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THERMOPLASTIC STRUCTURAL COMPONENTS AND STRUCTURES FORMED THEREFROM

5 **FIELD OF THE INVENTION**

 This invention relates to reduction of the costs of the novel thermoplastic structural system and structural components therefor and building structures erected therefrom which are disclosed in my copending
10 Canadian Application Serial No. 2,070,079, filed May 29th, 1992 without adversely affecting their integrity.

15 **BACKGROUND OF THE INVENTION**

 The structural system disclosed in my said copending application comprises novel interlocking thermoplastic structural components which can be mass produced at low cost and which can be quickly and easily
20 interlocked together to erect a wide range of structures which will require minimal maintenance and will be safe from termites, corrosion, rust or rot and will be highly resistant to the effects of weathering.

 The present invention is directed to significantly reducing the
25 costs of such components and hence the costs of structures erected therewith without sacrificing the structural integrity of the components or system.

 Further the invention is directed to such cost reductions of the components themselves and the structures formed therefrom without
30 increasing the costs of production of the components or interfering with the ease of their assembly.

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Further the invention is directed to providing such structural components as to aforesaid which will facilitate the conversion of the walls erected therewith into permanent wall structures, will enhance the air circulation in roofs erected therewith, and will provide reduced thermal transfer between the exterior and interwall surfaces of the walls and roofs.

DESCRIPTION OF PRIOR ART

While the use of plastic to form wall panels or the like for use in building construction has been proposed, such panels have not had the necessary load bearing or other structural requirements to form practical structures which could be mass produced at low cost and quickly and easily assembled to erect durable low cost structures and, in particular, low cost housing.

U.S. Patent 3,992,839, for instance, discloses a plastic panel fabricated from separate panel members, preferably formed of polyvinyl chloride which snap together to form a thin wall panel. The panels in turn are formed to snap together to provide a wall structure. Such fabricated panels are inherently weak and lack the strength and load bearing capacity to form adequate structural components for use, for instance, in the forming of the walls and roof of a practical durable building.

U.S. Patent 3,362,507 discloses the use of tongue and grooved individually prefabricated panels said to be preferably of plastic which are bonded or glued together and used particularly for the forming of basement walls. Such panels do not permit of high speed production and are not capable of being quickly and easily interlocked together in the erection of a house or other structure.

U.S. Patent No. 4,457,091 discloses a hollow panel member having a width of about one and one-half inches (1 1/2") and a complicated interior formed by pultrusion, a process involving drawing long glass strands and a plastic binding material forcefully through a die under heat to form the glass strands into a compacted glass mat bound together by the plastic material. Such a process is prohibitively slow and expensive and the panels

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themselves do not provide acceptable or practical low cost structures for forming the walls and roofing of a housing system such as contemplated by the present invention.

5 While modular building structures using modular building components formed of steel have also been proposed, such as disclosed in U.S. Patent 1,958,124, such systems involve welding together of the members to make up the components and the use of bolts or other fasteners to secure same together. Such systems are not practical for low cost practical housing
10 and the like with which the present invention is concerned.

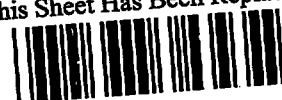
SUMMARY OF THE INVENTION

15 In accordance with the present invention, the structural building components comprise elongated thermoplastic extrusions presenting spaced interconnecting means, preferably spaced inwardly extending interlocking means extending the length thereof for sliding interlocking engagement with
20 mating interlocking means of an adjoining mating structural member, said extrusions having at least one longitudinal web supporting the interlocking means in spaced relation with the web having a plurality of openings cut therethrough inwardly of the interlocking means and spaced along the length of the web.

25 According to the preferred form of the invention the openings are circular and preferably of a uniform diameter and more preferably still the openings have a diameter equal to a major portion of but less than the spacing between the interlocking means.

30 Preferably the structural components of the present invention are extruded from a vinyl chloride, preferably a polyvinyl chloride, containing a reinforcing and expansion controlling agent which preferably is selected from one or more of mineral fibres, small glass fibers and calcium
35 carbonate.

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More particularly, the extruded structural components comprise a core of polyvinyl chloride containing a reinforcing and expansion controlling agent as aforesaid and a coextruded thermoplastic skin covering surfaces that will be exposed on assembly into a building structure.

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Further, in accordance with the invention, the openings in the at least one web of the structural component are bored out of the web immediately after the component has been extruded and while it is still feeding away from the extruder.

10

Also, according to the invention, the material removed from the web is returned for reuse as a core extrusion material.

15 BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will be understood from the following detailed description taken in conjunction with the accompanying drawings in which:

20

Figure 1 is a perspective view of a small house erected from interlocking thermoplastic structural components such as form the subject matter of the present invention.

25

Figure 2 is a broken away perspective view illustrating a wall panel embodying the present invention seated on a concrete base ready to receive concrete or other anchoring material to be anchored to the base through suitable anchor rods.

30

Figure 3 is a perspective view illustrating a wall section showing a pair of wall panels interlockingly engaged with a connecting box connector and showing the components as comprising a core having the exposed external surfaces thereof coated with a smooth thermoplastic skin with the thickness of the skin being somewhat exaggerated for purposes of illustration.

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Figure 4 is a perspective view illustrating a plurality of roof panels corresponding to the wall panels of Figure 3 embodying the invention connected by four-way box connectors according to the invention, the four-way box connectors being available for the attachment of cladding to the upper surface of the roof and for engagement with other components beneath the roof's surface.

Figure 5 is a plan view showing a three-way box connector interlockingly connecting two aligned wall panels and a third wall panel at right angles thereto.

Figure 6 is a perspective view illustrating a corner box connector connecting two wall panels in right angular relation.

Figure 7 is a perspective view illustrating a four-way box connector for connecting four wall panels in right angular relation.

Figure 8 is a perspective view of a slightly modified two-way box connector having interior locking fingers for interlocking engagement with a mating insert.

Figure 9 is a view similar to Figure 8 but showing a three-way box connector.

Figure 10 is a perspective view of a wall panel according to the invention having a single interior web.

Figure 11 is a perspective view of a wall panel with no interior web.

Figure 12 is a perspective view of a box connector joiner embodying the invention.

Figure 13 is a perspective view taken from the underside of a sloping wall cap embodying the invention.

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Figure 14 is a perspective view of the wall cap of Figure 13 taken from the top side.

5 Figure 15 is a diagrammatic view illustrating the manner in which the components of the present invention are extruded and then drilled to produce the openings through the webs thereof.

10 Figure 16 is a cross-sectional view of the particular box connector shown being extruded in Figure 15.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 It will be understood that while only Figure 3 illustrates the co-extruded skin on the exposed surfaces of the wall panels and the box connector, all of the panels and box connectors will have such an extruded skin and it is only components such as the box connector joiner of Figure 12 which will have no exposed surfaces when assembled into a building structure
20 that will be extruded without any skin coating.

 With reference to the drawings, Figure 1 is a perspective view of a house 1 as an example of the type of building that can be erected with the thermoplastic interlocking building components of the present invention
25 which can be assembled into walls 2 and roofing 3 with provision for doors 4 and windows 5.

 A building such as illustrated in Figure 1 is intended to be erected on a concrete pad 6 as illustrated in Figure 2 which shows how the
30 walls 2 of the building can be anchored to the concrete pad 6 by means of anchor rods 7 when the interior of the walls 2 are filled with concrete and the like as illustrated by the arrow A. Suitable means such as the strip 6' may be employed to contain the concrete from spilling out from underneath the wall 2.

35 As more particularly illustrated in Figure 3, the walls 2 are formed from wall panels 8 interlockingly interconnected by box connectors 9, one of which is illustrated in Figure 3.

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Each of the wall panels 8 in accordance with the invention disclosed in copending Canadian Application Serial Number 2,070,079 comprises a hollow rectilinear thermoplastic extrusion having a core 10 and
5 coextruded outer skin 11.

The core 10 preferably comprises a vinyl chloride and, more particularly, a polyvinyl chloride containing a suitable reinforcing and expansion controlling agent such as mineral or other fibers or other known
10 expansion controlling agents such as a calcium carbonate.

A reinforcing agent or constituent particularly useful for structural components of the present invention which are subject to high loading comprises small glass fibers which when anchored in a thermoplastic
15 material such as vinyl chloride or polyvinyl chloride provide the requisite reinforcing and expansion controlling characteristics to provide high structural strength.

A suitable material incorporating small glass fibers which can
20 be used in the production of these panels 8 is available under the trade-mark FIBERLOC from the B. F. Goodrich Company of Akron, Ohio, such material being described in detail in B.F. Goodrich's U.S. Patent 4,536,360 wherein very fine short glass fibers are bound within a composition of vinyl chloride resin.

25

The presence of glass fibers in the PVC or other thermoplastic material while providing tensile strength and expansion control to the material creates an extrusion problem and, if they are too large and too concentrated, it is not practical to extrude the material. Preferably, such
30 fibers should be of the order of a few microns in diameter and a few millimeters in length and in concentrations not greater than and preferably substantially less than about 35% by weight based upon the combined glass fibers and vinyl chloride resins.

35 The presence of the glass fibers creates a brittleness which makes a structure produced solely from a glass fiber reinforced plastic

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subject to potential fracture from impact. This potential increases with increased concentration of glass fibers.

5 The problems encountered with the use of the glass fibers as the reinforcing constituent while utilizing their beneficial reinforcing qualities for high loading capacity have been resolved by coextruding with the glass reinforced thermoplastic a smooth thermoplastic skin covering the external exposed surfaces of the panels.

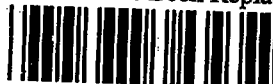
10 The smooth plastic skin may be PVC, rigid PVC, semi-rigid PVC, ABS, polycarbonate with thermoplastics available from G.E. under the trade-mark GELOY and NORYL.

15 This skin 11 serves a number of useful purposes. Because of the presence of the glass fibers in the core or substrate 10, the substrate is somewhat brittle and its surfaces are rough and abrasive with portions of the glass fibers projecting through the surface of the substrate rendering the substrate somewhat porous and susceptible to the ingress of moisture which can adversely affect the bond between the glass fibers and the thermoplastic material.

20 The coextrusion of the thermoplastic skin covers and seals the outer exposed surfaces of the structural component against the ingress of moisture, thereby maintaining the integrity of the binding of the glass fibers to substrate plastic. Further, the outer skin 11 not only covers exposed glass fibers but these exposed glass fibers become embedded in the thermoplastic material so that the external surface of the component is totally smooth. The glass fibers in turn in becoming embedded in the outer skin lock the skin to the substrate or core 10 so that the expansion and contraction of the outer skin is fixed to the expansion and contraction of the core which is controlled or limited by the presence of the incorporated glass fibers which have a much smaller co-efficient of expansion than the plastic.

30 It will be also understood that the skin 11 can be formulated to include agents providing impact resistance, resistance to ultraviolet radiation and the like.

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5 The combination of the co-extruded core or substrate 10 and smooth skin 11 thus enable the provision of wall panels having inherent structural strength and which are essentially maintenance free, impact resistant and they will be free from corrosion, rot or rusting and will be impervious to moisture, termites and other insects.

10 While the use of the glass fibers provides the strength necessary for handling high loading, where the panels will be subjected to much lighter loading the core 10 may be formed of a vinyl chloride containing from about 5% to about 50% calcium carbonate and preferably about 5% to 30% calcium carbonate by weight.

15 Alternatively, a mixture of calcium chloride and glass fibers or other reinforcing agents such as mineral fibers may be used to meet the particular load specifications required for the panel.

20 As illustrated in Figure 3, each of the panels 8 is provided with two transverse webs 12 which tie the opposing faces 13 of the panel together intermediate the edge walls 14 of the panel.

25 Adjacent each of the edge walls 14, the panel 8 is provided with inwardly extending oppositely registering grooves 15 with the width of the panel being reduced outwardly of the grooves 15 to the edge walls 14 to, in effect, provide a tongue portion 16.

30 As the cost factor is a critical element in the ability to provide affordable housing to the masses, it has been found that this cost factor can be significantly reduced in material costs by cutting a series of openings 17 out of the webs 12 and edge walls 14 at spaced points along their length.

This cut out material can then be collected and reused in the extrusion of the core of a subsequent extrusion.

35 The openings 17 are preferably circular openings having a diameter slightly less than the spacing between the most adjacent point 18 of the grooves 15.



With the openings 17 centered on the midpoint of the edge walls 14 and midway between the panel faces 13, the openings can be cut through the edge walls 14 and also through the webs 12 without interference with the grooves 15 which extend uninterrupted throughout the length of the
5 extrusion.

Still with reference to Figure 3, the panels 8 are shown interlocked with the box connector 9 in the form of a hollow extruded rectangle having projecting flanges 19 terminating in inturned oppositely
10 registering locking fingers 20 adapted to slidingly interlock with the grooves 15 of the panels 8.

The box connector 9 is extruded with a core 21 and a coextruded outer skin 22 covering the outer surfaces of the walls 23, the
15 flanges 19 and the locking fingers 20.

Because of the inherent strength of the configuration of the extruded rectangular box connector 9, its core 21 may comprise a PVC resin and, for example, calcium carbonate, as the expansion controlling and
20 reinforcing agent, although other agents including small glass fibers and mixtures of agents may be used.

It will be noted that the outer surfaces of the walls 23 of the box connector 9 covered by the outer skin 22 are precisely aligned with the outer
25 surfaces of the panel faces 13 with the tongue portions 16 of the panels being received in the space between the inturned locking fingers 20 and the transverse walls or webs 24 of the box connector.

Again, the box connector is provided with a series of openings
30 25 through the transverse walls or webs 24. Again, these openings are circular with a diameter centered on the midpoint of the transverse walls or webs 24 of the box connector and spaced along the length thereof with the diameters of the openings substantially equal to, but less than, the spacing between the inturned locking fingers 20 so that the locking fingers are not
35 intersected during the cutting of the openings 25.



It will be seen that the panel locking grooves 15 are covered in the smooth coextruded skin 11 to provide a smooth surface for smooth sliding interlocking engagement with the smooth skin coated locking fingers 20. Further, the outside faces of the tongues 16 which form the edge walls 14 of the panels are coated with the smooth skin 11 and preferably these faces are slightly concaved to eliminate any interference with the box connector transverse webs or walls 24.

Again, the material cut out from the box connector walls or webs 24 can be collected and returned to be used as material for extruding subsequent box connectors.

It has been found, for example, that with a wall panel width of 100 millimeters between the faces 13, circular holes having a diameter of 70 millimeters and spaced 12.7 millimeters apart provide a significant saving in material and cost of the vinyl extrusion product without significantly affecting the structural strength of the panel so that when concrete is poured therein such as illustrated in Figure 2 to convert the wall panel into a permanent wall configuration the webs and edge walls of the panels which are placed under tension exhibit adequate tensile strength tying the panel faces 13 against outward bulging under the concrete load.

In addition to the savings in material costs, the provisions of the openings 17 and 25 limits thermal transfer between the outer or exposed faces 13 of the panels 8 and the outer exposed walls 23 of the box connector 9. As a result the components provide increased insulation between the exterior and interior wall of a building such as shown in Figure 1.

Figure 4 illustrates an arrangement of roofing panels 26 which are shown interlocked together by four-way box connectors 27 rather than a two-way box connector 9 as illustrated in Figure 3 and which would be used to provide the smooth roof formation shown in Figure 1.

The four-way box connectors 27 provide for interlocking roof cladding to the upper surface of the roof and for engaging or supporting other structures beneath the roof.





The roof panels 26 are similar to the wall panels 8 and it will be understood that they are extruded to provide a core and a coextruded outer skin covering the outer surfaces thereof (the separate layers not being shown).

5

Again, depending upon the anticipated loading of the roof structure, the reinforcing agent or agents selected for the core of the roof panels 26 will be appropriately selected.

10

For high loads the reinforcing agent preferably would include at least some of the fine small diameter short glass fibers.

15

Again, as in the case of the wall panels 8, the roof panels 26 are formed at opposite longitudinal edges with oppositely registering inwardly extending locking grooves 28 and edge tongues 29 for sliding interlocking engagement with the inturned locking fingers 30 carried by the flange extensions 31 of the box connectors 27. Similar inturned locking fingers 30 are provided on the box connectors 27 to project above and below the interlocked roof panels.

20

The roof panels 26 have circular holes 32 cut through their edge tongues 29 and webs 33 corresponding to the circular holes or openings 17 cut out from the wall panels 8. Similarly, the four-way box connectors 27 have circular openings 34 cut therefrom corresponding to the openings 25 in the two-way box connector.

30

In a roofing structure formed from the thermoplastic components, it is highly desirable that air circulation be effected within the roof structure. In this respect, the cutting out of the holes 32 and 34 provides free air circulation laterally of the roof in addition to the air circulation which can be effected lengthwise of the elongated hollow extruded roof components.

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Additionally, it will be appreciated that the provision of the openings in the roof panels and their connecting box connectors restrict thermal transfer from the upper roof surface to the underside of the roof thereby adding to the thermal insulation provided by the components. It will



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also be appreciated that, if desired, the roof panels and connectors can be filled with suitable insulating material.

5 Despite the removal of the material resulting from the cutting of the circular holes 32 from the roof panels the webs 33 provide the requisite resistance to roof panel bending to sustain high roof panel loading augmented by the interengaging panel tongues 29 and box connector flanges 31 and locking finger 30.

10 Figure 5 is a plan view illustrating the connection of three wall panels 8 into a T-formation using a three-way box connector 35. The three-way box connector is provided with openings 25 in three of the walls thereof so that when material is introduced as indicated by the arrow 36 into the box connector 35, which material may be concrete, sand or insulation material, it
15 can flow through the various openings into the wall panels. As illustrated, the leg of the T-formation is closed by an end cap C formed to interlock with the tongue 16 and grooves 15 of one of the panels 8 to contain all material within the external walls of the panel and box connector.

20 Similarly, should it be desirable to introduce insulation material into the interlocked roof panel as illustrated in Figure 4, such material can be injected for distribution within the roof structure by virtue of the existence of the cut out holes. Since the spacing between the holes is much less than the diameter of the holes, there will always be significant registration between the
25 holes or openings cut in the adjoining interlocking components.

 Figure 6 illustrates a corner box connector 37 connecting two wall panels 8 together in right angular relation. Box connector 37, as before, is extruded with an appropriate core and a co-extruded outer skin and
30 is provided with the requisite inturned locking fingers 38 on adjacent sides and with the cut out circular openings 39 centered between these inturned locking fingers and having diameters less than the spacing between the locking fingers.

35 Figure 7 shows a four-way locking connector 40 for interlockingly connecting four wall panels 8 in right angular relation. In this case, the connector 40 has inturned locking fingers 41 at all four sides of the



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connector and circular openings cut out therefrom in all four walls of the connector.

5 It will be understood again that the connector 40 is formed of a reinforced core with the exposed surfaces, that is the locking fingers 41 and their supporting flanges 42 coated with a smooth skin:

10 It will be noted that the arrangement of the openings cut out from the various extruded components is such that the openings are internal of the exterior walls of the structure being assembled therefrom when they are slidingly interlocked with the appropriate mating components.

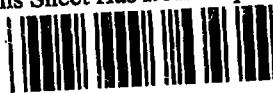
15 Figure 10 is a perspective view illustrating a wall panel 8' corresponding to the panel 8 except that it has a shorter span with a single web 12'. Otherwise the panel is identical with panel 8 and like numbers refer to like parts.

20 Similarly, Figure 11 illustrates a still smaller wall panel 80 which may be used at a wall corner. Panel 80 has no internal webs but otherwise has the same interlocking features and the same cutout openings as wall panel 8 and like numbers represent like parts.

25 Figure 8 illustrates a two-way box connector 9' corresponding to box connector 9 but additionally having internal key ways comprising out turned locking fingers 43 for sliding interlocking engagement with mating inserts (not shown).

30 Figure 9 is a perspective view of a three-way box connector 35' similar to box connector 35 but having an internal slideway comprised by out turned locking fingers 44 for supporting an internal insert (not shown).

35 Figures 13 and 14 illustrate a wall cap 45 adapted to fit down over the top of a wall formed from wall panels such as panels 8 and box connectors such as box connectors 9 to present a sloping support surface 46 for supporting a sloping roof such as illustrated at 3 in Figure 1.



Wall cap 45 is a hollow extrusion having a bottom wall 47 adapted to rest on the upper ends of an erected wall and having downturned flanges 48 forming interconnecting means adapted to embrace opposite faces 13 of the wall.

5

Webs 49 and 50 extending upwardly from the bottom wall 47 support the sloping upper surface 46 with the web 50 being of a greater height than the web 49.

10

The wall cap 45 is provided at the lower side of the sloping wall 46 with a chamber 51 which has an access slot 52 which may be closed by screening of the like (not shown). At the opposite side, the wall cap is provided with a closed chamber 53 and an open chamber 54.

15

In accordance with the invention, the bottom wall 47 and the sloping wall 46 are provided with circular openings 55 cut therethrough. For this particular component, the diameter of the openings, while less than the spacing between the flanges 48, is greater than the spacing between the webs 49 and 50 so that during the cutting of the openings 55 a portion of the webs 49 and 50 are removed to provide access openings 56 and 57 to the chambers 51 and 54.

20

Since the bottom wall 47 and the sloping upper wall 46 will not be exposed when the wall cap 45 is installed in place, these surfaces need not be coated with a covering skin. The other exposed surfaces, however, will have a skin coextruded over the core material to provide the desired smooth finish.

25

Figure 12 is an extrusion for connecting box connectors together and, when in place, will be totally enclosed and will have no exposed surfaces that require coating.

30

As illustrated, this box connector connector 58 comprises a web 59 spacing two outwardly facing channels presenting two inwardly projecting grooves 60 of a width to receive the interlocking fingers such as the fingers 20 of two adjoining box connectors 9 when their locking fingers are in abutting relation. In this manner connector 58 will lock the box connector

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together while being totally contained within the abutting box connector flanges and abutting interlocking fingers..

5 The web 59 is provided with a plurality of circular openings 61 cut therefrom with the diameter of the openings being substantially equal to but slightly less than the spacing between the two channels 60. Connector 58 is preferably extruded from a polyvinyl chloride but since it is not subjected to significant loading the amount of reinforcing agent, if any, can be minimal. Again, because it is enclosed when in position, no exposed surfaces requiring
10 a skin coating are presented.

Figure 15 is a diagrammatic illustration of the method of manufacturing the extruded components of the present invention and illustrating the extrusion of a straight box connector 9 having a core 21 and a
15 coextruded outer skin 22 and provided with circular openings 25 cut therefrom.

As illustrated, thermoplastic material 62 formulated with the desired ingredients to form the core of the box connector 9 is fed from
20 hopper 63 into a suitable extrusion die (not shown) from which it is delivered in a continuous stream having the requisite cross-sectional shape. At the same time, material 64 suitable for the coextruded skin is delivered from hopper 65 and coextruded to cover the exposed surfaces of the box connector.

25 As the coextruded core and skin are fed continuously out of the extrusion die arrangement suitable rotary drills 66 carried by a horizontally reciprocating carriage 67 mounted on guide 68 are utilized to drill the holes 25.

30 The movement of the carriage 67 is such that it moves away from the extrusion apparatus at the same speed as the box connector extrusion is delivered out of the extruder so that during the drilling the extrusion and the drills have no relative movement in the direction of extrusion feed. As soon as the holes are cut and the drills retracted, they are rapidly returned
35 rearwardly of extrusion feed to the start position to then recommence a fresh cycle of drilling while moving at the same speed as the extrusion feed.

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The drills are arranged so that when they retract they withdraw the material cut from the extrusion where it can be dropped unto a collector pan 69 and delivered back by a suitable feed 70 into the core material hopper 63.

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Following extrusion and drilling, the box connector extrusion can be cut off at the requisite lengths depending on the nature of the building structure with which it is to be employed.

10

By using the structural components of the invention which have material cut or removed therefrom and recycled as described, savings in the cost of a building such as a house of up to 25% can be achieved further significantly increasing the affordability of housing and the like for the low income masses.

15

While a number of different structural components have been shown and described, it will be understood that the principles of the invention may be employed to produce various other structural component profiles to meet the requirements for producing the shape of the building structure desired. It will also be understood that variations may be made in the details of the component structures and the arrangement of the material cut out may be made without departing from the spirit of the invention or scope of the appended claims.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS
FOLLOWS:

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1. An elongated extruded thermoplastic building component for use in the erection of a thermoplastic building structure, said component presenting spaced interlocking means extending the length thereof for sliding interlocking engagement with mating thermoplastic members, and at least one
10 longitudinally extending web supporting said spaced interlocking means in spaced relation, said web having a plurality of openings therethrough spaced along the length thereof, the perimeters of said openings being disposed entirely within the space between said interlocking means.

15

2. An extruded thermoplastic building component as claimed in Claim 1 in which said interlocking means supported by said web in spaced relation comprise spaced outwardly facing grooves extending the length of said component.

20

3. An extruded thermoplastic building component as claimed in Claim 1 in which said interlocking means supported by said web in spaced relation are spaced arms having spaced inturned locking fingers extending the length of said component.

25

4. An extruded thermoplastic building component as claimed in Claims 1, 2 or 3 in which said openings are circular and have a diameter less than the spacing between said interlocking means.

30

5. An extruded thermoplastic building component as claimed in Claims 1, 2 or 3 in which said openings are circular with said openings having uniform diameters and being centered on a line located centrally between said spaced interlocking means and uniformly spaced along said line, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.

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6. An elongated extruded thermoplastic building component as claimed in Claim 1, 2 or 3 having a plurality of longitudinally extending webs



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having a plurality of openings cut therethrough spaced along the length thereof, the perimeters of said opening being disposed entirely within the space between said interlocking means spaced along the length thereof.

- 5 7. An elongated extruded thermoplastic building component as claimed in Claims 1, 2 or 3 extruded from a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fiber and calcium carbonate.
- 10 8. An elongated extruded thermoplastic building component as claimed in Claims 1, 2 or 3 having a core extruded from a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fiber and calcium carbonate and a smooth coextruded skin on surfaces of said component which are exposed when said component
15 is incorporated into a building structure.
- 20 9. An elongated extruded thermoplastic hollow building component of generally rectilinear form for use in the erection of a thermoplastic building structure, said component having planar spaced walls
20 connected in spaced relation by spaced planar webs extending the length thereof, said spaced walls being provided at least adjacent one longitudinal edge with spaced inwardly projecting interlocking means extending
25 longitudinally thereof for interengagement with a mating component, at least one of said webs having a series of holes cut out therefrom along the length
25 thereof with the perimeters of said holes being within the space between said inwardly projecting interlocking means provided in said walls.
- 30 10. An elongated extruded thermoplastic hollow building component as claimed in Claim 9 in which said inwardly projecting
30 interlocking means oppositely registering grooves formed in said planar spaced walls.
- 35 11. An elongated extruded thermoplastic hollow building component as claimed in Claim 9 in which said planar spaced walls at said one
35 longitudinal edge extend beyond said planar webs at said edge and said inwardly projecting interlocking means comprises intumed locking fingers provided at the distal end of said wall extensions.



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12. An elongated extruded thermoplastic hollow building component as claimed in Claims 9, 10 or 11 which is extruded to provide a reinforced thermoplastic core having a smooth coextruded skin covering exposed surfaces thereof.

13. An elongated extruded thermoplastic hollow building component as claimed in Claims 9, 10 or 11 which is extruded to provide a core of polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fibers and calcium carbonate and a smooth coextruded skin overlying exposed surfaces of said component which are exposed when said component is interlocked into a building structure.

14. An elongated extruded thermoplastic hollow building component as claimed in Claims 9, 10 or 11 in which said holes are circular and of uniform diameter and are centered on and uniformly spaced along a line located centrally of the space between said interlocking means, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.

15. An elongated extruded thermoplastic hollow rectilinear building component for use in the erection of a thermoplastic building structure, said component having a pair of spaced generally planar walls connected in spaced relation by spaced transverse webs extending the length thereof, said walls being provided at least adjacent one longitudinal edge thereof with inwardly projecting oppositely registering interlocking means extending the length thereof, said interlocking means being selected from one of oppositely registering grooves in said walls to slidably receive oppositely registering locking fingers of a mating component, and oppositely registering inturned locking fingers carried by said walls outwardly of said webs at said at least one edge to slidably engage in oppositely registering locking grooves of a mating component, at least the web closest to said inwardly projecting locking means having a series of openings cut therefrom along the length thereof in an area within the spacing between said inwardly projecting locking means.



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16. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claim 15 in which said openings comprise circular holes.
- 5 17. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claim 15 in which said openings comprise circular holes of uniform diameter uniformly spaced along a line located centrally of the space between said interlocking means, the diameter of said holes being equal to a major portion of, but less than, the distance between said spaced
10 interlocking means.
18. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claims 15, 16 or 17 in which said component comprises a longitudinal panel and said transverse webs include webs which
15 extend across between said substantially planar walls and form the longitudinal edge walls of said panel and at least one web which defines internal compartments within said panel between said panel edge walls, and said interlocking means comprises inwardly projecting oppositely registering grooves in said substantially planar walls adjacent each of said panel edge
20 walls and extending throughout the length of said substantially planar walls, the spacing between said substantially planar walls being reduced outwardly of said grooves to provide a locking tongue and said openings are provided in each of said webs.
- 25 19. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claims 15, 16 and 17 in which said component comprises a box connector in the form of an elongated hollow rectangle, two opposed walls of which are constituted by said substantially planar walls, and two walls of which are constituted by said transverse webs.
- 30 20. An elongated extruded thermoplastic building component comprising an elongated hollow box connector, having four planar walls, spaced longitudinal flanges extending outwardly from at least two of said walls and terminating in intumed locking fingers, said walls from which said
35 spaced flanges project having a plurality of openings cut therein along the length thereof, said openings having a perimeter occupying a space within the spacing of said intumed fingers.



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21. A box connector as claimed in Claim 20 having spaced longitudinal flanges terminating in intumed locking finger flanges projecting from three of said walls.
- 5
22. A box connector as claimed in Claim 20 having spaced longitudinal flanges terminating in intumed locking fingers projecting from all four of said walls.
- 10
23. A box connector as claimed in Claims 20, 21 or 22 in which said openings are circular holes.
24. A box connector as claimed in Claims 20, 21 or 22 in which said openings are circular holes of uniform diameter uniformly spaced along the length thereof, the diameter of said holes being equal to a major portion of, but less than, the spacing between said intumed locking fingers.
- 15
25. A box connector as claimed in Claims 20, 21 or 22 having a core of polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fibers, and calcium carbonate and a coextruded smooth skin covering exposed surfaces of said box connector.
- 20
26. An elongated rectilinear hollow structural component for use in erecting a modular building structure, said component being extruded from a thermoplastic material and presenting means for sliding interlocking engagement with an adjoining mating structural component, said structural component having a plurality of openings cuts therefrom and clear of interference with said interlocking means providing communication from the interior thereof into the interior of an adjoining mating component.
- 25
27. An elongated hollow structural component as claimed in Claim 26 having at least one internal web forming internal compartments, said internal web having a plurality of openings therethrough to provide communication between said compartments.
- 30
28. An extruded thermoplastic structural component as claimed in Claims 26 or 27 having a core containing a reinforcing and expansion
- 35



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controlling agent and a coextruded smooth skin covering external surfaces of said component which are exposed when said component is interlocked with mating components.

29. An extruded thermoplastic structural component as claimed in Claims 26 or 27 having a core of polyvinyl chloride containing a reinforcing and expansion controlling agent selected from one or more of mineral fibers, glass fibers and calcium carbonate and a coextruded smooth skin covering external surfaces of said component which are exposed when said component is interlocked with other mating components.

30. An extruded thermoplastic component as claimed in Claim 28 having a core of polyvinyl chloride containing from about 5% to about 50% calcium carbonate and a coextruded smooth skin covering external surfaces of said component which are exposed when said component is interlocked with other mating components.

31. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 30% of calcium carbonate.

32. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 35% of fine short glass fibers.

33. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 20% of fine short glass fibers.

34. In the manufacture of thermoplastic structural building components having spaced inwardly extending interlocking means for sliding interlocking engagement with mating components and at least one web supporting said interlocking means in spaced relation, the steps of extruding the desired component profile in a longitudinal continuously fed extrusion stream presenting said spaced inwardly extending interlocking means and said at least one web supporting said interlocking means in spaced relation, cutting a series of openings in said web along the length thereof while the extruded profile stream is being fed, the perimeters of said openings lying within the

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spacing between said interlocking means, and cutting off lengths of said extruded profile stream according to the desired length of the component.

35. In the manufacture of thermoplastic structural building components, as claimed in Claim 34, the further steps of collecting the material cut from the web and feeding same back for incorporation into a following segment of the profile stream being extruded.

36. The manufacture of thermoplastic structural components as claimed in Claims 34 or 35 in which the thermoplastic material from which said components are extruded comprises a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from one or more of mineral fibers, small glass fibers and calcium carbonate.

37. The method of manufacturing hollow rectilinear thermoplastic structural building components having at least four walls, and having adjacent at least one of said walls spaced inwardly extending and oppositely registering interlocking means for sliding interlocking engagement with mating components and having a plurality of openings cut out of said at least one wall along the length thereof, said method comprising the steps of feeding thermoplastic material through an extrusion die arrangement to extrude the desired component profile in a longitudinal continuously moving stream, cutting openings in said at least one wall while said extruded profile stream is moving with the perimeters of said openings lying within the spacing between said spaced interlocking means, removing the material cut from said at least one wall and returning same for refeeding through said extrusion die arrangement, and cutting off lengths of said extruded profile stream according to the desired component length.

38. The method as claimed in Claim 37 in which said openings are circular.

39. The method as claimed in Claim 37 in which said openings are circular and of a uniform diameter equal to a major portion of but less than the distance between said spaced interlocking means.

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40. The method as claimed in Claims 37, 38 or 39 in which said extrusion die arrangement is constituted to coextrude a core fed from a core material supply source, and a smooth skin covering exposed external surface of said core fed from a skin material supply source, and said material cut from said at least one wall is returned to said core material supply source.
41. The method as claimed in Claim 39 in which said extrusion die arrangement is constituted to coextrude a core fed from a core material supply source comprising a polyvinyl chloride and a reinforcing and expansion controlling agent selected from one or more of mineral fibers, small glass fibers, and calcium carbonate, and a smooth skin covering exposed external surfaces of said core fed from a skin material supply source, and said material cut from said at least one wall is returned to said core material supply source.
42. The method as claimed in Claim 41 in which said smooth skin material is selected from polyvinyl chloride, rigid polyvinyl chloride, ABS and polycarbonate.
43. The method as claimed in Claim 39 in which said hollow component is extruded to provide an inwardly extending channel in at least one of said walls other than the wall having said circular openings cut out therefrom, said channel projecting into the space between said spaced interlocking means; and said step of cutting said spaced openings in said at least one wall is utilized to remove material from said channel at spaced points where it projects into said space between interlocking means.
44. An elongated hollow structural component as claimed in Claim 26 in which said component is formed to provide a channel having a bottom projecting into the space between said spaced interlocking means, said channel having material cut from the bottom thereof at spaced points along its length to provide access to the interior of said components.
45. An elongated extruded thermoplastic building component having at least one web and interlock means to opposite sides of said web for interlocking engagement with a mating thermoplastic member in a thermoplastic building structure, said web having a plurality of openings cut





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therethrough and spaced from one another longitudinally of said web, said openings being located between without penetrating said interlock means of said building component.

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ABSTRACT OF THE DISCLOSURE

An elongated extruded thermoplastic building component for use in the erection of a thermoplastic building structure, said component presenting spaced interlocking means extending the length thereof for sliding interlocking engagement with mating thermoplastic member, and at least one longitudinally extending web supporting said spaced interlocking means in spaced relation with said web having a plurality of openings cut therethrough inwardly of said interlocking means spaced along the length thereof. In its most common form the component is extruded with a core of reinforced thermoplastic material having a coextruded smooth skin covering exposed surfaces thereof and is rectilinear having planar spaced walls connected in spaced relation by spaced planar webs extending the length thereof, with the spaced walls being provided at least adjacent one longitudinal edge with spaced inwardly projecting interlocking means extending longitudinally thereof for interengagement with a mating component, at least one of said webs having a series of circular holes cut out therefrom along the length thereof with the perimeters of said holes being within the space between said inwardly projecting interlocking means.

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FIG.1.

