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van der Lely et al.

[11] **3,919,812**

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[54] **JOINDURE OF MODULES IN PREFABRICATED BUILDINGS**

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Nov. 7, 1972 Netherlands 7215005

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[51] **Int. Cl.²** **E04B 2/10**

[58] **Field of Search** 52/79, 438, 440, 442, 437, 52/432, 431, 429, 428, 422, 418, 415, 259

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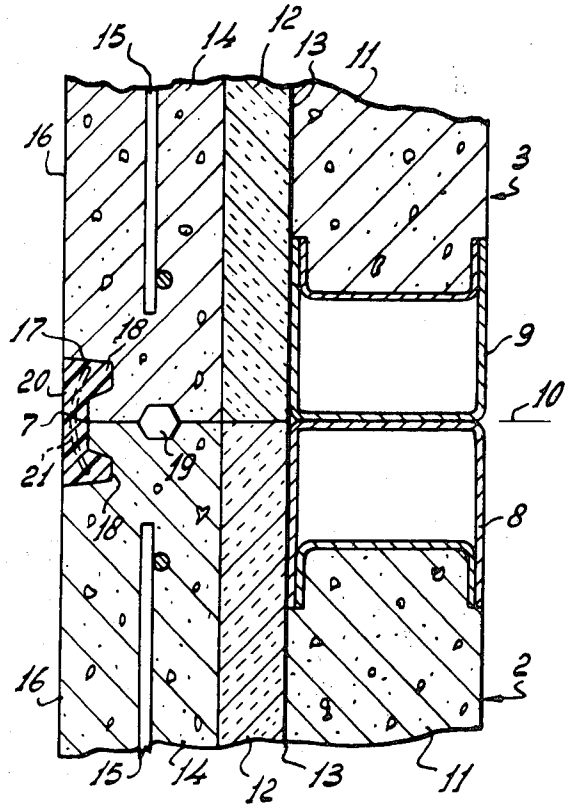
Attorney, Agent, or Firm—Mason, Mason & Albright

[57] **ABSTRACT**

A building constructed of elongated prefabricated box-shaped sections, each having a framework of metal beams, inner wall panels, an insulation layer, and outer wall panels which define a recess where the panels join, the panels otherwise having coplanar outer surfaces, the recess being provided with a hardenable plastic material with reinforcement members embedded therein which also may be embedded in and extend from the reinforcement rods. Alternately, the recess may have enlarged opposite channels which receive a curved reinforcement mesh, such mesh being received only in the filling material for the recess. A protective layer is provided over the outer wall panels and the filling material in the recess. The parts of adjacent sections near where they join are symmetrical relative to a vertical plane perpendicular to the plane containing the outer surfaces of the outer wall panels. A slanting gable type roof is disclosed with symmetrical head facade portions of right triangular configuration which during transportation of the sections to the building site are disposed adjacent a side of the section with the roof being in a substantially flat condition on top of the section and when at the building site, the facade portions are raised to their desired upright positions in the building and then are movable transversely parallel to the ridge of the roof along horizontal cylindrical rods extending from the roof to bring the facade portions into the same plane with the sides of the section, such facade portions being connected together and to such side by filling joints which are recessed between the members and providing reinforcement for the filling material as described above.

