to replace the fluid lost by leakage, evaporation, or the like. FIG. 6 shows the liquid being pumped from cylinder 81 into cylinder 83 by means of the pump 85 through valves 103, 105. This pumping action draws a vacuum in the space above the level of the fluid 87 in each reservoir and through conduits 89, 97. A simple floatation valve (not shown), may be located inside each reservoir whereby if the fluid reaches too high or too low a level, the exit at either end may be blocked.

A two-way check valve 95 is provided at the top of each chamber 81, 83, and a two-way valve 99 controls the flow of fluid from the conduits 89, 97, respectively, to conduit 60.

As the water is being withdrawn from reservoir 81, (FIG. 6), air will be withdrawn from conduits 89, 97, 60 and 61, thereby drawing a vacuum within the system. In addition, as the reservoir 81 is being emptied, the reservoir 83 is filled thereby forcing any air remaining therein through the valve 95 and to waste at 101. After water is drained from the reservoir 81, and the reservoir 83 is filled, valves 99, 103 and 105 are operated or reversed. Pump 85 will continue pumping, and water 87 now will be pumped from the reservoir 83 to the reservoir 81 drawing a vacuum in lines 60 and 97 through valve 99. At the same time fluid will be pumped into the reservoir 81 and air will be exhausted through valve 95 to waste at 101. In this manner it can be seen that an extremely simple vacuum source is provided to continuously draw a vacuum in the system set forth above.

The operation or reversing of the valves 99, 103, and 105 is preferably simultaneous, and may be provided

by automatic, mechanical, or manual means. One means of automatically operating the valves is by the provision of electrical or pressure switches **108.** These switches may be provided in both lines above the reservoirs, and are activated when the level or pressure of the fluid in the cylinders **83,** or **83** reaches a predetermined position. The switch will then automatically activate solenoids or other means to simultaneously operate or reverse the valves **99, 103,** and **105** 90° from the position shown in FIG. **6** to reverse the flow of fluid within the system. The directional flow of fluid through the pump is always the same, and will not be changed by the reversal of the valves.

Turning now to FIG. **8,** there shown is an enlarged cross sectional view of the novel double check valve **95** of applicant's present invention. These valves include a lower body sealingly inserted into the conduits **89, 97** as shown. Body **106** is provided with internal threads **107** into which is threaded a further pipe **109** leading to exhaust at **101.** Pipe **109** also includes exterior threads **111** coacting with the internal threads **107** of the body, and internal threads **113** into which an insert **115** is threaded.

The insert is provided with two conically shaped seating portions **117, 119** at either end of a passage **121** extending therethrough. A lightweight needle valve **123,** having a conical tip **125** formed at the bottom thereof for coaction with the valve seat **117** is provided within pipe **109** for controlling flow of fluid through the passage **121.** Valve **123** is biased to the position shown, when air passes therearound to exhaust at **101.** Upon drawing a vacuum in the line, the valve **123** will be forced downwardly into contact with the seat **117** by atmospheric pressure. In this manner, air may pass through passage **121** but any vacuum drawn within the lines will be retained.

Body **106** is also provided with an insert **127** having a plurality of holes or perforations **129** passing therethrough for the passage of fluid. In addition, insert **127** is provided with a central bore or hole **131** for the receipt of the stem **133** of a further needle valve **135.** Needle valve **135** includes a portion of buoyant material **137** whereby fluid other than air passing through holes **129** in insert **127** will bias the conical tip **139** into contact with the valve seat **119** to stop the flow of the fluid. It should be noted that air will normally pass around the valve **135** to exhaust **101,** without causing closure thereof.

The two-way check valve **95** therefore prevents the loss of vacuum drawn in the system, allows air to be exhausted from the reservoirs, but prevents the loss of fluid from either of the reservoirs.

It therefore can be seen that applicant's invention provides a novel panel means which may be assembled without the use of fastening members other than magnets, pins or vacuum means coacting at the corners of the panel and sidings held within the framing members. A plurality of these panel members may then be assembled and be secured together by magnetic means, vacuum means or their own wieght. The invention further provides for magnetic and vacuum means for strengthening an assembled structure.

In this manner, it can be seen that a structure may be formed which is easily assembled and taken apart and which may be readily and inexpensively maintained, moved, or redesigned.

With the vacuum insulating and sealing system of the present invention provided for a structure, no insects or other pests will be present, thereby further increasing the life of the structure.

In addition, applicant has provided a novel and efficient vacuum pump coacting with a novel two-way check valve for providing sufficient vacuum to stabilize and strengthen a rigid structure by the continuous pumping of water between two cylinders.

While the invention has been described in considerable detail, it is not to be limited to such details as have been set forth except as may be necessitated by the appended claims.

I claim:

1. A plurality of individual detachably interlocking panels, said panels forming in combination a demountable modular dwelling structure, each of said panels comprising:

a. at least three framing members joined end-to-end to define a framework;

b. each of said framing members having a cutaway part and an overhang part at each end, said cutaway part at one end of one of said members mating with said overhang part at the end of an adjacent joined one of said members to form an overlapping joint;

c. each said overhang part including an elongated recess to form a cavity within said overlapping joint;

d. pin means mating with said cavity for restraining lateral movement between said overhanging parts forming said overlapping joint;

e. a set of grooves, one of said set of grooves being disposed in each of matched sides of at least two said members forming said framework, said set of grooves defining an enclosure shaped similar to said framework but of lesser size; and

f. a siding sized to conform with the dimensions of said enclosure, each edge of said siding being mating with and locking within the respective one of said set of grooves; whereby, said panel is formed of a plurality of interlocking frame members rigidly retained in angular relationship with one another by said overlapping joints and said keyed siding.

2. The combination set forth in claim **1,** including:

a. a further set of undercut grooves, one of said further set of grooves being disposed in each of further matched sides of said members forming said framework, said further set of grooves defining a further enclosure shaped similarly to said framework but of lesser size; and

b. a further siding sized to conform with the dimensions of said further enclosure, each edge of said further siding being mated with and locked within the respective one of said further set of undercut grooves; whereby, said siding and said further siding together with said members define an enclosed space.

3. The combination set forth in claim **2,** including protrusions extending beyond the periphery of said framework to shield said overlapping joint from the elements.

4. The combination set forth in claim **2,** including:

a. a vacuum pump;

b. means for connecting said pump to said panel to draw air from within said enclosed space; whereby the pressure differential between ambient atmospheric pressure and the pressure within said en-

closed space creates a force tending to secure said siding and said further siding to said framing members and said framing members to one another.

5. The combination set forth in claim **1** wherein said panels are reinforced and secured together by a vacuum.

6. The combination of claim **5** including magnetic means for the reinforcing of the securing of adjacent panels.

7. The combination set forth in claim **1** wherein said panels have vacuum and magnetic means provided between adjacent panels to secure said panels together.

8. The combination set forth in claim **1** wherein said panels are releasably secured together by interfitting means, and provided with a vacuum holding system connected between spaces formed in and between said panels to securely bind said panels together.

9. The combination of claim **8** wherein said panels are provided with magnetic means for further securing said panels together.

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