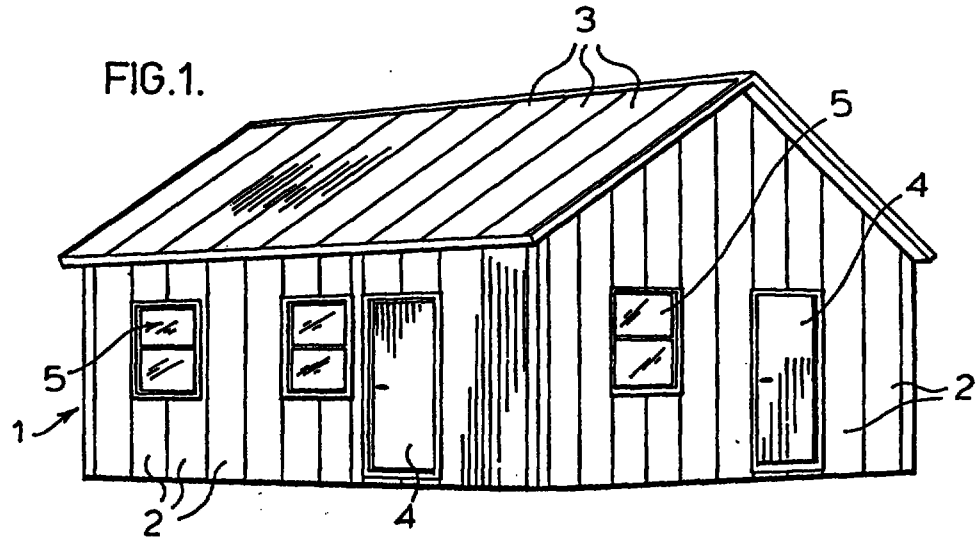
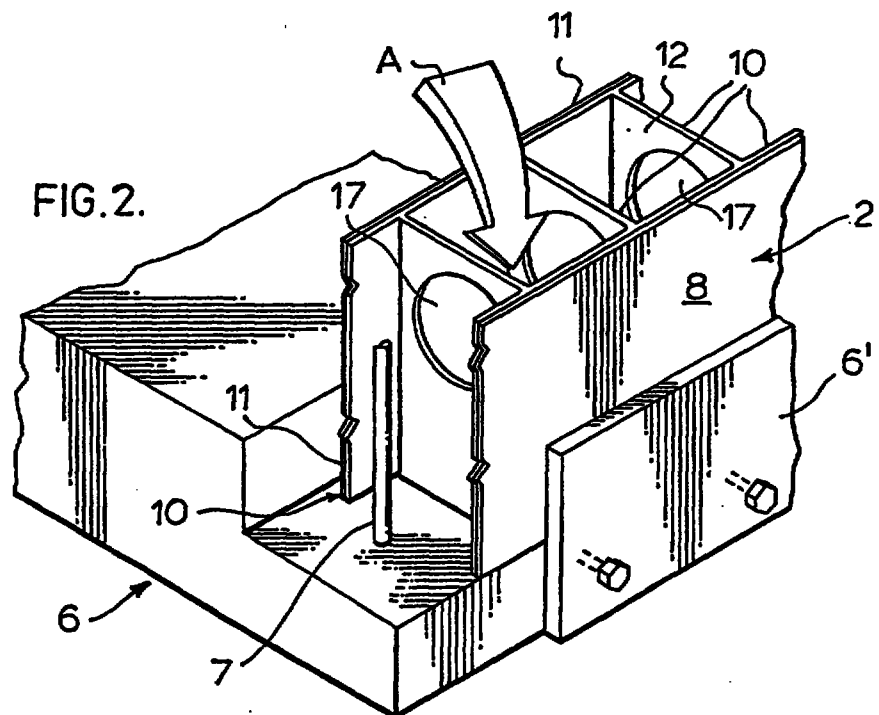
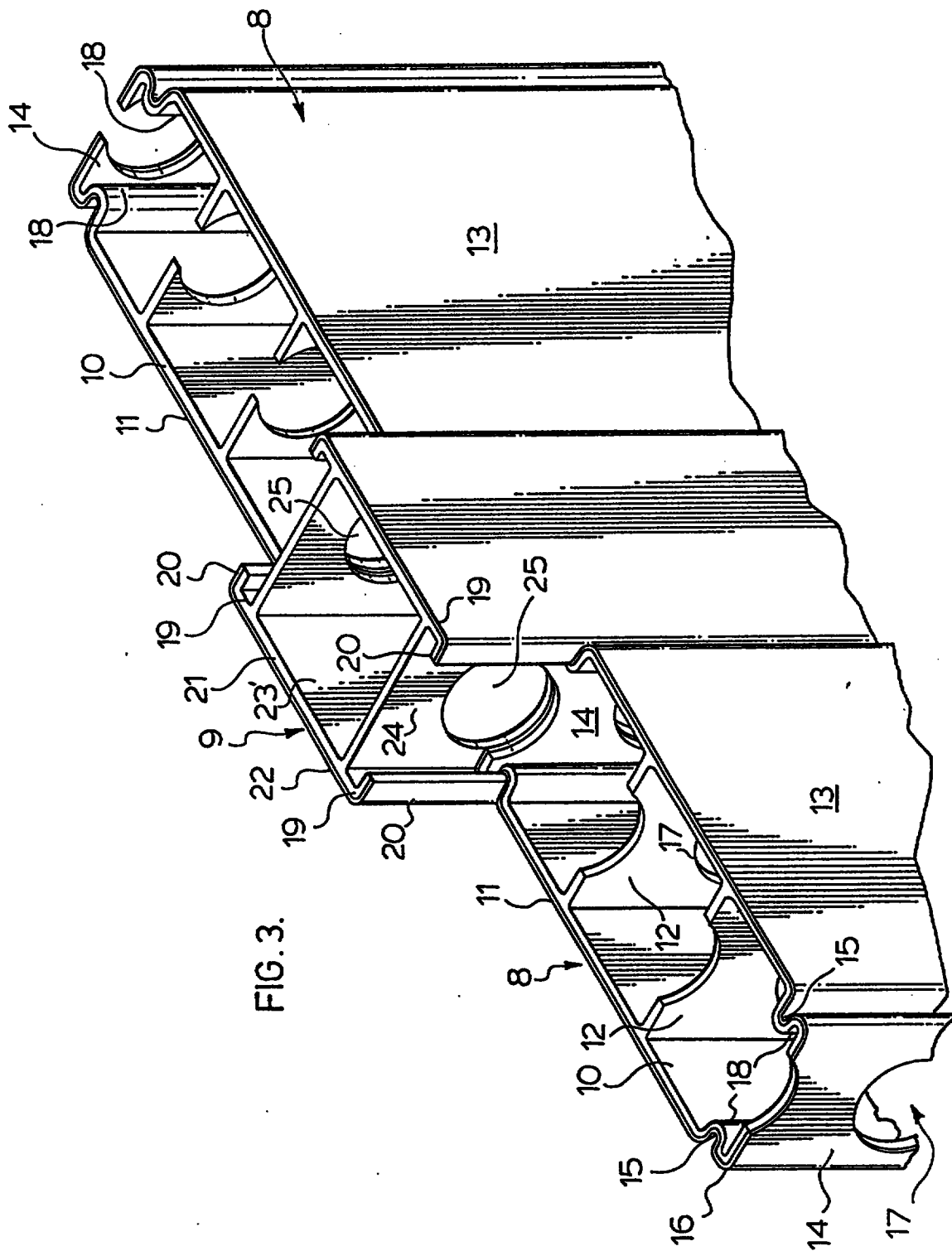


FIG.2.



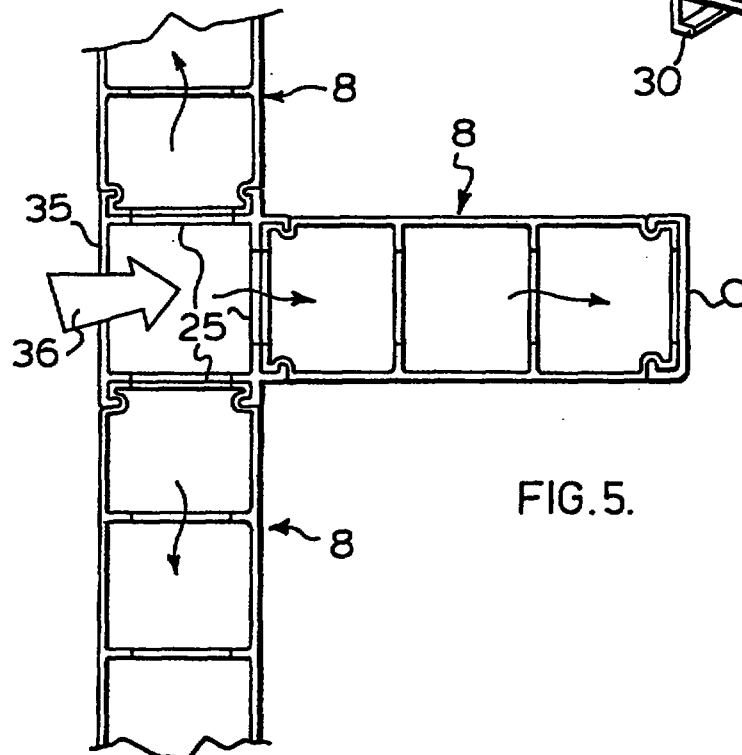
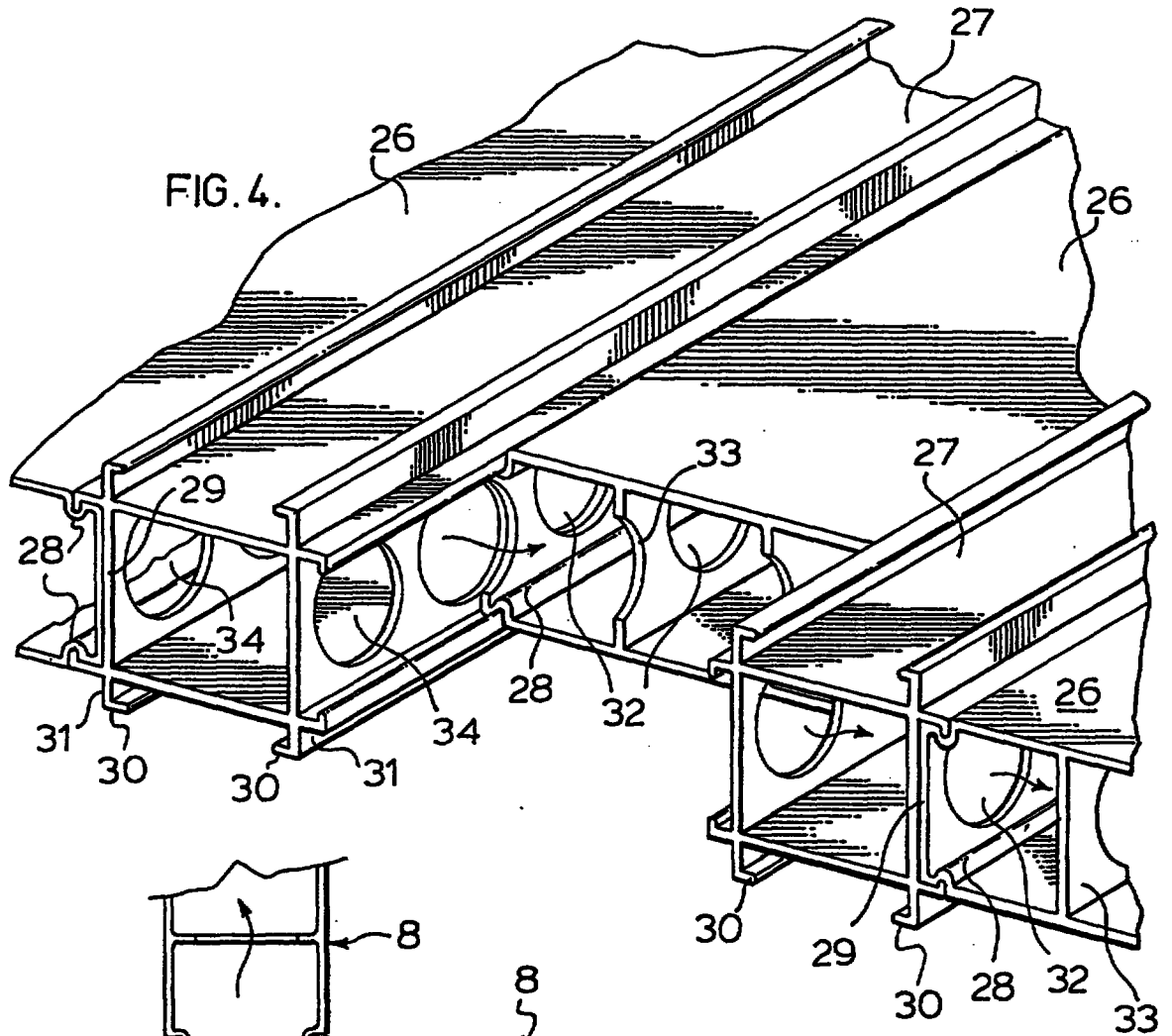
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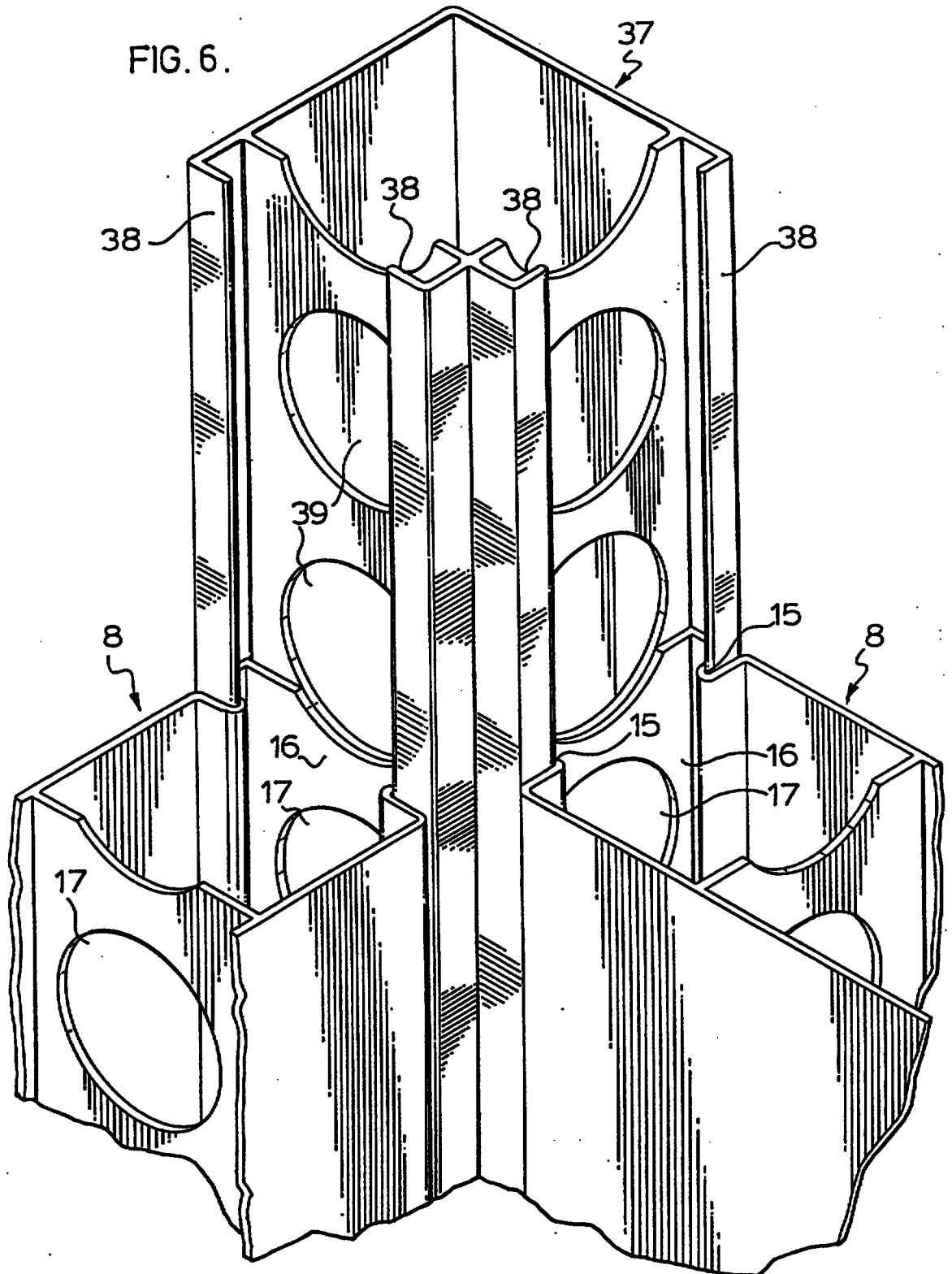


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FIG. 6.

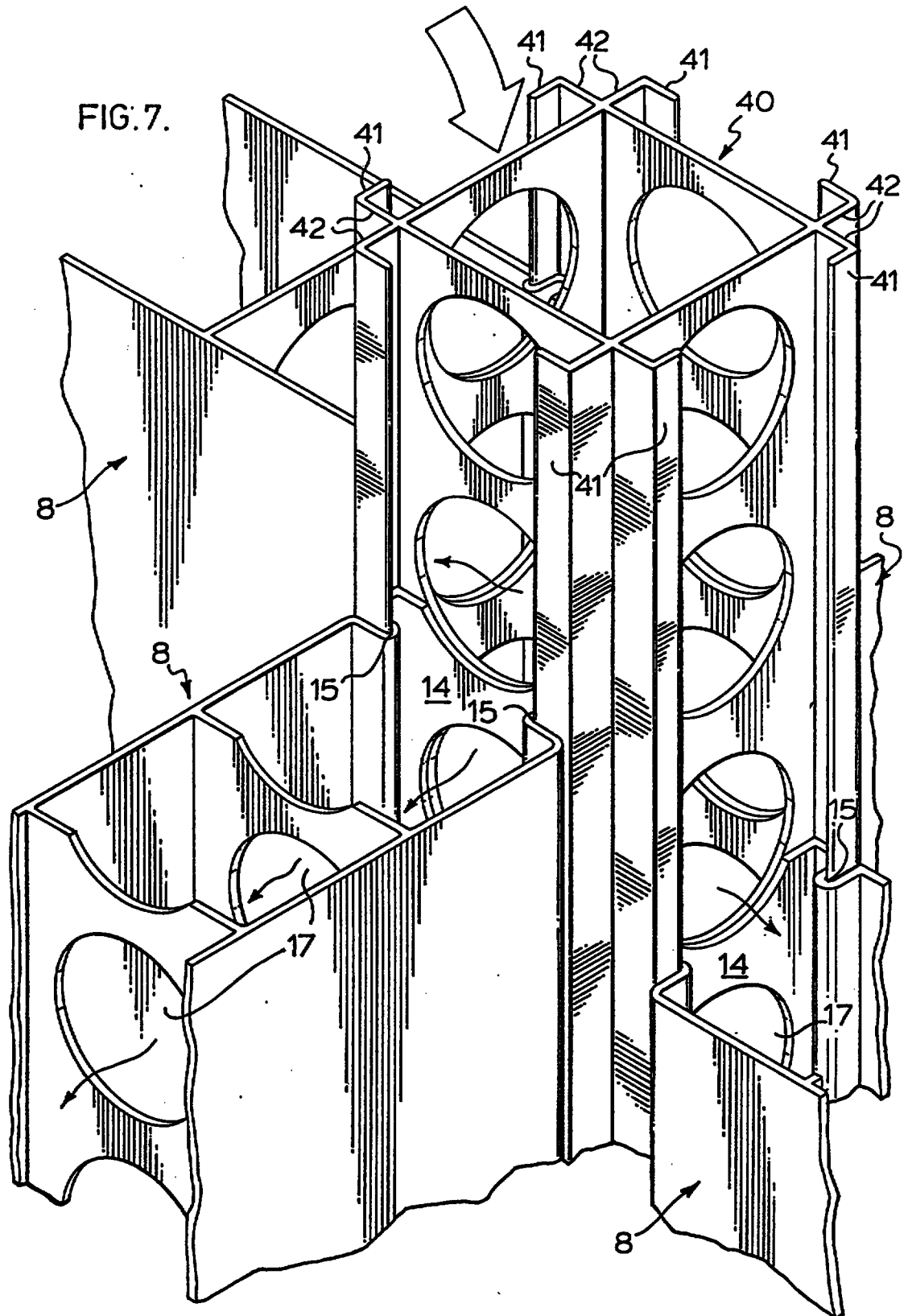




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FIG. 7.



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FIG. 8.

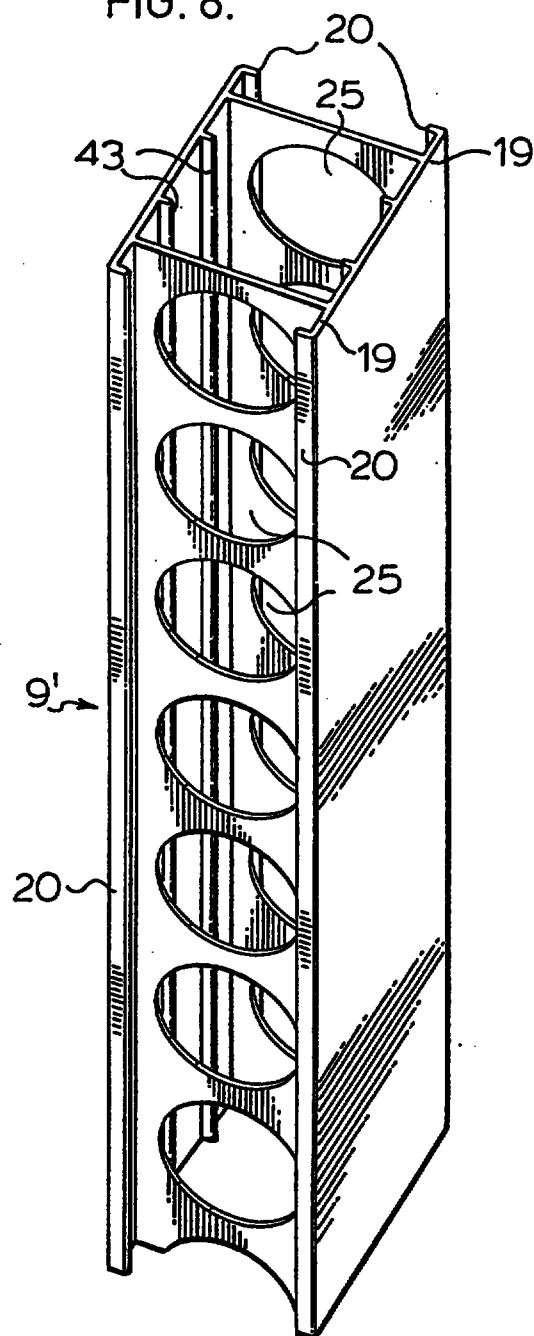
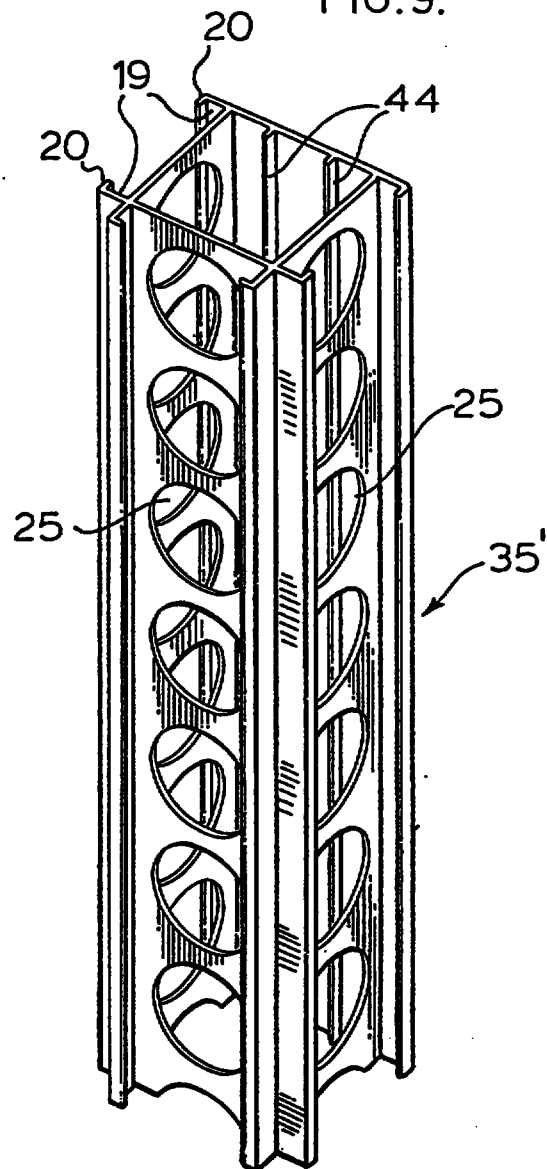


FIG. 9.



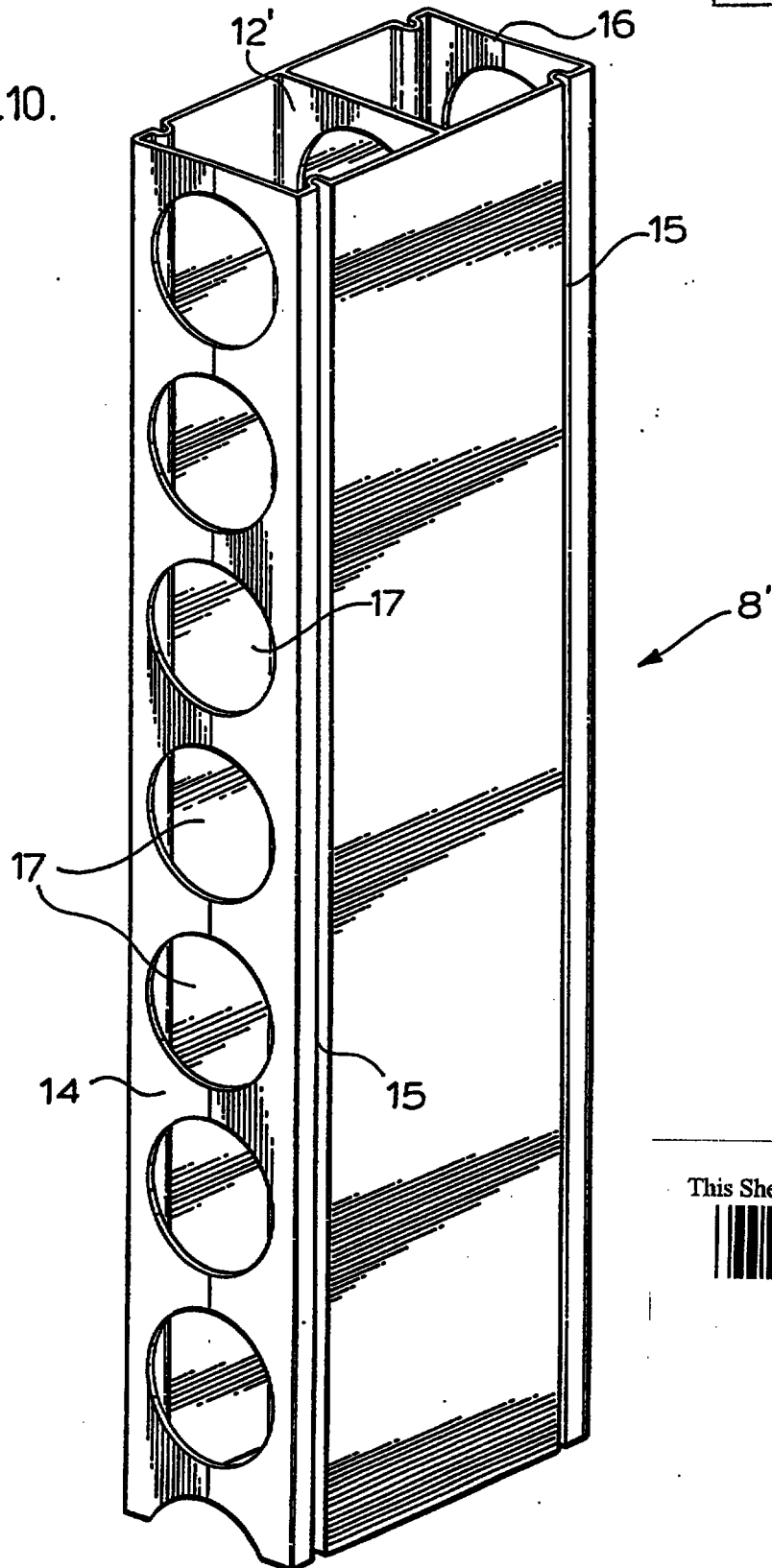
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FIG.10.



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FIG.11.

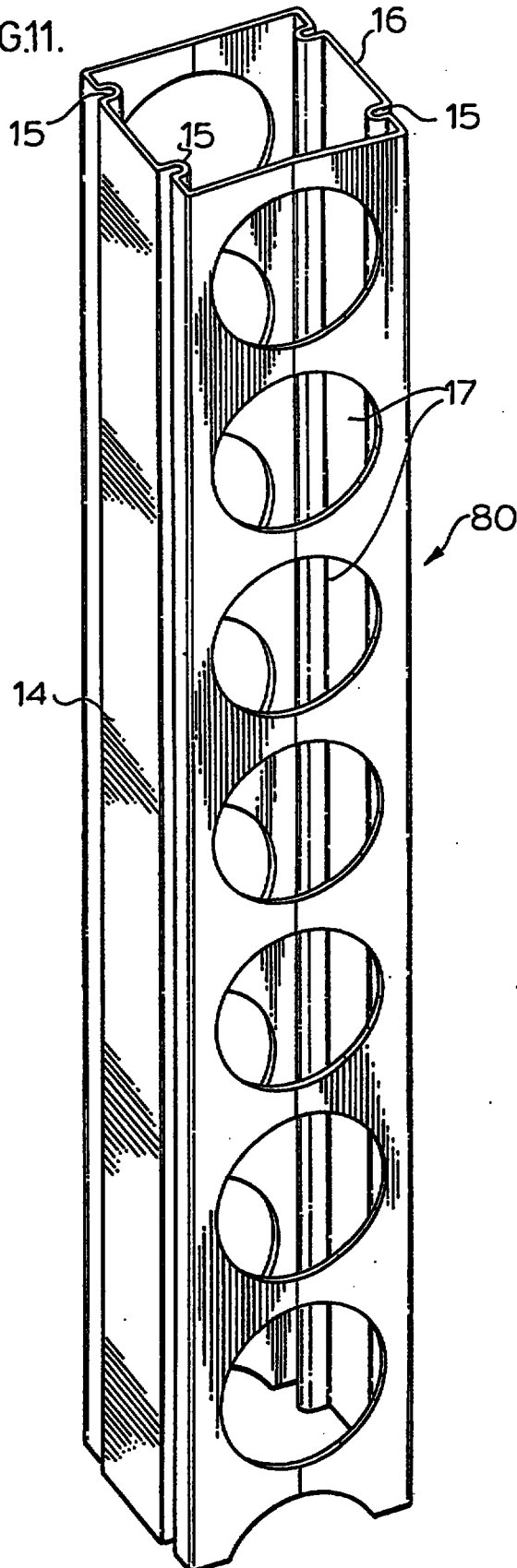
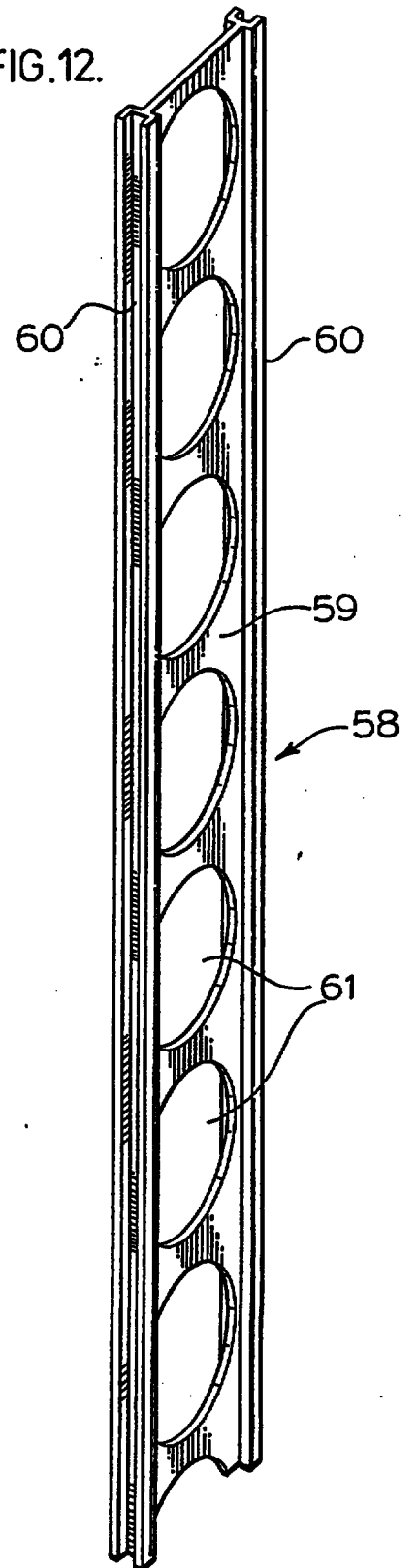


FIG.12.





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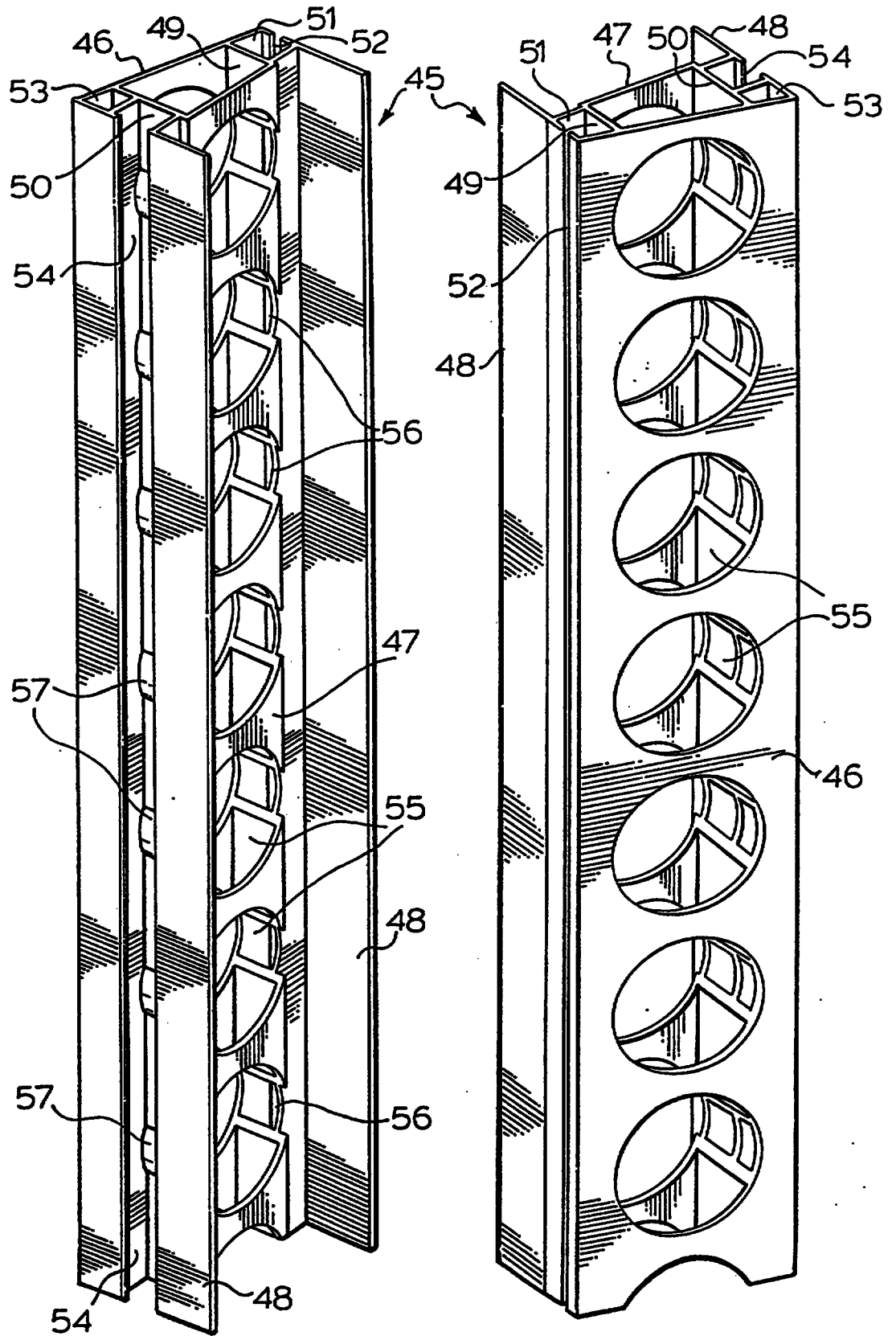
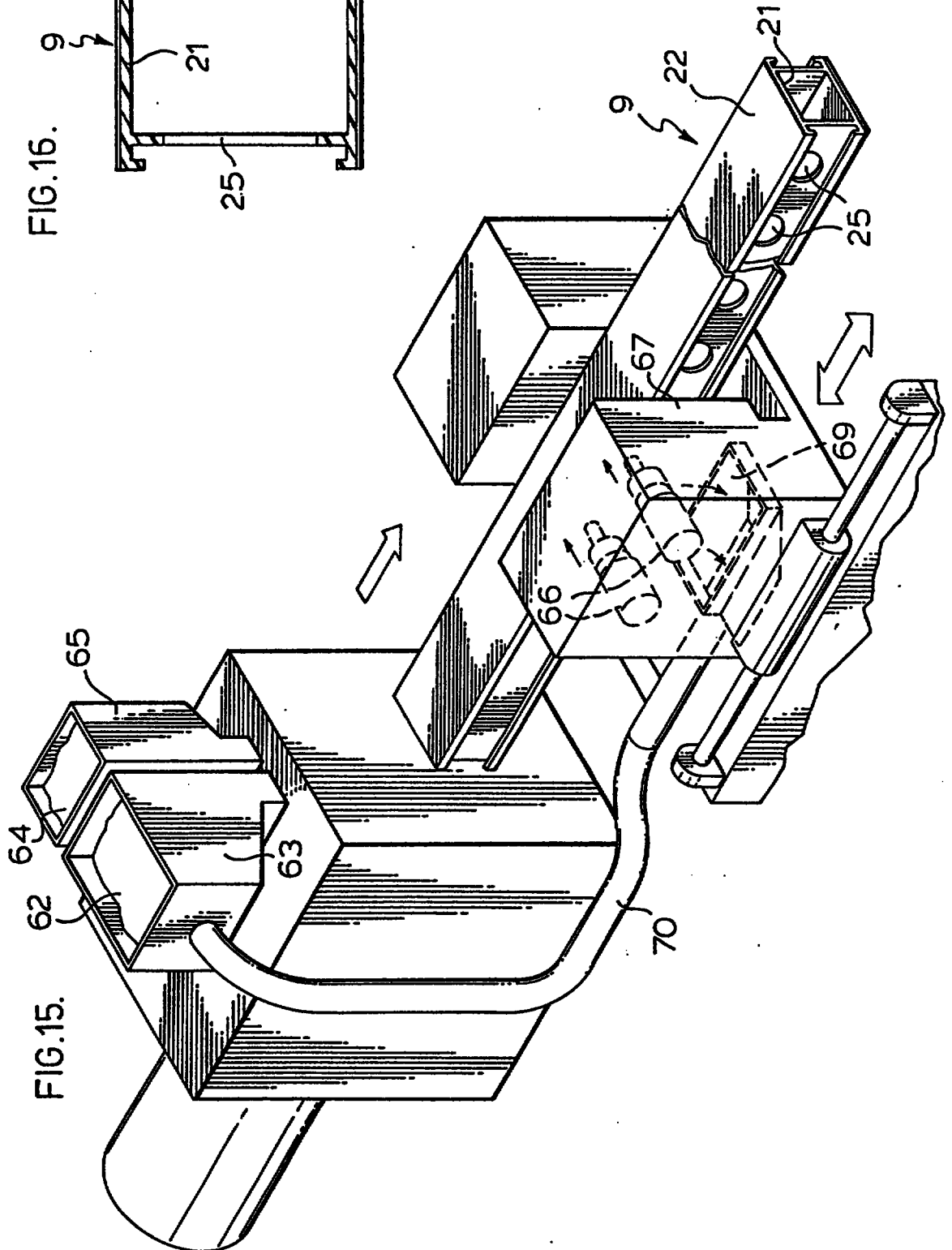
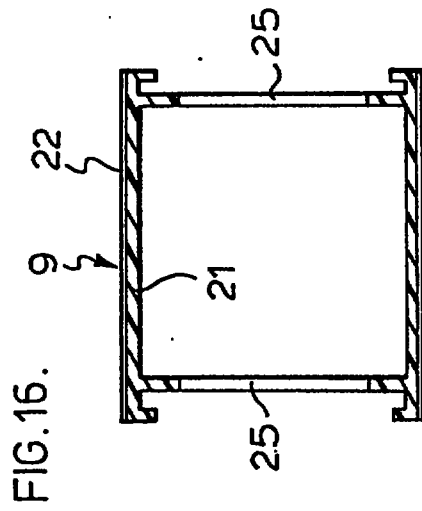


FIG.13.

FIG.14.





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controlling agent and a coextruded smooth skin covering external surfaces of said component which are exposed when said component is interlocked with mating components.

- 5 29. An extruded thermoplastic structural component as claimed in Claims 26 or 27 having a core of polyvinyl chloride containing a reinforcing and expansion controlling agent selected from one or more of mineral fibers, glass fibers and calcium carbonate and a coextruded smooth skin covering external surfaces of said component which are exposed when said component
10 is interlocked with other mating components.
30. An extruded thermoplastic component as claimed in Claim 28 having a core of polyvinyl chloride containing from about 5% to about 50% calcium carbonate and a coextruded smooth skin covering external surfaces of
15 said component which are exposed when said component is interlocked with other mating components.
- 20 31. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 30% of calcium carbonate.
33. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 35% of fine short glass fibers.
- 25 34. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 20% of fine short glass fibers.
- 30 35. In the manufacture of thermoplastic structural building components having spaced inwardly extending interlocking means for sliding interlocking engagement with mating components and at least one web supporting said interlocking means in spaced relation, the steps of extruding the desired component profile in a longitudinal continuously fed extrusion stream presenting said spaced inwardly extending interlocking means and said
35 at least one web supporting said interlocking means in spaced relation, cutting a series of openings in said web along the length thereof while the extruded profile stream is being fed, the perimeters of said openings lying within the

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spacing between said interlocking means, and cutting off lengths of said extruded profile stream according to the desired length of the component.