33 Claims, 10 Drawing Figures



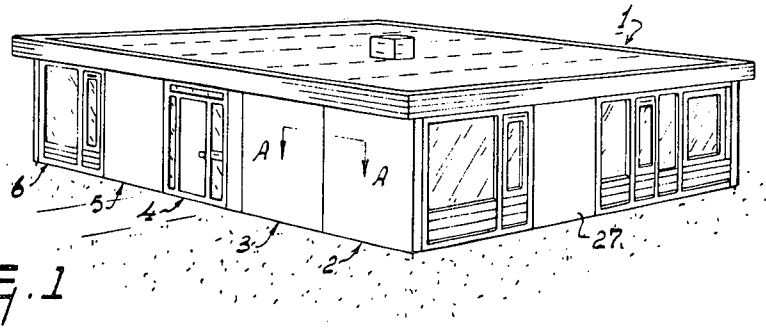


FIG. 1

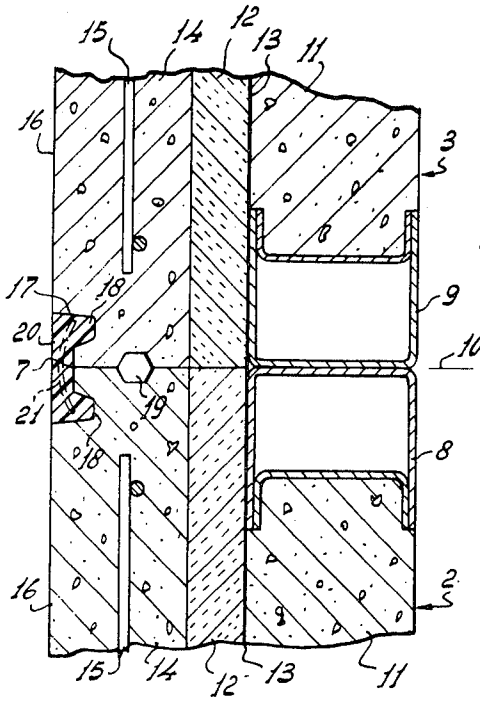


FIG. 2

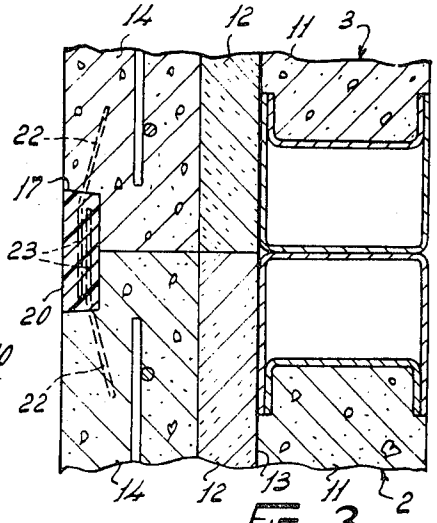


FIG. 3

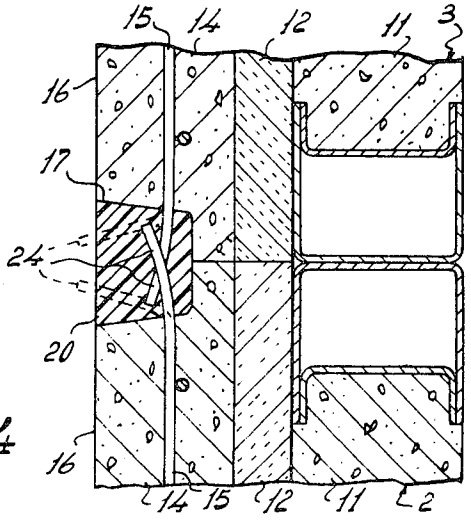


FIG. 4

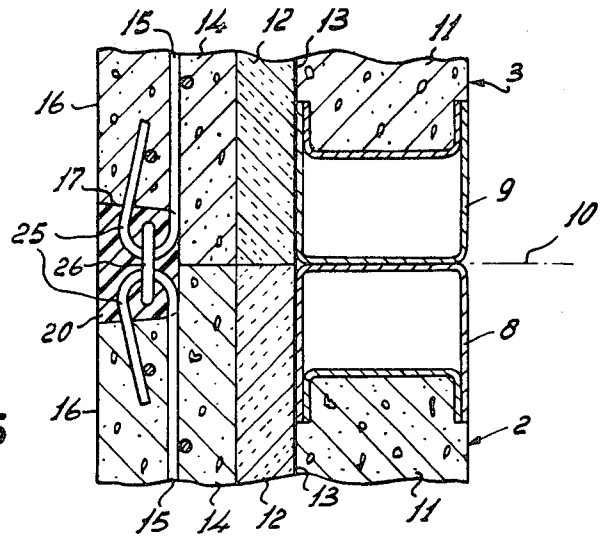


FIG. 5

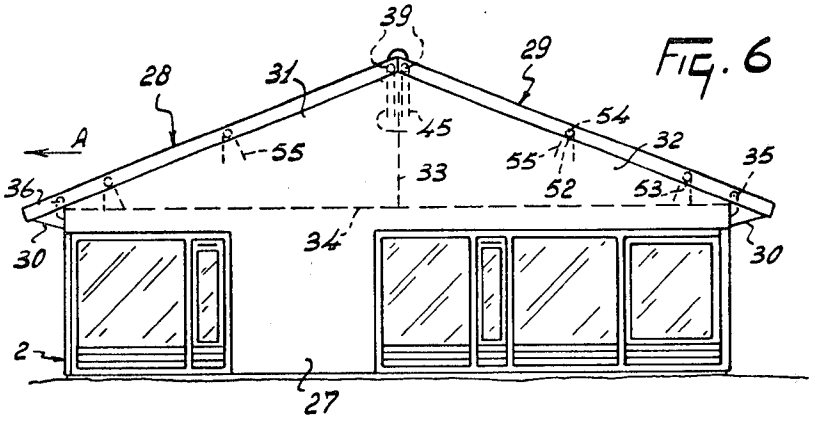


FIG. 6

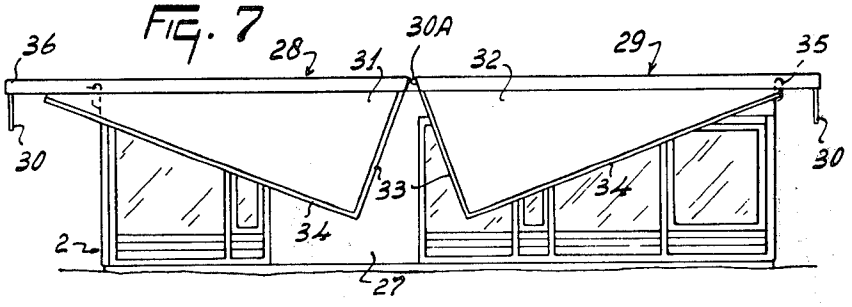


FIG. 7

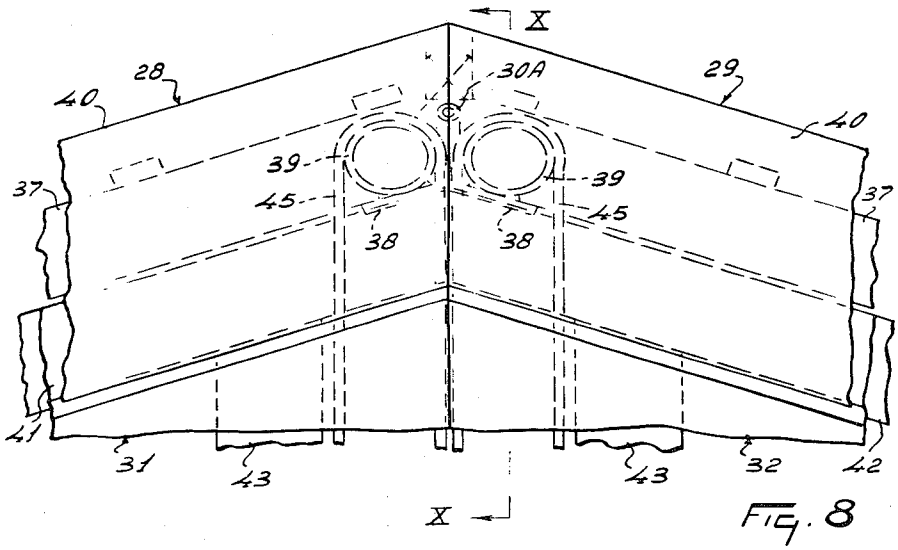

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FIG. 8

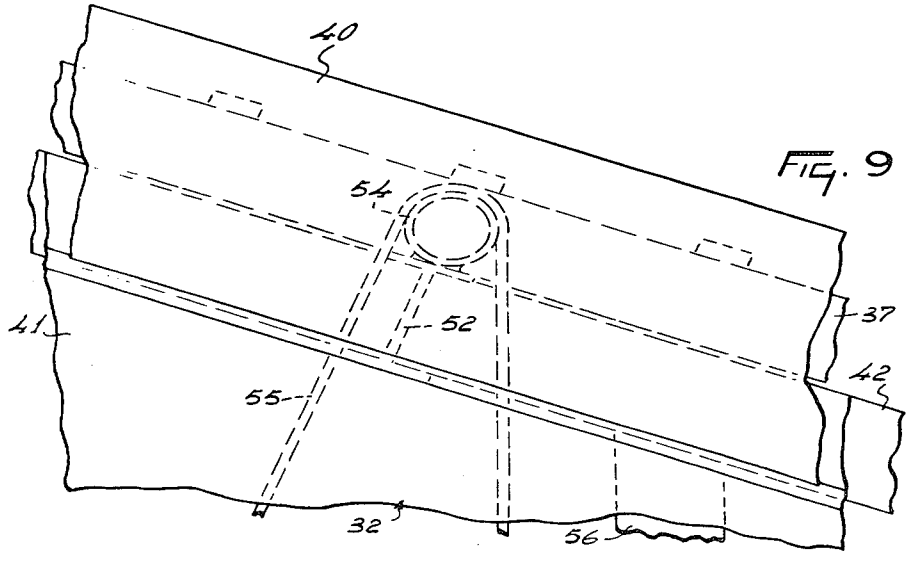
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FIG. 9