36. In the manufacture of thermoplastic structural building components, as claimed in Claim 35, the further steps of collecting the material cut from the web and feeding same back for incorporation into a following segment of the profile stream being extruded.
37. The manufacture of thermoplastic structural components as claimed in Claims 35 or 36 in which the thermoplastic material from which said components are extruded comprises a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from one or more of mineral fibers, small gals fibers and calcium carbonate.
38. The method of manufacturing hollow rectilinear thermoplastic structural building components having at least four walls, and having adjacent at least one of said walls spaced inwardly extending and oppositely registering interlocking means for sliding interlocking engagement with mating components and having a plurality of openings cut outs of said at least one wall along the length thereof, said method comprising the steps of feeding thermoplastic material through an extrusion die arrangement to extrude the desired component profile in a longitudinal continuously moving stream, cutting openings in said at least one wall while said extruded profile stream is moving with the perimeters of said openings lying within the spacing between said spaced interlocking means, removing the material cut from said at least one wall and returning same for refeeding through said extrusion die arrangement, and cutting off lengths of said extruded profile stream according to the desired component length.
39. The method as claimed in Claim 38 in which said openings are circular.
40. The method as claimed in Claim 38 in which said openings are circular and of a uniform diameter equal to a major portion of but less than the distance between said spaced interlocking means.



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41. The method as claimed in Claims 38, 39 or 40 in which said extrusion die arrangement is constituted to coextrude a core fed from a core material supply source, and a smooth skin covering exposed external surface of said core fed from a skin material supply source, and said material cut from said at least one wall is returned to said core material supply source.
42. The method as claimed in Claim 40 in which said extrusion die arrangement is constituted to coextrude a core fed from a core material supply source comprising a polyvinyl chloride and a reinforcing and expansion controlling agent selected from one or more of mineral fibers, small glass fibers, and calcium carbonate, and a smooth skin covering exposed external surfaces of said core fed from a skin material supply source, and said material cut from said at least one wall is returned to said core material supply source.
43. The method as claimed in Claim 42 in which said smooth skin material is selected from polyvinyl chloride, rigid polyvinyl chloride, ABS and polycarbonate.
44. The method as claimed in Claim 40 in which said hollow component is extruded to provide an inwardly extending channel in at least one of said walls other than the wall having said circular openings cut-out therefrom, said channel projecting into the space between said spaced interlocking means; and said step of cutting said spaced openings in said at least one wall is utilized to remove material from said channel at spaced points where it projects into said space between interlocking means.
45. An elongated hollow structural component as claimed in Claim 26 in which said component is formed to provide a channel having a bottom projecting into the space between said spaced interlocking means, said channel having material cut from the bottom thereof at spaced points along its length to provide access to the interior of said components.
46. An elongated extruded thermoplastic building component having at least one web and interlock means to opposite sides of said web for interlocking engagement with a mating thermoplastic member in a thermoplastic building structure, said web having a plurality of openings cut

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therethrough and spaced from one another longitudinally of said web, said openings being located between without penetrating said interlock means of said building component.



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THERMOPLASTIC STRUCTURAL COMPONENTS AND STRUCTURES FORMED THEREFROM

5 FIELD OF THE INVENTION

This invention relates to reduction of the costs of the novel thermoplastic structural system and structural components therefor and building structures erected therefrom which are disclosed in my copending
10 Canadian Application Serial No. 2,070,079, filed May 29th, 1992 without adversely affecting their integrity.

15 BACKGROUND OF THE INVENTION

The structural system disclosed in my said copending application comprises novel interlocking thermoplastic structural components which can be mass produced at low cost and which can be quickly and easily
20 interlocked together to erect a wide range of structures which will require minimal maintenance and will be safe from termites, corrosion, rust or rot and will be highly resistant to the effects of weathering.

The present invention is directed to significantly reducing the
25 costs of such components and hence the costs of structures erected therewith without sacrificing the structural integrity of the components or system.

Further the invention is directed to such cost reductions of the components themselves and the structures formed therefrom without
30 increasing the costs of production of the components or interfering with the ease of their assembly.

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Further the invention is directed to providing such structural components as to aforesaid which will facilitate the conversion of the walls erected therewith into permanent wall structures, will enhance the air circulation in roofs erected therewith, and will provide reduced thermal transfer between the exterior and interwall surfaces of the walls and roofs.

DESCRIPTION OF PRIOR ART

While the use of plastic to form wall panels or the like for use in building construction has been proposed, such panels have not had the necessary load bearing or other structural requirements to form practical structures which could be mass produced at low cost and quickly and easily assembled to erect durable low cost structures and, in particular, low cost housing.

U.S. Patent 3,992,839, for instance, discloses a plastic panel fabricated from separate panel members, preferably formed of polyvinyl chloride which snap together to form a thin wall panel. The panels in turn are formed to snap together to provide a wall structure. Such fabricated panels are inherently weak and lack the strength and load bearing capacity to form adequate structural components for use, for instance, in the forming of the walls and roof of a practical durable building.

U.S. Patent 3,362,507 discloses the use of tongue and grooved individually prefabricated panels said to be preferably of plastic which are bonded or glued together and used particularly for the forming of basement walls. Such panels do not permit of high speed production and are not capable of being quickly and easily interlocked together in the erection of a house or other structure.

U.S. Patent No. 4,457,091 discloses a hollow panel member having a width of about one and one-half inches (1 1/2") and a complicated interior formed by pultrusion, a process involving drawing long glass strands and a plastic binding material forcefully through a die under heat to form the glass strands into a compacted glass mat bound together by the plastic material. Such a process is prohibitively slow and expensive and the panels

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themselves do not provide acceptable or practical low cost structures for forming the walls and roofing of a housing system such as contemplated by the present invention.

5 While modular building structures using modular building components formed of steel have also been proposed, such as disclosed in U.S. Patent 1,958,124, such systems involve welding together of the members to make up the components and the use of bolts or other fasteners to secure same together. Such systems are not practical for low cost practical housing
10 and the like with which the present invention is concerned.

SUMMARY OF THE INVENTION

15 In accordance with the present invention, the structural building components comprise elongated thermoplastic extrusions presenting spaced interconnecting means, preferably spaced inwardly extending interlocking means extending the length thereof for sliding interlocking engagement with
20 mating interlocking means of an adjoining mating structural member, said extrusions having at least one longitudinal web supporting the interlocking means in spaced relation with the web having a plurality of openings cut therethrough inwardly of the interlocking means and spaced along the length of the web.

25 According to the preferred form of the invention the openings are circular and preferably of a uniform diameter and more preferably still the openings have a diameter equal to a major portion of but less than the spacing between the interlocking means.

30 Preferably the structural components of the present invention are extruded from a vinyl chloride, preferably a polyvinyl chloride, containing a reinforcing and expansion controlling agent which preferably is selected from one or more of mineral fibres, small glass fibers and calcium
35 carbonate.

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More particularly, the extruded structural components comprise a core of polyvinyl chloride containing a reinforcing and expansion controlling agent as aforesaid and a coextruded thermoplastic skin covering surfaces that will be exposed on assembly into a building structure.

5

Further, in accordance with the invention, the openings in the at least one web of the structural component are bored out of the web immediately after the component has been extruded and while it is still feeding away from the extruder.

10

Also, according to the invention, the material removed from the web is returned for reuse as a core extrusion material.

15 BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will be understood from the following detailed description taken in conjunction with the accompanying drawings in which:

20

Figure 1 is a perspective view of a small house erected from interlocking thermoplastic structural components such as form the subject matter of the present invention.

25

Figure 2 is a broken away perspective view illustrating a wall panel embodying the present invention seated on a concrete base ready to receive concrete or other anchoring material to be anchored to the base through suitable anchor rods.

30

Figure 3 is a perspective view illustrating a wall section showing a pair of wall panels interlockingly engaged with a connecting box connector and showing the components as comprising a core having the exposed external surfaces thereof coated with a smooth thermoplastic skin with the thickness of the skin being somewhat exaggerated for purposes of illustration.

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Figure 4 is a perspective view illustrating a plurality of roof panels corresponding to the wall panels of Figure 3 embodying the invention connected by four-way box connectors according to the invention, the four-way box connectors being available for the attachment of cladding to the upper surface of the roof and for engagement with other components beneath the roof's surface.

Figure 5 is a plan view showing a three-way box connector interlockingly connecting two aligned wall panels and a third wall panel at right angles thereto.

Figure 6 is a perspective view illustrating a corner box connector connecting two wall panels in right angular relation.

Figure 7 is a perspective view illustrating a four-way box connector for connecting four wall panels in right angular relation.

Figure 8 is a perspective view of a slightly modified two-way box connector having interior locking fingers for interlocking engagement with a mating insert.

Figure 9 is a view similar to Figure 8 but showing a three-way box connector.

Figure 10 is a perspective view of a wall panel according to the invention having a single interior web.

Figure 11 is a perspective view of a wall panel with no interior web.

Figure 12 is a perspective view of a box connector joiner embodying the invention.

Figure 13 is a perspective view taken from the underside of a sloping wall cap embodying the invention.

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Figure 14 is a perspective view of the wall cap of Figure 13 taken from the top side.

Figure 15 is a diagrammatic view illustrating the manner in which the components of the present invention are extruded and then drilled to produce the openings through the webs thereof.

Figure 16 is a cross-sectional view of the particular box connector shown being extruded in Figure 15.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

It will be understood that while only Figure 3 illustrates the co-extruded skin on the exposed surfaces of the wall panels and the box connector, all of the panels and box connectors will have such an extruded skin and it is only components such as the box connector joiner of Figure 12 which will have no exposed surfaces when assembled into a building structure that will be extruded without any skin coating.

With reference to the drawings, Figure 1 is a perspective view of a house 1 as an example of the type of building that can be erected with the thermoplastic interlocking building components of the present invention which can be assembled into walls 2 and roofing 3 with provision for doors 4 and windows 5.

A building such as illustrated in Figure 1 is intended to be erected on a concrete pad 6 as illustrated in Figure 2 which shows how the walls 2 of the building can be anchored to the concrete pad 6 by means of anchor rods 7 when the interior of the walls 2 are filled with concrete and the like as illustrated by the arrow A. Suitable means such as the strip 6' may be employed to contain the concrete from spilling out from underneath the wall 2.

As more particularly illustrated in Figure 3, the walls 2 are formed from wall panels 8 interlockingly interconnected by box connectors 9, one of which is illustrated in Figure 3.

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Each of the wall panels 8 in accordance with the invention disclosed in copending Canadian Application Serial Number 2,070,079 comprises a hollow rectilinear thermoplastic extrusion having a core 10 and
5 coextruded outer skin 11.

The core 10 preferably comprises a vinyl chloride and, more particularly, a polyvinyl chloride containing a suitable reinforcing and expansion controlling agent such as mineral or other fibers or other known
10 expansion controlling agents such as a calcium carbonate.

A reinforcing agent or constituent particularly useful for structural components of the present invention which are subject to high loading comprises small glass fibers which when anchored in a thermoplastic
15 material such as vinyl chloride or polyvinyl chloride provide the requisite reinforcing and expansion controlling characteristics to provide high structural strength.

A suitable material incorporating small glass fibers which can be used in the production of these panels 8 is available under the trade-mark FIBERLOC from the B. F. Goodrich Company of Akron, Ohio, such material being described in detail in B.F. Goodrich's U.S. Patent 4,536,360 wherein very fine short glass fibers are bound within a composition of vinyl
20 chloride resin.

The presence of glass fibers in the PVC or other thermoplastic material while providing tensile strength and expansion control to the material creates an extrusion problem and, if they are too large and too concentrated, it is not practical to extrude the material. Preferably, such
25 fibers should be of the order of a few microns in diameter and a few millimeters in length and in concentrations not greater than and preferably substantially less than about 35% by weight based upon the combined glass fibers and vinyl chloride resins.

The presence of the glass fibers creates a brittleness which
35 makes a structure produced solely from a glass fiber reinforced plastic

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subject to potential fracture from impact. This potential increases with increased concentration of glass fibers.

5 The problems encountered with the use of the glass fibers as the reinforcing constituent while utilizing their beneficial reinforcing qualities for high loading capacity have been resolved by coextruding with the glass reinforced thermoplastic a smooth thermoplastic skin covering the external exposed surfaces of the panels.

10 The smooth plastic skin may be PVC, rigid PVC, semi-rigid PVC, ABS, polycarbonate with thermoplastics available from G.E. under the trade-mark GELOY and NORYL.

15 This skin 11 serves a number of useful purposes. Because of the presence of the glass fibers in the core or substrate 10, the substrate is somewhat brittle and its surfaces are rough and abrasive with portions of the glass fibers projecting through the surface of the substrate rendering the substrate somewhat porous and susceptible to the ingress of moisture which can adversely affect the bond between the glass fibers and the thermoplastic material.

20 The coextrusion of the thermoplastic skin covers and seals the outer exposed surfaces of the structural component against the ingress of moisture, thereby maintaining the integrity of the binding of the glass fibers to substrate plastic. Further, the outer skin 11 not only covers exposed glass fibers but these exposed glass fibers become embedded in the thermoplastic material so that the external surface of the component is totally smooth. The glass fibers in turn in becoming embedded in the outer skin lock the skin to the substrate or core 10 so that the expansion and contraction of the outer skin is fixed to the expansion and contraction of the core which is controlled or limited by the presence of the incorporated glass fibers which have a much smaller co-efficient of expansion than the plastic.

30 It will be also understood that the skin 11 can be formulated to include agents providing impact resistance, resistance to ultraviolet radiation and the like.

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5 The combination of the co-extruded core or substrate 10 and smooth skin 11 thus enable the provision of wall panels having inherent structural strength and which are essentially maintenance free, impact resistant and they will be free from corrosion, rot or rusting and will be impervious to moisture, termites and other insects.

10 While the use of the glass fibers provides the strength necessary for handling high loading, where the panels will be subjected to much lighter loading the core 10 may be formed of a vinyl chloride containing from about 5% to about 50% calcium carbonate and preferably about 5% to 30% calcium carbonate by weight.

15 Alternatively, a mixture of calcium chloride and glass fibers or other reinforcing agents such as mineral fibers may be used to meet the particular load specifications required for the panel.

20 As illustrated in Figure 3, each of the panels 8 is provided with two transverse webs 12 which tie the opposing faces 13 of the panel together intermediate the edge walls 14 of the panel.

25 Adjacent each of the edge walls 14, the panel 8 is provided with inwardly extending oppositely registering grooves 15 with the width of the panel being reduced outwardly of the grooves 15 to the edge walls 14 to, in effect, provide a tongue portion 16.

30 As the cost factor is a critical element in the ability to provide affordable housing to the masses, it has been found that this cost factor can be significantly reduced in material costs by cutting a series of openings 17 out of the webs 12 and edge walls 14 at spaced points along their length.

This cut out material can then be collected and reused in the extrusion of the core of a subsequent extrusion.

35 The openings 17 are preferably circular openings having a diameter slightly less than the spacing between the most adjacent point 18 of the grooves 15.

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5 With the openings 17 centered on the midpoint of the edge walls 14 and midway between the panel faces 13, the openings can be cut through the edge walls 14 and also through the webs 12 without interference with the grooves 15 which extend uninterrupted throughout the length of the extrusion.

10 Still with reference to Figure 3, the panels 8 are shown interlocked with the box connector 9 in the form of a hollow extruded rectangle having projecting flanges 19 terminating in inturned oppositely registering locking fingers 20 adapted to slidingly interlock with the grooves 15 of the panels 8.

15 The box connector 9 is extruded with a core 21 and a coextruded outer skin 22 covering the outer surfaces of the walls 23, the flanges 19 and the locking fingers 20.

20 Because of the inherent strength of the configuration of the extruded rectangular box connector 9, its core 21 may comprise a PVC resin and, for example, calcium carbonate, as the expansion controlling and reinforcing agent, although other agents including small glass fibers and mixtures of agents may be used.

25 It will be noted that the outer surfaces of the walls 23 of the box connector 9 covered by the outer skin 22 are precisely aligned with the outer surfaces of the panel faces 13 with the tongue portions 16 of the panels being received in the space between the inturned locking fingers 20 and the transverse walls or webs 24 of the box connector.

30 Again, the box connector is provided with a series of openings 25 through the transverse walls or webs 24. Again, these openings are circular with a diameter centered on the midpoint of the transverse walls or webs 24 of the box connector and spaced along the length thereof with the diameters of the openings substantially equal to, but less than, the spacing between the inturned locking fingers 20 so that the locking fingers are not
35 intersected during the cutting of the openings 25.

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It will be seen that the panel locking grooves 15 are covered in the smooth coextruded skin 11 to provide a smooth surface for smooth sliding interlocking engagement with the smooth skin coated locking fingers 20. Further, the outside faces of the tongues 16 which form the edge walls 14 of the panels are coated with the smooth skin 11 and preferably these faces are slightly concaved to eliminate any interference with the box connector transverse webs or walls 24.

Again, the material cut out from the box connector walls or webs 24 can be collected and returned to be used as material for extruding subsequent box connectors.

It has been found, for example, that with a wall panel width of 100 millimeters between the faces 13, circular holes having a diameter of 70 millimeters and spaced 12.7 millimeters apart provide a significant saving in material and cost of the vinyl extrusion product without significantly affecting the structural strength of the panel so that when concrete is poured therein such as illustrated in Figure 2 to convert the wall panel into a permanent wall configuration the webs and edge walls of the panels which are placed under tension exhibit adequate tensile strength tying the panel faces 13 against outward bulging under the concrete load.

In addition to the savings in material costs, the provisions of the openings 17 and 25 limits thermal transfer between the outer or exposed faces 13 of the panels 8 and the outer exposed walls 23 of the box connector 9. As a result the components provide increased insulation between the exterior and interior wall of a building such as shown in Figure 1.

Figure 4 illustrates an arrangement of roofing panels 26 which are shown interlocked together by four-way box connectors 27 rather than a two-way box connector 9 as illustrated in Figure 3 and which would be used to provide the smooth roof formation shown in Figure 1.

The four-way box connectors 27 provide for interlocking roof cladding to the upper surface of the roof and for engaging or supporting other structures beneath the roof.

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The roof panels 26 are similar to the wall panels 8 and it will be understood that they are extruded to provide a core and a coextruded outer skin covering the outer surfaces thereof (the separate layers not being shown).

5

Again, depending upon the anticipated loading of the roof structure, the reinforcing agent or agents selected for the core of the roof panels 26 will be appropriately selected.

10 For high loads the reinforcing agent preferably would include at least some of the fine small diameter short glass fibers.

Again, as in the case of the wall panels 8, the roof panels 26 are formed at opposite longitudinal edges with oppositely registering inwardly
15 extending locking grooves 28 and edge tongues 29 for sliding interlocking engagement with the inturned locking fingers 30 carried by the flange extensions 31 of the box connectors 27. Similar inturned locking fingers 30 are provided on the box connectors 27 to project above and below the interlocked roof panels.

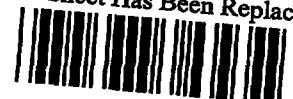
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The roof panels 26 have circular holes 32 cut through their edge tongues 29 and webs 33 corresponding to the circular holes or openings 17 cut out from the wall panels 8. Similarly, the four-way box connectors 27 have circular openings 34 cut therefrom corresponding to the openings 25
25 in the two-way box connector.

In a roofing structure formed from the thermoplastic components, it is highly desirable that air circulation be effected within the roof structure. In this respect, the cutting out of the holes 32 and 34
30 provides free air circulation laterally of the roof in addition to the air circulation which can be effected lengthwise of the elongated hollow extruded roof components.

Additionally, it will be appreciated that the provision of the
35 openings in the roof panels and their connecting box connectors restrict thermal transfer from the upper roof surface to the underside of the roof thereby adding to the thermal insulation provided by the components. It will

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also be appreciated that, if desired, the roof panels and connectors can be filled with suitable insulating material.

5 Despite the removal of the material resulting from the cutting of the circular holes 32 from the roof panels the webs 33 provide the requisite resistance to roof panel bending to sustain high roof panel loading augmented by the interengaging panel tongues 29 and box connector flanges 31 and locking finger 30.

10 Figure 5 is a plan view illustrating the connection of three wall panels 8 into a T-formation using a three-way box connector 35. The three-way box connector is provided with openings 25 in three of the walls thereof so that when material is introduced as indicated by the arrow 36 into the box connector 35, which material may be concrete, sand or insulation material, it
15 can flow through the various openings into the wall panels. As illustrated, the leg of the T-formation is closed by an end cap C formed to interlock with the tongue 16 and grooves 15 of one of the panels 8 to contain all material within the external walls of the panel and box connector.

20 Similarly, should it be desirable to introduce insulation material into the interlocked roof panel as illustrated in Figure 4, such material can be injected for distribution within the roof structure by virtue of the existence of the cut out holes. Since the spacing between the holes is much less than the diameter of the holes, there will always be significant registration between the
25 holes or openings cut in the adjoining interlocking components.

Figure 6 illustrates a corner box connector 37 connecting two wall panels 8 together in right angular relation. Box connector 37, as before, is extruded with an appropriate core and a co-extruded outer skin and
30 is provided with the requisite inturned locking fingers 38 on adjacent sides and with the cut out circular openings 39 centered between these inturned locking fingers and having diameters less than the spacing between the locking fingers.

35 Figure 7 shows a four-way locking connector 40 for interlockingly connecting four wall panels 8 in right angular relation. In this case, the connector 40 has inturned locking fingers 41 at all four sides of the



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connector and circular openings cut out therefrom in all four walls of the connector.

5 It will be understood again that the connector 40 is formed of a reinforced core with the exposed surfaces, that is the locking fingers 41 and their supporting flanges 42 coated with a smooth skin:

10 It will be noted that the arrangement of the openings cut out from the various extruded components is such that the openings are internal of the exterior walls of the structure being assembled therefrom when they are slidingly interlocked with the appropriate mating components.

15 Figure 10 is a perspective view illustrating a wall panel 8' corresponding to the panel 8 except that it has a shorter span with a single web 12'. Otherwise the panel is identical with panel 8 and like numbers refer to like parts.

20 Similarly, Figure 11 illustrates a still smaller wall panel 80 which may be used at a wall corner. Panel 80 has no internal webs but otherwise has the same interlocking features and the same cutout openings as wall panel 8 and like numbers represent like parts.

25 Figure 8 illustrates a two-way box connector 9' corresponding to box connector 9 but additionally having internal key ways comprising out turned locking fingers 43 for sliding interlocking engagement with mating inserts (not shown).

30 Figure 9 is a perspective view of a three-way box connector 35' similar to box connector 35 but having an internal slideway comprised by out turned locking fingers 44 for supporting an internal insert (not shown).

35 Figures 13 and 14 illustrate a wall cap 45 adapted to fit down over the top of a wall formed from wall panels such as panels 8 and box connectors such as box connectors 9 to present a sloping support surface 46 for supporting a sloping roof such as illustrated at 3 in Figure 1.

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Wall cap 45 is a hollow extrusion having a bottom wall 47 adapted to rest on the upper ends of an erected wall and having downturned flanges 48 forming interconnecting means adapted to embrace opposite faces 13 of the wall.

5

Webs 49 and 50 extending upwardly from the bottom wall 47 support the sloping upper surface 46 with the web 50 being of a greater height than the web 49.

10

The wall cap 45 is provided at the lower side of the sloping wall 46 with a chamber 51 which has an access slot 52 which may be closed by screening of the like (not shown). At the opposite side, the wall cap is provided with a closed chamber 53 and an open chamber 54.

15

In accordance with the invention, the bottom wall 47 and the sloping wall 46 are provided with circular openings 55 cut therethrough. For this particular component, the diameter of the openings, while less than the spacing between the flanges 48, is greater than the spacing between the webs 49 and 50 so that during the cutting of the openings 55 a portion of the webs 49 and 50 are removed to provide access openings 56 and 57 to the chambers 51 and 54.

20

Since the bottom wall 47 and the sloping upper wall 46 will not be exposed when the wall cap 45 is installed in place, these surfaces need not be coated with a covering skin. The other exposed surfaces, however, will have a skin coextruded over the core material to provide the desired smooth finish.

25

Figure 12 is an extrusion for connecting box connectors together and, when in place, will be totally enclosed and will have no exposed surfaces that require coating.

30

As illustrated, this box connector connector 58 comprises a web 59 spacing two outwardly facing channels presenting two inwardly projecting grooves 60 of a width to receive the interlocking fingers such as the fingers 20 of two adjoining box connectors 9 when their locking fingers are in abutting relation. In this manner connector 58 will lock the box connector

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together while being totally contained within the abutting box connector flanges and abutting interlocking fingers..

5 The web 59 is provided with a plurality of circular openings 61 cut therefrom with the diameter of the openings being substantially equal to but slightly less than the spacing between the two channels 60. Connector 58 is preferably extruded from a polyvinyl chloride but since it is not subjected to significant loading the amount of reinforcing agent, if any, can be minimal. Again, because it is enclosed when in position, no exposed surfaces requiring
10 a skin coating are presented.

Figure 15 is a diagrammatic illustration of the method of manufacturing the extruded components of the present invention and illustrating the extrusion of a straight box connector 9 having a core 21 and a
15 coextruded outer skin 22 and provided with circular openings 25 cut therefrom.

As illustrated, thermoplastic material 62 formulated with the desired ingredients to form the core of the box connector 9 is fed from
20 hopper 63 into a suitable extrusion die (not shown) from which it is delivered in a continuous stream having the requisite cross-sectional shape. At the same time, material 64 suitable for the coextruded skin is delivered from hopper 65 and coextruded to cover the exposed surfaces of the box connector.

25 As the coextruded core and skin are fed continuously out of the extrusion die arrangement suitable rotary drills 66 carried by a horizontally reciprocating carriage 67 mounted on guide 68 are utilized to drill the holes 25.

30 The movement of the carriage 67 is such that it moves away from the extrusion apparatus at the same speed as the box connector extrusion is delivered out of the extruder so that during the drilling the extrusion and the drills have no relative movement in the direction of extrusion feed. As soon as the holes are cut and the drills retracted, they are rapidly returned
35 rearwardly of extrusion feed to the start position to then recommence a fresh cycle of drilling while moving at the same speed as the extrusion feed.

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The drills are arranged so that when they retract they withdraw the material cut from the extrusion where it can be dropped unto a collector pan 69 and delivered back by a suitable feed 70 into the core material hopper 63.

5

Following extrusion and drilling, the box connector extrusion can be cut off at the requisite lengths depending on the nature of the building structure with which it is to be employed.

10

By using the structural components of the invention which have material cut or removed therefrom and recycled as described, savings in the cost of a building such as a house of up to 25% can be achieved further significantly increasing the affordability of housing and the like for the low income masses.

15

While a number of different structural components have been shown and described, it will be understood that the principles of the invention may be employed to produce various other structural component profiles to meet the requirements for producing the shape of the building structure desired. It will also be understood that variations may be made in the details of the component structures and the arrangement of the material cut out may be made without departing from the spirit of the invention or scope of the appended claims.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS
FOLLOWS:

5

1. An elongated extruded thermoplastic building component for use in the erection of a thermoplastic building structure, said component presenting spaced interlocking means extending the length thereof for sliding interlocking engagement with mating thermoplastic members, and at least one
10 longitudinally extending web supporting said spaced interlocking means in spaced relation, said web having a plurality of openings therethrough spaced along the length thereof, the perimeters of said openings being disposed entirely within the space between said interlocking means.
- 15 2. An extruded thermoplastic building component as claimed in Claim 1 in which said interlocking means supported by said web in spaced relation comprise spaced outwardly facing grooves extending the length of said component.
- 20 3. An extruded thermoplastic building component as claimed in Claim 1 in which said interlocking means supported by said web in spaced relation are spaced arms having spaced intumed locking fingers extending the length of said component.
- 25 4. An extruded thermoplastic building component as claimed in Claims 1, 2 or 3 in which said openings are circular and have a diameter less than the spacing between said interlocking means.
- 30 5. An extruded thermoplastic building component as claimed in Claims 1, 2 or 3 in which said openings are circular with said openings having uniform diameters and being centered on a line located centrally between said spaced interlocking means and uniformly spaced along said line, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.
- 35 6. An elongated extruded thermoplastic building component as claimed in Claim 1, 2 or 3 having a plurality of longitudinally extending webs

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having a plurality of openings cut therethrough spaced along the length thereof, the perimeters of said opening being disposed entirely within the space between said interlocking means spaced along the length thereof.

- 5 7. An elongated extruded thermoplastic building component as claimed in Claims 1, 2 or 3 extruded from a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fiber and calcium carbonate.
- 10 8. An elongated extruded thermoplastic building component as claimed in Claims 1, 2 or 3 having a core extruded from a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fiber and calcium carbonate and a smooth coextruded skin on surfaces of said component which are exposed when said component
- 15 is incorporated into a building structure.
9. An elongated extruded thermoplastic hollow building component of generally rectilinear form for use in the erection of a thermoplastic building structure, said component having planar spaced walls
- 20 connected in spaced relation by spaced planar webs extending the length thereof, said spaced walls being provided at least adjacent one longitudinal edge with spaced inwardly projecting interlocking means extending longitudinally thereof for interengagement with a mating component, at least one of said webs having a series of holes cut out therefrom along the length
- 25 thereof with the perimeters of said holes being within the space between said inwardly projecting interlocking means provided in said walls.
10. An elongated extruded thermoplastic hollow building component as claimed in Claim 9 in which said inwardly projecting
- 30 interlocking means oppositely registering grooves formed in said planar spaced walls.
11. An elongated extruded thermoplastic hollow building component as claimed in Claim 9 in which said planar spaced walls at said one
- 35 longitudinal edge extend beyond said planar webs at said edge and said inwardly projecting interlocking means comprises intumed locking fingers provided at the distal end of said wall extensions.

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12. An elongated extruded thermoplastic hollow building component as claimed in Claims 9, 10 or 11 which is extruded to provide a reinforced thermoplastic core having a smooth coextruded skin covering exposed surfaces thereof.

13. An elongated extruded thermoplastic hollow building component as claimed in Claims 9, 10 or 11 which is extruded to provide a core of polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fibers and calcium carbonate and a smooth coextruded skin overlying exposed surfaces of said component which are exposed when said component is interlocked into a building structure.

14. An elongated extruded thermoplastic hollow building component as claimed in Claims 9, 10 or 11 in which said holes are circular and of uniform diameter and are centered on and uniformly spaced along a line located centrally of the space between said interlocking means, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.

15. An elongated extruded thermoplastic hollow rectilinear building component for use in the erection of a thermoplastic building structure, said component having a pair of spaced generally planar walls connected in spaced relation by spaced transverse webs extending the length thereof, said walls being provided at least adjacent one longitudinal edge thereof with inwardly projecting oppositely registering interlocking means extending the length thereof, said interlocking means being selected from one of oppositely registering grooves in said walls to slidably receive oppositely registering locking fingers of a mating component, and oppositely registering inturned locking fingers carried by said walls outwardly of said webs at said at least one edge to slidably engage in oppositely registering locking grooves of a mating component, at least the web closest to said inwardly projecting locking means having a series of openings cut therefrom along the length thereof in an area within the spacing between said inwardly projecting locking means.

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16. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claim 15 in which said openings comprise circular holes.
- 5 17. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claim 15 in which said openings comprise circular holes of uniform diameter uniformly spaced along a line located centrally of the space between said interlocking means, the diameter of said holes being equal to a major portion of, but less than, the distance between said spaced
10 interlocking means.
18. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claims 15, 16 or 17 in which said component comprises a longitudinal panel and said transverse webs include webs which
15 extend across between said substantially planar walls and form the longitudinal edge walls of said panel and at least one web which defines internal compartments within said panel between said panel edge walls, and said interlocking means comprises inwardly projecting oppositely registering grooves in said substantially planer walls adjacent each of said panel edge
20 walls and extending throughout the length of said substantially planar walls, the spacing between said substantially planar walls being reduced outwardly of said grooves to provide a locking tongue and said openings are provided in each of said webs.
- 25 19. An elongated extruded thermoplastic hollow rectilinear building component as claimed in Claims 15, 16 and 17 in which said component comprises a box connector in the form of an elongated hollow rectangle, two opposed walls of which are constituted by said substantially planar walls, and two walls of which are constituted by said transverse webs.
- 30 20. An elongated extruded thermoplastic building component comprising an elongated hollow box connector, having four planar walls, spaced longitudinal flanges extending outwardly from at least two of said walls and terminating in inturned locking fingers, said walls from which said
35 spaced flanges project having a plurality of openings cut therein along the length thereof, said openings having a perimeter occupying a space within the spacing of said inturned fingers.

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21. A box connector as claimed in Claim 20 having spaced longitudinal flanges terminating in inturned locking finger flanges projecting from three of said walls.
- 5
22. A box connector as claimed in Claim 20 having spaced longitudinal flanges terminating in inturned locking fingers projecting from all four of said walls.
- 10
23. A box connector as claimed in Claims 20, 21 or 22 in which said openings are circular holes.
24. A box connector as claimed in Claims 20, 21 or 22 in which said openings are circular holes of uniform diameter uniformly spaced along the length thereof, the diameter of said holes being equal to a major portion of, but less than, the spacing between said intened locking fingers.
- 15
25. A box connector as claimed in Claims 20, 21 or 22 having a core of polyvinyl chloride containing a reinforcing and expansion controlling agent selected from mineral fibers, glass fibers, and calcium carbonate and a coextruded smooth skin covering exposed surfaces of said box connector.
- 20
26. An elongated rectilinear hollow structural component for use in erecting a modular building structure, said component being extruded from a thermoplastic material and presenting means for sliding interlocking engagement with an adjoining mating structural component, said structural component having a plurality of openings cuts therefrom and clear of interference with said interlocking means providing communication from the interior thereof into the interior of an adjoining mating component.
- 25
27. An elongated hollow structural component as claimed in Claim 26 having at least one internal web forming internal compartments, said internal web having a plurality of openings therethrough to provide communication between said compartments.
- 30
28. An extruded thermoplastic structural component as claimed in Claims 26 or 27 having a core containing a reinforcing and expansion
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controlling agent and a coextruded smooth skin covering external surfaces of said component which are exposed when said component is interlocked with mating components.

29. An extruded thermoplastic structural component as claimed in Claims 26 or 27 having a core of polyvinyl chloride containing a reinforcing and expansion controlling agent selected from one or more of mineral fibers, glass fibers and calcium carbonate and a coextruded smooth skin covering external surfaces of said component which are exposed when said component is interlocked with other mating components.

30. An extruded thermoplastic component as claimed in Claim 28 having a core of polyvinyl chloride containing from about 5% to about 50% calcium carbonate and a coextruded smooth skin covering external surfaces of said component which are exposed when said component is interlocked with other mating components.

31. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 30% of calcium carbonate.

32. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 35% of fine short glass fibers.

33. An extruded thermoplastic component as claimed in Claim 30 in which said core contains from about 5% to about 20% of fine short glass fibers.

34. In the manufacture of thermoplastic structural building components having spaced inwardly extending interlocking means for sliding interlocking engagement with mating components and at least one web supporting said interlocking means in spaced relation, the steps of extruding the desired component profile in a longitudinal continuously fed extrusion stream presenting said spaced inwardly extending interlocking means and said at least one web supporting said interlocking means in spaced relation, cutting a series of openings in said web along the length thereof while the extruded profile stream is being fed, the perimeters of said openings lying within the

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spacing between said interlocking means, and cutting off lengths of said extruded profile stream according to the desired length of the component.

35. In the manufacture of thermoplastic structural building components, as claimed in Claim 34, the further steps of collecting the material cut from the web and feeding same back for incorporation into a following segment of the profile stream being extruded.

36. The manufacture of thermoplastic structural components as claimed in Claims 34 or 35 in which the thermoplastic material from which said components are extruded comprises a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from one or more of mineral fibers, small glass fibers and calcium carbonate.

37. The method of manufacturing hollow rectilinear thermoplastic structural building components having at least four walls, and having adjacent at least one of said walls spaced inwardly extending and oppositely registering interlocking means for sliding interlocking engagement with mating components and having a plurality of openings cut out of said at least one wall along the length thereof, said method comprising the steps of feeding thermoplastic material through an extrusion die arrangement to extrude the desired component profile in a longitudinal continuously moving stream, cutting openings in said at least one wall while said extruded profile stream is moving with the perimeters of said openings lying within the spacing between said spaced interlocking means, removing the material cut from said at least one wall and returning same for refeeding through said extrusion die arrangement, and cutting off lengths of said extruded profile stream according to the desired component length.

38. The method as claimed in Claim 37 in which said openings are circular.

39. The method as claimed in Claim 37 in which said openings are circular and of a uniform diameter equal to a major portion of but less than the distance between said spaced interlocking means.

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40. The method as claimed in Claims 37, 38 or 39 in which said extrusion die arrangement is constituted to coextrude a core fed from a core material supply source, and a smooth skin covering exposed external surface of said core fed from a skin material supply source, and said material cut from said at least one wall is returned to said core material supply source.

41. The method as claimed in Claim 39 in which said extrusion die arrangement is constituted to coextrude a core fed from a core material supply source comprising a polyvinyl chloride and a reinforcing and expansion controlling agent selected from one or more of mineral fibers, small glass fibers, and calcium carbonate, and a smooth skin covering exposed external surfaces of said core fed from a skin material supply source, and said material cut from said at least one wall is returned to said core material supply source.

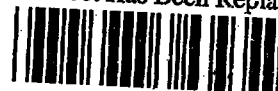
42. The method as claimed in Claim 41 in which said smooth skin material is selected from polyvinyl chloride, rigid polyvinyl chloride, ABS and polycarbonate.

43. The method as claimed in Claim 39 in which said hollow component is extruded to provide an inwardly extending channel in at least one of said walls other than the wall having said circular openings cut out therefrom, said channel projecting into the space between said spaced interlocking means; and said step of cutting said spaced openings in said at least one wall is utilized to remove material from said channel at spaced points where it projects into said space between interlocking means.

44. An elongated hollow structural component as claimed in Claim 26 in which said component is formed to provide a channel having a bottom projecting into the space between said spaced interlocking means, said channel having material cut from the bottom thereof at spaced points along its length to provide access to the interior of said components.

45. An elongated extruded thermoplastic building component having at least one web and interlock means to opposite sides of said web for interlocking engagement with a mating thermoplastic member in a thermoplastic building structure, said web having a plurality of openings cut

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therethrough and spaced from one another longitudinally of said web, said openings being located between without penetrating said interlock means of said building component.

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**THERMOPLASTIC STRUCTURAL COMPONENTS
AND STRUCTURES FORMED THEREFROM**

ABSTRACT OF THE DISCLOSURE

An elongated extruded thermoplastic building component for use in the erection of a thermoplastic building structure, said component presenting spaced interlocking means extending the length thereof for sliding interlocking engagement with mating thermoplastic member, and at least one longitudinally extending web supporting said spaced interlocking means in spaced relation with said web having a plurality of openings cut therethrough inwardly of said interlocking means spaced along the length thereof. In its most common form the component is extruded with a core of reinforced thermoplastic material having a coextruded smooth skin covering exposed surfaces thereof and is rectilinear having planar spaced walls connected in spaced relation by spaced planar webs extending the length thereof, with the spaced walls being provided at least adjacent one longitudinal edge with spaced inwardly projecting interlocking means extending longitudinally thereof for interengagement with a mating component, at least one of said webs having a series of circular holes cut out therefrom along the length thereof with the perimeters of said holes being within the space between said inwardly projecting interlocking means.

FIGURE 3.

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FIG.1.

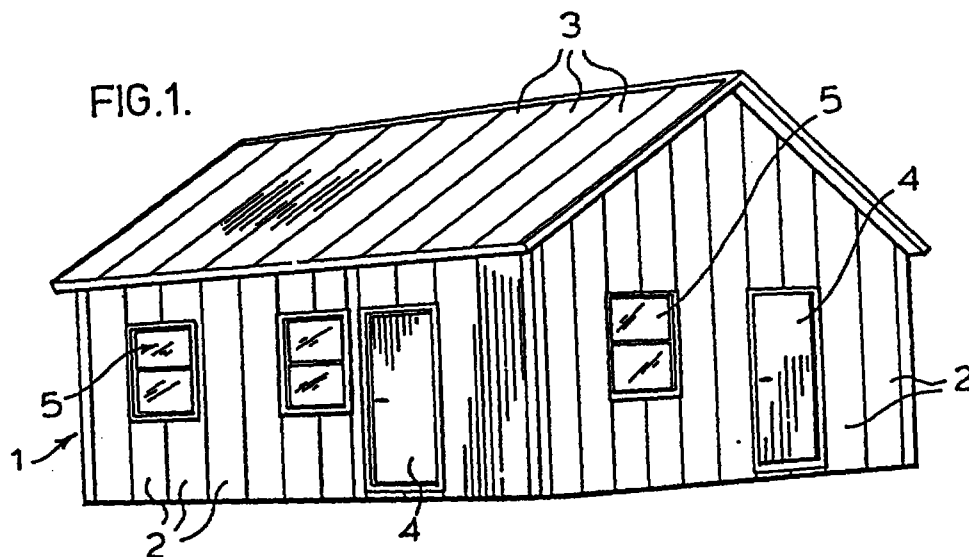
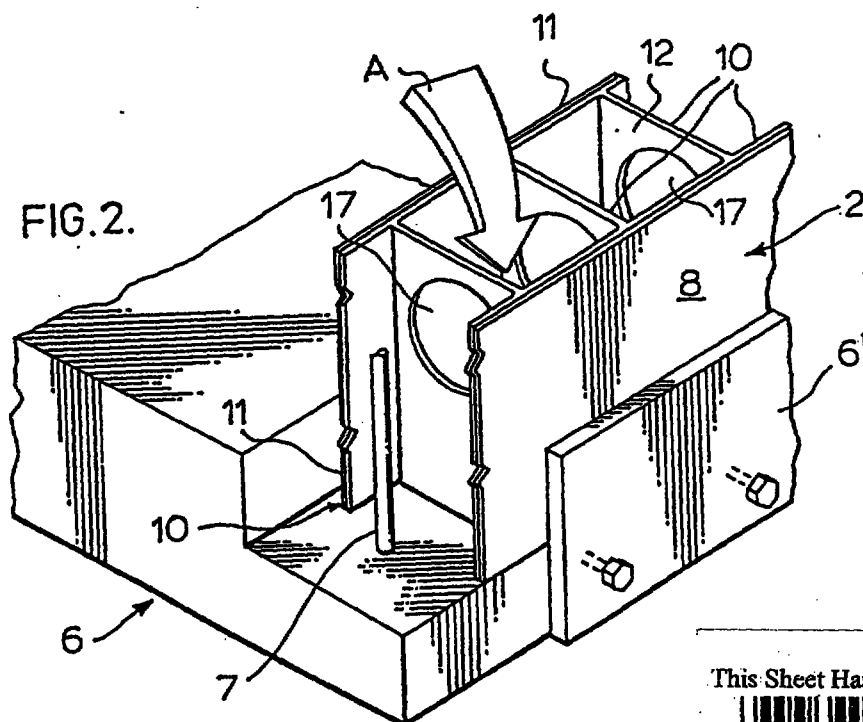


FIG.2.



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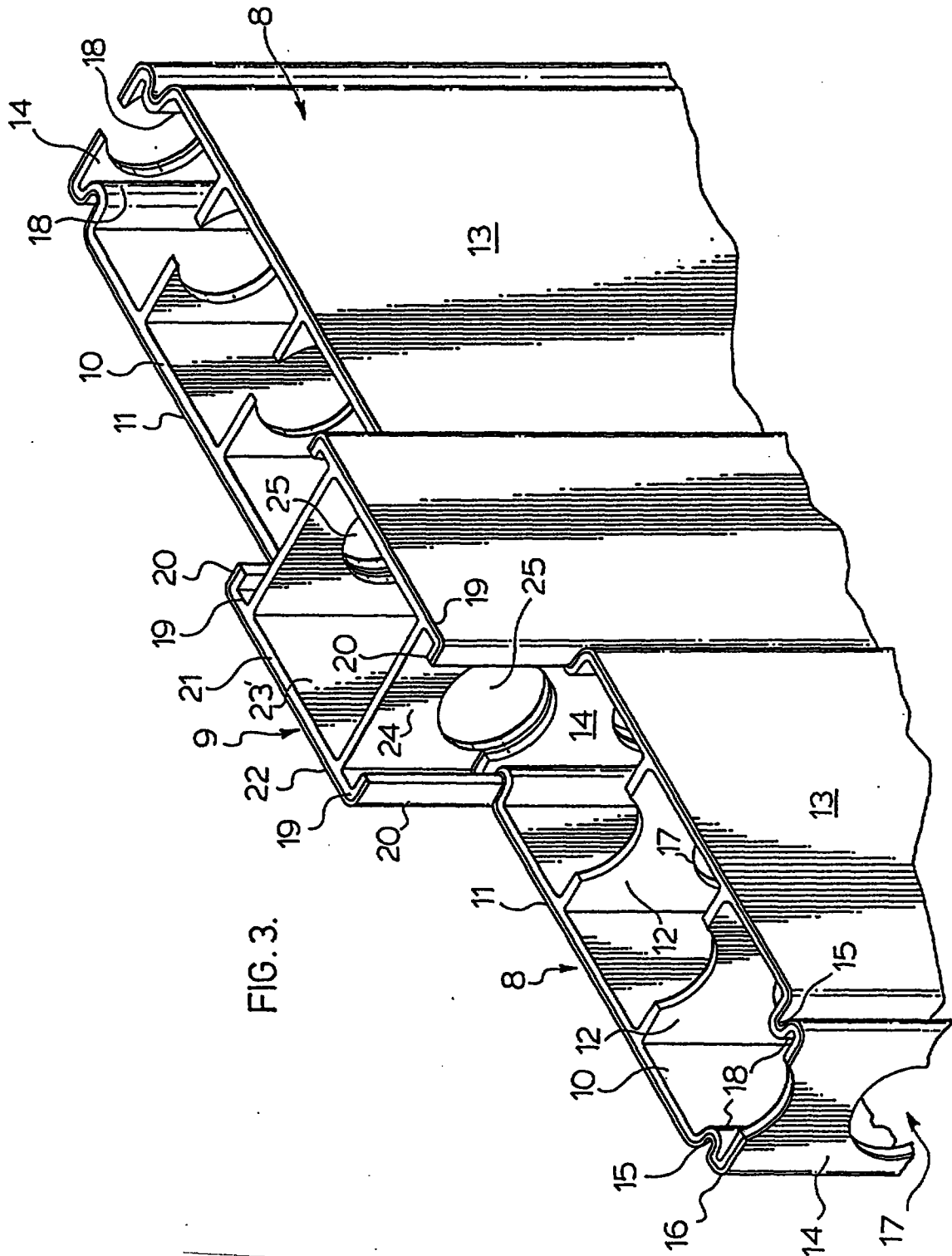


FIG. 3.

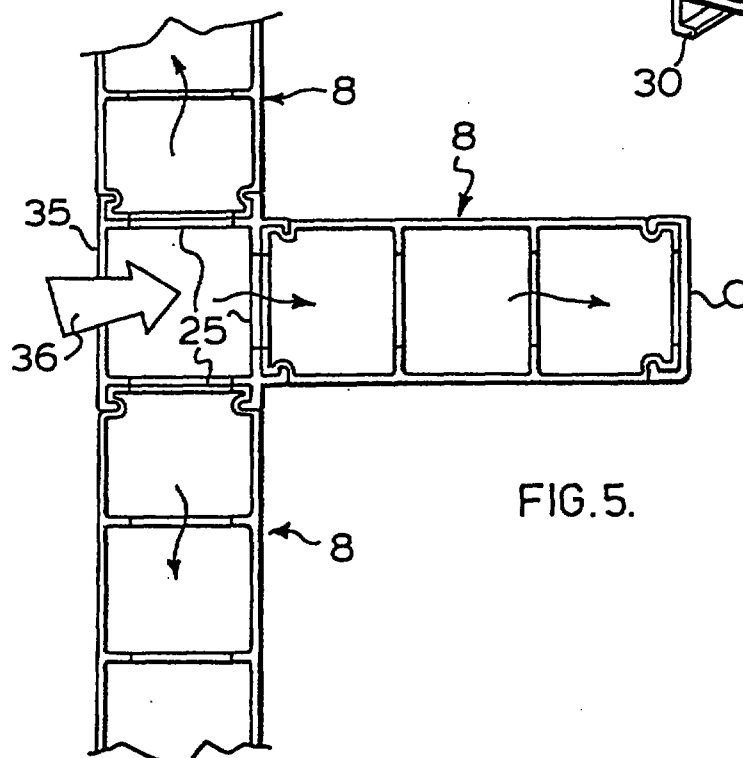
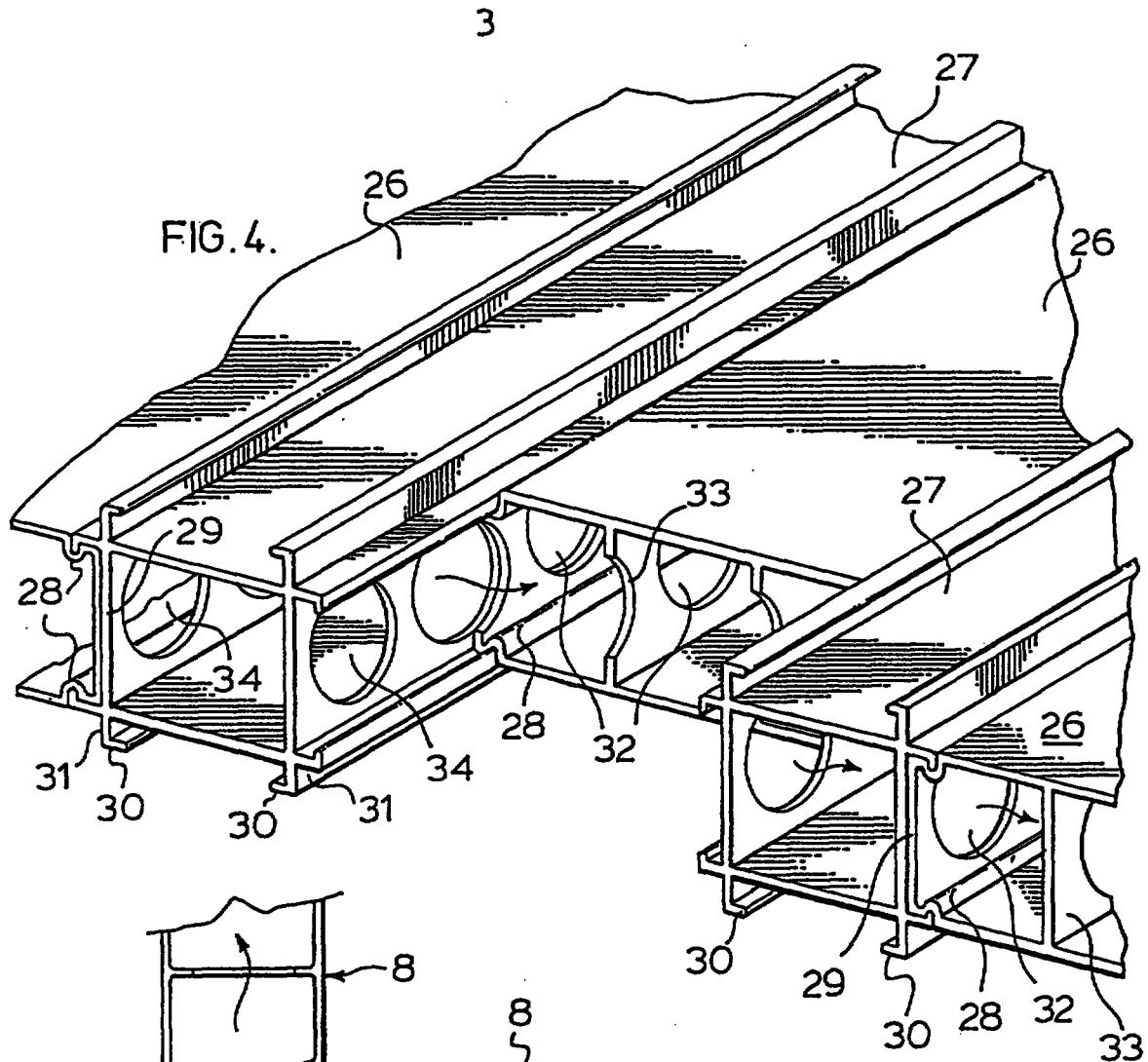
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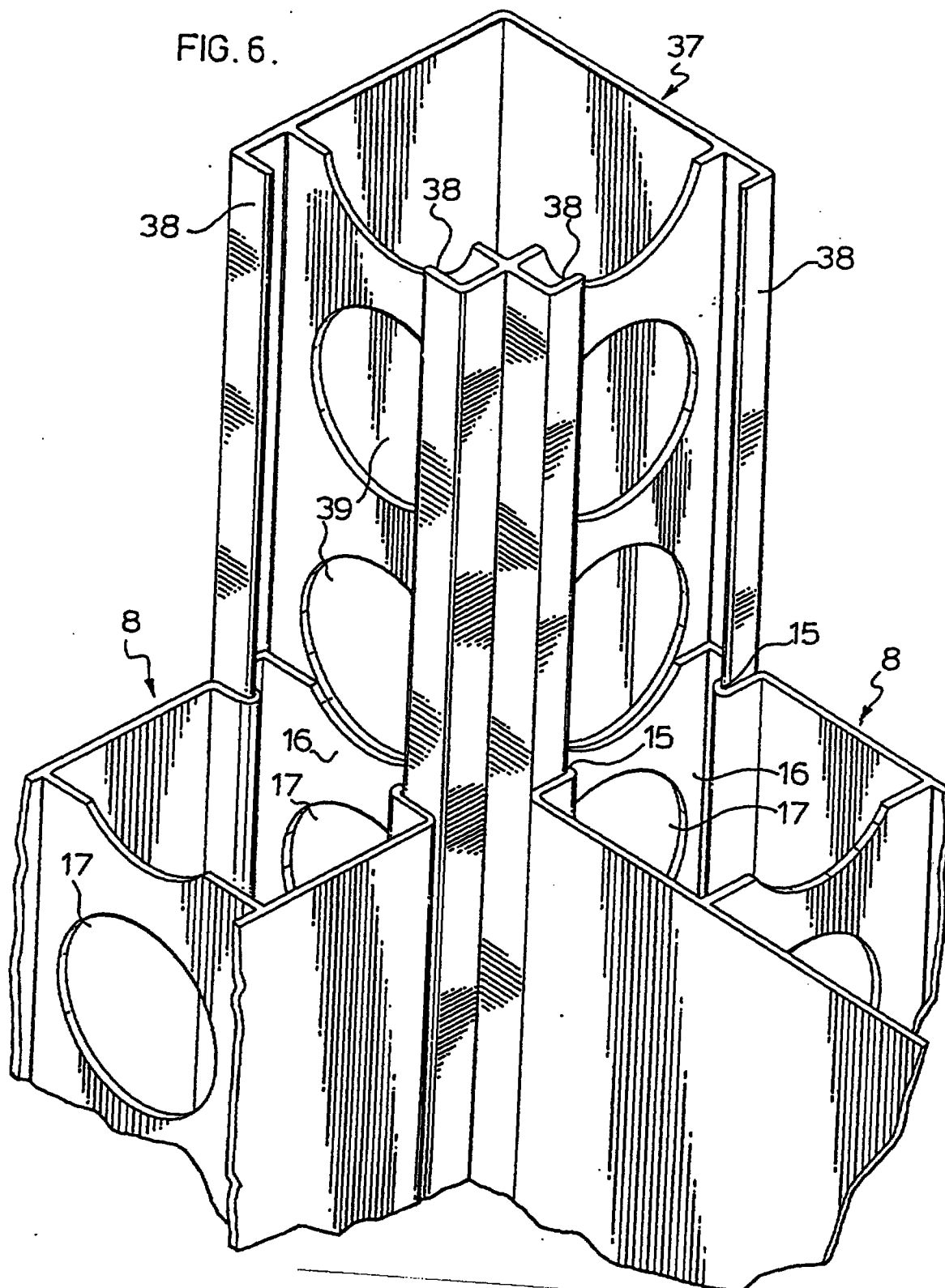


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FIG. 6.

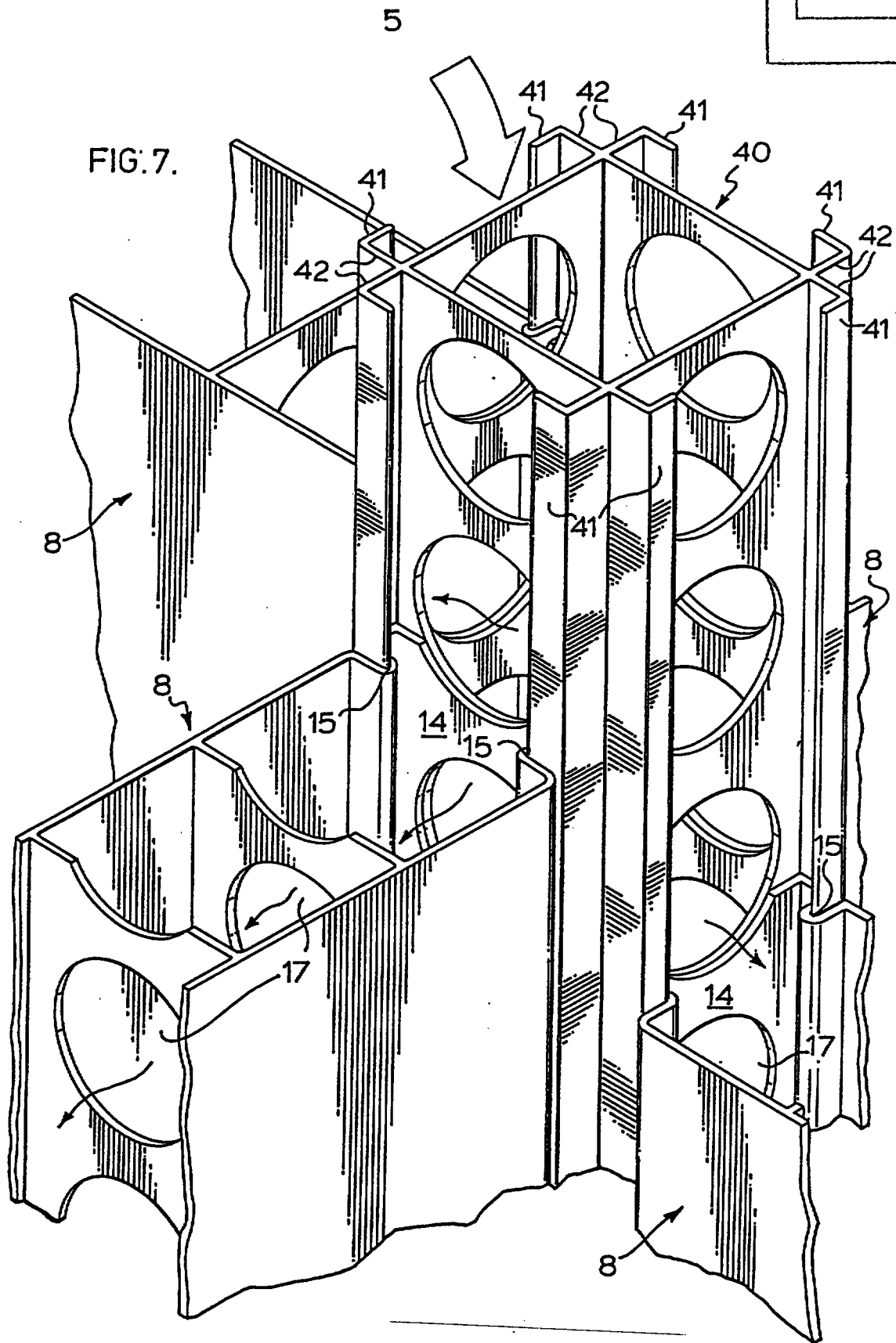


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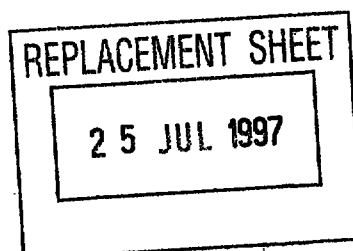
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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A wall structure comprising a plurality of elongated vertically oriented plastic members (8, 8', 80, 9, 9', 35, 35', 37, 40) formed with interlocking means (15, 20, 38, 41) and interlocked together into a longitudinal hollow wall formation having spaced generally planar parallel walls (13, 23) characterized in that said parallel walls (13, 23) have smooth exterior surfaces and are connected by transverse webs (12, 24) extending at right angles to said parallel walls (13, 23), said webs (12, 24) having openings (17, 25, 39) therethrough which provide flow pathways along the length of said hollow form between said parallel walls (13, 23), and said interlocking means (15, 20, 38, 41) provides for positive engagement to prevent separation of said elongated plastic members in the lengthwise direction of said hollow wall formation.
2. A wall structure as claimed in Claim 1 characterized in that said plastic members (8, 8', 80, 9, 9', 35, 35', 37, 40) are longitudinal extrusions in which said transverse webs (12, 24) are formed as part of said extrusions to extend the length of said extrusions and said openings (17, 25, 39) through said transverse webs (12, 24) are formed by cutting material out of said transverse webs (12, 24) at spaced intervals along the length thereof.
3. A wall structure as claimed in Claims 1 or 2 characterized in that said plastic members (8, 8', 80, 9, 9', 35, 35', 37, 40) are extruded from polyvinyl chloride containing a reinforcing and expansion controlling agent.
4. A wall structure as claimed in Claims 1, 2 or 3 characterized in that said reinforcing and expansion controlling agent is selected from one or more of mineral fibers and calcium carbonate.
5. A wall structure as claimed in Claim 4 characterized in that said reinforcing and expansion controlling agent is calcium carbonate.



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6. A wall structure as claimed in Claim 5 characterized in that said calcium carbonate comprises from about 5% to 35% by weight of said members.

7. A wall structure as claimed in any of the preceding claims characterized in that said interlocked hollow wall formation presents integral internal vertical keyways (43, 44) for interlocking engagement with a mating insert.

8. A wall structure as claimed in Claim 7 characterized in that said keyways (43, 44) comprise spaced out turned locking fingers.

9. A wall structure as claimed in any one of the preceding claims characterized in that it is filled with concrete (A, 36) which is continuous along the length of said wall formation through said openings.

10. A wall structure as claimed in Claim 9 characterized in that reinforcing rods (7) are embedded in said concrete.

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ABSTRACT

A wall structure comprising a plurality of elongated vertically oriented plastic members (8, 8', 80, 9, 9', 35, 35', 37, 40) formed with interlocking means (15, 20, 38, 41) and interlocked together into a longitudinal hollow wall formation having spaced generally planar parallel walls (13, 23) characterized in that said parallel walls (13, 23) have smooth exterior surfaces and are connected by transverse webs (12, 24) extending at right angles to said parallel walls (13, 23), said webs (12, 24) having openings (17, 25, 39) therethrough which provide flow pathways along the length of said hollow form between said parallel walls (13, 23), and said interlocking means (15, 20, 38, 41) provides for positive engagement to prevent separation of said elongated plastic members in the lengthwise direction of said hollow wall formation.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An elongated hollow generally rectilinear structural component (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) for use in the erection of a thermoplastic building structure said component presenting planar spaced walls held in spaced relation by transverse walls or webs and having interlocking means extending the length thereof for interlocking by engaging with mating components characterized in that said component is a coextrusion of a hollow substrate (10, 21) and a smooth protective skin (11, 22) covering said hollow substrate on surfaces which are exposed as exterior walls (13, 23) when said component is interlocked with mating components with said transverse walls or webs (12, 14, 24) which are interior walls when said component is interlocked with mating components having material cut out therefrom to provide a plurality of openings (17, 25) therethrough spaced along the length thereof and inwardly of said interlocking means (15, 19, 20) to provide interior communication between interlocked components, the material cut out from the walls or webs (12, 14, 24) providing material suitable for use in extruding the substrate of a subsequent component.
2. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said substrate (10, 21) is a polyvinyl chloride containing a reinforcing and expansion controlling agent.
3. An elongated thermoplastic building component as claimed in Claim 2 characterized in that said substrate (10, 21) contains material cut out from the walls and webs of previously extruded components.
4. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said reinforcing and

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expansion controlling agent in said substrate (10, 21) is selected from mineral fibers, glass fibers and calcium carbonate.

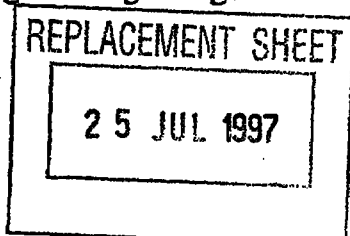
5. An elongated thermoplastic building component as claimed in any preceding claim characterized in that said openings are circular and have a diameter less than the spaces between said interlocking means (15, 19, 20).

6. An extruded thermoplastic building component as claimed in Claim 5 characterized in that said openings have uniform diameters and are centered on a line located centrally between said spaced interlocking means (15, 19, 20) are uniformly spaced along said line, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.

7. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said component comprises a longitudinal panel (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) and said transverse webs include webs (14) which extend across between said substantially planar walls and form the longitudinal edge walls of said panel and at least one web (12, 12') which defines internal compartments within said panel between said panel edge walls, and said interlocking means comprises inwardly projecting oppositely registering grooves (15) in said substantially planar walls adjacent each of said panel edge walls and extending throughout the length of said substantially planar walls, the spacing between said substantially planar walls being reduced outwardly of said grooves to provide a locking tongue (16) and said openings are provided in each of said webs.

8. An elongated thermoplastic building component as claimed in Claims 1 to 6 characterized in that said component comprises a box connector (9) in the form of an elongated hollow rectangle, two opposed walls (23) of which are constituted by said substantially planar walls, and two walls (24) of which are constituted by said transverse webs.

9. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a corner box connector (37) having openings (39) formed in the walls thereof which become internal walls when same is interlocked with mating components arranged in right angular relation.



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10. An elongated thermoplastic building component as claimed in Claims 1 characterized in that said component is a three way box connector (35') having openings (25) formed in the walls thereof which become internal walls when same is interlocked with mating components.

11. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a four way box connector (4) having openings formed in the walls thereof which become internal walls when same is interlocked with mating components.

12. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said smooth skin (11, 22) is selected from PVC, rigid PVC, semi-rigid PVC, ABS or polycarbonate

13. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said substrate (5, 10, 21) comprises a polyvinyl chloride containing from about 5 to 50% calcium carbonate.

14. An elongated thermoplastic building component as claimed in Claim 13 characterized in that said substrate contains from about 5 to 30% calcium carbonate by weight.

15. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said skin (11, 22) has a thickness at least of the order of about .015 inches and said substrate (5, 10, 21) has a thickness of the order of at least about 4 to 5 times the thickness of said skin.

16. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the spacing between opposing walls of each said component is of the order of several tens of times the combined thickness of said substrate (5, 10, 21) and skin (11, 22).

17. An elongated thermoplastic building component as claimed in Claim 16 characterized in that the spacing between opposing walls of each said components is of the order of about 4 inches.

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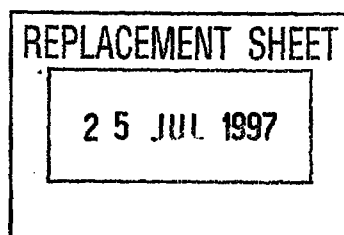
18. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the amount of material cut from the walls or webs is a substantial proportion of the total amount of material in said component prior to removal of the cut out material.

19. An elongated thermoplastic building component as claimed in Claim 19 characterized in that said substantial proportion is of the order of up to about 25% by weight

20. A method of manufacturing hollow rectilinear thermoplastic building components (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) adapted for interlocking engagement to form building structures characterized in that each said building component is extruded as a coextrusion of a substrate of thermoplastic material (10, 21) containing a reinforcing and expansion controlling agent and a smooth thermoplastic skin (11, 22) covering the walls of said component which are exposed as exterior walls (13, 23) when said component is interlocked with mating components, following said extrusion cutting openings (17, 25) through the walls of said component which form interior walls (12, 14, 24) when same is interlocked with mating components, and utilizing the material cut from said interior walls as substrate material in the extruding of a subsequent component.

21. A method as claimed in Claim 20 characterized in that said core material is a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from calcium carbonate, mineral fibers, and small glass fibers.

22. A method as claimed in Claim 20 or 21 in which said smooth thermoplastic skin is selected from polyvinyl chloride, rigid polyvinyl chloride, ABS and polycarbonate.



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**THERMOPLASTIC STRUCTURAL COMPONENTS
AND STRUCTURES FORMED THEREFROM**

FIELD OF THE INVENTION

This invention relates to reduction of the costs of the novel thermoplastic structural system and structural components therefor and building structures erected therefrom which are disclosed in my copending Canadian Application Serial No. 2,070,079, filed May 29th, 1992 without adversely affecting their integrity.

BACKGROUND OF THE INVENTION

The structural system disclosed in my said copending application comprises novel interlocking thermoplastic structural components which can be mass produced at low cost and which can be quickly and easily interlocked together to erect a wide range of structures which will require minimal maintenance and will be safe from termites, corrosion, rust or rot and will be highly resistant to the effects of weathering.

The present invention is directed to significantly reducing the costs of such components and hence the costs of structures erected therewith without sacrificing the structural integrity of the components or system.

Further the invention is directed to such cost reductions of the components themselves and the structures formed therefrom without increasing the costs of production of the components or interfering with the ease of their assembly.

Further the invention is directed to providing such structural components as to aforesaid which will facilitate the conversion of the walls erected therewith into permanent wall structures, will enhance the air circulation in roofs erected therewith, and will provide reduced thermal transfer between the exterior and interwall surfaces of the walls and

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roofs.

DESCRIPTION OF PRIOR ART

While the use of plastic to form wall panels or the like for use in building construction has been proposed, such panels have not had the necessary load bearing or other structural requirements to form practical structures which could be mass produced at low cost and quickly and easily assembled to erect durable low cost structures and, in particular, low cost housing.

U.S. Patent 3,992,839, for instance, discloses a plastic panel fabricated from separate panel members, preferably formed of polyvinyl chloride which snap together to form a thin wall panel. The panels in turn are formed to snap together to provide a wall structure. Such fabricated panels are inherently weak and lack the strength and load bearing capacity to form adequate structural components for use, for instance, in the forming of the walls and roof of a practical durable building.

U.S. Patent, 3,662,507 discloses the use of tongue and grooved individually prefabricated panels said to be preferably of plastic which are bonded or glued together and used particularly for the forming of basement walls. Such panels do not permit of high speed production and are not capable of being quickly and easily interlocked together in the erection of a house or other structure.

U.S. Patent No. 4,557,091 discloses a hollow panel member having a width of about one and one-half inches (1½", 38mm) and a complicated interior formed by pultrusion, a process involving drawing long glass strands and a plastic binding material forcefully through a die under heat to form the glass strands into a compacted glass mat bound together by the plastic material. Such a process is prohibitively slow and expensive and the panels themselves do not provide acceptable or practical low cost structures for forming the

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walls and roofing of a housing system such as contemplated by the present invention.

While modular building structures using modular building components formed of steel have also been proposed, such as disclosed in U.S. Patent 1,958,124, such systems involve welding together of the members to make up the components and the use of bolts or other fasteners to secure same together. Such systems are not practical for low cost practical housing and the like with which the present invention is concerned.

EP-A-0,320,745 discloses an arrangement of hollow interlocking structural components for a modular building which it is said may comprise extruded thermoplastic resin preferably reinforced with preferably about 30 per cent by weight glass fibres such as described in U.S. Patent 4,536,630.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided an elongated hollow generally rectilinear thermoplastic structural component for use in the erection of a thermoplastic building structure, said component presenting planar spaced walls held in spaced relation by transverse walls or webs and having interlocking means extending the length thereof for interlockingly engaging with mating components, characterized in that said component is a coextrusion of a hollow substrate and a smooth protective skin covering said hollow substrate on surfaces which are exposed as exterior walls when said component is interlocked with mating components with said transverse walls or webs which are interior walls when said component is interlocked with mating components having material cut out therefrom to provide a plurality of openings therethrough spaced along the length thereof and inwardly of said interlocking means to provide interior communication

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between interlocked components, the material cut out from the walls or webs providing material suitable for use in extruding the substrate of a subsequent component.

According to the preferred form of the invention the openings are circular and preferably of a uniform diameter and more preferably still the openings have a diameter equal to a major portion of but less than the spacing between the interlocking means.

Preferably the structural components of the present invention are extruded from a vinyl chloride, preferably a polyvinyl chloride, containing a reinforcing and expansion controlling agent which preferably is selected from one or more of mineral fibres, small glass fibres and calcium carbonate.



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More particularly, the extruded structural components comprise a core of polyvinyl chloride containing a reinforcing and expansion controlling agent as aforesaid and a coextruded thermoplastic skin covering surfaces that will be exposed on assembly into a building structure.

Further, in accordance with the invention, the openings in the at least one web of the structural component are bored out of the web immediately after the component has been extruded and while it is still feeding away from the extruder.

Also, according to the invention, the material removed from the web is returned for reuse as a core extrusion material.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will be understood from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a perspective view of a small house erected from interlocking thermoplastic structural components such as form the subject matter of the present invention.

Figure 2 is a broken away perspective view illustrating a wall panel embodying the present invention seated on a concrete base ready to receive concrete or other anchoring material to be anchored to the base through suitable anchor rods.

Figure 3 is a perspective view illustrating a wall section showing a pair of wall panels interlockingly engaged with a connecting box connector and showing the components as comprising a core having the exposed external surfaces thereof coated with a smooth thermoplastic skin with the thickness of the skin being somewhat exaggerated for purposes of illustration.

Figure 4 is a perspective view illustrating a plurality of roof panels corresponding to the wall panels of Figure 3 embodying the invention connected by four-way box connectors according to the invention, the four-way box connectors being available for the attachment of cladding to the upper surface of the roof and for engagement with other components beneath the roof's surface.

Figure 5 is a plan view showing a three-way box connector interlockingly connecting two aligned wall panels and a third wall panel at right angles thereto.

Figure 6 is a perspective view illustrating a corner box connector connecting two wall panels in right angular relation.

Figure 7 is a perspective view illustrating a four-way box connector for connecting four wall panels in right angular relation.

Figure 8 is a perspective view of a slightly modified two-way box connector having interior locking fingers for interlocking engagement with a mating insert.

Figure 9 is a view similar to Figure 8 but showing a three-way box connector.

Figure 10 is a perspective view of a wall panel according to the invention having a single interior web.

Figure 11 is a perspective view of a wall panel with no interior web.

Figure 12 is a perspective view of a box connector joiner embodying the invention.

Figure 13 is a perspective view taken from the underside of a sloping wall cap embodying the invention.



Figure 14 is a perspective view of the wall cap of Figure 13 taken from the top side.

Figure 15 is a diagrammatic view illustrating the manner in which the components of the present invention are extruded and then drilled to produce the openings through the webs thereof.

Figure 16 is a cross-sectional view of the particular box connector shown being extruded in Figure 15.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

It will be understood that while only Figure 3 illustrates the co-extruded skin on the exposed surfaces of the wall panels and the box connector, all of the panels and box connectors will have such an extruded skin and it is only components such as the box connector joiner of Figure 12 which will have no exposed surfaces when assembled into a building structure that will be extruded without any skin coating.

With reference to the drawings, Figure 1 is a perspective view of a house 1 as an example of the type of building that can be erected with the thermoplastic interlocking building components of the present invention which can be assembled into walls 2 and roofing 3 with provision for doors 4 and windows 5.

A building such as illustrated in Figure 1 is intended to be erected on a concrete pad 6 as illustrated in Figure 2 which shows how the walls 2 of the building can be anchored to the concrete pad 6 by means of anchor rods 7 when the interior of the walls 2 are filled with concrete and the like as illustrated by the arrow A. Suitable means such as the strip 6' may be employed to contain the concrete from spilling out from underneath the wall 2.

As more particularly illustrated in Figure 3, the walls 2 are formed from wall panels 8 interlockingly interconnected by box connectors 9, one of which is illustrated in Figure 3.



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Each of the wall panels 8 in accordance with the invention disclosed in copending Canadian Application Serial Number 2,070,079 comprises a hollow rectilinear thermoplastic extrusion having a core 10 and coextruded outer skin 11.

The core 10 preferably comprises a vinyl chloride and, more particularly, a polyvinyl chloride containing a suitable reinforcing and expansion controlling agent such as mineral or other fibers or other known expansion controlling agents such as a calcium carbonate.

A reinforcing agent or constituent particularly useful for structural components of the present invention which are subject to high loading comprises small glass fibers which when anchored in a thermoplastic material such as vinyl chloride or polyvinyl chloride provide the requisite reinforcing and expansion controlling characteristics to provide high structural strength.

A suitable material incorporating small glass fibers which can be used in the production of these panels 8 is available under the trade-mark FIBERLOC from the B. F. Goodrich Company of Akron, Ohio, such material being described in detail in B.F. Goodrich's U.S. Patent 4,536,360 wherein very fine short glass fibers are bound within a composition of vinyl chloride resin.

The presence of glass fibers in the PVC or other thermoplastic material while providing tensile strength and expansion control to the material creates an extrusion problem and, if they are too large and too concentrated, it is not practical to extrude the material. Preferably, such fibers should be of the order of a few microns in diameter and a few millimeters in length and in concentrations not greater than and preferably substantially less than about 35% by weight based upon the combined glass fibers and vinyl chloride resins.

The presence of the glass fibers creates a brittleness which makes a structure produced solely from a glass fiber reinforced plastic

subject to potential fracture from impact. This potential increases with increased concentration of glass fibers.

The problems encountered with the use of the glass fibers as the reinforcing constituent while utilizing their beneficial reinforcing qualities for high loading capacity have been resolved by coextruding with the glass reinforced thermoplastic a smooth thermoplastic skin covering the external exposed surfaces of the panels.

The smooth plastic skin may be PVC, rigid PVC, semi-rigid PVC, ABS, polycarbonate with thermoplastics available from G.E. under the trade-mark GELOY and NORYL.

This skin 11 serves a number of useful purposes. Because of the presence of the glass fibers in the core or substrate 10, the substrate is somewhat brittle and its surfaces are rough and abrasive with portions of the glass fibers projecting through the surface of the substrate rendering the substrate somewhat porous and susceptible to the ingress of moisture which can adversely affect the bond between the glass fibers and the thermoplastic material.

The coextrusion of the thermoplastic skin covers and seals the outer exposed surfaces of the structural component against the ingress of moisture, thereby maintaining the integrity of the binding of the glass fibers to substrate plastic. Further, the outer skin 11 not only covers exposed glass fibers but these exposed glass fibers become embedded in the thermoplastic material so that the external surface of the component is totally smooth. The glass fibers in turn in becoming embedded in the outer skin lock the skin to the substrate or core 10 so that the expansion and contraction of the outer skin is fixed to the expansion and contraction of the core which is controlled or limited by the presence of the incorporated glass fibers which have a much smaller co-efficient of expansion than the plastic.

It will be also understood that the skin 11 can be formulated to include agents providing impact resistance, resistance to ultraviolet radiation and the like.



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The combination of the co-extruded core or substrate 10 and smooth skin 11 thus enable the provision of wall panels having inherent structural strength and which are essentially maintenance free, impact resistant and they will be free from corrosion, rot or rusting and will be impervious to moisture, termites and other insects.

While the use of the glass fibers provides the strength necessary for handling high loading, where the panels will be subjected to much lighter loading the core 10 may be formed of a vinyl chloride containing from about 5% to about 50% calcium carbonate and preferably about 5% to 30% calcium carbonate by weight.