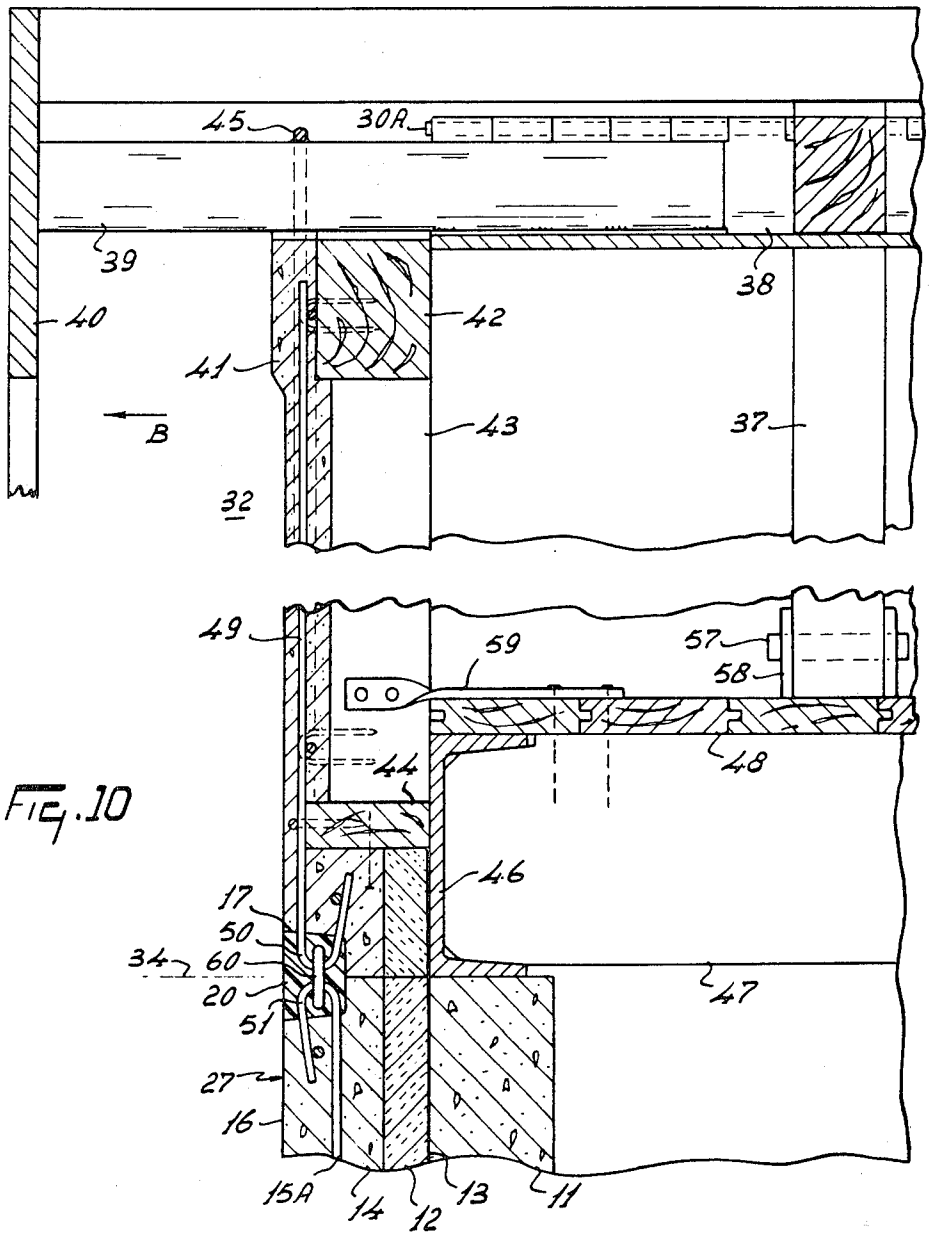
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FIG. 10

JOINDURE OF MODULES IN PREFABRICATED BUILDINGS

SUMMARY OF THE INVENTION

This invention relates to prefabricated buildings and to methods for the construction of such buildings.

According to one aspect of the invention, there is provided a prefabricated building comprising a plurality of interconnected building sections or room units, wherein at least one section or unit is provided, in at least one edge region thereof, with at least one support for finishing material to be applied to said region.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

FIG. **1** is a perspective view of a prefabricated bungalow constructed in accordance with the invention,

FIGS. **2, 3, 4** and **5** are all sectional views, to an enlarged scale, taken on the line A—A of FIG. **1** but illustrating four alternative embodiments,

FIG. **6** is an elevation of a longer side of a prefabricated building that has a slanting roof and is constructed in accordance with the invention,

FIG. **7** corresponds to FIG. **6** but shows parts of the roof occupying downwardly tilted positions suitable for transport purposes,

FIG. **8** is a broken view in elevation illustrating parts located in the region of the ridge of the roof of the building on FIG. **6** to an enlarged scale and in greater detail,

FIG. **9** is a further broken view in elevation, to the same scale as FIG. **8**, showing further details of the roof structure of the building of FIG. **6** in a region of that roof located close to one of the eaves of the building, and

FIG. **10** is a sectional view to an enlarged scale, taken on the line X—X in FIG. **8**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1** of the drawings, the building is illustrated as an example to which the present invention can be applied is a bungalow **1** that is afforded principally by five prefabricated building sections or room units **2, 3, 4, 5** and **6** arranged in juxtaposed successively adjoining relationship. Each of the building sections **2** to **6** inclusive is a hollow oblong (in plan view) parallelepiped, the sections all having substantially the same lengths, widths and heights. Each section **2** to **6** inclusive comprises a structural framework having parts located along the edges of the flat surfaces thereof and, in most cases, other rib-like parts at locations between those edges. The spaces between the rib-like structural frame parts that have just been mentioned are, where appropriate, filled by parts defining various surfaces such as floors, ceilings, roofs and walls. The outer walls include appropriate window frames, door frames and any other required apertures and the inner walls and other partitions defining various rooms and other spaces are also provided, where required, with door frames and other apertures. In the example which is being described, the sections **2** to **6** inclusive are prefabricated in a factory and are finished to an extent which is such that they are provided with all or most of the fixed decorations, appliances and other utility components normally required in a building that is ready for occupation. Such items may include, purely as examples, sanitary ware, cooking and heating equipment, wallpaper or other wall coverings, floor, wall, or ceiling tiles and even ready-laid carpets. After the sections **2** to **6** inclusive have been completed in the factory, they are brought individually to the building site on transporter vehicles and are placed in their correct relative positions on a previously prepared foundation. The transporter vehicles are usually highway tractor trailers and it will thus be realized that the maximum dimensions which each section can have cannot exceed the dimensions that are allowed for road transport by the legal regulations of the jurisdictions through which the loaded transport vehicles must pass. It is usually the width of each section that is of primary importance in this regard and this must generally not exceed substantially three meters. The permissible height is dependent to some extent upon the height above road level of the supporting surface of the transporter vehicle but will not usually to exceed a value between substantially three to three and one-half meters.

The sections **2** to **6** inclusive are displaced substantially horizontally to their appointed positions along the previously prepared foundation at the building site or, as an alternative, they are brought to those positions by a lifting mechanism. In either case, neighboring sections must be brought to adjoining positions in which outer surfaces of the sections are substantially coplanar with a close fit between them. It is desirable for aesthetic reasons that the junction lines between the successive prefabricated building sections **2** to **6** inclusive should be visible to only a minimum extent on the external surface of the bungalow **1** and it is also important for practical reasons that effective seals should be produced at the junctions or seams that have just been mentioned to prevent gaps through which draughts, moisture, dirt, insects and the like can penetrate into the interior of the bungalow to the annoyance and discomfort of its occupants and with a possible adverse effect upon the contents of the bungalow and upon the structure of its sections **2** to **6** inclusive in the regions of the junctions therebetween.