Alternatively, a mixture of calcium chloride and glass fibers or other reinforcing agents such as mineral fibers may be used to meet the particular load specifications required for the panel.

As illustrated in Figure 3, each of the panels 8 is provided with two transverse webs 12 which tie the opposing faces 13 of the panel together intermediate the edge walls 14 of the panel.

Adjacent each of the edge walls 14, the panel 8 is provided with inwardly extending oppositely registering grooves 15 with the width of the panel being reduced outwardly of the grooves 15 to the edge walls 14 to, in effect, provide a tongue portion 16.

As the cost factor is a critical element in the ability to provide affordable housing to the masses, it has been found that this cost factor can be significantly reduced in material costs by cutting a series of openings 17 out of the webs 12 and edge walls 14 at spaced points along their length.

This cut out material can then be collected and reused in the extrusion of the core of a subsequent extrusion.

The openings 17 are preferably circular openings having a diameter slightly less than the spacing between the most adjacent point 18 of the grooves 15.

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With the openings 17 centered on the midpoint of the edge walls 14 and midway between the panel faces 13, the openings can be cut through the edge walls 14 and also through the webs 12 without interference with the grooves 15 which extend uninterrupted throughout the length of the extrusion.

Still with reference to Figure 3, the panels 8 are shown interlocked with the box connector 9 in the form of a hollow extruded rectangle having projecting flanges 19 terminating in inturned oppositely registering locking fingers 20 adapted to slidingly interlock with the grooves 15 of the panels 8.

The box connector 9 is extruded with a core 21 and a coextruded outer skin 22 covering the outer surfaces of the walls 23, the flanges 19 and the locking fingers 20.

Because of the inherent strength of the configuration of the extruded rectangular box connector 9, its core 21 may comprise a PVC resin and, for example, calcium carbonate, as the expansion controlling and reinforcing agent, although other agents including small glass fibers and mixtures of agents may be used.

It will be noted that the outer surfaces of the walls 23 of the box connector 9 covered by the outer skin 22 are precisely aligned with the outer surfaces of the panel faces 13 with the tongue portions 16 of the panels being received in the space between the inturned locking fingers 20 and the transverse walls or webs 24 of the box connector.

Again, the box connector is provided with a series of openings 25 through the transverse walls or webs 24. Again, these openings are circular with a diameter centered on the midpoint of the transverse walls or webs 24 of the box connector and spaced along the length thereof with the diameters of the openings substantially equal to, but less than, the spacing between the inturned locking fingers 20 so that the locking fingers are not intersected during the cutting of the openings 25.



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It will be seen that the panel locking grooves 15 are covered in the smooth coextruded skin 11 to provide a smooth surface for smooth sliding interlocking engagement with the smooth skin coated locking fingers 20. Further, the outside faces of the tongues 16 which form the edge walls 14 of the panels are coated with the smooth skin 11 and preferably these faces are slightly concaved to eliminate any interference with the box connector transverse webs or walls 24.

Again, the material cut out from the box connector walls or webs 24 can be collected and returned to be used as material for extruding subsequent box connectors.

It has been found, for example, that with a wall panel width of 100 millimeters between the faces 13, circular holes having a diameter of 70 millimeters and spaced 12.7 millimeters apart provide a significant saving in material and cost of the vinyl extrusion product without significantly affecting the structural strength of the panel so that when concrete is poured therein such as illustrated in Figure 2 to convert the wall panel into a permanent wall configuration the webs and edge walls of the panels which are placed under tension exhibit adequate tensile strength tying the panel faces 13 against outward bulging under the concrete load.

In addition to the savings in material costs, the provisions of the openings 17 and 25 limits thermal transfer between the outer or exposed faces 13 of the panels 8 and the outer exposed walls 23 of the box connector 9. As a result the components provide increased insulation between the exterior and interior wall of a building such as shown in Figure 1.

Figure 4 illustrates an arrangement of roofing panels 26 which are shown interlocked together by four-way box connectors 27 rather than a two-way box connector 9 as illustrated in Figure 3 and which would be used to provide the smooth roof formation shown in Figure 1.

The four-way box connectors 27 provide for interlocking roof cladding to the upper surface of the roof and for engaging or supporting other structures beneath the roof.

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The roof panels 26 are similar to the wall panels 8 and it will be understood that they are extruded to provide a core and a coextruded outer skin covering the outer surfaces thereof (the separate layers not being shown).

Again, depending upon the anticipated loading of the roof structure, the reinforcing agent or agents selected for the core of the roof panels 26 will be appropriately selected.

For high loads the reinforcing agent preferably would include at least some of the fine small diameter short glass fibers.

Again, as in the case of the wall panels 8, the roof panels 26 are formed at opposite longitudinal edges with oppositely registering inwardly extending locking grooves 28 and edge tongues 29 for sliding interlocking engagement with the intumed locking fingers 30 carried by the flange extensions 31 of the box connectors 27. Similar intumed locking fingers 30 are provided on the box connectors 27 to project above and below the interlocked roof panels.

The roof panels 26 have circular holes 32 cut through their edge tongues 29 and webs 33 corresponding to the circular holes or openings 17 cut out from the wall panels 8. Similarly, the four-way box connectors 27 have circular openings 34 cut therefrom corresponding to the openings 25 in the two-way box connector.

In a roofing structure formed from the thermoplastic components, it is highly desirable that air circulation be effected within the roof structure. In this respect, the cutting out of the holes 32 and 34 provides free air circulation laterally of the roof in addition to the air circulation which can be effected lengthwise of the elongated hollow extruded roof components.

Additionally, it will be appreciated that the provision of the openings in the roof panels and their connecting box connectors restrict thermal transfer from the upper roof surface to the underside of the roof thereby adding to the thermal insulation provided by the components. It will



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also be appreciated that, if desired, the roof panels and connectors can be filled with suitable insulating material.

Despite the removal of the material resulting from the cutting of the circular holes 32 from the roof panels the webs 33 provide the requisite resistance to roof panel bending to sustain high roof panel loading augmented by the interengaging panel tongues 29 and box connector flanges 31 and locking finger 30.

Figure 5 is a plan view illustrating the connection of three wall panels 8 into a T-formation using a three-way box connector 35. The three-way box connector is provided with openings 25 in three of the walls thereof so that when material is introduced as indicated by the arrow 36 into the box connector 35, which material may be concrete, sand or insulation material, it can flow through the various openings into the wall panels. As illustrated, the leg of the T-formation is closed by an end cap C formed to interlock with the tongue 16 and grooves 15 of one of the panels 8 to contain all material within the external walls of the panel and box connector.

Similarly, should it be desirable to introduce insulation material into the interlocked roof panel as illustrated in Figure 4, such material can be injected for distribution within the roof structure by virtue of the existence of the cut out holes. Since the spacing between the holes is much less than the diameter of the holes, there will always be significant registration between the holes or openings cut in the adjoining interlocking components.

Figure 6 illustrates a corner box connector 37 connecting two wall panels 8 together in right angular relation. Box connector 37, as before, is extruded with an appropriate core and a co-extruded outer skin and is provided with the requisite intumed locking fingers 38 on adjacent sides and with the cut out circular openings 39 centered between these intumed locking fingers and having diameters less than the spacing between the locking fingers.

Figure 7 shows a four-way locking connector 40 for interlockingly connecting four wall panels 8 in right angular relation. In this case, the connector 40 has intumed locking fingers 41 at all four sides of the

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connector and circular openings cut out therefrom in all four walls of the connector.

It will be understood again that the connector 40 is formed of a reinforced core with the exposed surfaces, that is the locking fingers 41 and their supporting flanges 42 coated with a smooth skin:

It will be noted that the arrangement of the openings cut out from the various extruded components is such that the openings are internal of the exterior walls of the structure being assembled therefrom when they are slidingly interlocked with the appropriate mating components.

Figure 10 is a perspective view illustrating a wall panel 8' corresponding to the panel 8 except that it has a shorter span with a single web 12'. Otherwise the panel is identical with panel 8 and like numbers refer to like parts.

Similarly, Figure 11 illustrates a still smaller wall panel 80 which may be used at a wall corner. Panel 80 has no internal webs but otherwise has the same interlocking features and the same cutout openings as wall panel 8 and like numbers represent like parts.

Figure 8 illustrates a two-way box connector 9' corresponding to box connector 9 but additionally having internal key ways comprising out turned locking fingers 43 for sliding interlocking engagement with mating inserts (not shown).

Figure 9 is a perspective view of a three-way box connector 35' similar to box connector 35 but having an internal slideway comprised by out turned locking fingers 44 for supporting an internal insert (not shown).

Figures 13 and 14 illustrate a wall cap 45 adapted to fit down over the top of a wall formed from wall panels such as panels 8 and box connectors such as box connectors 9 to present a sloping support surface 46 for supporting a sloping roof such as illustrated at 3 in Figure 1.

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Wall cap 45 is a hollow extrusion having a bottom wall 47 adapted to rest on the upper ends of an erected wall and having downturned flanges 48 forming interconnecting means adapted to embrace opposite faces 13 of the wall.

Webs 49 and 50 extending upwardly from the bottom wall 47 support the sloping upper surface 46 with the web 50 being of a greater height than the web 49.

The wall cap 45 is provided at the lower side of the sloping wall 46 with a chamber 51 which has an access slot 52 which may be closed by screening of the like (not shown). At the opposite side, the wall cap is provided with a closed chamber 53 and an open chamber 54.

In accordance with the invention, the bottom wall 47 and the sloping wall 46 are provided with circular openings 55 cut therethrough. For this particular component, the diameter of the openings, while less than the spacing between the flanges 48, is greater than the spacing between the webs 49 and 50 so that during the cutting of the openings 55 a portion of the webs 49 and 50 are removed to provide access openings 56 and 57 to the chambers 51 and 54.

Since the bottom wall 47 and the sloping upper wall 46 will not be exposed when the wall cap 45 is installed in place, these surfaces need not be coated with a covering skin. The other exposed surfaces, however, will have a skin coextruded over the core material to provide the desired smooth finish.

Figure 12 is an extrusion for connecting box connectors together and, when in place, will be totally enclosed and will have no exposed surfaces that require coating.

As illustrated, this box connector connector 58 comprises a web 59 spacing two outwardly facing channels presenting two inwardly projecting grooves 60 of a width to receive the interlocking fingers such as the fingers 20 of two adjoining box connectors 9 when their locking fingers are in abutting relation. In this manner connector 58 will lock the box connector

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together while being totally contained within the abutting box connector flanges and abutting interlocking fingers..

The web 59 is provided with a plurality of circular openings 61 cut therefrom with the diameter of the openings being substantially equal to but slightly less than the spacing between the two channels 60. Connector 58 is preferably extruded from a polyvinyl chloride but since it is not subjected to significant loading the amount of reinforcing agent, if any, can be minimal. Again, because it is enclosed when in position, no exposed surfaces requiring a skin coating are presented.

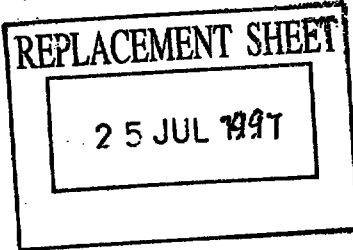
Figure 15 is a diagrammatic illustration of the method of manufacturing the extruded components of the present invention and illustrating the extrusion of a straight box connector 9 having a core 21 and a coextruded outer skin 22 and provided with circular openings 25 cut therefrom.

As illustrated, thermoplastic material 62 formulated with the desired ingredients to form the core of the box connector 9 is fed from hopper 63 into a suitable extrusion die (not shown) from which it is delivered in a continuous stream having the requisite cross-sectional shape. At the same time, material 64 suitable for the coextruded skin is delivered from hopper 65 and coextruded to cover the exposed surfaces of the box connector.

As the coextruded core and skin are fed continuously out of the extrusion die arrangement suitable rotary drills 66 carried by a horizontally reciprocating carriage 67 mounted on guide 68 are utilized to drill the holes 25.

The movement of the carriage 67 is such that it moves away from the extrusion apparatus at the same speed as the box connector extrusion is delivered out of the extruder so that during the drilling the extrusion and the drills have no relative movement in the direction of extrusion feed. As soon as the holes are cut and the drills retracted, they are rapidly returned rearwardly of extrusion feed to the start position to then recommence a fresh cycle of drilling while moving at the same speed as the extrusion feed.

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The drills are arranged so that when they retract they withdraw the material cut from the extrusion where it can be dropped unto a collector pan 69 and delivered back by a suitable feed 70 into the core material hopper 63.

Following extrusion and drilling, the box connector extrusion can be cut off at the requisite lengths depending on the nature of the building structure with which it is to be employed.

By using the structural components of the invention which have material cut or removed therefrom and recycled as described, savings in the cost of a building such as a house of up to 25% can be achieved further significantly increasing the affordability of housing and the like for the low income masses.

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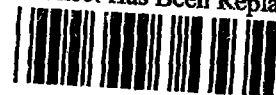
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CLAIMS

1. An elongated hollow generally rectilinear ^{thermoplastic} structural component (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) for use in the erection of a thermoplastic building structure, said component presenting planar spaced walls held in spaced relation by transverse walls or webs and having interlocking means extending the length thereof for interlockingly engaging with mating components, characterized in that said component is a coextrusion of a hollow substrate (10, 21) and a smooth protective skin (11, 22) covering said hollow substrate on surfaces which are exposed as exterior walls (13, 23) when said component is interlocked with mating components with said transverse walls or webs (12, 14, 24) which are interior walls when said component is interlocked with mating components having material cut out therefrom to provide a plurality of openings (17, 25) therethrough spaced along the length thereof and inwardly of said interlocking means (15, 19, 20) to provide interior communication between interlocked components; the material cut out from the walls or webs (12, 14, 24) providing material suitable for use in extruding the substrate of a subsequent component.

2. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said substrate (10, 21) is a polyvinyl chloride containing a reinforcing and expansion controlling agent.

3. An elongated thermoplastic building component as claimed in Claim 2 characterized in that said substrate (10, 21) contains material cut out from the walls and webs of previously extruded components.

4. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said reinforcing and



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expansion controlling agent in said substrate (10, 21) is selected from mineral fibers, glass fibers and calcium carbonate.

5. An elongated thermoplastic building component as claimed in any preceding claim characterized in that said openings are circular and have a diameter less than the spaces between said interlocking means (15, 19, 20).
6. An extruded thermoplastic building component as claimed in Claim 5 characterized in that said openings have uniform diameters and are centered on a line located centrally between said spaced interlocking means (15, 19, 20) are uniformly spaced along said line, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.
7. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said component comprises a longitudinal panel (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) and said transverse webs include webs (14) which extend across between said substantially planar walls and form the longitudinal edge walls of said panel and at least one web (12, 12') which defines internal compartments within said panel between said panel edge walls, and said interlocking means comprises inwardly projecting oppositely registering grooves (15) in said substantially planar walls adjacent each of said panel edge walls and extending throughout the length of said substantially planar walls, the spacing between said substantially planar walls being reduced outwardly of said grooves to provide a locking tongue (16) and said openings are provided in each of said webs.
8. An elongated thermoplastic building component as claimed in Claims 1 to 6 characterized in that said component comprises a box connector (9) in the form of an elongated hollow rectangle, two opposed walls (23) of which are constituted by said substantially planar walls, and two walls (24) of which are constituted by said transverse webs.
9. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a corner box connector (37) having openings (39) formed in the walls thereof which become internal walls when same is interlocked with mating components arranged in right angular relation.

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10. An elongated thermoplastic building component as claimed in Claims 1 characterized in that said component is a three way box connector (35') having openings (25) formed in the walls thereof which become internal walls when same is interlocked with mating components.

11. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a four way box connector (4) having openings formed in the walls thereof which become internal walls when same is interlocked with mating components.

12. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said smooth skin (11, 22) is selected from PVC, rigid PVC, semi-rigid PVC, ABS or polycarbonate

13. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said substrate (5, 10, 21) comprises a polyvinyl chloride containing from about 5 to 50% calcium carbonate.

14. An elongated thermoplastic building component as claimed in Claim 13 characterized in that said substrate contains from about 5 to 30% calcium carbonate by weight.

15. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said skin (11, 22) has a thickness at least of the order of about .015 inches and said substrate (5, 10, 21) has a thickness of the order of at least about 4 to 5 times the thickness of said skin.

16. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the spacing between opposing walls of each said component is of the order of several tens of times the combined thickness of said substrate (5, 10, 21) and skin (11, 22).

17. An elongated thermoplastic building component as claimed in Claim 16 characterized in that the spacing between opposing walls of each said components is of the order of about 4 inches.

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18. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the amount of material cut from the walls or webs is a substantial proportion of the total amount of material in said component prior to removal of the cut out material.

19. An elongated thermoplastic building component as claimed in Claim 19 characterized in that said substantial proportion is of the order of up to about 25% by weight

20. A method of manufacturing hollow rectilinear thermoplastic building components (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) adapted for interlocking engagement to form building structures characterized in that each said building component is extruded as a coextrusion of a substrate of thermoplastic material (10, 21) containing a reinforcing and expansion controlling agent and a smooth thermoplastic skin (11, 22) covering the walls of said component which are exposed as exterior walls (13, 23) when said component is interlocked with mating components, following said extrusion cutting openings (17, 25) through the walls of said component which form interior walls (12, 14, 24) when same is interlocked with mating components, and utilizing the material cut from said interior walls as substrate material in the extruding of a subsequent component.

21. A method as claimed in Claim 20 characterized in that said core material is a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from calcium carbonate, mineral fibers, and small glass fibers.

22. A method as claimed in Claim 20 or 21 in which said smooth thermoplastic skin is selected from polyvinyl chloride, rigid polyvinyl chloride, ABS and polycarbonate.

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FIG. 1.

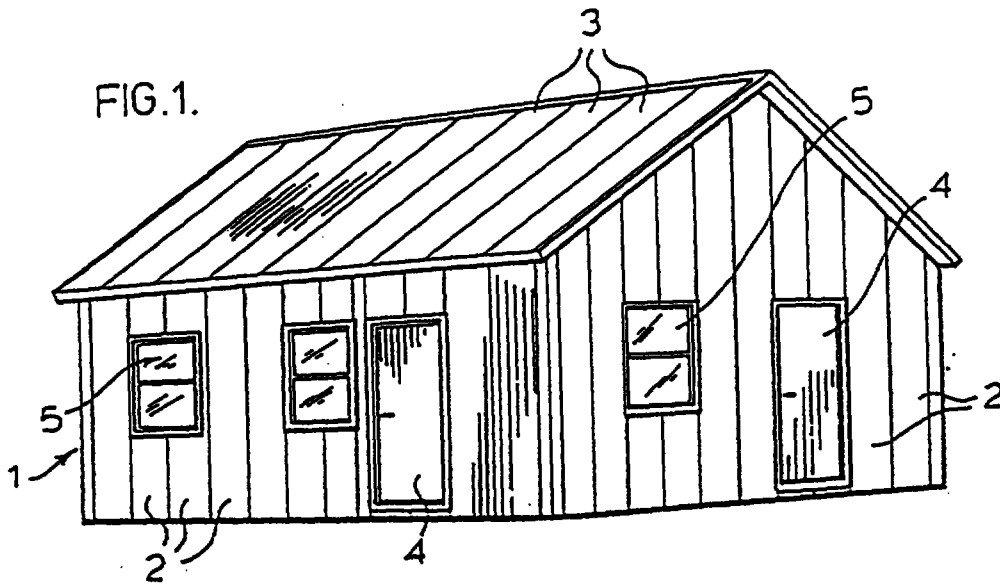
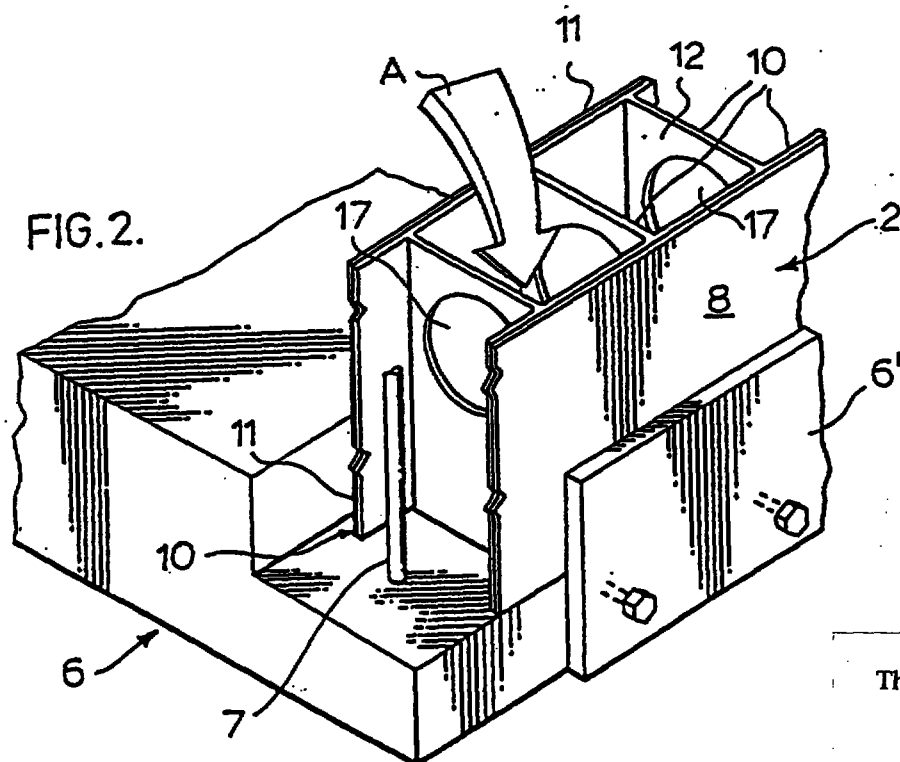


FIG. 2.



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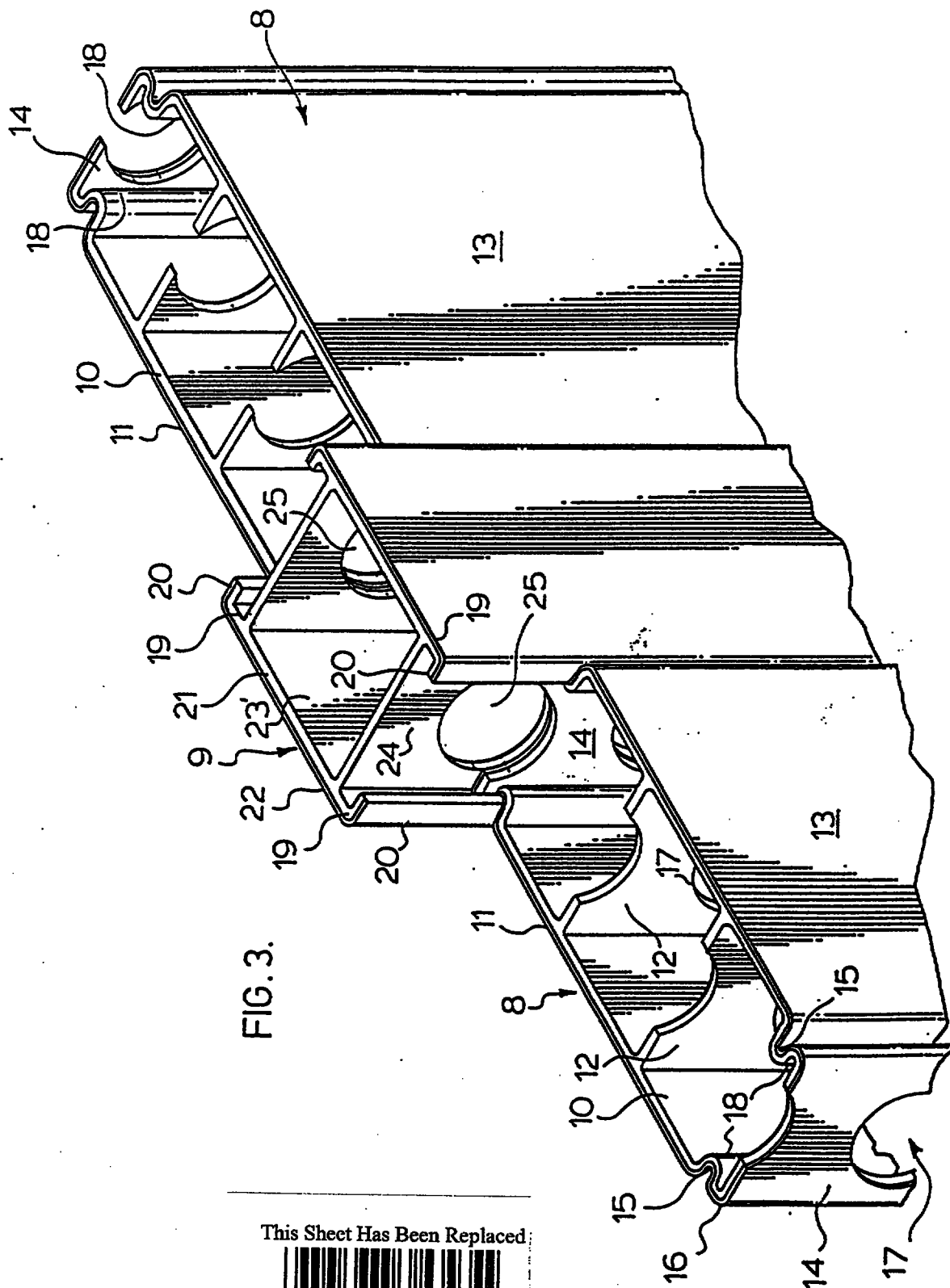


FIG. 3.

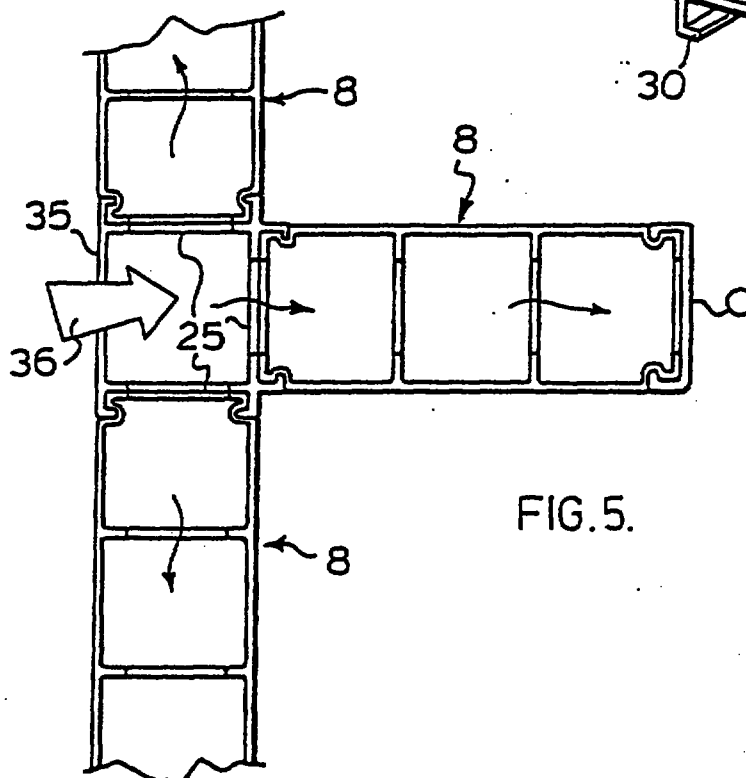
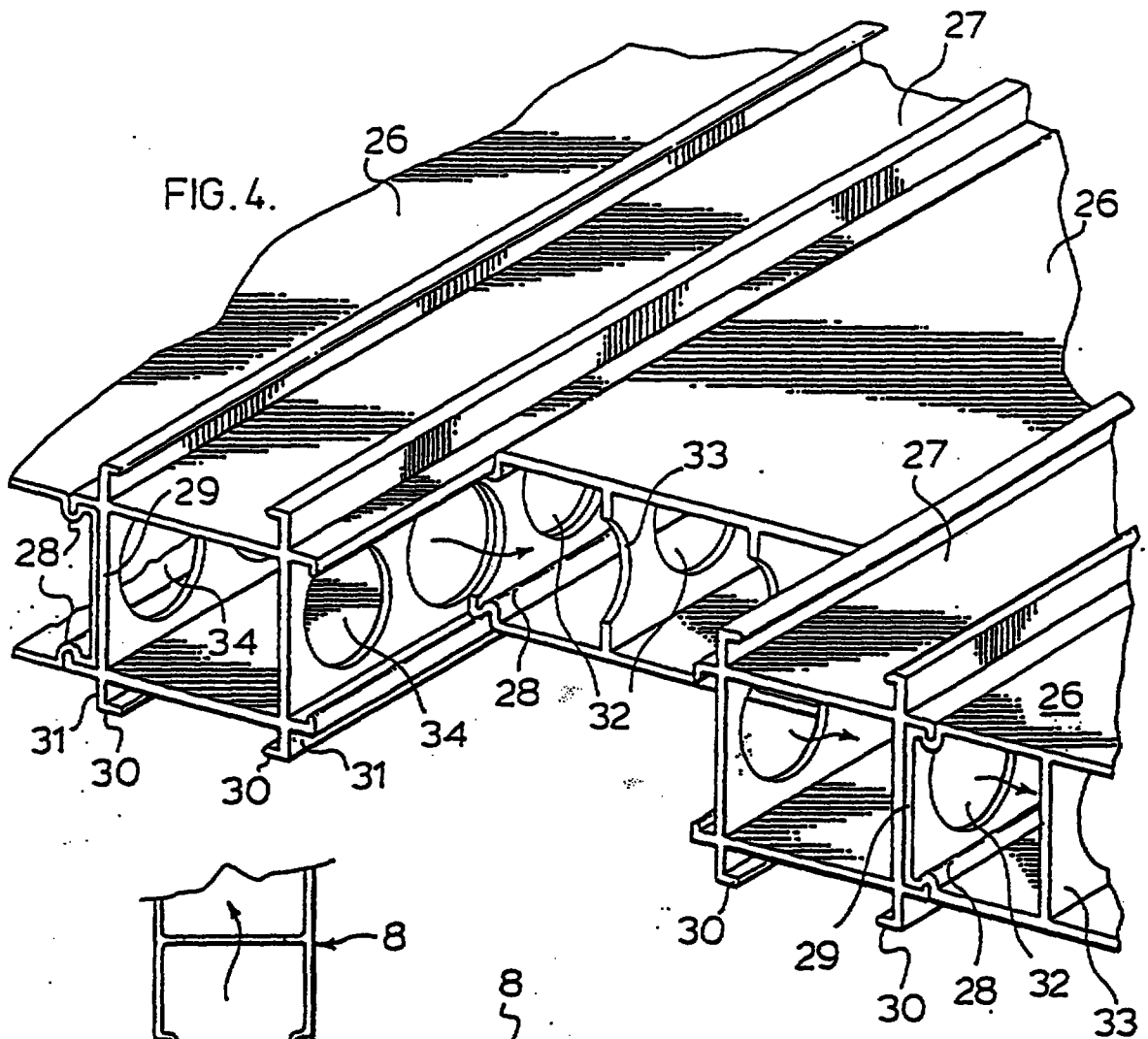
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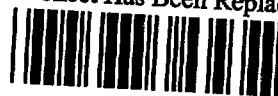
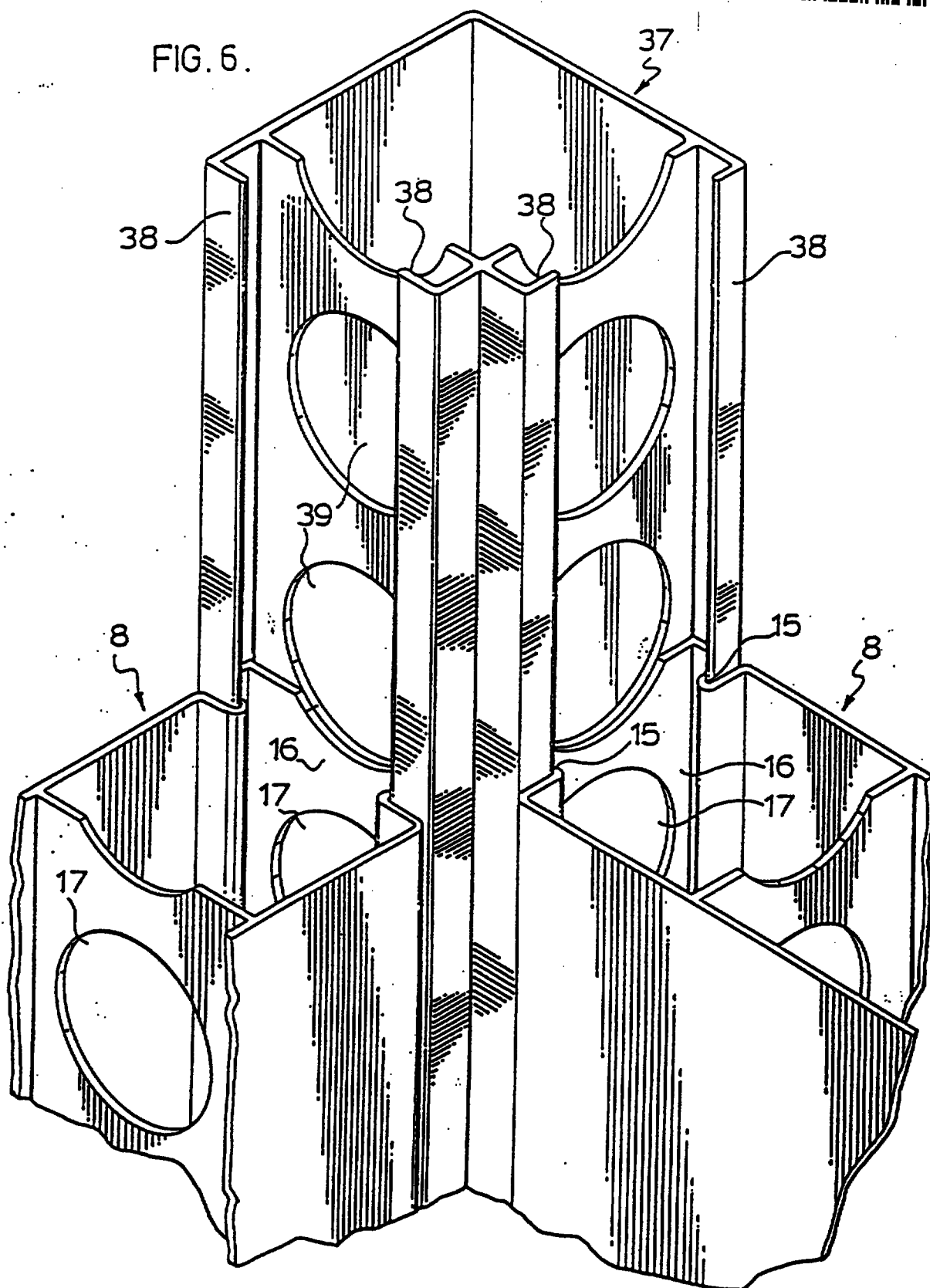
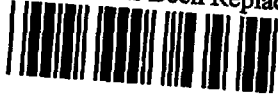


FIG. 6.



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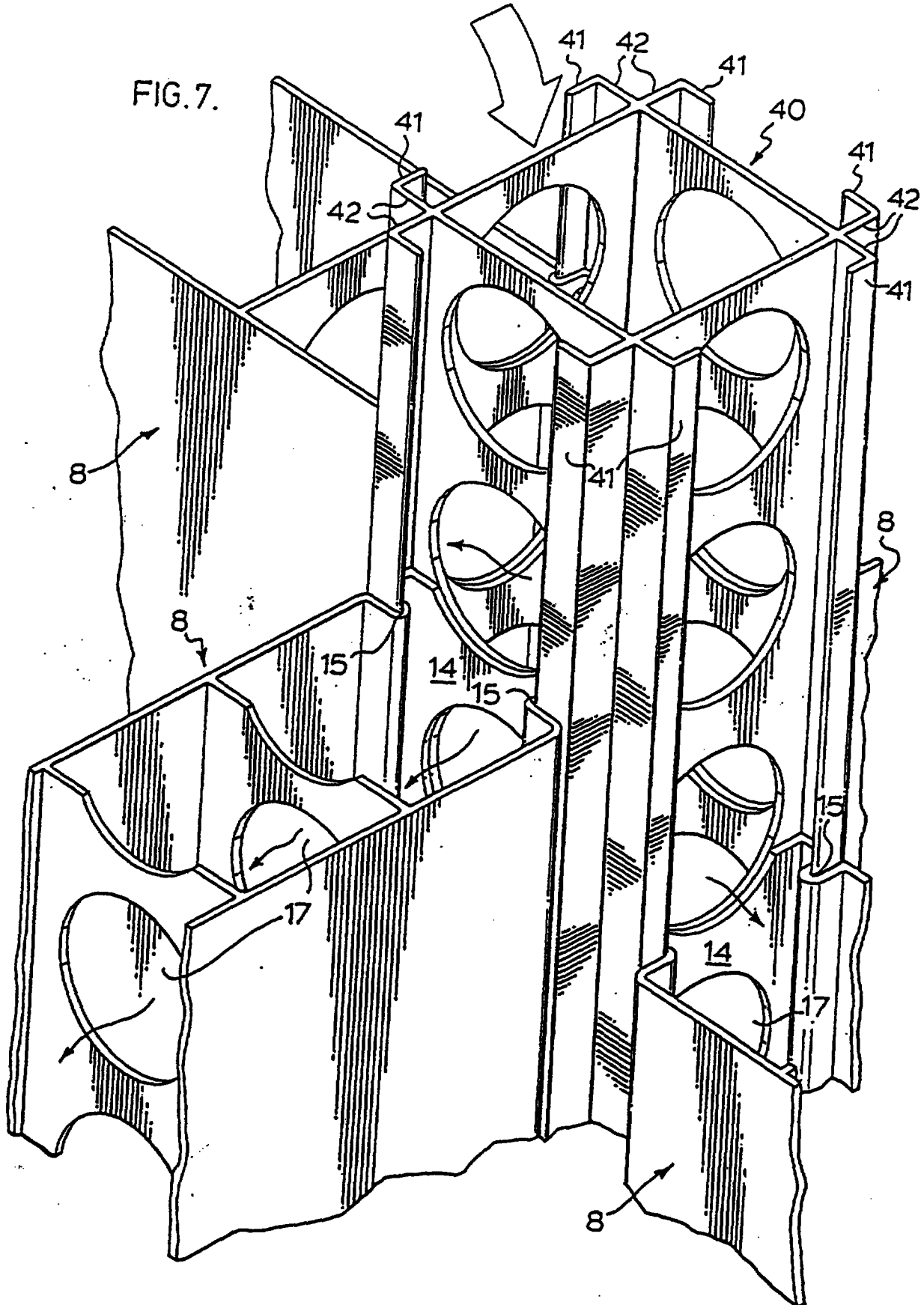


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FIG. 8.