The sections **2** to **6** inclusive may be made from various materials and may include wooden or metal frame structures, synthetic resins and other synthetic plastics materials, reinforced concrete and various combinations of such materials. For the purposes of the examples that are illustrated in the accompanying drawings and that will be further described below, it will be assumed that two prefabricated building sections are located at opposite sides of a junction line therebetween or that one individual section has a junction line between parts thereof. In the examples that are being described, each building section has a metallic frame structure with at least some of the rib-like beams of that structure located along the edges of the rectangular box-like configuration of that section. The flat surfaces between the metal beams are formed, except where door frames, window frames and the like are provided, by castable cementitious material which it is preferred should be plain or reinforced concrete.

FIG. **2** of the drawings is an enlarged section taken on the line A—A in FIG. **1** and it will be seen that it comprises part of the junction line between the prefabricated building sections or room units **2** and **3**, the sec-

tion A—A being taken at two of the upright shorter sides or ends of the sections 2 and 3. After the two sections 2 and 3 have been placed alongside one another in adjoining relationship on the previously prepared foundation, a junction line 7 therebetween is visible. The section 2 includes, near the junction line 7, a columnar vertical steel beam 8, the lower end of which is welded to a rectangular horizontal metal frame at or near one corner of that frame. The frame which has just been mentioned forms part of the floor of the section 2 and the upper end of the beam 8 is secured in a similar way to a further horizontally disposed rectangular metal frame forming part of the roof or ceiling structure of the section 2 of the bungalow 1. An abutting columnar vertical beam 9 that forms part of the section 3 is located close to one corner of that section and has its upper and lower ends welded to substantially horizontal metal floor and ceiling/roof frames of the same section in the manner that has just been briefly described for the beam 8 of the section 2. Each of the columnar beams 8 and 9 is afforded by a pair of metallic channels of greater and lesser depth that are spot-welded to one another so as to locate the channel of lesser depth between the limbs of the channel of greater depth and thus form a space of substantially rectangular cross-section between the webs or bases of two channels and the limbs of the channel of greater depth. With this construction, each beam has a substantially closed box-shaped cross-section which is resistant to torsional deformation. The overlapping and interconnected limbs of the two channels of each beam 8 and 9 project away from a vertical plane 10 that substantially contains the whole of the junction line 7 between the two sections 2 and 3 and said overlapping limbs, together with the webs or bases of the shallower channels, define recesses that receive edge regions of inner wall panels 11 of the two sections 2 and 3. The inner panels 11 form parts of the walls of a living room of the bungalow 1 and are preferably made from reinforced light concrete. The surfaces of the inner panels 11 that are remote from the interior of the living room that has just been mentioned are provided with layers 12 of heat and sound insulating material which may conveniently be expanded polystyrene. However, it will be noted that thin layers 13 are provided between the inner wall panels 11 and the insulating layers 12, said thin layers 13 being designed to prevent the passage of moisture and preferably being afforded by a waterproof synthetic plastics foil. It will be noted that both the layers 12 and 13 extend over the surfaces of the beams 8 and 9 to the location of the plane 10.

Outer wall panels 14 are applied to the surfaces of the insulating layers 12 that are remote from the inner wall panels 11, said panels 14 having outer surfaces 16 which are visible at the exterior of the bungalow 1. The outer wall panels 14 are preferably formed from heavy concrete reinforced by steel mesh 15. As previously mentioned, the inner wall panels 11 are preferably also provided with reinforcements that are not shown in the drawings, said reinforcements being welded to the beams 8 and 9 in the regions of vertical planes of symmetry thereof that extend perpendicular to the plane 10. The parts 8, 9, 12, 13 and 14 are rigidly secured to each other at either side of the plane 10 when the sections 2 and 3 are arranged in their appointed places of the foundation. Each of the walls shown in FIG. 2 of the drawings is preferably made in a jig, the reinforcements (not shown) of the inner panels 11 and the reinforcing steel mesh 15 of the outer panels 14 preferably being interconnected at various points by anchoring means that are not shown in the drawings but that extend through, and substantially perpendicular to, the insulating and moisture-resistant layers 12 and 13. Such anchoring means fix the inner and outer slab-like panels 11 and 14 in their appointed places relative to one another in both vertical and horizontal directions. The outer surfaces 16 of the outer slab-like wall panels 14 have a smooth finish and are provided with a decorative and protective layer of, for example, emulsion paint.

Each outer wall panel 14 is provided adjacent the plane 10 and its outer surface 16 with a cavity 17 and it will be seen from FIG. 2 of the drawings that the two cavities 17 are symmetrically similar with respect to the plane 10 and join one another when the sections 2 and 3 are arranged in juxtaposed relationship to produce, in effect, a single cavity. That portion of each cavity 17 which is nearest to the plane 10 is of generally rectangular configuration as seen in cross-section but merges into an inwardly (with respect to the center of the bungalow 1) directed extension or enlargement 18 that is spaced from the plane 10. If considered necessary, the vertical edge regions of the outer wall panels 14 may be provided, in the thicknesses of those edge regions, with expansion cavities 19 that open only onto the imaginary plane 10 and that are spaced inwardly from both the outer surfaces 16 of the panels 14 and the cavities 17.

Once the sections 2 and 3 are in their correct juxtaposed adjoining positions on the foundation at the building site, the two cavities 17 are filled by a joint or seam filler 20 which may take the form of an elastic synthetic plastics mortar, an epoxy resin based material or a more conventional mortar incorporating a quick-hardening cement. The outer exposed surface of the filler 20 is given a smooth finish so as to be coplanar with the neighboring surfaces 16 after which the above-mentioned emulsion paint or other decorative or protective layer or both can be applied over the coplanar surfaces 16 and the surface of the filler 20. The use of fillers 20 of the kind that have been mentioned often involves the difficulty that the material affording the filler is in a soft, plastic and only semi-solid condition at the time of its application and will not adhere easily to the rigid material to which it is being applied. Sagging of the material of the filler 20 often results so that it is difficult to achieve the desired result of a completely filled cavity with the filler 20 having a uniformly smooth and unblemished outer surface. This difficulty is avoided, or considerably reduced, by applying a first amount of the joint filler 20 into the extensions or enlargements 18 of the cavities 17 and into the deepest parts of those cavities 17 themselves. Once this amount of filler 20 has been applied, which will usually adhere successfully as a result of its relatively large adhering surface to volume ratio, a support 21 is applied to said first amount of layer. The support 21 may be in the form of an elongated network or mesh of metal, synthetic resin or other substantially rigid material and preferably has a length substantially equal to the height of the sections 2 and 3 and a width which is a little less than the combined width of the two co-operating cavities 17, as seen in a direction parallel to the plane 10 (FIG. 2). As shown in FIG. 2 of the drawings, it is pre-

ferred that the vertically elongated support **21** should be curved to some extent as viewed in a direction parallel to its length, the support **21** being so arranged that it curves inwardly towards, or actually into, the extensions or enlargements **18** of the cavities **17.** Once the support **21** has been pressed firmly against the first applied amount or layer of the filler **20,** this amount or layer is sustained by the mesh or network of the support which very greatly reduces the tendency to sagging of the filler. A second amount of layer of the filler **20** can then be applied to embed the support **21** in the filler **20** and completely fill up the two co-operating cavities **17.** The outer exposed surface of the filler **20** is then smoothed ready for the application of emulsion paint or other decorative or protective material or a combination thererof. The support **21** may advantageously be formed from rod-like material, said material advantageously having a curved cross-section or a rectangular or other angular cross-section designed to enhance the adherence or keying of the joint or seam filler **20** thereto. The rod-like material may be formed on its surface with projections or recesses or both for the same purpose. The thickness of the material of the support **21** is chosen in relation to the thickness of the filler **20** measured in a direction parallel to the plane **10.** The support **21** not only tends to prevent the joint or seam filler **20** from sagging prior to the setting, hardening, drying and/or curing thereof but also serves a generally similar function after the filler **20** has lost its semi-solid consistency. In particular, if the material of the filler **20** eventually attains a somewhat brittle condition, the support **21** greatly facilitates the avoidance of cracks due to temperature fluctuations, shrinkage and the like. The support **21** is thus functional both before and after the setting, hardening, drying and/or curing of the material of the joint or seam filler **20.**