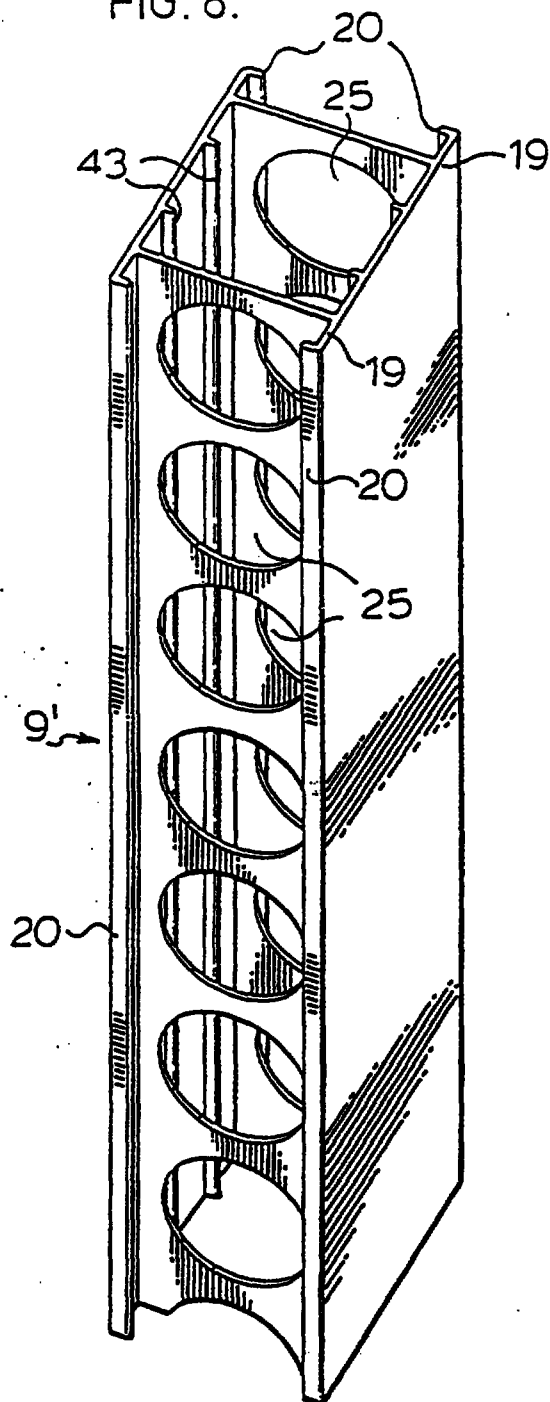
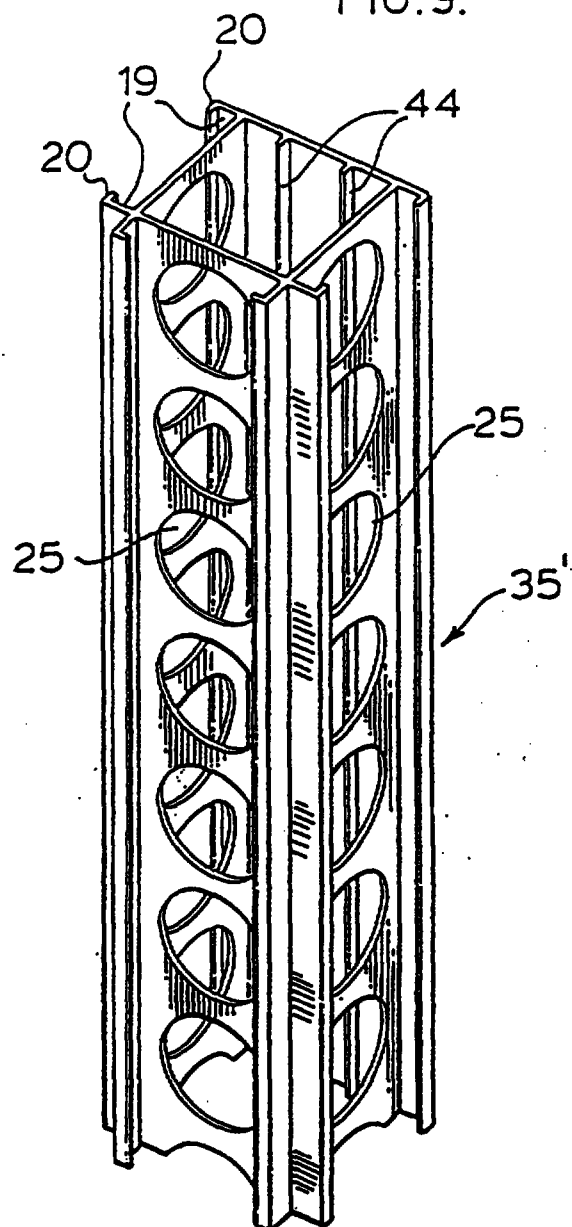


FIG. 9.



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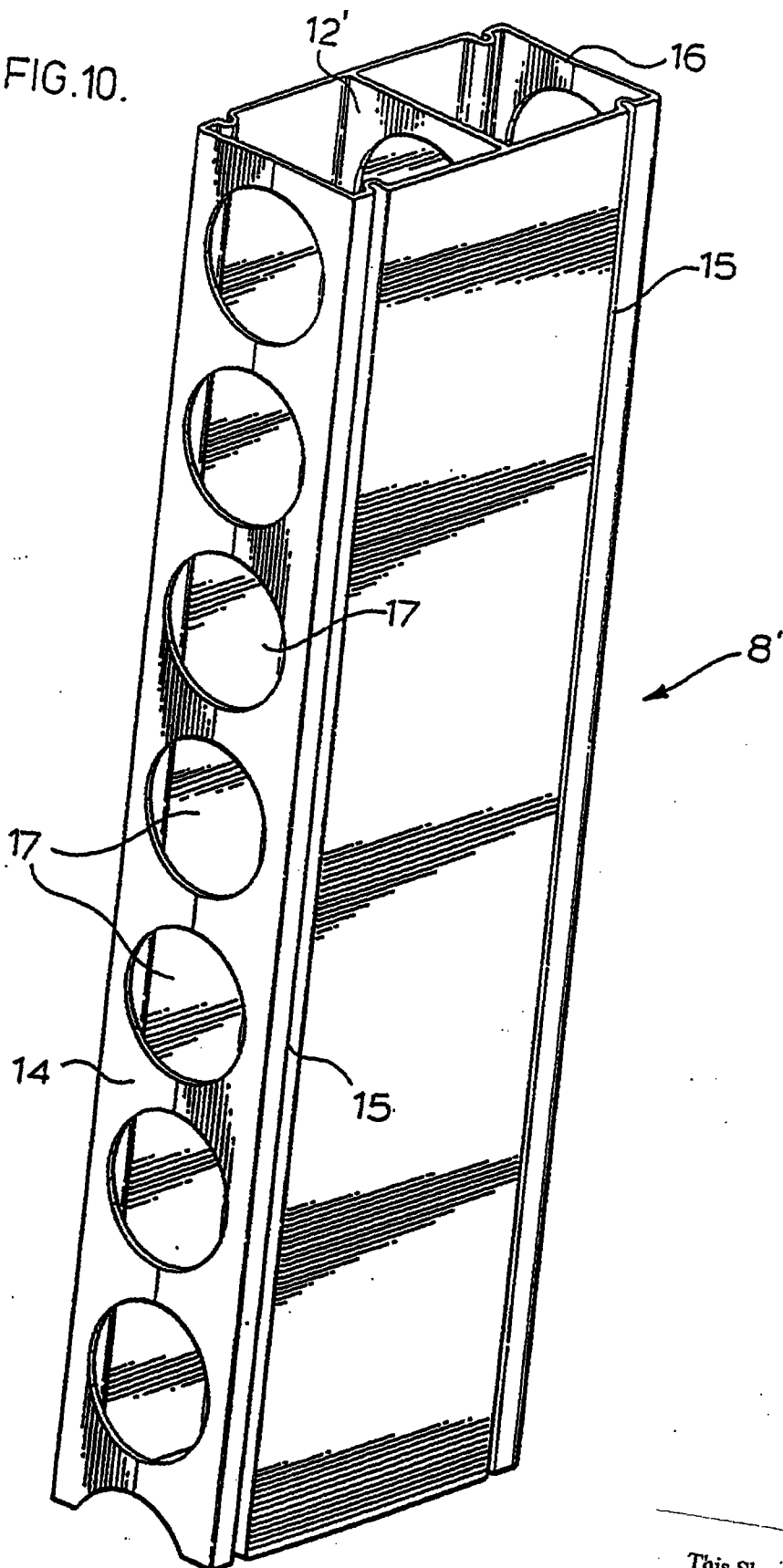
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FIG.10.



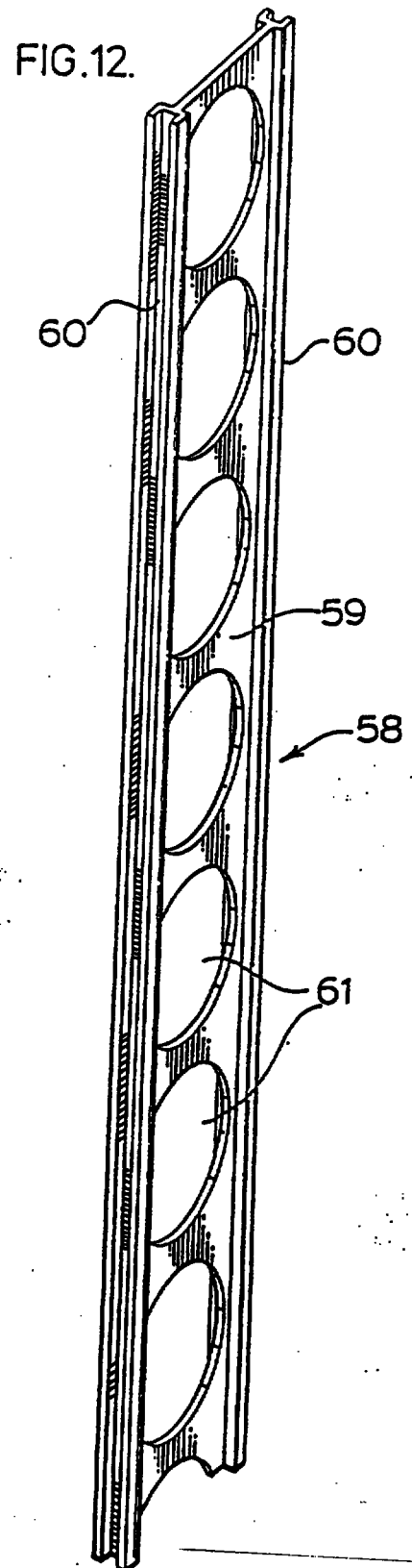
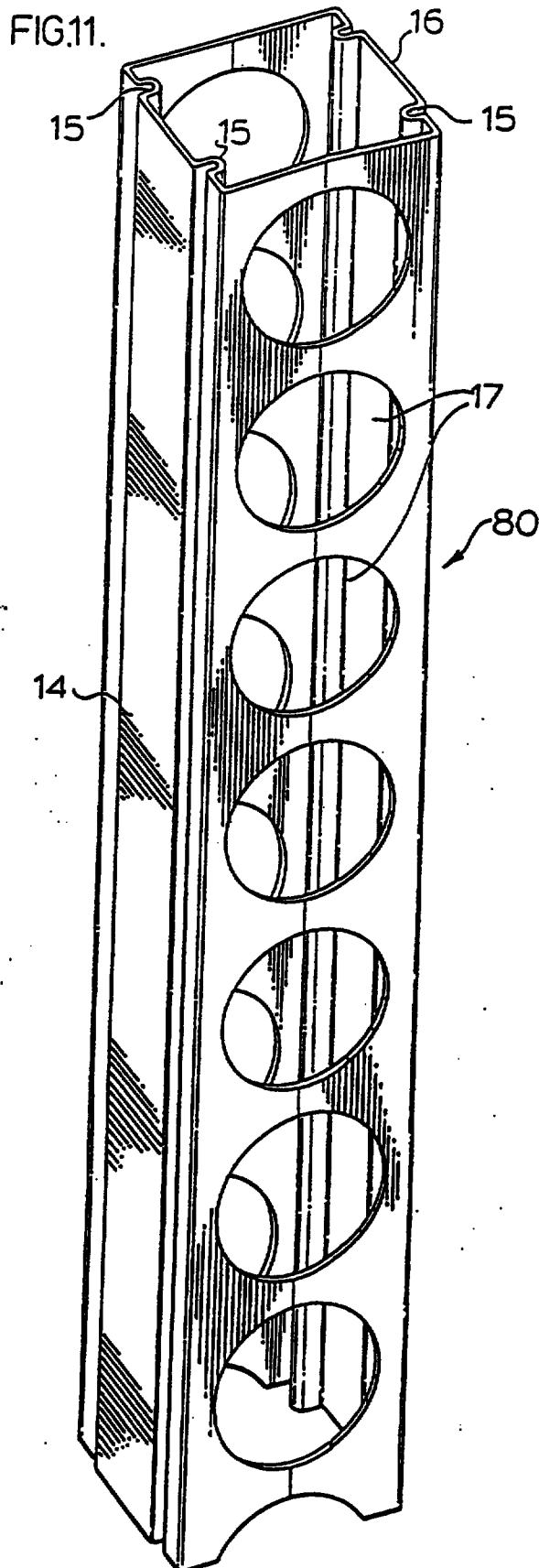
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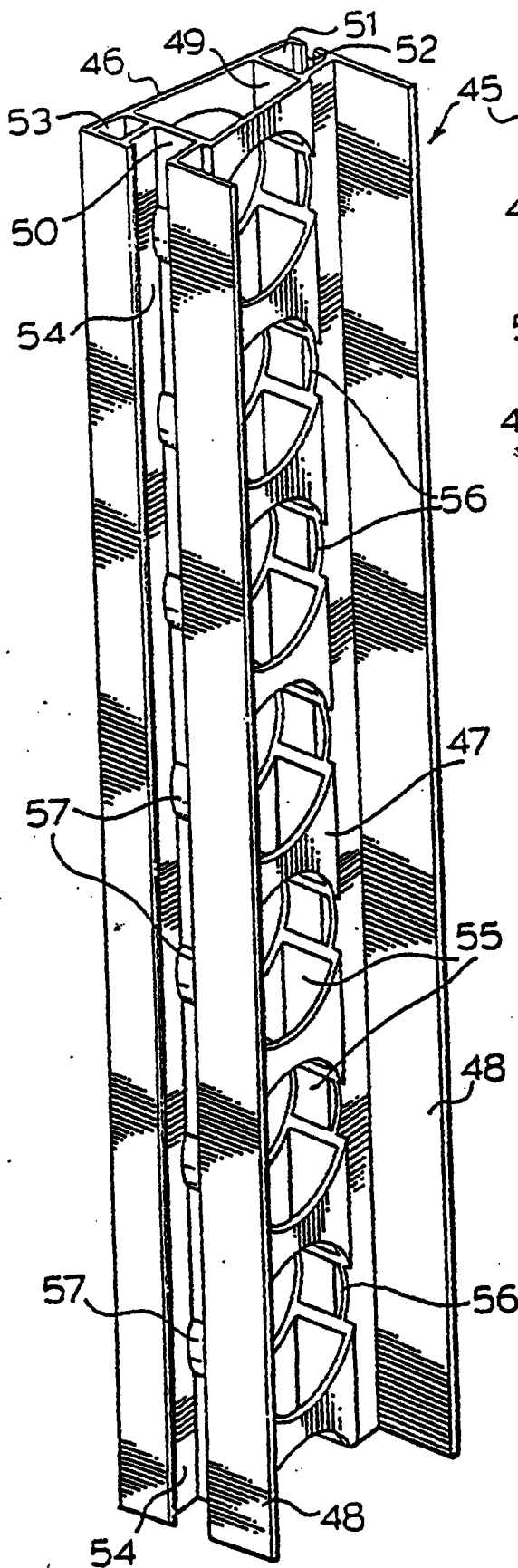


FIG. 13.

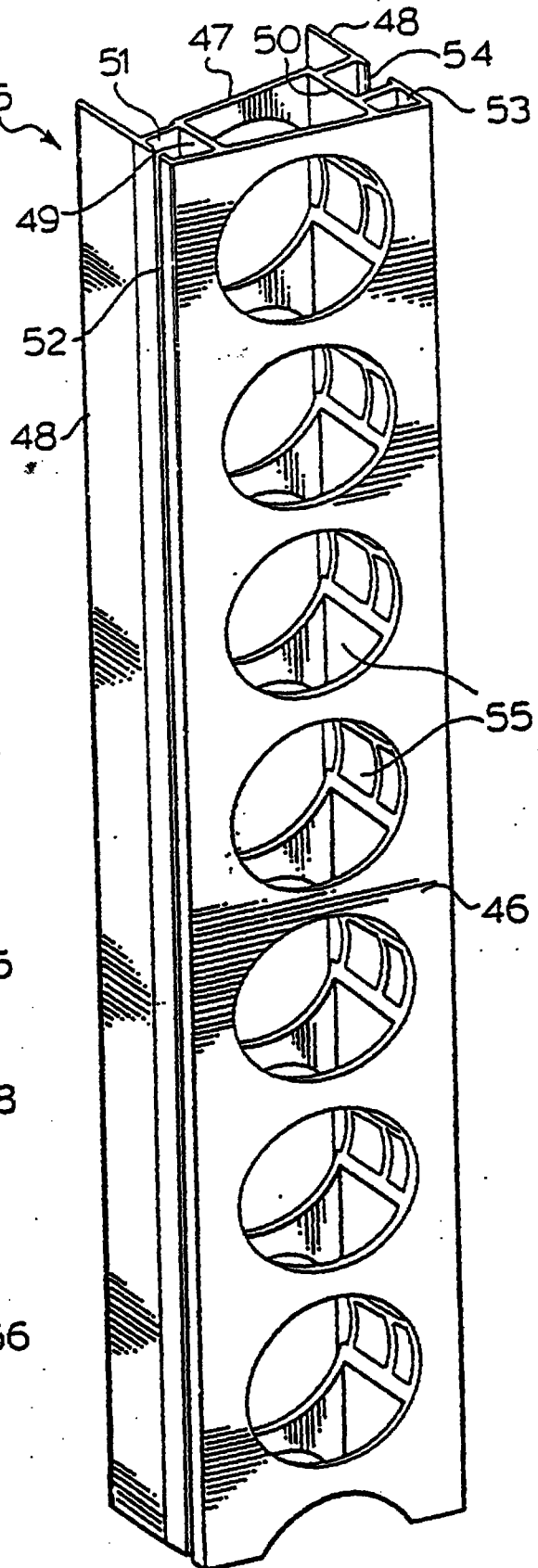


FIG. 14.

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THERMOPLASTIC STRUCTURAL COMPONENTS AND STRUCTURES FORMED THEREFROM**Description**FIELD OF THE INVENTION

This invention relates to reduction of the costs of the novel thermoplastic structural system and structural components therefor and building structures erected therefrom which are disclosed in my copending Canadian Application Serial No. 2,070,079, filed May 29th, 1992 without adversely affecting their integrity.

BACKGROUND OF THE INVENTION

The structural system disclosed in my said copending application comprises novel interlocking thermoplastic structural components which can be mass produced at low cost and which can be quickly and easily interlocked together to erect a wide range of structures which will require minimal maintenance and will be safe from termites, corrosion, rust or rot and will be highly resistant to the effects of weathering.

The present invention is directed to significantly reducing the costs of such components and hence the costs of structures erected therewith without sacrificing the structural integrity of the components or system.

Further the invention is directed to such cost reductions of the components themselves and the structures formed therefrom without increasing the costs of production of the components or interfering with the ease of their assembly.

Further the invention is directed to providing such structural components as to aforesaid which will facilitate the conversion of the walls erected therewith into permanent wall structures, will enhance the air circulation in roofs erected therewith, and will provide reduced thermal transfer between the exterior and interwall surfaces of the walls and roofs.

DESCRIPTION OF PRIOR ART

While the use of plastic to form wall panels or the like for use in building construction has been proposed, such panels have not had the necessary load bearing or other structural requirements to form practical structures which could be mass produced at low cost and quickly and easily assembled to erect durable low cost structures and, in particular, low cost housing.

U.S. Patent 3,992,839, for instance, discloses a plastic panel fabricated from separate panel members, preferably formed of polyvinyl chloride which snap together to form a thin wall panel. The panels in turn are formed to snap together to provide a wall structure. Such fabricated panels are inherently weak and lack the strength and load bearing capacity to form adequate structural components for use, for instance, in the forming of the walls and roof of a practical durable building.

U.S. Patent, 3,662,507 discloses the use of tongue and grooved individually prefabricated panels said to be preferably of plastic which are bonded or glued together and used particularly for the forming of basement walls. Such panels do not permit of high speed production and are not capable of being quickly and easily interlocked together in the erection of a house or other structure.

U.S. Patent No. 4,557,091 discloses a hollow panel member having a width of about one and one-half inches (1½", 38mm) and a complicated interior formed by pultrusion, a process involving drawing long glass strands and a plastic binding material forcefully through a die under heat to form the glass strands into a compacted glass mat bound together by the plastic material. Such a process is prohibitively slow and expensive and the panels themselves do not provide acceptable or practical low cost structures for forming the walls and roofing of a housing system such as contemplated by the present invention.

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While modular building structures using modular building components formed of steel have also been proposed, such as disclosed in U.S. Patent 1,958,124, such systems involve welding together of the members to make up the components and the use of bolts or other fasteners to secure same together. Such systems are not practical for low cost practical housing and the like with which the present invention is concerned.

EP-A-0,320,745 discloses an arrangement of hollow interlocking structural components for a modular building which it is said may comprise extruded thermoplastic-resin preferably reinforced with preferably about 30 per cent by weight glass fibres such as described in U.S. Patent 4,536,630.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided an elongated hollow generally rectilinear thermoplastic structural component for use in the erection of a thermoplastic building structure, said component presenting planar spaced walls held in spaced relation by transverse walls or webs and having interlocking means extending the length thereof for interlockingly engaging with mating components, characterized in that said component is a coextrusion of a hollow substrate and a smooth protective skin covering said hollow substrate on surfaces which are exposed as exterior walls when said component is interlocked with mating components with said transverse walls or webs which are interior walls when said component is interlocked with mating components having material cut out therefrom to provide a plurality of openings therethrough spaced along the length thereof and inwardly of said interlocking means to provide interior communication between interlocked components, the material cut out from the walls or webs providing material suitable for use in extruding

the substrate of a subsequent component.

According to the preferred form of the invention the openings are circular and preferably of a uniform diameter and more preferably still the openings have a diameter equal to a major portion of but less than the spacing between the interlocking means.

Preferably the structural components of the present invention are extruded from a vinyl chloride, preferably a polyvinyl chloride, containing a reinforcing and expansion controlling agent which preferably is selected from one or more of mineral fibres, small glass fibres and calcium carbonate.

More particularly, the extruded structural components comprise a core of polyvinyl chloride containing a reinforcing and expansion controlling agent as aforesaid and a coextruded thermoplastic skin covering surfaces that will be exposed on assembly into a building structure.

Further, in accordance with the invention, the openings in the at least one web of the structural component are bored out of the web immediately after the component has been extruded and while it is still feeding away from the extruder.

Also, according to the invention, the material removed from the web is returned for reuse as a core extrusion material.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will be understood from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a perspective view of a small house erected from interlocking thermoplastic structural components such as form the subject matter of the present invention.

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Figure 2 is a broken away perspective view illustrating a wall panel embodying the present invention seated on a concrete base ready to receive concrete or other anchoring material to be anchored to the base through suitable anchor rods.

Figure 3 is a perspective view illustrating a wall section showing a pair of wall panels interlockingly engaged with a connecting box connector and showing the components as comprising a core having the exposed external surfaces thereof coated with a smooth thermoplastic skin with the thickness of the skin being somewhat exaggerated for purposes of illustration.

Figure 4 is a perspective view illustrating a plurality of roof panels corresponding to the wall panels of Figure 3 embodying the invention connected by four-way box connectors according to the invention, the four-way box connectors being available for the attachment of cladding to the upper surface of the roof and for engagement with other components beneath the roofs surface.

Figure 5 is a plan view showing a three-way box connector interlockingly connecting two aligned wall panels and a third wall panel at right angles thereto.

Figure 6 is a perspective view illustrating a corner box connector connecting two wall panels in right angular relation.

Figure 7 is a perspective view illustrating a four-way box connector for connecting four wall panels in right angular relation.

Figure 8 is a perspective view of a slightly modified two-way box connector having interior locking fingers for interlocking engagement with a mating insert.

Figure 9 is a view similar to Figure 8 but showing a three-way box connector.

Figure 10 is a perspective view of a wall panel according to the invention having a single interior web.

Figure 11 is a perspective view of a wall panel with no interior web.

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Figure 12 is a perspective view of a box connector joiner embodying the invention.

Figure 13 is a perspective view taken from the underside of a sloping wall cap embodying the invention.

Figure 14 is a perspective view of the wall cap of Figure 13 taken from the top side.

Figure 15 is a diagrammatic view illustrating the manner in which the components of the present invention are extruded and then drilled to produce the openings through the webs thereof.

Figure 16 is a cross-sectional view of the particular box connector shown being extruded in Figure 15.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

It will be understood that while only Figure 3 illustrates the co-extruded skin on the exposed surfaces of the wall panels and the box connector, all of the panels and box connectors will have such an extruded skin and it is only components such as the box connector joiner of Figure 12 which will have no exposed surfaces when assembled into a building structure that will be extruded without any skin coating.

With reference to the drawings, Figure 1 is a perspective view of a house 1 as an example of the type of building that can be erected with the thermoplastic interlocking building components of the present invention which can be assembled into walls 2 and roofing 3 with provision for doors 4 and windows 5.

A building such as illustrated in Figure 1 is intended to be erected on a concrete pad 6 as illustrated in Figure 2 which shows how the walls 2 of the building can be anchored to the concrete pad 6 by means of anchor rods 7 when the interior of the walls 2 are filled with concrete and the like as illustrated by the arrow A. Suitable means such as the strip 6' may be employed to contain the con-

crete from spilling out from underneath the wall 2.

As more particularly illustrated in Figure 3, the walls 2 are formed from wall panels 8 interlockingly interconnected by box connectors 9, one of which is illustrated in Figure 3.

Each of the wall panels 8 in accordance with the invention disclosed in copending Canadian Application Serial Number 2,070,079 comprises a hollow rectilinear thermoplastic extrusion having a core 10 and coextruded outer skin 11.

The core 10 preferably comprises a vinyl chloride and, more particularly, a polyvinyl chloride containing a suitable reinforcing and expansion controlling agent such as mineral or other fibers or other known expansion controlling agents such as a calcium carbonate.

A reinforcing agent or constituent particularly useful for structural components of the present invention which are subject to high loading comprises small glass fibers which when anchored in a thermoplastic material such as vinyl chloride or polyvinyl chloride provide the requisite reinforcing and expansion controlling characteristics to provide high structural strength.

A suitable material incorporating small glass fibers which can be used in the production of these panels 8 is available under the trade-mark FIBERLOC from the B. F. Goodrich Company of Akron, Ohio, such material being described in detail in B.F. Goodrich's U.S. Patent 4,536,360 wherein very fine short glass fibers are bound within a composition of vinyl chloride resin.

The presence of glass fibers in the PVC or other thermoplastic material while providing tensile strength and expansion control to the material creates an extrusion problem and, if they are too large and too concentrated, it is not practical to extrude the material. Preferably, such fibers should be of the order of a few microns in diameter and a few millimeters in length and in concentrations not greater than and preferably substantially

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less than about 35% by weight based upon the combined glass fibers and vinyl chloride resins.

The presence of the glass fibers creates a brittleness which makes a structure produced solely from a glass fiber reinforced plastic subject to potential fracture from impact. This potential increases with increased concentration of glass fibers.

The problems encountered with the use of the glass fibers as the reinforcing constituent while utilizing their beneficial reinforcing qualities for high loading capacity have been resolved by coextruding with the glass reinforced thermoplastic a smooth thermoplastic skin covering the external exposed surfaces of the panels.

The smooth plastic skin may be PVC, rigid PVC, within a composition of vinyl chloride resin.

The presence of glass fibers in the PVC or other thermoplastic material while providing tensile strength and expansion control to the material creates an extrusion problem and, if they are too large and too concentrated, it is not practical to extrude the material. Preferably, such fibers should be of the order of a few microns in diameter and a few millimeters in length and in concentrations not greater than and preferably substantially less than about 35% by weight based upon the combined glass fibers and vinyl chloride resins.

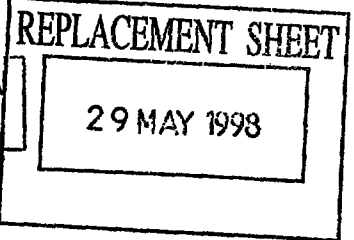
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The smooth plastic skin may be PVC, rigid PVC, semi-rigid PVC, ABS, polycarbonate with thermoplastics available from G.E. under the trade-mark GELOY and NORYL.

This skin 11 serves a number of useful purposes. Because of the presence of the glass fibers in the core or substrate 10, the substrate is somewhat brittle and its surfaces are rough and abrasive with portions of the glass fibers projecting through the surface of the substrate rendering the substrate somewhat porous and susceptible to the ingress of moisture which can adversely affect the bond between the glass fibers and the thermoplastic material.

The coextrusion of the thermoplastic skin covers and seals the outer exposed surfaces of the structural component against the ingress of moisture, thereby maintaining the integrity of the binding of the glass fibers to substrate plastic. Further, the outer skin 11 not only covers exposed glass fibers but these exposed glass fibers become embedded in the thermoplastic material so that the external surface of the component is totally smooth. The glass fibers in turn in becoming embedded in the outer skin lock the skin to the substrate or core 10 so that the expansion and contraction of the outer skin is fixed to the expansion and contraction of the core which is controlled or limited by the presence of the incorporated glass fibers which have a much smaller coefficient of expansion than the plastic.

It will be also understood that the skin 11 can be formulated to include agents providing impact resistance, resistance to ultraviolet radiation and the like.

The combination of the co-extruded core or substrate 10 and smooth skin 11 thus enable the provision of wall panels having inherent structural strength and which are essentially maintenance free, impact resistant and they will be free from corrosion, rot or rusting and

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will be impervious to moisture, termites and other insects.

While the use of the glass fibers provides the strength necessary for handling high loading, where the panels will be subjected to much lighter loading the core 10 may be formed of a vinyl chloride containing from about 5% to about 50% calcium carbonate and preferably about 5% to 30% calcium carbonate by weight.

Alternatively, a mixture of calcium chloride and glass fibers or other reinforcing agents such as mineral fibers may be used to meet the particular load specifications required for the panel.

As illustrated in Figure 3, each of the panels 8 is provided with two transverse webs 12 which tie the opposing faces 13 of the panel together intermediate the edge walls 14 of the panel.

Adjacent each of the edge walls 14, the panel 8 is provided with inwardly extending oppositely registering grooves 15 with the width of the panel being reduced outwardly of the grooves 15 to the edge walls 14 to, in effect, provide a tongue portion 16.

As the cost factor is a critical element in the ability to provide affordable housing to the masses, it has been found that this cost factor can be significantly reduced in material costs by cutting a series of openings 17 out of the webs 12 and edge walls 14 at spaced points along their length.

This cut out material can then be collected and re-used in the extrusion of the core of a subsequent extrusion.

The openings 17 are preferably circular openings having a diameter slightly less than the spacing between the most adjacent point 18 of the grooves 15.

With the openings 17 centered on the midpoint of the edge walls 14 and midway between the panel faces 13, the openings can be cut through the edge walls 14 and also through the webs 12 without interference with

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the grooves 15 which extend uninterrupted throughout the length of the extrusion.

Still with reference to Figure 3, the panels 8 are shown interlocked with the box connector 9 in the form of a hollow extruded rectangle having projecting flanges 19 terminating in intumed oppositely registering locking fingers 20 adapted to slidingly interlock with the grooves 15 of the panels 8.

The box connector 9 is extruded with a core 21 and a coextruded outer skin 22 covering the outer surfaces of the walls 23, the flanges 19 and the locking fingers 20.

Because of the inherent strength of the configuration of the extruded rectangular box connector 9, its core 21 may comprise a PVC resin and, for example, calcium carbonate, as the expansion controlling and reinforcing agent, although other agents including small glass fibers and mixtures of agents may be used.

It will be noted that the outer surfaces of the walls 23 of the box connector 9 covered by the outer skin 22 are precisely aligned with the outer surfaces of the panel faces 13 with the tongue portions 16 of the panels being received in the space between the intumed locking fingers 20 and the transverse walls or webs 24 of the box connector.

Again, the box connector is provided with a series of openings 25 through the transverse walls or webs 24. Again, these openings are circular with a diameter centered on the midpoint of the transverse walls or webs 24 of the box connector and spaced along the length thereof with the diameters of the openings substantially equal to, but less than, the spacing between the intumed locking fingers 20 so that the locking fingers are not intersected during the cutting of the openings 25.

It will be seen that the panel locking grooves 15 are covered in the smooth coextruded skin 11 to provide a smooth surface for smooth sliding interlocking engage-



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ment with the smooth skin coated locking fingers 20. Further, the outside faces of the tongues 16 which form the edge walls 14 of the panels are coated with the smooth skin 11 and preferably these faces are slightly concaved to eliminate any interference with the box connector transverse webs or walls 24.

Again, the material cut out from the box connector walls or webs 24 can be collected and returned to be used as material for extruding subsequent box connectors.

It has been found, for example, that with a wall panel width of 100 millimeters between the faces 13, circular holes having a diameter of 70 millimeters and spaced 12.7 millimeters apart provide a significant saving in material and cost of the vinyl extrusion product without significantly affecting the structural strength of the panel so that when concrete is poured therein such as illustrated in Figure 2 to convert the wall panel into a permanent wall configuration the webs and edge walls of the panels which are placed under tension exhibit adequate tensile strength tying the panel faces 13 against outward bulging under the concrete load.

In addition to the savings in material costs, the provisions of the openings 17 and 25 limits thermal transfer between the outer or exposed faces 13 of the panels 8 and the outer exposed walls 23 of the box connector 9. As a result the components provide increased insulation between the exterior and interior wall of a building such as shown in Figure 1.

Figure 4 illustrates an arrangement of roofing panels 26 which are shown interlocked together by four-way box connectors 27 rather than a two-way box connector 9 as illustrated in Figure 3 and which would be used to provide the smooth roof formation shown in Figure 1.

The four-way box connectors 27 provide for interlocking roof cladding to the upper surface of the roof and for engaging or supporting other structures beneath the roof.

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The roof panels 26 are similar to the wall panels 8 and it will be understood that they are extruded to provide a core and a coextruded outer skin covering the outer surfaces thereof (the separate layers not being shown).

Again, depending upon the anticipated loading of the roof structure, the reinforcing agent or agents selected for the core of the roof panels 26 will be appropriately selected.

For high loads the reinforcing agent preferably would include at least some of the fine small diameter short glass fibers.

Again, as in the case of the wall panels 8, the roof panels 26 are formed at opposite longitudinal edges with oppositely registering inwardly extending locking grooves 28 and edge tongues 29 for sliding interlocking engagement with the intumed locking fingers 30 carried by the flange extensions 31 of the box connectors 27. Similar intumed locking fingers 30 are provided on the box connectors 27 to project above and below the interlocked roof panels.

The roof panels 26 have circular holes 32 cut through their edge tongues 29 and webs 33 corresponding to the circular holes or openings 17 cut out from the wall panels 8. Similarly, the four-way box connectors 27 have circular openings 34 cut therefrom corresponding to the openings 25 in the two-way box connector.

In a roofing structure formed from the thermoplastic components, it is highly desirable that air circulation be effected within the roof structure. In this respect, the cutting out of the holes 32 and 34 provides free air circulation laterally of the roof in addition to the air circulation which can be effected lengthwise of the elongated hollow extruded roof components.

Additionally, it will be appreciated that the provision of the openings in the roof panels and their connecting box connectors restrict thermal transfer from the upper roof surface to the underside of the roof thereby adding

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to the thermal insulation provided by the components. It will also be appreciated that, if desired, the roof panels and connectors can be filled with suitable insulating material.

Despite the removal of the material resulting from the cutting of the circular holes 32 from the roof panels the webs 33 provide the requisite resistance to roof panel bending to sustain high roof panel loading augmented by the interengaging panel tongues 29 and box connector flanges 31 and locking finger 30.

Figure 5 is a plan view illustrating the connection of three wall panels 8 into a T-formation using a three-way box connector 35. The three-way box connector is provided with openings 25 in three of the walls thereof so that when material is introduced as indicated by the arrow 36 into the box connector 35, which material may be concrete, sand or insulation material, it can flow through the various openings into the wall panels. As illustrated, the leg of the T-formation is closed by an end cap C formed to interlock with the tongue 16 and grooves 15 of one of the panels 8 to contain all material within the external walls of the panel and box connector.

Similarly, should it be desirable to introduce insulation material into the interlocked roof panel as illustrated in Figure 4, such material can be injected for distribution within the roof structure by virtue of the existence of the cut out holes. Since the spacing between the holes is much less than the diameter of the holes, there will always be significant registration between the holes or openings cut in the adjoining interlocking components.

Figure 6 illustrates a corner box connector 37 connecting two wall panels 8 together in right angular relation. Box connector 37, as before, is extruded with an appropriate core and a co-extruded outer skin and is provided with the requisite intumed locking fingers 38 on adjacent sides and with the cut out circular openings 39 centered between these intumed locking fingers and

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having diameters less than the spacing between the locking fingers.

Figure 7 shows a four-way locking connector 40 for interlockingly connecting four wall panels 8 in right angular relation. In this case, the connector 40 has in-turned locking fingers 41 at all four sides of the connector and circular openings cut out therefrom in all four walls of the connector.

It will be understood again that the connector 40 is formed of a reinforced core with the exposed surfaces, that is the locking fingers 41 and their supporting flanges 42 coated with a smooth skin:

It will be noted that the arrangement of the openings cut out from the various extruded components is such that the openings are internal of the exterior walls of the structure being assembled therefrom when they are slidingly interlocked with the appropriate mating components.

Figure 10 is a perspective view illustrating a wall panel 8' corresponding to the panel 8 except that it has a shorter span with a single web 12'. Otherwise the panel is identical with panel 8 and like numbers refer to like parts.

Similarly, Figure 11 illustrates a still smaller wall panel 80 which may be used at a wall corner. Panel 80 has no internal webs but otherwise has the same interlocking features and the same cutout openings as wall panel 8 and like numbers represent like parts.

Figure 8 illustrates a two-way box connector 9' corresponding to box connector 9 but additionally having internal key ways comprising out turned locking fingers 43 for sliding interlocking engagement with mating inserts (not shown).

Figure 9 is a perspective view of a three-way box connector 35' similar to box connector 35 but having an internal slideway comprised by out turned locking fin-

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gers 44 for supporting an internal insert (not shown).

Figures 13 and 14 illustrate a wall cap 45 adapted to fit down over the top of a wall formed from wall panels such as panels 8 and box connectors such as box connectors 9 to present a sloping support surface 46 for supporting a sloping roof such as illustrated at 3 in Figure 1.

Wall cap 45 is a hollow extrusion having a bottom wall 47 adapted to rest on the upper ends of an erected wall and having downturned flanges 48 forming inter-connecting means adapted to embrace opposite faces 13 of the wall.

Webs 49 and 50 extending upwardly from the bottom wall 47 support the sloping upper surface 46 with the web 50 being of a greater height than the web 49.

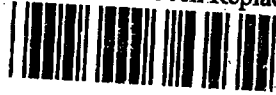
The wall cap 45 is provided at the lower side of the sloping wall 46 with a chamber 51 which has an access slot 52 which may be closed by screening of the like (not shown). At the opposite side, the wall cap is provided with a closed chamber 53 and an open chamber 54.

In accordance with the invention, the bottom wall 47 and the sloping wall 46 are provided with circular openings 55 cut therethrough. For this particular component, the diameter of the openings, while less than the spacing between the flanges 48, is greater than the spacing between the webs 49 and 50 so that during the cutting of the openings 55 a portion of the webs 49 and 50 are removed to provide access openings 56 and 57 to the chambers 51 and 54.

Since the bottom wall 47 and the sloping upper wall 46 will not be exposed when the wall cap 45 is installed in place, these surfaces need not be coated with a covering skin. The other exposed surfaces, however, will have a skin coextruded over the core material to provide the desired smooth finish.

Figure 12 is an extrusion for connecting box connectors together and, when in place, will be totally enclosed and will have no exposed surfaces that require

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coating.