In the embodiment which has been described with reference to FIG. **2** of the drawings, the support **21** is separate from the sections **2** and **3** and is applied independently thereto. Such a construction is, however, by no means essential and the support may be a prefabricated element of at least one of each adjoining pair of building sections. FIG. **3** of the drawings illustrates an example of such a construction in which the co-operating cavities **17** have a basically rectangular shape (as seen in cross-section) and open directly onto the outer surfaces **16** of the two panels **14.** A plurality of somewhat thin rods **22** are embedded in the concrete of the panels **14** in such a way that each rod **22** has an unembedded portion **23** that projects freely into the cavities **17.** Actually, the portions **23** are bent around the jigs that are employed to form the panels **14** and their cavities **17** so that said portions **23** will, at that time, remain free of the concrete of the panels **14.** The portions **23** are bent into substantially the positions shown in FIG. **3** of the drawings once the sections **2** and **3** are in their appointed juxtaposed adjoining positions, said portions **23** then extending perpendicular or at least transverse to the plane **10** and through that plane. It is, in fact, preferred that the rods **22** corresponding to the section **2** and those corresponding to the section **3** should be staggered vertically as regards their position, the arrangement preferably being such that, moving upwardly along the junction line **7,** portions **23** of the rods **22** are encountered alternately having regard to the panel **14** of the section **2,** or the section or unit **3,** in which said rods **22** are embedded. A preferred way of employing the support that is afforded by the rod portions **23** is to apply a first amount or layer of the filler **20** at the base of the combined cavity **17,** behind the portions **23,** subsequently twist portions **23** corresponding to the two sections **2** and **3** together, press the interconnected portions **23** into the first amount or layer of the filler **20** and lastly apply the second and final amount of layer of the filler **20** over the twistedly interconnecting portions **23.** The exposed outer surface of the filler **20** is then smoothed and finished in the same manner as previously described with reference to FIG. **2** of the drawings.

FIG. **4** of the drawings illustrates an embodiment in which the co-operating cavities **17** are again of basically rectangular shape as seen in cross-section but, in this case, the cavities **17** are of such a depth in a direction parallel to the plane **10** that the inner extremities thereof are disposed between the reinforcing steel mesh **15** and the insulating layers **12.** During the manufacture of the outer wall panel **14** in the embodiment of FIG. **4,** filling beams (not shown) are arranged in the jigs at the places at which the cavities **17** are to be formed, said filling beams being formed with a plurality of bores whose diameters are slightly greater than those of the rods forming the steel mesh **15,** said bores extending substantially perpendicular to the plane **10.** The spacing between the bores which have just been mentioned is the same as the spacing between the rods of the steel mesh **15** and, prior to the casting of the concrete of the outer wall panels **14,** the ends **24** of substantially horizontally disposed rods of the mesh **15** are entered into the bores of the filling beams during the disposition of the reinforcements in their correct places. Once the subsequently poured concrete has set or hardened, the upright beams of the jigs and the filling beams are removed so that the substantially horizontally disposed ends **24** of the rods of the steel mesh **15** project freely into the cavities **17** in substantially the manner indicated in solid lines in FIG. **4** of the drawings. Once the sections have been assembled in the prefabricating factory, the projecting ends **24** are bent over to substantially the positons thereof that are shown by broken lines in FIG. **4** of the drawings to prevent those ends from projecting dangerously beyond the sections or units during transport. When the sections **2** and **3** have been placed in their appointed positions on the foundation at the building site and the cavities **17** are to be filled, the first amount or layer of the filler **20** is applied to the innermost region of the combined cavities **17** after which the ends **24** affording the support are bent back into substantially the positions thereof that are indicated by solid lines in FIG. **4** of the drawings. Such bending back presses the rod ends into the first amount or layer of the filler **20** and the second or final amount or layer of said filler **20** is subsequently applied, the ends **24** being embedded in the combined amounts or layers of the filler **20** and acting to support that filler against sagging. Smoothing and finishing is subsequently effected in the manner that has been described above.

FIG. **5** of the drawings illustrates an embodiment in which the substantially horizontally extending rods of the meshes **15** of the outer wall panels **14** are again employed for the purposes of support. Before the concrete of the outer wall panels **14** is poured, filling beams are positioned to define the cavities **17,** said filling beams being formed with disc-shaped recesses that extend

substantially perpendicular to the plane **10** at the sides of the filling beams remote from the edges of the jigs in which the casting operations are performed. In this embodiment, the cavities **17** have depths in the direction of the plane **10** that are substantially equal in magnitude to the distance between neighboring rods of the reinforcing steel mesh **15** in a direction parallel to the plane **10.** An end **25** of each substantially horizontal reinforcing rod of the mesh **15** is bent over through not less than substantially **180°** as illustrated in FIG. **5** of the drawings so that said ends **25** form loops in the cavities **17.** The general planes of said loops are perpendicular to the plane **10,** said loops being dimensioned to fit into the disc-shaped recesses of the filling beams that are referred to above. Some concrete will occasionally penetrate into the loops afforded by the bent-over ends **25** during the casting operations in the jigs at the prefabricating factory but, once the concrete has set or hardened, the excess amounts thereof that have penetrated into said loops can readily be removed by, usually, single strokes of hammers or other suitable tools.

When the building sections **2** and **3** are arranged in their appointed juxtaposed adjoining positions on the foundation at the building site, the first amount or layer of the filler **20** is applied at the base or rear of the combined cavities **17** after which steel connectors **26** are pushed downwardly through the loops afforded by the rod ends **25** to couple those rod ends to one another and complete the support for the filler **20.** Each connector **26** conveniently has the shape of an inverted "U" but it is emephasized that the connectors may have limbs which are so long that they can be pushed downwardly through a plurality of pairs of the loops and even may be so long that a single connector **26** will be sufficient to couple together all of the loops corresponding to one vertical portion of the junction line **7.** Once the connector or connectors **26** has or have been installed, the second and final amount or layer of the filler **20** is installed, the connectors having previously been pressed firmly into the first amount or layer of the filler **20.** With this construction, both the first and second or final amounts or layers of the filler **20** bear upon the substantially horizontally disposed but vertically spaced apart pairs of loops that are afforded by the bent-over ends **25** of the reinforcing mesh rods.