As illustrated, this box connector connector 58 comprises a web 59 spacing two outwardly facing channels presenting two inwardly projecting grooves 60 of a width to receive the interlocking fingers such as the fingers 20 of two adjoining box connectors 9 when their locking fingers are in abutting relation. In this manner connector 58 will lock the box connector together while being totally contained within the abutting box connector flanges and abutting interlocking fingers..

The web 59 is provided with a plurality of circular openings 61 cut therefrom with the diameter of the openings being substantially equal to but slightly less than the spacing between the two channels 60. Connector 58 is preferably extruded from a polyvinyl chloride but since it is not subjected to significant loading the amount of reinforcing agent, if any, can be minimal. Again, because it is enclosed when in position, no exposed surfaces requiring a skin coating are presented.

Figure 15 is a diagrammatic illustration of the method of manufacturing the extruded components of the present invention and illustrating the extrusion of a straight box connector 9 having a core 21 and a coextruded outer skin 22 and provided with circular openings 25 cut therefrom.

As illustrated, thermoplastic material 62 formulated with the desired ingredients to form the core of the box connector 9 is fed from hopper 63 into a suitable extrusion die (not shown) from which it is delivered in a continuous stream having the requisite cross-sectional shape. At the same time, material 64 suitable for the coextruded skin is delivered from hopper 65 and coextruded to cover the exposed surfaces of the box connector.

As the coextruded core and skin are fed continuously out of the extrusion die arrangement suitable rotary drills 66 carried by a horizontally reciprocating carriage 67 mounted on guide 68 are utilized to drill the



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holes 25.

The movement of the carriage 67 is such that it moves away from the extrusion apparatus at the same speed as the box connector extrusion is delivered out of the extruder so that during the drilling the extrusion and the drills have no relative movement in the direction of extrusion feed. As soon as the holes are cut and the drills retracted, they are rapidly returned rearwardly of extrusion feed to the start position to then recommence a fresh cycle of drilling while moving at the same speed as the extrusion feed.

The drills are arranged so that when they retract they withdraw the material cut from the extrusion where it can be dropped unto a collector pan 69 and delivered back by a suitable feed 70 into the core material hopper 63.

Following extrusion and drilling, the box connector extrusion can be cut off at the requisite lengths depending on the nature of the building structure with which it is to be employed.

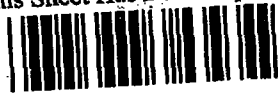
By using the structural components of the invention which have material cut or removed therefrom and recycled as described, savings in the cost of a building such as a house of up to 25% can be achieved further significantly increasing the affordability of housing and the like for the low income masses.

Claims

1. An elongated hollow generally rectilinear thermoplastic structural component (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) for use in the erection of a thermoplastic building structure, said component presenting planar spaced walls held in spaced relation by transverse walls or webs and having interlocking means extending the length thereof for interlockingly engaging with mating components, characterized



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in that said component is a coextrusion of a hollow substrate (10, 21) and a smooth protective skin (11, 22) covering said hollow substrate on surfaces which are exposed as exterior walls (13, 23) when said component is interlocked with mating components with said transverse walls or webs (12, 14, 24) which are interior walls when said component is interlocked with mating components having material cut out therefrom to provide a plurality of openings (17, 25) therethrough spaced along the length thereof and inwardly of said interlocking means (15, 19, 20) to provide interior communication between interlocked components, the material cut out from the walls or webs (12, 14, 24) providing material suitable for use in extruding the substrate of a subsequent component.

2. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said substrate (10, 21) is a polyvinyl chloride containing a reinforcing and expansion controlling agent.
3. An elongated thermoplastic building component as claimed in Claim 2 characterized in that said substrate (10, 21) contains material cut out from the walls and webs of previously extruded components.
4. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said reinforcing and expansion controlling agent in said substrate (10, 21) is selected from mineral fibers, glass fibers and calcium carbonate.
5. An elongated thermoplastic building component as claimed in any preceding claim characterized in that said openings are circular and have a diameter less



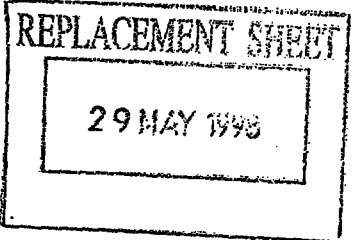
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than the spaces between said interlocking means (15, 19, 20).

6. An extruded thermoplastic building component as claimed in Claim 5 characterized in that said openings have uniform diameters and are centered on a line located centrally between said spaced interlocking means (15, 19, 20) are uniformly spaced along said line, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.
7. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said component comprises a longitudinal panel (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) and said transverse webs include webs (14) which extend across between said substantially planar walls and form the longitudinal edge walls of said panel and at least one web (12, 12') which defines internal compartments within said panel between said panel edge walls, and said interlocking means comprises inwardly projecting oppositely registering grooves (15) in said substantially planar walls adjacent each of said panel edge walls and extending throughout the length of said substantially planar walls, the spacing between said substantially planar walls being reduced outwardly of said grooves to provide a locking tongue (16) and said openings are provided in each of said webs.
8. An elongated thermoplastic building component as claimed in Claims 1 to 6 characterized in that said component comprises a box connector (9) in the form of an elongated hollow rectangle, two opposed walls (23) of which are constituted by said substantially planar walls, and two walls (24) of which are



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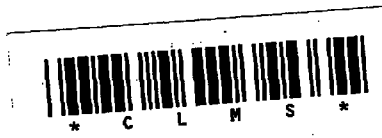
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constituted by said transverse webs.

9. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a corner box connector (37) having openings (39) formed in the walls thereof which become internal walls when same is interlocked with mating components arranged in right angular relation.
10. An elongated thermoplastic building component as claimed in Claims 1 characterized in that said component is a three way box connector (35') having openings (25) formed in the walls thereof which become internal walls when same is interlocked with mating components.
11. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a four way box connector (4) having openings formed in the walls thereof which become internal walls when same is interlocked with mating components.
12. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said smooth skin (11, 22) is selected from PVC, rigid PVC, semi-rigid PVC, ABS or polycarbonate.
13. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said substrate (5, 10, 21) comprises a polyvinyl chloride containing from about 5 to 50% calcium carbonate.
14. An elongated thermoplastic building component as

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claimed in Claim 13 characterized in that said substrate contains from about 5 to 30% calcium carbonate by weight.

15. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said skin (11, 22) has a thickness at least of the order of about .015 inches and said substrate (5, 10, 21) has a thickness of the order of at least about 4 to 5 times the thickness of said skin.
16. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the spacing between opposing walls of each said component is of the order of several tens of times the combined thickness of said substrate (5, 10, 21) and skin (11, 22).
17. An elongated thermoplastic building component as claimed in Claim 16 characterized in that the spacing between opposing walls of each said components is of the order of about 4 inches.
18. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the amount of material cut from the walls or webs is a substantial proportion of the total amount of material in said component prior to removal of the cut out material.
19. An elongated thermoplastic building component as claimed in Claim 18 characterized in that said substantial proportion is of the order of up to about 25% by weight.

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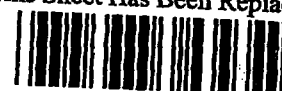
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20. A method of manufacturing hollow rectilinear thermoplastic building components (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) adapted for interlocking engagement to form building structures characterized in that each said building component is extruded as a coextrusion of a substrate of thermoplastic material (10, 21) containing a reinforcing and expansion controlling agent and a smooth thermoplastic skin (11, 22) covering the walls of said component which are exposed as exterior walls (13, 23) when said component is interlocked with mating components, following said extrusion cutting openings (17, 25) through the walls of said component which form interior walls (12, 14, 24) when same is interlocked with mating components, and utilizing the material cut from said interior walls as substrate material in the extruding of a subsequent component.
21. A method as claimed in Claim 20 characterized in that said core material is a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from calcium carbonate, mineral fibers, and small glass fibers.
22. A method as claimed in Claim 20 or 21 in which said smooth thermoplastic skin is selected from polyvinyl chloride, rigid polyvinyl chloride, ABS and polycarbonate.

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FIG.1.

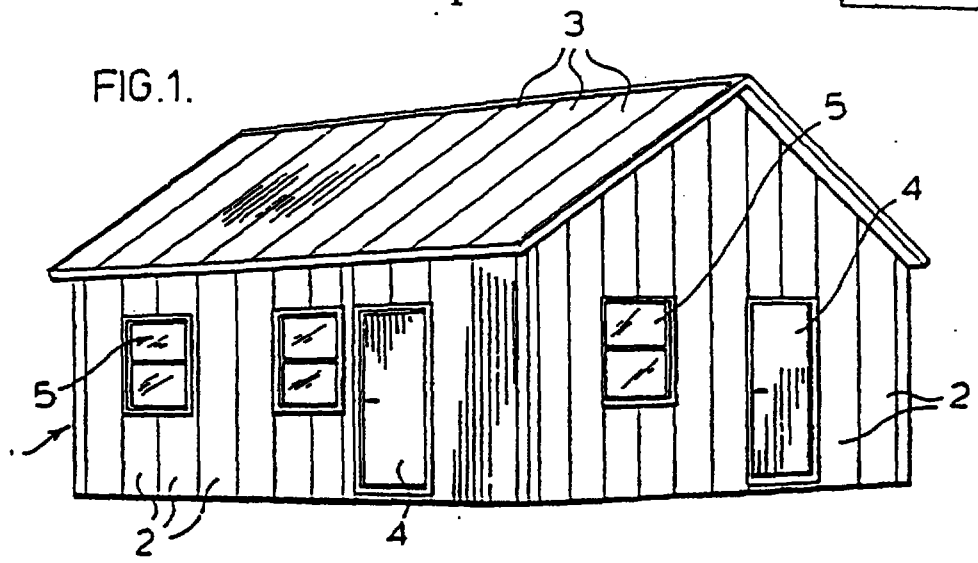
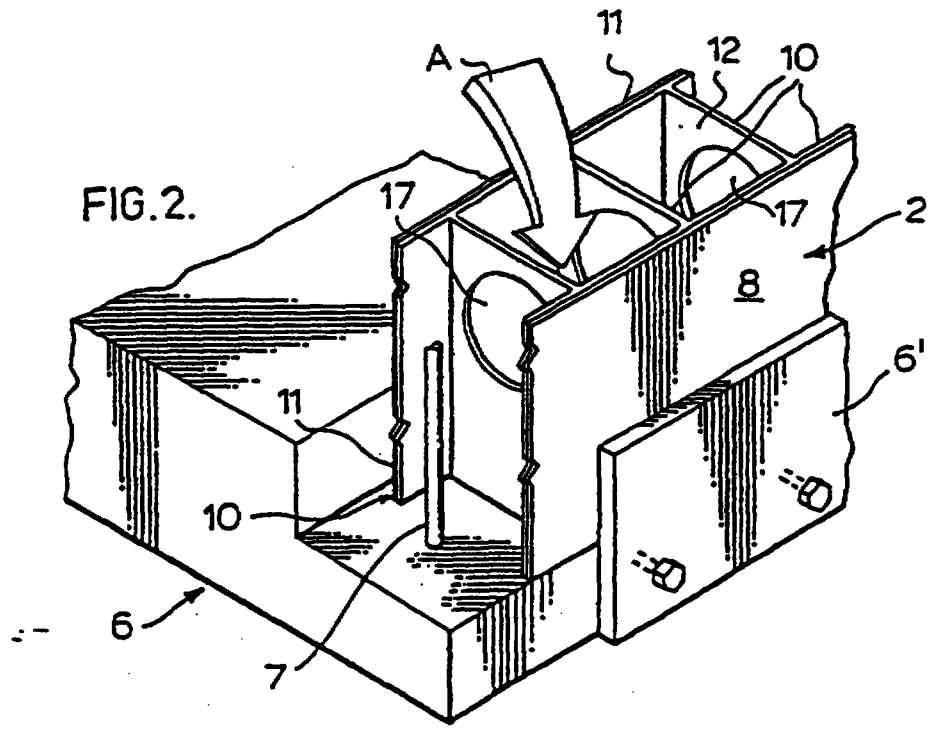
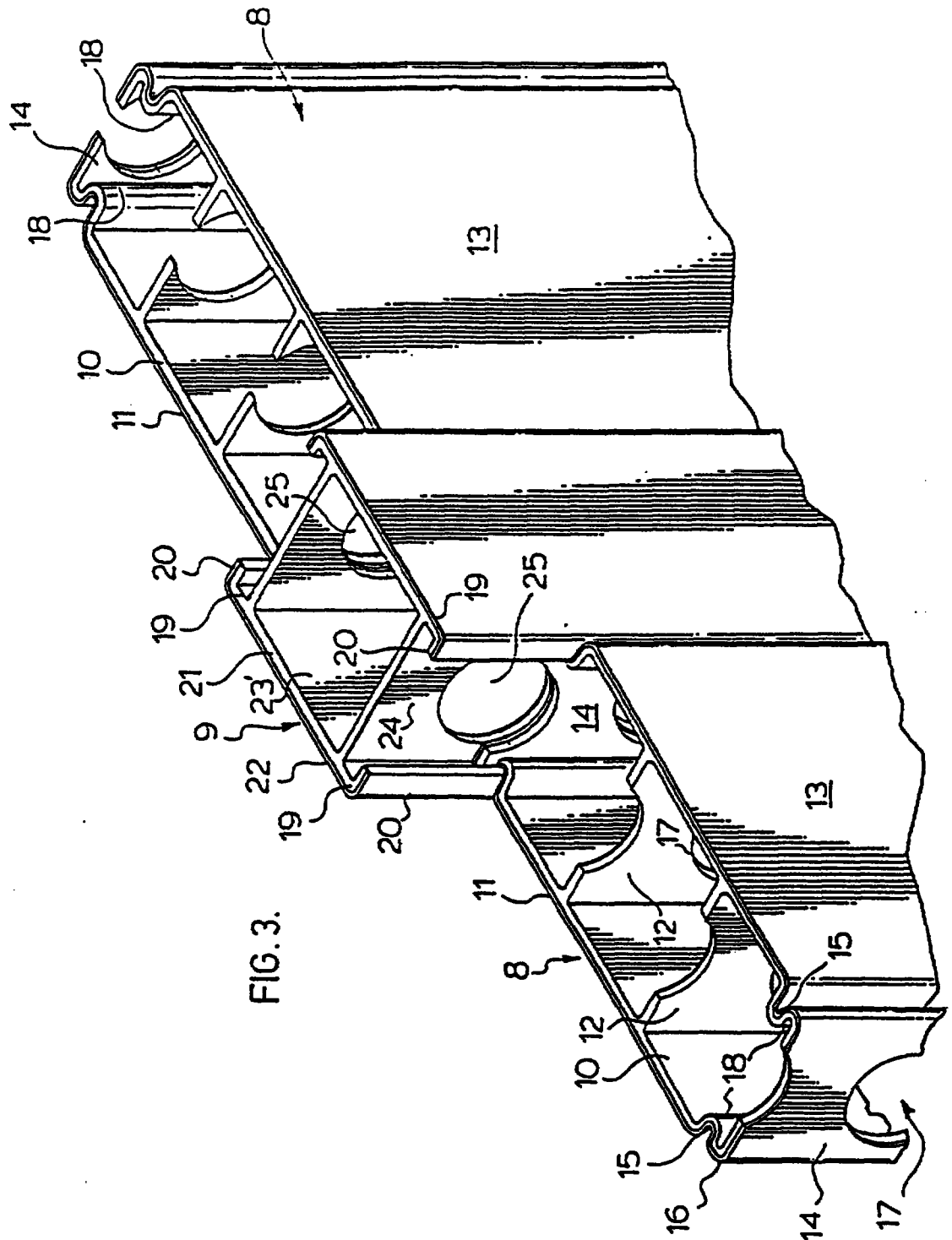


FIG.2.



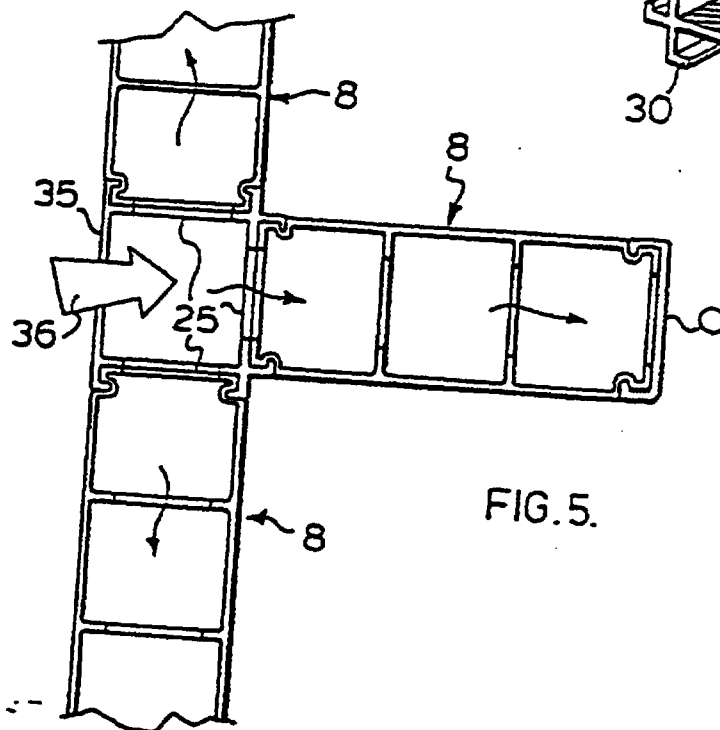
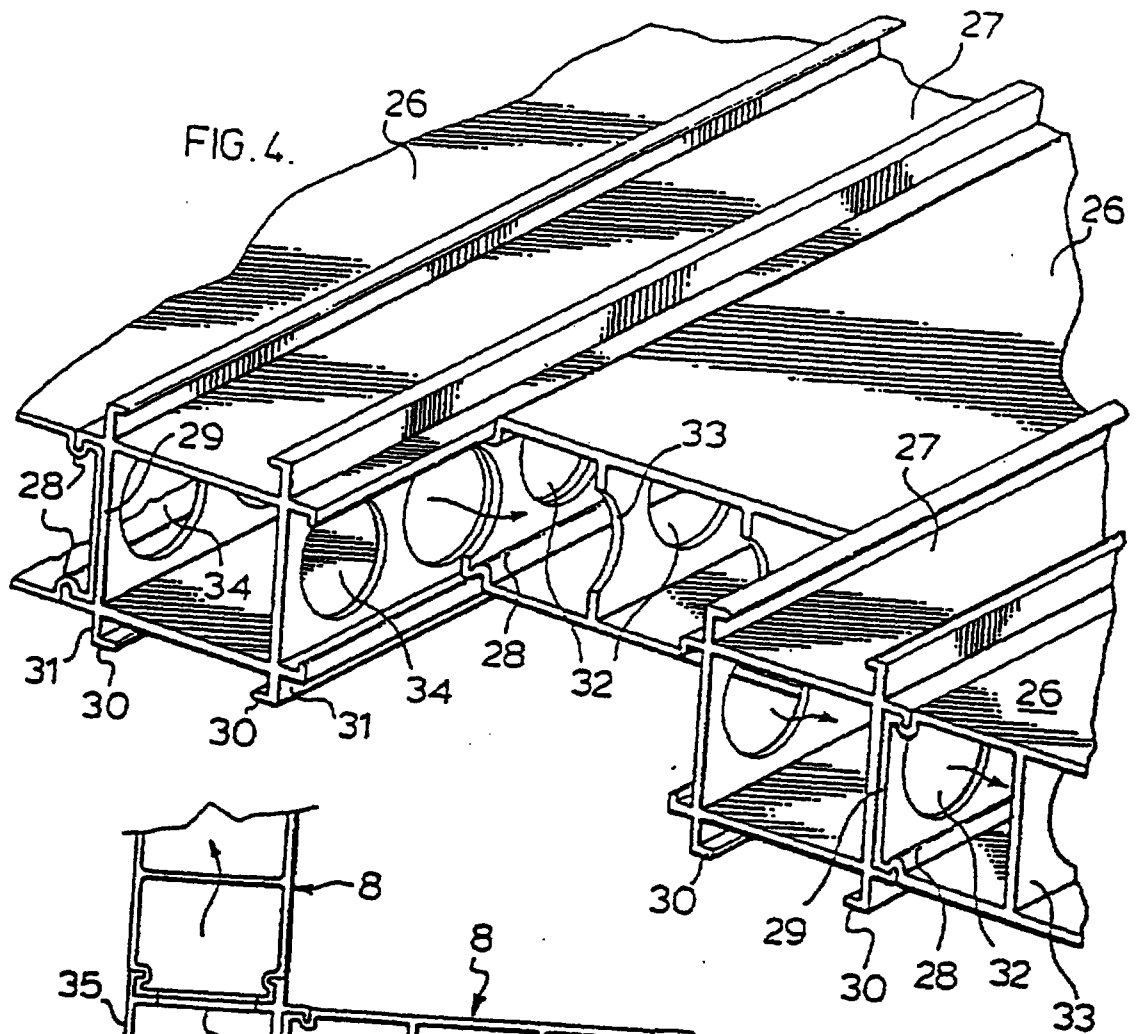
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FIG. 7.

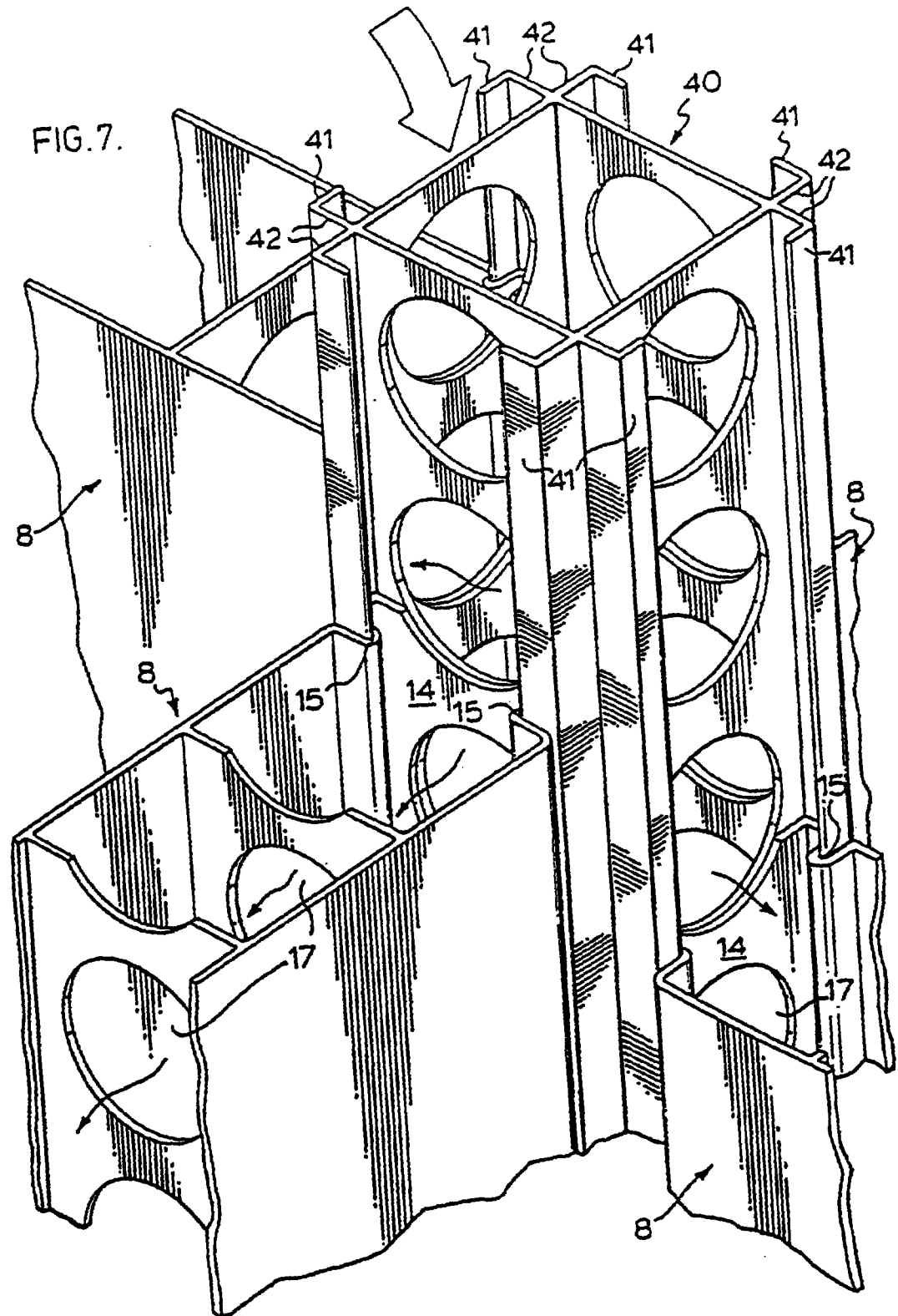


FIG. 8.

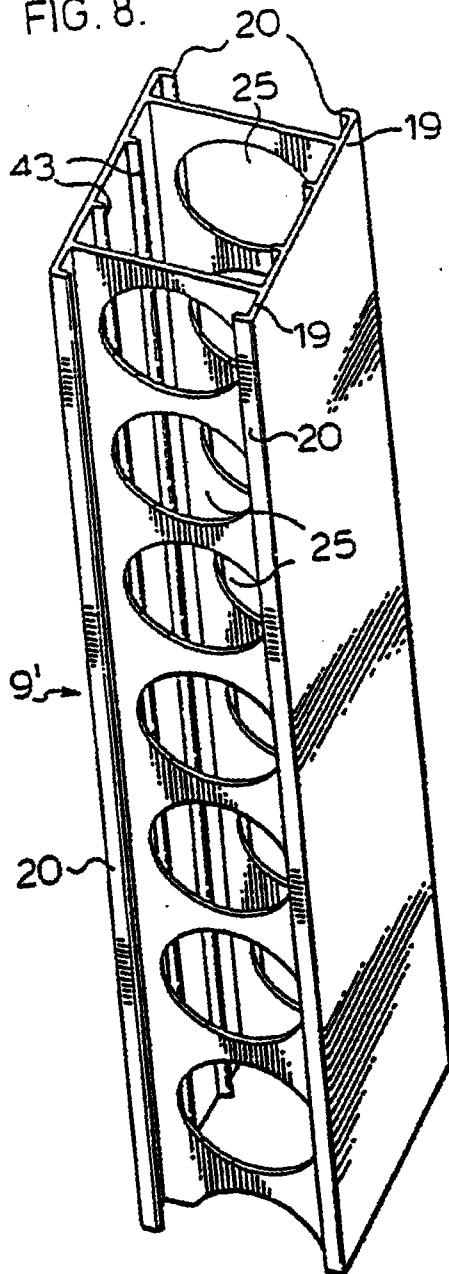
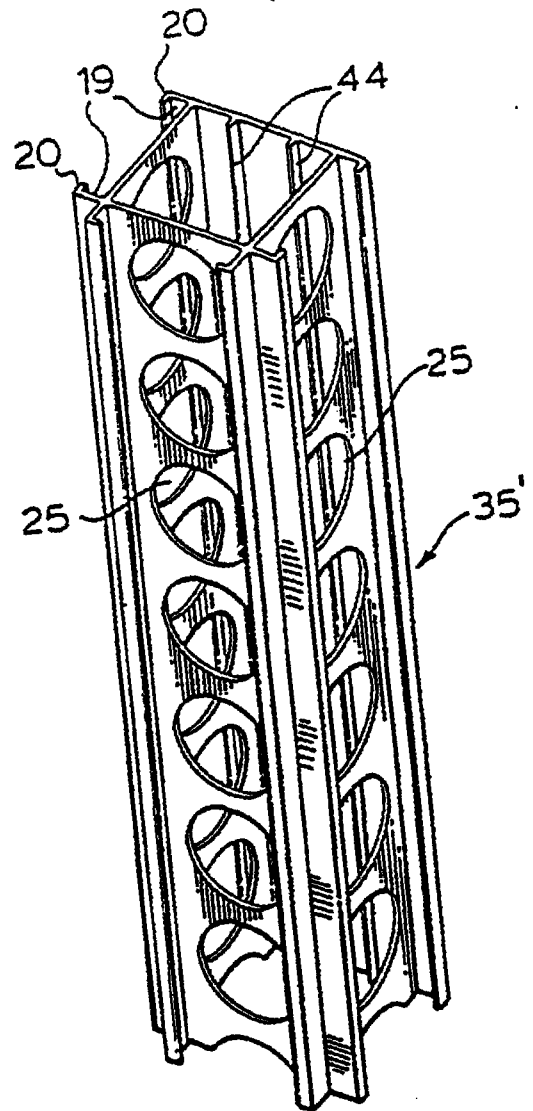


FIG. 9.



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FIG.11.

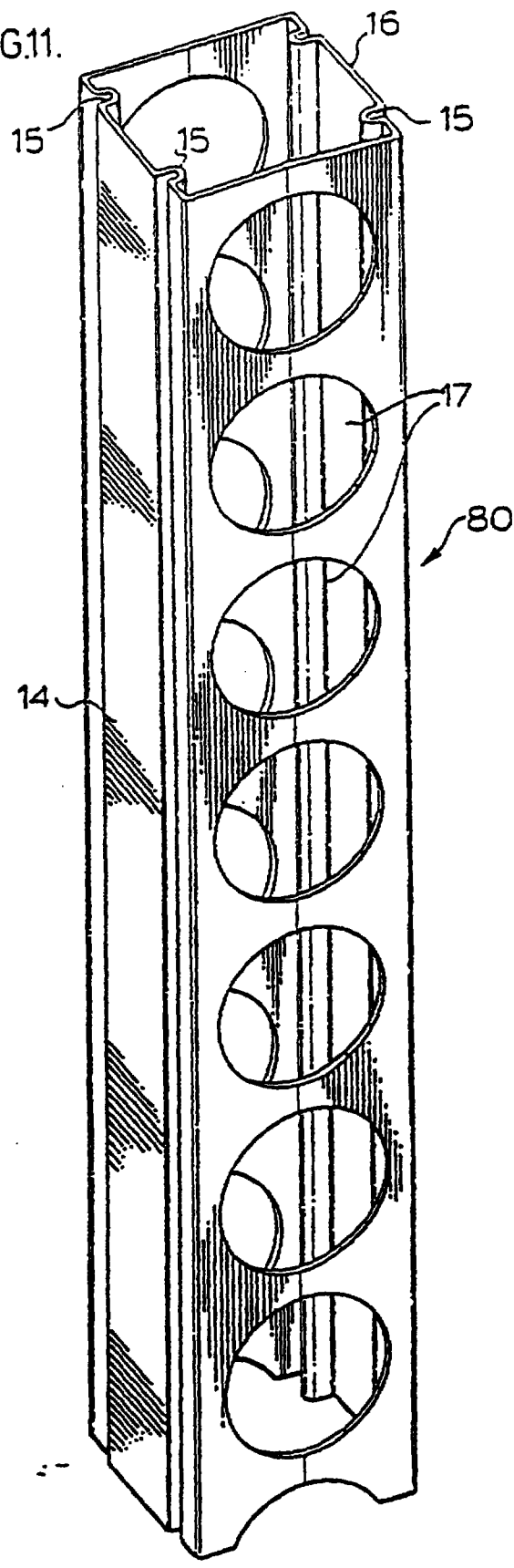
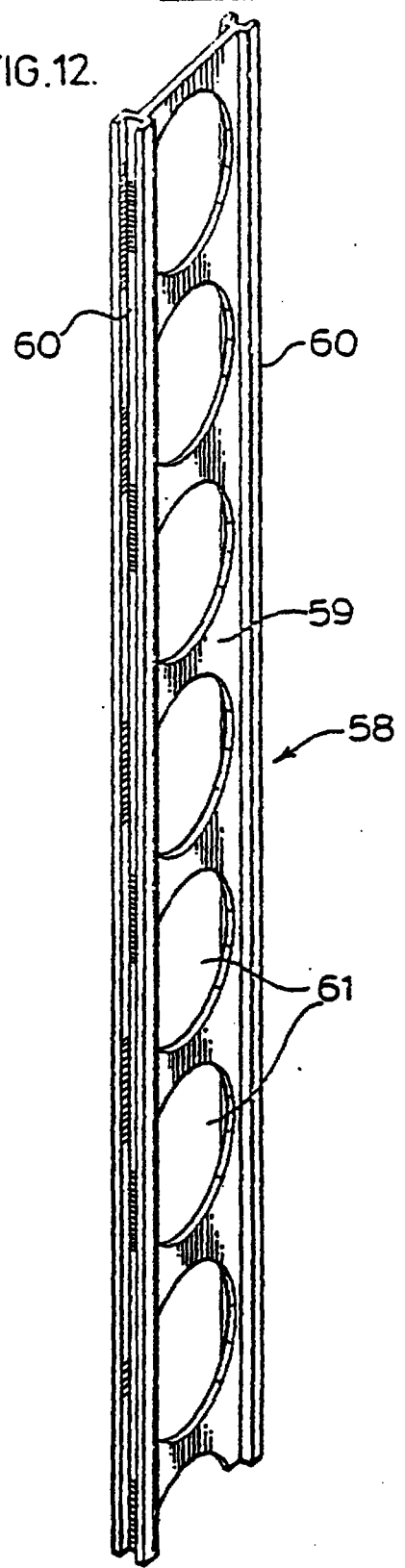


FIG.12.



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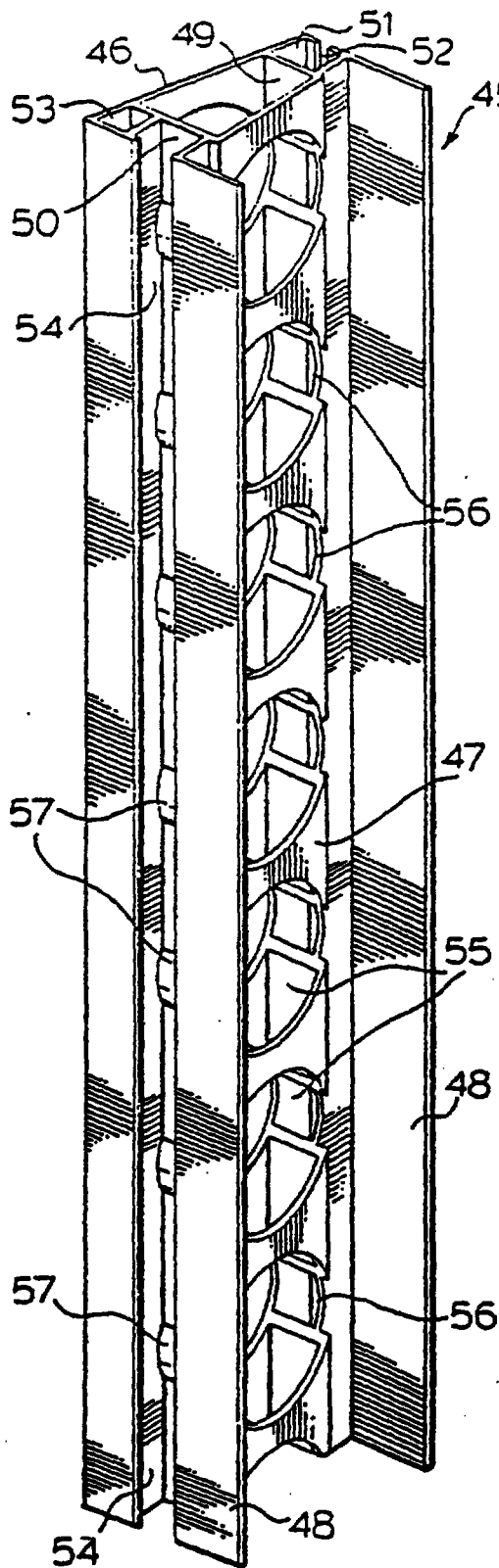


FIG. 13.

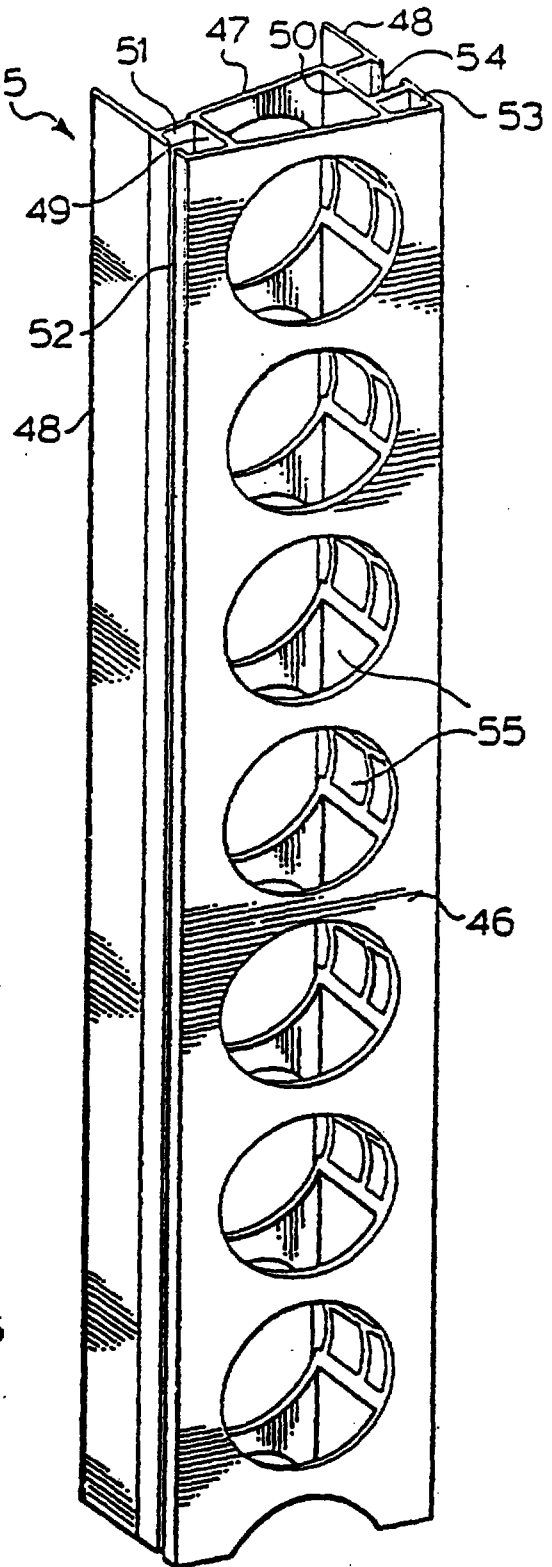
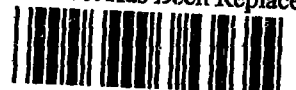


FIG. 14.