The following description relates to embodiments in which at least one part of a building section is displaceable relative to at least one further part thereof and is particularly concerned with the reliable filling and sealing of junction line or seams between such relatively displaceable parts when those parts are brought to what will usually be finally fixed relative dispositions. It will be remembered that the maximum dimensions that can be given to prefabricated building sections are limited by the legally prescribed maximum measurements, usually for road transport, that prevail in the jurisdictions through which the sections must be carried to reach their destinations. No great difficulties are encountered in matching these dimensional restrictions as regards the widths of the sections and, in the case of a single story flat-roofed building, such as the bungalow of FIG. **1,** the restrictions as to maximum height are not usually troublesome. However, in the case of a building that is to have a slanting roof, the maximum heights of the sections that will include all, or parts, of said roof will usually be in excess of the legally prescribed limits when the height of the load supporting surface of the transporter vehicle above the ground is added thereto. The following embodiments relate to constructions that will allow the use of slanting roofs without the danger of breaking the road transport laws and regulations of most jurisdictions.

FIG. **6** of the drawings illustrate a building section **27** which, apart from its roof structure, may be substantially identical to the building section **2** that is illustrated in FIG. **1** of the drawings. The building section in question is accordingly indicated by the two reference numerals, **2** and **27** in FIGS. **1, 6** and **7** of the drawings and it will be seen from a comparison between FIGS. **1** and **6** thereof that the building of FIG. **6** is seen in that Figure in side elevation in a direction parallel to the general plane of the front of the building. The section **27** is provided with a sloping roof which comprises two roof surfaces **28** and **29** that are disposed substantially symmetrically at the opposite sides of a vertical plane containing the junction between them. That junction, which substantially coincides with the ridge or apex of the roof, extends perpendicular to the maximum length of the section **27** and thus perpendicular to the plane of FIG. **6** of the drawings. Lower end regions of the surfaces **28** and **29** are located in the regions of the shorter sides or ends of the substantially oblong section **27.**

The two roof surfaces **28** and **29** are pivotally interconnected close to the apex or ridge of the roof by a shaft **30A** (FIGS. **7** and **8** of the drawings) that extends parallel to said apex or ridge and thus perpendicular to the planes of FIGS. **6, 7** and **8** of the drawings. An outer wall portion of the building that partially defines the space beneath the slanting roof and that is located above the main parallelepiped-shaped body of the section or unit **27** is termed the "head facade" of the building. The head facade comprises two portions **31** and **32** that are each of substantially right-angled triangular configurations, the "adjacent" edges **33** meeting along the substantially vertical broken line that can be seen in FIG. **6** of the drawings when the head facade is erected. The head facade also, under these circumstances, joins the upright side of the section **27** that can be seen in FIG. **6** of the drawings in substantially coplanar relationship therewith along a broken line **34** that is shown in FIG. **6.** The sides of the two triangular head facade portions **31** and **32** that correspond to the line **34** are the "opposite" sides of the two triangles in question.

The lowermost edges of the roof surfaces **28** and **29** are connected to the shorter sides or ends of the section **27** by awnings or weather boards **30** of sheet like configuration that are turnably connected to the lower edge regions of the roof surfaces **28** and **29** by pivots that extend substantially perpendicular to the plane of FIG. **6** of the drawings. The roof surface **29** is turnable about a substantially horizontal axis that is afforded by at least one pivot **35,** said axis extending parallel to the apex or ridge of the roof and being substantially coplaner with the upright shorter side or end of the section **27** that is at the right thereof as viewed in FIG. **6** of the drawings. Each pivot **35** affording said axis is carried by brackets at a short distance above the uppermost edge of the wall affording the shorter side or end that has just been mentioned of the section **27.** A lower end region **36** of the other roof surface **28** is movable in substantially the direction indicated by an arrow A in FIG. **6** of the drawings for transport purposes. In the

erected condition of the roof that is shown in FIG. 6 of the drawings, the roof surface 28 is rigidly secured to the top of the section 27 along a line substantially coinciding with the region 36, the head facade portions 31 and 32 then being substantially coplanar with the upright wall of the section that is faced by a viewer of FIG. 6 of the drawings. During the construction of the building is a prefabrication factory, the head facade portions 31 and 32 hang loosely downwards in side-by-side relationship from the roof portions 28 and 29 in substantially the positions shown in FIG. 6 of the drawings said portions not, however, being rigidly secured to the section 27 or to each other at that time.

In order to reduce the height of the section 27 and the slanting roof thereof for transport purposes, the roof surface 29 is turned downwardly about the pivot or pivots 35 towards the top of the section 27 with the result that the surface 28 also turns relative to the surface 29 about the shaft 30A and moves downwardly towards the top of the section 27 while simultaneously being displaced to some extent in the direction A shown in FIG. 6. The awnings or weather boards 30 are not directly connected to the shorter sides or ends of the section 27 at this time and merely hang perpendicularly downwards from the edges of the roof surfaces 28 and 29 as shown in FIG. 7 of the drawings. As the roof surfaces 28 and 29 turn relative to one another about the shaft 30A, the head facade portions 31 and 32 move away from one another to some extent to take up substantially the positions shown in FIG. 7 of the drawings in which Figure the sides or edges of the portions 31 and 32 that combine to form the broken line 34 (FIG. 6) are again indicated by the same reference 34 for the purpose of clarity. In the position of the roof that is illustrated in FIG. 7 of the drawings, the two head facade portions 31 and 32 are disposed a little in front of the visible side of the section 27 in substantially parallel relationship therewith. It will be remembered that, in the erected state of the roof that is shown in FIG. 6 of the drawings, the head facade portions 31 and 32 are substantially coplanar with the side of the section 27 that is visible in elevation in FIGS. 6 and 7. Accordingly, it will be realized that, to enable those portions 31 and 32 to hang downwardly in front of the side of the section 27 that has just been mentioned, it is necessary to be able to displace said portions 31 and 32 to some extent in a direction perpendicular to the plane of FIGS. 6 and 7 of the drawings. The way in which this is achieved will be described below.

Each of the roof surfaces 28 and 29 comprises a plurality of rafters 37 (FIGS. 8, 9 and 10 of the drawings) that each extends substantially perpendicular to the apex or ridge of the roof, said rafters 37 carrying roof covering material, tiles or the like which it is not necessary to describe in detail. The rafters 37 are fastened, near the apex or ridge of the roof, to obtuse-angled brackets 38 that extend parallel to said apex or ridge. The two brackets 38 that correspond respectively to the two roof portions 28 and 29 are pivotally interconnected by the shaft 30A and, in the obtuse angles that are defined between their limbs, tubular steel supporting members 39 are welded in such a way that the longitudinal axes thereof again extend parallel to the apex or ridge of the roof. Each tubular member 39 has a length in a direction parallel to the apex or ridge of the roof which is such that it extends from an associated connecting part 40 that is fastened to the overhanging edge of the roof surface 28 or 29 concerned inwardly to near the innermost surface of the corresponding head facade portion 31 or 32. This disposition, which exists in the erected state of the roof, can be seen best in FIG. 10 of the drawings.

The head facade portions 31 and 32 are of substantially symmetrically similar construction and the portion 32 that is shown in FIG. 10 of the drawings in its final erected position is afforded principally by a reinforced concrete slab or plate 41 which is cast so as to be rigid with a wooden framework, said framework including a wooden beam 42 that is substantially parallel to the associated rafters 37 that will usually also be wooden rafters. The framework which has just been mentioned also includes a plurality of uprights 43 and a lower beam or girder 44, the whole framework having, as will be expected from the preceding description, the shape of a right-angle triangle. An eye 45 of U-shaped configuration has its limbs embedded in the concrete of the slab or plate 41 in such a way that a plane containing said limbs is substantially coincident with the general plane of the slab or plate 41 and thus perpendicular to the roof surface 29 and to the longitudinal axis of the corresponding tubular supporting member 39. The unembedded semi-circular bend between the two limbs of the eye 45 has an internal diameter that is equal to the external diameter of the corresponding supporting member 39.

The building section 27 includes an oblong steel floor frame and an oblong steel ceiling frame, one ceiling beam 46 of the latter frame being visible in FIG. 10 of the drawings. The two frames that have just been mentioned are held in vertically spaced apart relationship by columnar steel beams that may be substantially identical in construction to the beams 8 and 9 that have already been described with reference to FIGS. 2 to 5 of the drawings. That part of the outer wall of the section 27 that is shown in FIG. 10 of the drawings is of the same construction as the outer wall of the bungalow 1 that is shown in FIGS. 2 to 5 of those drawings. Wooden girders 47 are keyed or otherwise shaped to fit between the ceiling beam 46 and at least one other steel ceiling beam and a floor formed by boards 48 is secured to the tops of the girders 47, said floor of boards 48 serving as a loft floor after the building has been erected and as a strong supporting abutment for the collapsed roof surfaces 28 and 29 during transport to the building site. The concrete slab or plate 41 extends downwardly beyond the lower beam or girder 44 of the wooden framework so that it may abut against the upper edge of the outer wall panel 14 of the section 27 which, as previously mentioned, is of substantially identical construction to the section 2 apart from the roofing thereof. It will be noted in this regard that layers corresponding in construction and thickness to the insulating layers 12 and waterproof layers 13 are provided between the downward extension of the concrete slab or plate 41 and the neighboring surface of the steel ceiling beam 46. The upper and outer edge of the wall panel 14 of the section 27 that is visible in FIG. 10 of the drawings is formed with a cavity 17 and the lower and outer edge of the downward extension of the concrete slab or plate 41 that is shown in the same Figure is formed with a symmetrically similar cavity 17. The joint cavity 17 has a depth which is substantially the same as the distance between the outer wall surface 16 and a plane containing the inner extremities of vertical

rods 15A of a reinforcement mesh that is employed in the illustrated outer wall panel 14. The reinforcements that form part of the slab or plate 41 include substantially vertical rods 49 and these rods are bent over to afford eye-like loops 50 in the corresponding cavity 17, said loops 50 being contained in substantially vertical planes that are substantially perpendicular to the neighboring outer wall surface 16. It will be noted that the rods 49 are bent over to form the loops 50 in a direction which is such that the embedded ends thereof are located rearwardly in the downward extension of the slab or plate 41 behind the remainders of said rods and that said rods are spaced inwardly from the outer surface of the slab or plate 41 that is substantially coplanar with the outer wall surface 16 by a distance which is less than the corresponding inward spacing of the substantially vertical rods 15A of the steel reinforcing mesh forming part of the outer wall panel 14 of the section 27. The rods 15A are bent over at their upper ends to form eye-like loops 51 in the corresponding cavities 17 but it will be seen from FIG. 10 of the drawing that, in this case, the bends are made in opposite directions to those required to form the loops 50 so that the bent-over ends of the rods 15A are nearer to the outer wall surface 16 than are the remainders of the rods 15A. The loops 50 and 51 do not cross the imaginary plane that is indicated in FIG. 10 by the reference 34 since that plane is a horizontal plane substantially containing the broken line 34 that can be seen in FIG. 6 of the drawings.

Between the apex or ridge of the roof and the lowermost and outermost regions of the roof surfaces 28 and 29 a number of steel roof girders are provided having functions similar to those of the obtuse-angled brackets 38. In the embodiment which is being described, there are two steel roof girders 52 and 53 (FIG. 6) in respect of each roof surface and FIG. 9 of the drawings illustrates the construction and arrangement of one of the girders 52 in more detail. The girder 52 is arranged beneath the corresponding normally wooden rafters 37 and, at its top, is provided with a tubular steel supporting member 54 which is of substantially the same length as the corresponding member 39 and that extends similarly between the corresponding connecting part 40 and a region near the interior of the neighboring head facade portion. Each of the head facade portions 31 and 32 is provided with a manner of barbed eyes 55 that corresponds to the number of neighbouring supporting members 54. The barbed eyes 55 are of generally hairpin-shaped configuration and form parts of the metallic reinforcements of the concrete slabs or plates 41, the limbs of said eyes 55 being embedded in said slabs or plates 41. However, portions of said limbs including approximately 180° interconnecting bends between those limbs project above the head facade portions 31 and 32 with said bends embracing the tubular steel supporting members 54. It will be noted that the steel roof girder 52 illustrated in FIG. 9, together with the corresponding bracket 38, ends in a plane that is substantially coincident with the upright web of the corresponding ceiling beam 46 (see FIG. 10). A wooden upright 56 interconnects the wooden beam 42 and the lower wooden beam or girder 44 at a location close to the steel roof girder 52 that is illustrated in FIG. 9.

The collapsing of the roof of the section 27 from substantially the position shown in FIG. 6 thereof to substantially the position shown in FIG. 7 thereof for transport purposes has been briefly described above and the necessity has been mentioned of displacing the head facade portions 31 and 32 in a direction perpendicular to the plane of FIGS. 6 and 7 of the drawings to bring them to substantially the positions thereof that are shown in the latter Figure. The section 27 is constructed in the prefabricated factory in substantially the disposition shown in FIGS. 6 and 10 of the drawings except that the cavities 17 shown in the latter Figure are unfilled at that time. However, it will be noted that the outer surfaces of the head facade portions 31 and 32 are substantially coplanar with the outer surfaces 16 of the underlying wall panels 14 at this time and, as previously discussed, they must be displaced to allow the disposition shown in FIG. 7 to be attained. The head facade portions 31 and 32 are suspended from the tubular supporting members 39 and 54 by the eyes 45 and 55 and said portions, together with the eyes 45 and 55, can be slid along the tubular supporting members 39 and 54 in the direction indicated by an arrow B in FIG. 10 of the drawings to positions in which the head facade portions 31 and 32 are located, in plan view, outwardly beyond the underlying wall panels 14. As soon as displacements in the direction B have been made, the previously described downward tilting movements of the roof portions 28 and 29 can be undertaken so that substantially the disposition shown in FIG. 7 of the drawings is reached in which the head facade portions 31 and 32 hang substantially vertically in front of the illustrated wall of the section 27. Once the section or unit 27 has been transported to the building site and has been correctly positioned on the foundation at that site, the roof surfaces 28 and 29 are slantingly repositioned as shown in FIG. 6 which may be accomplished by simple known mechanical or hydraulic tools such as jacks. When the required angular dispositions of the roof surfaces 28 and 29 have been reached, the rafters 37 of the roof surface 28 are fixed to the top of the section 27 by horizontal pins 57 (FIG. 10) entered through bores in said rafters and through holes in pairs of lugs 58 that are carried by the oblong steel ceiling frame of the section 27. At this stage, the head facade portions 31 and 32 are slid back along the tubular steel supporting members 39 and 54 in directions opposite to the direction B shown in FIG. 10 of the drawings until they reach the dispositions shown for the portion 32 in FIG. 10. The eyes 45 and 55 are then welded to the supporting members 39 and 54, the wooden uprights 43 and 56 are coupled to the floor boards 48 by twisted connecting strips 59 and the awnings or weather boards 30 are tilted upwardly about their pivotal mountings to bring them to the positions that are shown in FIG. 6 of the drawings in which positions they are fixed by suitable known fastening members such as nails, screws or the like.