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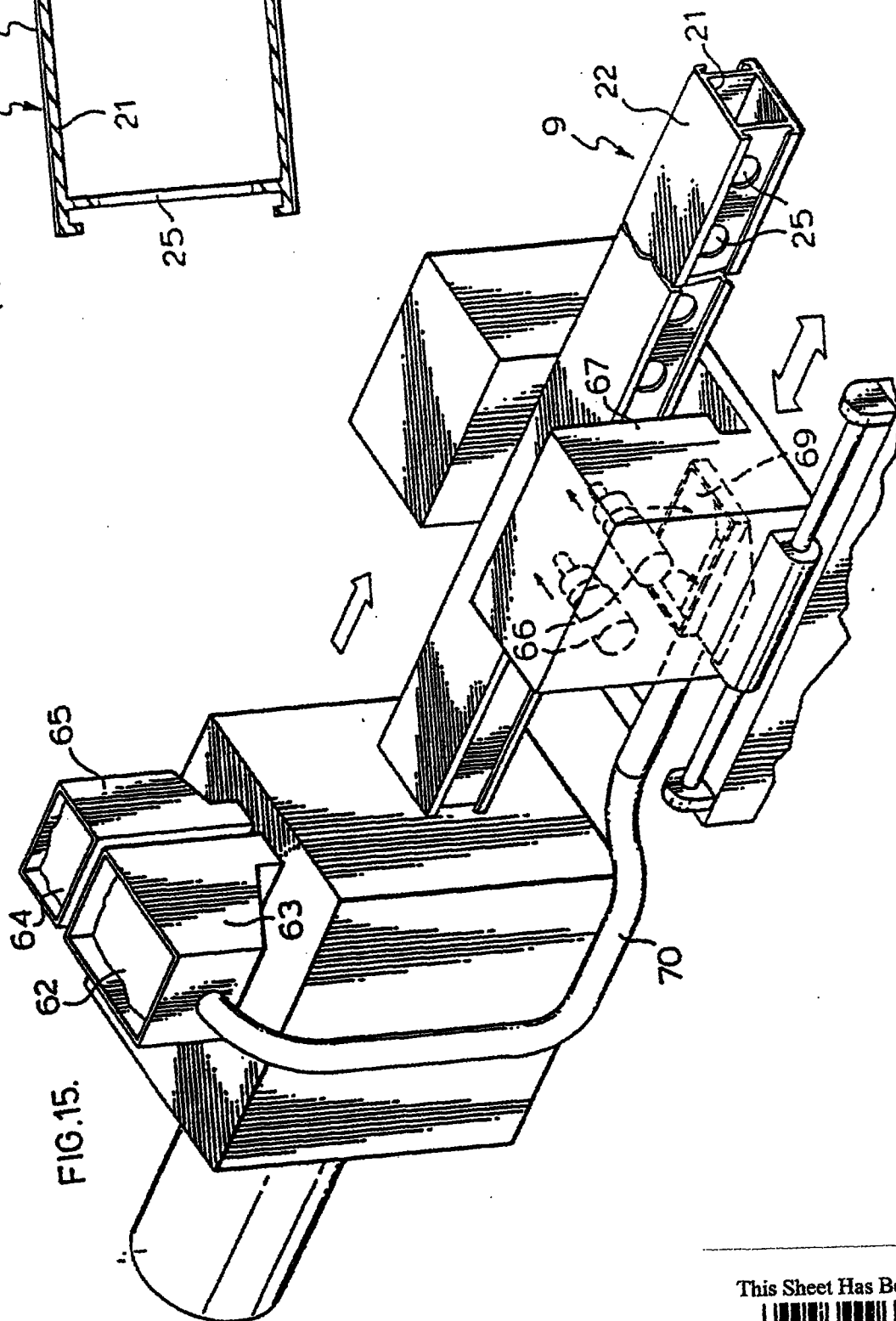
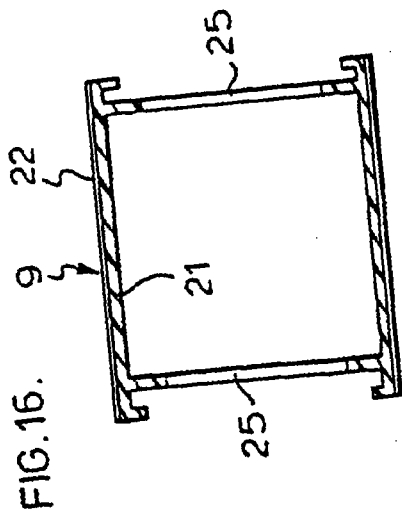


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less than about 35% by weight based upon the combined glass fibers and vinyl chloride resins.

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The smooth plastic skin may be PVC, rigid PVC, semi-rigid PVC, ABS, polycarbonate with thermoplastics available from G.E. under the trade-mark GELOY and NORYL.

This skin 11 serves a number of useful purposes. Because of the presence of the glass fibers in the core or substrate 10, the substrate is somewhat brittle and its surfaces are rough and abrasive with portions of the glass fibers projecting through the surface of the substrate rendering the substrate somewhat porous and susceptible to the ingress of moisture which can adversely affect the bond between the glass fibers and the thermoplastic material.

The coextrusion of the thermoplastic skin covers and seals the outer exposed surfaces of the structural component against the ingress of moisture, thereby maintaining the integrity of the binding of the glass fibers to substrate plastic. Further, the outer skin 11 not only covers exposed glass fibers but these exposed glass fibers become embedded in the thermoplastic material so that the external surface of the component is totally smooth. The glass fibers in turn in becoming embedded in the outer skin lock the skin to the substrate or core 10 so that the expansion and contraction of the outer skin is fixed to the expansion and contraction of the core which is controlled or limited by the presence of the in-

corporated glass fibers which have a much smaller coefficient of expansion than the plastic.

It will be also understood that the skin 11 can be formulated to include agents providing impact resistance, resistance to ultraviolet radiation and the like.

The combination of the co-extruded core or substrate 10 and smooth skin 11 thus enable the provision of wall panels having inherent structural strength and which are essentially maintenance free, impact resistant and they will be free from corrosion, rot or rusting and will be impervious to moisture, termites and other insects.

While the use of the glass fibers provides the strength necessary for handling high loading, where the panels will be subjected to much lighter loading the core 10 may be formed of a vinyl chloride containing from about 5% to about 50% calcium carbonate and preferably about 5% to 30% calcium carbonate by weight.

Alternatively, a mixture of calcium chloride and glass fibers or other reinforcing agents such as mineral fibers may be used to meet the particular load specifications required for the panel.

As illustrated in Figure 3, each of the panels 8 is provided with two transverse webs 12 which tie the opposing faces 13 of the panel together intermediate the edge walls 14 of the panel.

Adjacent each of the edge walls 14, the panel 8 is provided with inwardly extending oppositely registering grooves 15 with the width of the panel being reduced outwardly of the grooves 15 to the edge walls 14 to, in effect, provide a tongue portion 16.

As the cost factor is a critical element in the ability to provide affordable housing to the masses, it has been found that this cost factor can be significantly reduced in material costs by cutting a series of openings 17 out of the webs 12 and edge walls 14 at spaced points along their length.

This cut out material can then be collected and re-used in the extrusion of the core of a subsequent extru-

sion.

The openings 17 are preferably circular openings having a diameter slightly less than the spacing between the most adjacent point 18 of the grooves 15.

With the openings 17 centered on the midpoint of the edge walls 14 and midway between the panel faces 13, the openings can be cut through the edge walls 14 and also through the webs 12 without interference with the grooves 15 which extend uninterrupted throughout the length of the extrusion.

Still with reference to Figure 3, the panels 8 are shown interlocked with the box connector 9 in the form of a hollow extruded rectangle having projecting flanges 19 terminating in intumed oppositely registering locking fingers 20 adapted to slidingly interlock with the grooves 15 of the panels 8.

The box connector 9 is extruded with a core 21 and a coextruded outer skin 22 covering the outer surfaces of the walls 23, the flanges 19 and the locking fingers 20.

Because of the inherent strength of the configuration of the extruded rectangular box connector 9, its core 21 may comprise a PVC resin and, for example, calcium carbonate, as the expansion controlling and reinforcing agent, although other agents including small glass fibers and mixtures of agents may be used.

It will be noted that the outer surfaces of the walls 23 of the box connector 9 covered by the outer skin 22 are precisely aligned with the outer surfaces of the panel faces 13 with the tongue portions 16 of the panels being received in the space between the intumed locking fingers 20 and the transverse walls or webs 24 of the box connector.

Again, the box connector is provided with a series of openings 25 through the transverse walls or webs 24. Again, these openings are circular with a diameter centered on the midpoint of the transverse walls or webs 24 of the box connector and spaced along the length thereof with the diameters of the openings substantially equal to, but less than, the spacing between the intumed locking fingers 20 so that the locking fingers are not inter-

sected during the cutting of the openings 25.

It will be seen that the panel locking grooves 15 are covered in the smooth coextruded skin 11 to provide a smooth surface for smooth sliding interlocking engagement with the smooth skin coated locking fingers 20. Further, the outside faces of the tongues 16 which form the edge walls 14 of the panels are coated with the smooth skin 11 and preferably these faces are slightly concaved to eliminate any interference with the box connector transverse webs or walls 24.

Again, the material cut out from the box connector walls or webs 24 can be collected and returned to be used as material for extruding subsequent box connectors.

It has been found, for example, that with a wall panel width of 100 millimeters between the faces 13, circular holes having a diameter of 70 millimeters and spaced 12.7 millimeters apart provide a significant saving in material and cost of the vinyl extrusion product without significantly affecting the structural strength of the panel so that when concrete is poured therein such as illustrated in Figure 2 to convert the wall panel into a permanent wall configuration the webs and edge walls of the panels which are placed under tension exhibit adequate tensile strength tying the panel faces 13 against outward bulging under the concrete load.

In addition to the savings in material costs, the provisions of the openings 17 and 25 limits thermal transfer between the outer or exposed faces 13 of the panels 8 and the outer exposed walls 23 of the box connector 9. As a result the components provide increased insulation between the exterior and interior wall of a building such as shown in Figure 1.

Figure 4 illustrates an arrangement of roofing panels 26 which are shown interlocked together by four-way box connectors 27 rather than a two-way box connector 9 as illustrated in Figure 3 and which would be used to provide the smooth roof formation shown in Figure 1.

The four-way box connectors 27 provide for interlocking roof cladding to the upper surface of the roof and

for engaging or supporting other structures beneath the roof.

The roof panels 26 are similar to the wall panels 8 and it will be understood that they are extruded to provide a core and a coextruded outer skin covering the outer surfaces thereof (the separate layers not being shown).

Again, depending upon the anticipated loading of the roof structure, the reinforcing agent or agents selected for the core of the roof panels 26 will be appropriately selected.

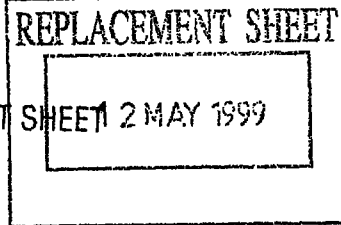
For high loads the reinforcing agent preferably would include at least some of the fine small diameter short glass fibers.

Again, as in the case of the wall panels 8, the roof panels 26 are formed at opposite longitudinal edges with oppositely registering inwardly extending locking grooves 28 and edge tongues 29 for sliding interlocking engagement with the intumed locking fingers 30 carried by the flange extensions 31 of the box connectors 27. Similar intumed locking fingers 30 are provided on the box connectors 27 to project above and below the interlocked roof panels.

The roof panels 26 have circular holes 32 cut through their edge tongues 29 and webs 33 corresponding to the circular holes or openings 17 cut out from the wall panels 8. Similarly, the four-way box connectors 27 have circular openings 34 cut therefrom corresponding to the openings 25 in the two-way box connector.

In a roofing structure formed from the thermoplastic components, it is highly desirable that air circulation be effected within the roof structure. In this respect, the cutting out of the holes 32 and 34 provides free air circulation laterally of the roof in addition to the air circulation which can be effected lengthwise of the elongated hollow extruded roof components.

Additionally, it will be appreciated that the provision of the openings in the roof panels and their connecting box connectors restrict thermal transfer from the upper roof surface to the underside of the roof thereby adding



to the thermal insulation provided by the components. It will also be appreciated that, if desired, the roof panels and connectors can be filled with suitable insulating material.

Despite the removal of the material resulting from the cutting of the circular holes 32 from the roof panels the webs 33 provide the requisite resistance to roof panel bending to sustain high roof panel loading augmented by the interengaging panel tongues 29 and box connector flanges 31 and locking finger 30.

Figure 5 is a plan view illustrating the connection of three wall panels 8 into a T-formation using a three-way box connector 35. The three-way box connector is provided with openings 25 in three of the walls thereof so that when material is introduced as indicated by the arrow 36 into the box connector 35, which material may be concrete, sand or insulation material, it can flow through the various openings into the wall panels. As illustrated, the leg of the T-formation is closed by an end cap C formed to interlock with the tongue 16 and grooves 15 of one of the panels 8 to contain all material within the external walls of the panel and box connector.

Similarly, should it be desirable to introduce insulation material into the interlocked roof panel as illustrated in Figure 4, such material can be injected for distribution within the roof structure by virtue of the existence of the cut out holes. Since the spacing between the holes is much less than the diameter of the holes, there will always be significant registration between the holes or openings cut in the adjoining interlocking components.

Figure 6 illustrates a corner box connector 37 connecting two wall panels 8 together in right angular relation. Box connector 37, as before, is extruded with an appropriate core and a co-extruded outer skin and is provided with the requisite intumed locking fingers 38 on adjacent sides and with the cut out circular openings 39 centered between these intumed locking fingers and

having diameters less than the spacing between the locking fingers.

Figure 7 shows a four-way locking connector 40 for interlockingly connecting four wall panels 8 in right angular relation. In this case, the connector 40 has in-turned locking fingers 41 at all four sides of the connector and circular openings cut out therefrom in all four walls of the connector.

It will be understood again that the connector 40 is formed of a reinforced core with the exposed surfaces, that is the locking fingers 41 and their supporting flanges 42 coated with a smooth skin:

It will be noted that the arrangement of the openings cut out from the various extruded components is such that the openings are internal of the exterior walls of the structure being assembled therefrom when they are slidingly interlocked with the appropriate mating components.

Figure 10 is a perspective view illustrating a wall panel 8' corresponding to the panel 8 except that it has a shorter span with a single web 12'. Otherwise the panel is identical with panel 8 and like numbers refer to like parts.

Similarly, Figure 11 illustrates a still smaller wall panel 80 which may be used at a wall corner. Panel 80 has no internal webs but otherwise has the same interlocking features and the same cutout openings as wall

panel 8 and like numbers represent like parts.

Figure 8 illustrates a two-way box connector 9' corresponding to box connector 9 but additionally having internal key ways comprising out turned locking fingers 43 for sliding interlocking engagement with mating inserts (not shown).

Figure 9 is a perspective view of a three-way box connector 35' similar to box connector 35 but having an internal slideway comprised by out turned locking fin-

gers 44 for supporting an internal insert (not shown).

Figures 13 and 14 illustrate a wall cap 45 adapted to fit down over the top of a wall formed from wall panels such as panels 8 and box connectors such as box connectors 9 to present a sloping support surface 46 for supporting a sloping roof such as illustrated at 3 in Figure 1.

Wall cap 45 is a hollow extrusion having a bottom wall 47 adapted to rest on the upper ends of an erected wall and having downturned flanges 48 forming interconnecting means adapted to embrace opposite faces 13 of the wall.

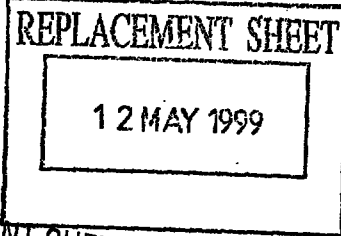
Webs 49 and 50 extending upwardly from the bottom wall 47 support the sloping upper surface 46 with the web 50 being of a greater height than the web 49.

The wall cap 45 is provided at the lower side of the sloping wall 46 with a chamber 51 which has an access slot 52 which may be closed by screening of the like (not shown). At the opposite side, the wall cap is provided with a closed chamber 53 and an open chamber 54.

In accordance with the invention, the bottom wall 47 and the sloping wall 46 are provided with circular openings 55 cut therethrough. For this particular component, the diameter of the openings, while less than the spacing between the flanges 48, is greater than the spacing between the webs 49 and 50 so that during the cutting of the openings 55 a portion of the webs 49 and 50 are removed to provide access openings 56 and 57 to the chambers 51 and 54.

Since the bottom wall 47 and the sloping upper wall 46 will not be exposed when the wall cap 45 is installed in place, these surfaces need not be coated with a covering skin. The other exposed surfaces, however, will have a skin coextruded over the core material to provide the desired smooth finish.

Figure 12 is an extrusion for connecting box connectors together and, when in place, will be totally enclosed and will have no exposed surfaces that require



REPLACEMENT SHEET

coating.

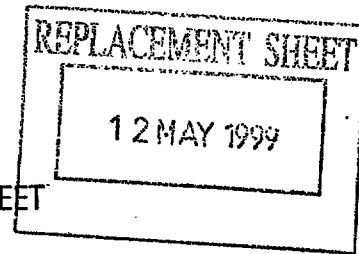
As illustrated, this box connector connector 58 comprises a web 59 spacing two outwardly facing channels presenting two inwardly projecting grooves 60 of a width to receive the interlocking fingers such as the fingers 20 of two adjoining box connectors 9 when their locking fingers are in abutting relation. In this manner connector 58 will lock the box connector together while being totally contained within the abutting box connector flanges and abutting interlocking fingers..

The web 59 is provided with a plurality of circular openings 61 cut therefrom with the diameter of the openings being substantially equal to but slightly less than the spacing between the two channels 60. Connector 58 is preferably extruded from a polyvinyl chloride but since it is not subjected to significant loading the amount of reinforcing agent, if any, can be minimal. Again, because it is enclosed when in position, no exposed surfaces requiring a skin coating are presented.

Figure 15 is a diagrammatic illustration of the method of manufacturing the extruded components of the present invention and illustrating the extrusion of a straight box connector 9 having a core 21 and a coextruded outer skin 22 and provided with circular openings 25 cut therefrom.

As illustrated, thermoplastic material 62 formulated with the desired ingredients to form the core of the box connector 9 is fed from hopper 63 into a suitable extrusion die (not shown) from which it is delivered in a continuous stream having the requisite cross-sectional shape. At the same time, material 64 suitable for the coextruded skin is delivered from hopper 65 and coextruded to cover the exposed surfaces of the box connector.

As the coextruded core and skin are fed continuously out of the extrusion die arrangement suitable rotary drills 66 carried by a horizontally reciprocating carriage 67 mounted on guide 68 are utilized to drill the



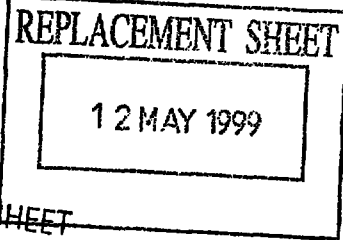
holes 25.

The movement of the carriage 67 is such that it moves away from the extrusion apparatus at the same speed as the box connector extrusion is delivered out of the extruder so that during the drilling the extrusion and the drills have no relative movement in the direction of extrusion feed. As soon as the holes are cut and the drills retracted, they are rapidly returned rearwardly of extrusion feed to the start position to then recommence a fresh cycle of drilling while moving at the same speed as the extrusion feed.

The drills are arranged so that when they retract they withdraw the material cut from the extrusion where it can be dropped into a collector pan 69 and delivered back by a suitable feed 70 into the core material hopper 63.

Following extrusion and drilling, the box connector extrusion can be cut off at the requisite lengths depending on the nature of the building structure with which it is to be employed.

By using the structural components of the invention which have material cut or removed therefrom and recycled as described, savings in the cost of a building such as a house of up to 25% can be achieved further significantly increasing the affordability of housing and the like for the low income masses.



Claims

1. An elongated hollow generally rectilinear thermoplastic structural component (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) for use in the erection of a thermoplastic building structure, said component presenting planar spaced walls held in spaced relation by transverse walls or webs and having interlocking means extending the length thereof for interlocking-ly engaging with mating components, characterized in that said component is a coextrusion of a hollow substrate (10, 21) and a smooth protective skin (11, 22) covering said hollow substrate on surfaces which are exposed as exterior walls (13, 23) when said component is interlocked with mating components with said transverse walls or webs (12, 14, 24) which are interior walls when said component is interlocked with mating components having material cut out therefrom to provide a plurality of openings (17, 25) therethrough spaced along the length thereof and inwardly of said interlocking means (15, 19, 20) to provide interior communication between interlocked components, the material cut out from the walls or webs (12, 14, 24) providing material suitable for use in extruding the substrate of a subsequent component.
2. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said substrate (10, 21) is a polyvinyl chloride containing a reinforcing and expansion controlling agent.
3. An elongated thermoplastic building component as claimed in Claim 2 characterized in that said substrate (10, 21) contains material cut out from the walls and webs of previously extruded components.
4. An elongated thermoplastic building component as claimed in any of the preceding claims character-



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ized in that said reinforcing and expansion controlling agent in said substrate (10, 21) is selected from mineral fibers, glass fibers and calcium carbonate.

5. An elongated thermoplastic building component as claimed in any preceding claim characterized in that said openings are circular and have a diameter less than the spaces between said interlocking means (15, 19, 20).
6. An extruded thermoplastic building component as claimed in Claim 5 characterized in that said openings have uniform diameters and are centered on a line located centrally between said spaced interlocking means (15, 19, 20) are uniformly spaced along said line, the diameter of said openings being equal to a major portion of, but less than, the distance between said spaced interlocking means.
7. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said component comprises a longitudinal panel (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) and said transverse webs include webs (14) which extend across between said substantially planar walls and form the longitudinal edge walls of said panel and at least one web (12, 12') which defines internal compartments within said panel between said panel edge walls, and said interlocking means comprises inwardly projecting oppositely registering grooves (15) in said substantially planar walls adjacent each of said panel edge walls and extending throughout the length of said substantially planar walls, the spacing between said substantially planar walls being reduced outwardly of said grooves to provide a locking tongue (16) and said openings are provided in each of said webs.
8. An elongated thermoplastic building component as

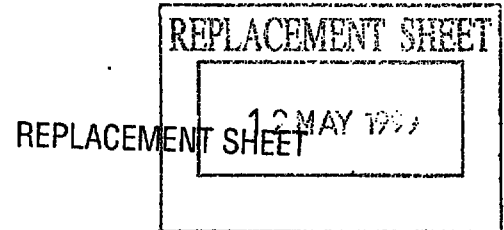


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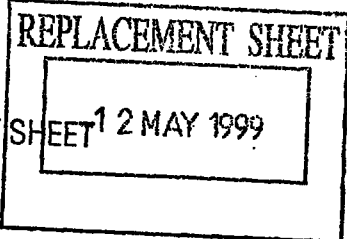
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claimed in Claims 1 to 6 characterized in that said component comprises a box connector (9) in the form of an elongated hollow rectangle, two opposed walls (23) of which are constituted by said substantially planar walls, and two walls (24) of which are constituted by said transverse webs.

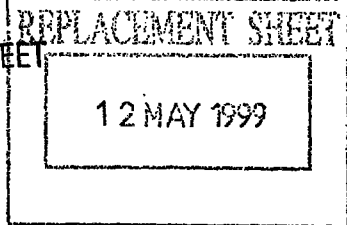
9. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a corner box connector (37) having openings (39) formed in the walls thereof which become internal walls when same is interlocked with mating components arranged in right angular relation.
10. An elongated thermoplastic building component as claimed in Claims 1 characterized in that said component is a three way box connector (35') having openings (25) formed in the walls thereof which become internal walls when same is interlocked with mating components.
11. An elongated thermoplastic building component as claimed in Claim 1 characterized in that said component comprises a four way box connector (4) having openings formed in the walls thereof which become internal walls when same is interlocked with mating components.
12. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said smooth skin (11, 22) is selected from PVC, rigid PVC, semi-rigid PVC, ABS or polycarbonate.
13. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said substrate (5, 10, 21) comprises a polyvinyl chloride containing from about 5 to 50% calcium carbonate.



14. An elongated thermoplastic building component as claimed in Claim 13 characterized in that said substrate contains from about 5 to 30% calcium carbonate by weight.
15. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that said skin (11, 22) has a thickness at least of the order of about .015 inches and said substrate (5, 10, 21) has a thickness of the order of at least about 4 to 5 times the thickness of said skin.
16. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the spacing between opposing walls of each said component is of the order of several tens of times the combined thickness of said substrate (5, 10, 21) and skin (11, 22).
17. An elongated thermoplastic building component as claimed in Claim 16 characterized in that the spacing between opposing walls of each said components is of the order of about 4 inches.
18. An elongated thermoplastic building component as claimed in any of the preceding claims characterized in that the amount of material cut from the walls or webs is a substantial proportion of the total amount of material in said component prior to removal of the cut out material.
19. An elongated thermoplastic building component as claimed in Claim 18 characterized in that said substantial proportion is of the order of up to about 25% by weight.



20. A method of manufacturing hollow rectilinear thermoplastic building components (8, 8', 9, 9', 26, 27, 35, 35', 37, 40, 80) adapted for interlocking engagement to form building structures characterized in that each said building component is extruded as a coextrusion of a substrate of thermoplastic material (10, 21) containing a reinforcing and expansion controlling agent and a smooth thermoplastic skin (11, 22) covering the walls of said component which are exposed as exterior walls (13, 23) when said component is interlocked with mating components, following said extrusion cutting openings (17, 25) through the walls of said component which form interior walls (12, 14, 24) when same is interlocked with mating components, and utilizing the material cut from said interior walls as substrate material in the extruding of a subsequent component.
21. A method as claimed in Claim 20 characterized in that said core material is a polyvinyl chloride containing a reinforcing and expansion controlling agent selected from calcium carbonate, mineral fibers, and small glass fibers.
22. A method as claimed in Claim 20 or 21 in which said smooth thermoplastic skin is selected from polyvinyl chloride, rigid polyvinyl chloride, ABS and polycarbonate.



**THERMOPLASTIC STRUCTURAL COMPONENTS
AND STRUCTURES FORMED THEREFROM**

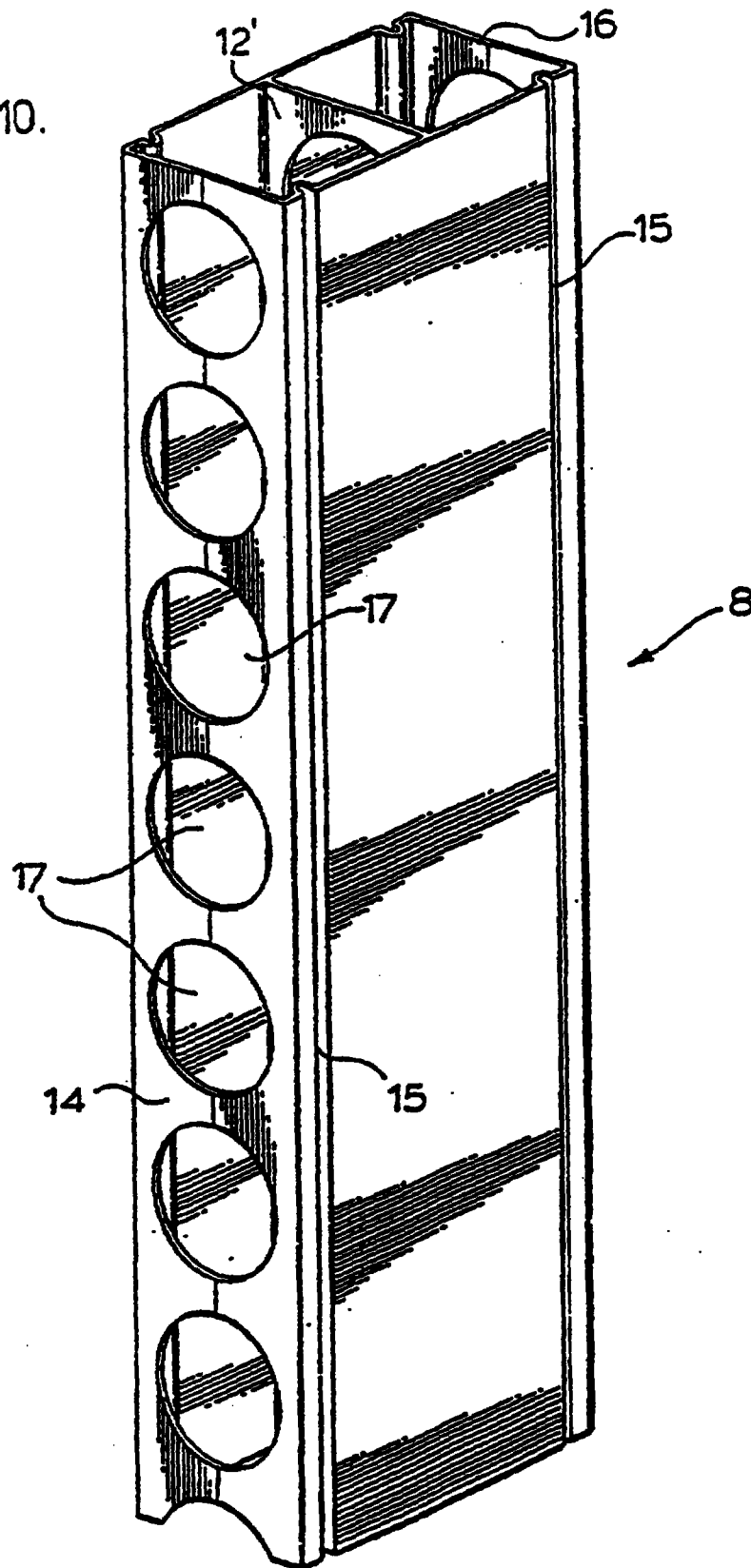
ABSTRACT OF THE DISCLOSURE

An elongated extruded thermoplastic building component for use in the erection of a thermoplastic building structure, said component presenting spaced interlocking means extending the length thereof for sliding interlocking engagement with mating thermoplastic member, and at least one longitudinally extending web supporting said spaced interlocking means in spaced relation with said web having a plurality of openings cut therethrough inwardly of said interlocking means spaced along the length thereof. In its most common form the component is extruded with a core of reinforced thermoplastic material having a coextruded smooth skin covering exposed surfaces thereof and is rectilinear having planar spaced walls connected in spaced relation by spaced planar webs extending the length thereof, with the spaced walls being provided at least adjacent one longitudinal edge with spaced inwardly projecting interlocking means extending longitudinally thereof for interengagement with a mating component, at least one of said webs having a series of circular holes cut out therefrom along the length thereof with the perimeters of said holes being within the space between said inwardly projecting interlocking means.

FIGURE 3.

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FIG.10.



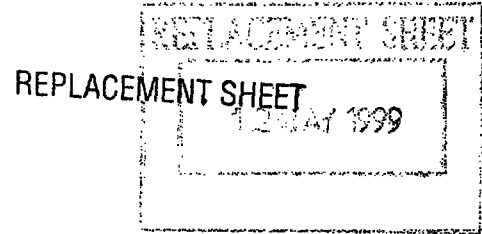


FIG.11.

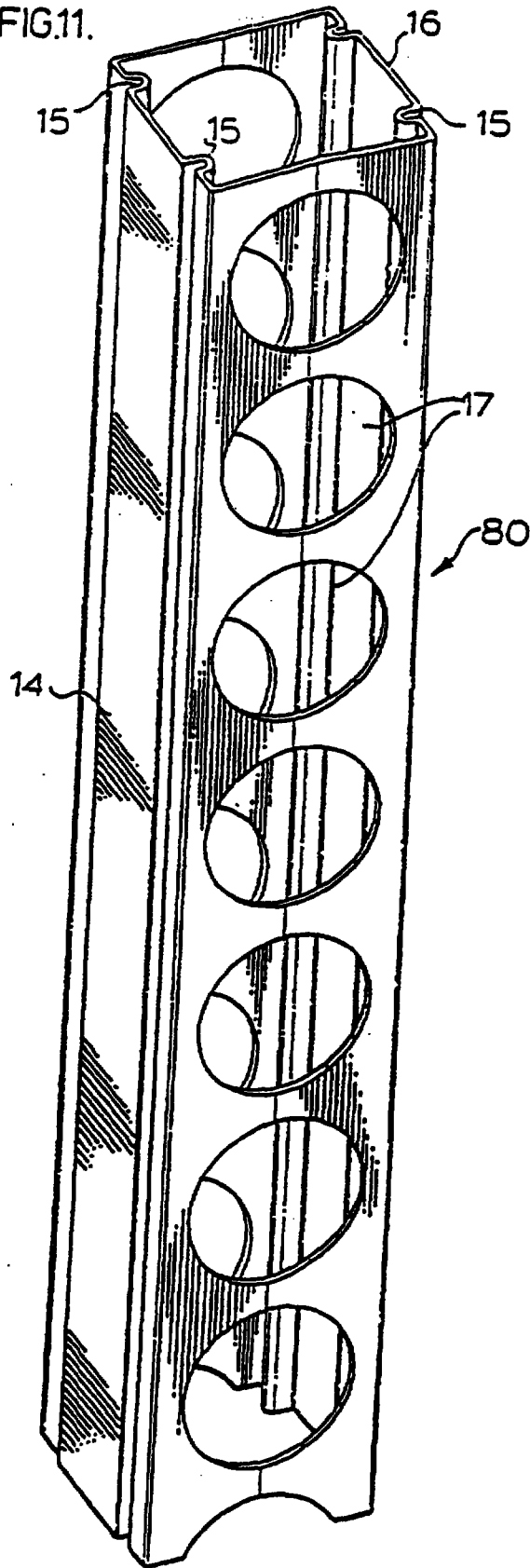
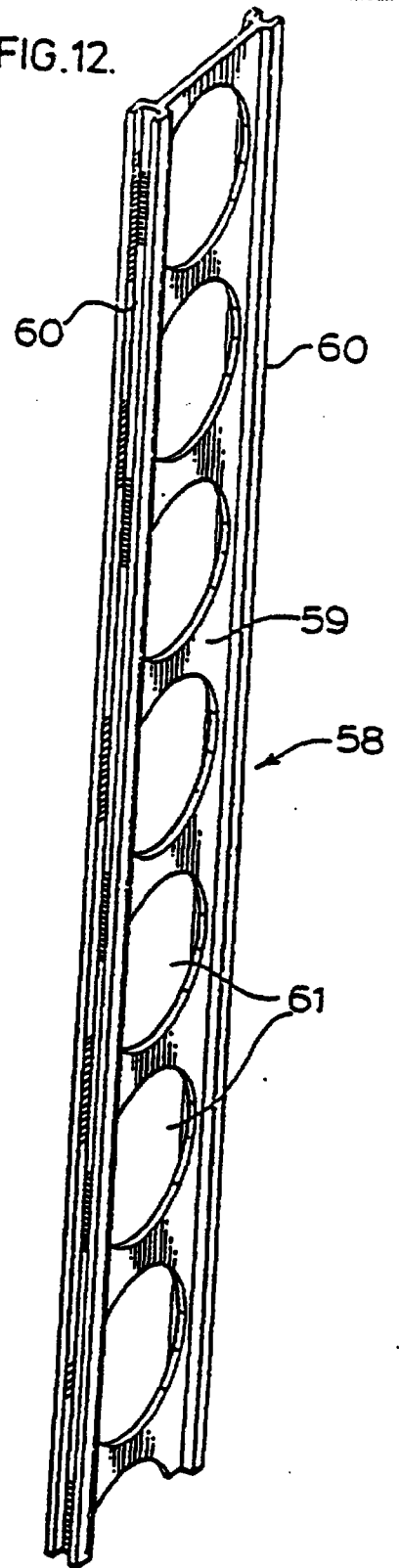


FIG.12.



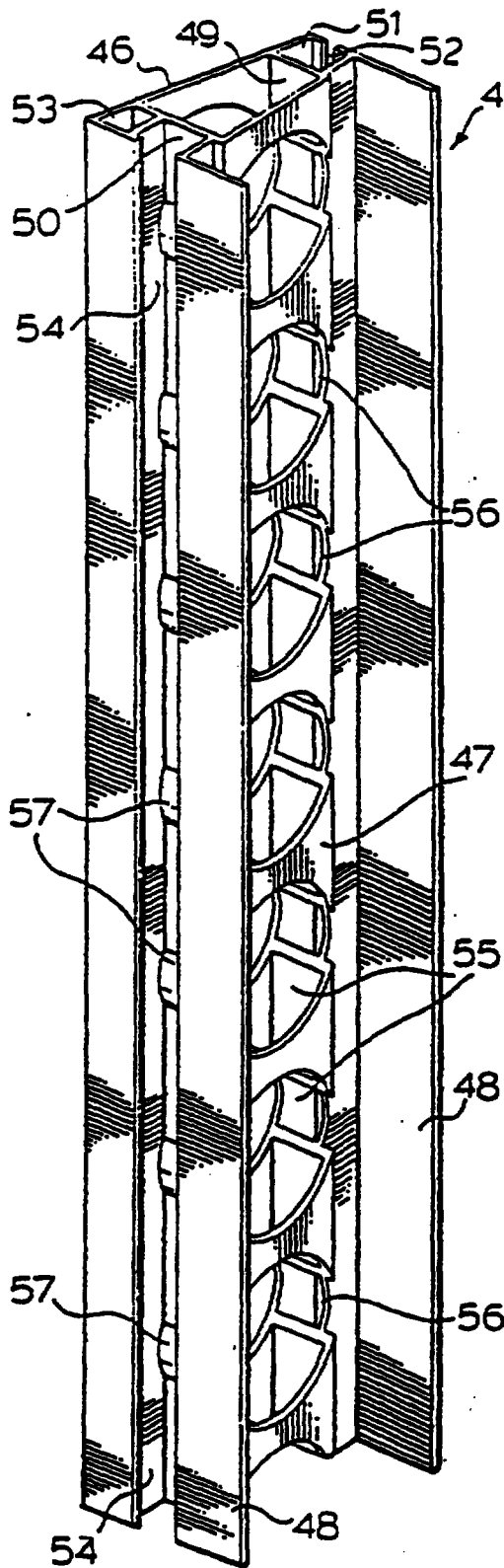


FIG. 13.

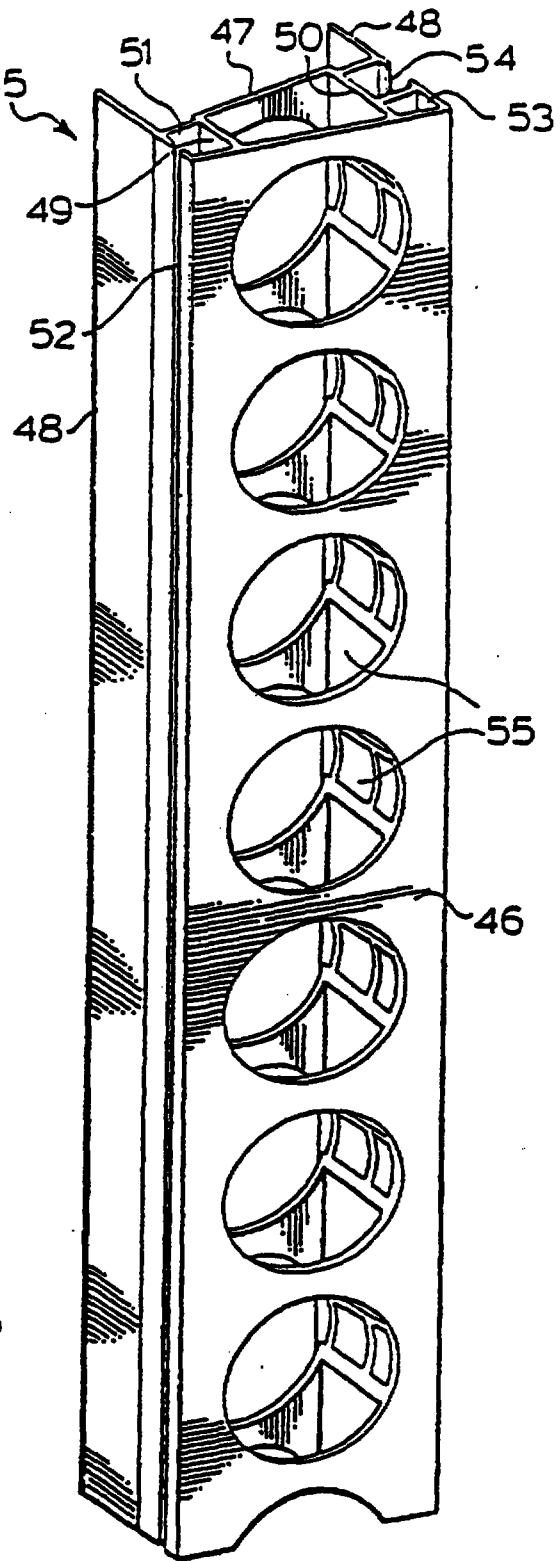


FIG. 14.