The joint or seam that substantially coincides with the abutting "opposite" edges 33 of the head facade portions 31 and 32 when said edges 33 occupy the positions indicated by a broken line in FIG. 6 of the drawings may be filled and finished in a manner substantially identical to one of those that has previously been described with reference to FIGS. 2 to 5 of the drawings, the slabs or plates 41 of the two head facade portions 31 and 32 being equivalent, in this respect, to two neighboring outer wall panels 14. A further junction line or seam extends horizontally along the broken line

34 shown in FIG. 6 of the drawings and the coincident plane 34 that is shown in FIG. 10. The co-operating cavities 17 of this joint or seam have the loops 50 and 51 located therein and a first amount or layer of the joint or seam filler 20 is pressed into the base of the double cavity 17 to an extent such as at least partially to embed said loops 50 and 51. Once this stage has been reached, steel connectors 60 that may be similar or identical in construction to the previously described connectors 26 are pushed lengthwise along the double cavity 17 to interconnect single or multiple pairs of the loops 50 and 51. The second and final amount or layer of the joint or seam filler 20 is then applied and embeds the supporting loops 50 and 51 and the substantially U-shaped connectors 60. Once the outer surface of the filler 20 has been smoothed, a finishing layer of emulsion paint or other decorative or protective material or a combination thereof can be applied over the surface 16 and the coplanar surfaces of the head facade portions 31 and 32 and the joint or seam filler 20.

By employing the techniques that have been described, it is possible to manufacture and finish prefabricated, building sections such as the section 27 in a factory including the sloping roofs of such sections. The roofs can be collapsed for transport purposes to avoid violating any road transport maximum height laws or regulations that may exist in the jurisdictions through which transport must take place. When the building site has been reached, the roofs can quickly and easily be re-erected in their sloping positions and the joints or seams between necessarily displaceable parts thereof can quickly and reliably be filled and sealed by a material that is initially in a plastic condition with a greatly reduced danger of sagging or other undesired displacement of that material.

Although various features of the buildings that have been described and illustrated in the accompanying drawings and various steps in the methods of construction of those buildings will be set forth in the following claims as inventive features, it is emphasized that the invention is not necessarily limited to such features and includes within its scope each part that has been described or illustrated or both and each step in the methods that have been described or illustrated both individually and in various combinations.

What we claim is:

1. In a building, a pair of prefabricated box-shaped space enclosing sections which are adjoining and connected in a substantially contacting side-by-side relationship, the area of the junction between said pair of said sections being completely coincident with a vertically disposed plane, inner wall panels in each section whereby each said inner wall extends perpendicularly away from said plane, heat and sound insulatng material extending over the outer surface of said inner wall panels, outer wall panels on the outer surface of said insulating material, said outer wall panels adjoining at said plane and being perpendicular to and extending away from said plane, said inner wall panels, said insulating material and said outer panels being symmetrical in the region of said plane relative thereto, said outer wall panels together defining a recess extending across said plane and filled with a plastic material adapted to harden in place, at least one support arranged in said recess for supporting said plastic material.

2. A building as claimed in claim 1, wherein each said support is of flexible formation.

3. A building as claimed in claim 1, wherein said support is substantially completely embedded in said plastic material.

4. A building as claimed in claim 1, wherein said support is embedded in said material and composed of a synthetic resin.

5. A building as claimed in claim 1, wherein said recess is afforded by co-operating cavities provided in the adjoining edge regions of said outer wall panels.

6. A building as claimed in claim 5, wherein said cavities extend substantially vertically.

7. A building as claimed in claim 5, wherein said edge regions, said support and said plastic material comprise a connection provided between said two sections.

8. A building as claimed in claim 5, wherein said cavities each comprise at least one inward enlargment.

9. A building as claimed in claim 8, wherein said support is in the form of a mesh.

10. A building as claimed in claim 8, wherein said support projects inwardly into said enlargements.

11. A pair of prefabricated box-shaped space enclosing sections adapted to be connected in side to side contact in a building comprised of such sections whereby the outer facing sides of the pair of sections are coplanar and meet at a vertical joint, said joint comprising: a wall portion in each said section adjacent to where the pair of sections meet, said wall portions defining at least in part said outer facing sides of the pair of sections; a longitudinal recess defined by at least part of the thickness of said each wall portion where the pair of sections meet, said recesses being conjoined to form a longitudinal cavity with vertical sides diverging outwardly formed substantially completely by said wall portions; a reinforcement member received in said conjoined recesses, said reinforcement member being received substantially through the length of said conjoined recesses and extending from one said recess to the other said recess and being curved; said conjoined recesses being filled with a plastic filler material which hardens in place, said reinforcement member being substantially completely embedded in said plastic filler material, the outer surface of said plastic filler material being coplanar with said outer facing sides; and a protective layer applied on the outer facing sides of said wall portions and said plastic filler material.

12. Prefabricated sections in accordance with claim 11, wherein said recesses are symmetrical in shape.

13. Prefabricated sections in accordance with claim 12, wherein each said recess includes an enlargement, said enlargements spaced from each other and each receiving an edge portion of said reinforcement member.

14. Prefabricated sections in accordance with claim 12, wherein said wall portions are composed of reinforced concrete.

15. A prefabricated building comprising a plurality of interconnecting prefabricated box-shaped sections and at least a pair of said sections connecting in a side-to-side contacting relationship whereby the outer facing sides of the pair of said sections are coplanar, the conjunction of said pair of sections comprising a pair of contacting vertical metal beams, a pair of contacting insulation layers and a pair of contacting wall portions, one of said beams, layers and wall portions being included in each said section for said pair of sections, said insulation layer being between the corresponding said wall portion and said beam, said wall portions together defining where said pair of sections meet a longitudinal

recess, a reinforcement member in said recess, a plastic material adapted to harden in place filling said recess and said reinforcement member embedded therein.

16. A prefabricated building in accordance with claim **15,** wherein said recess includes spaced enlargements, one said enlargement defined by each said wall portion, said reinforcement member extending between said enlargements.

17. A prefabricated building in accordance with claim **15,** wherein the outer surface of said plastic material filling said recess is coplanar with said outer surfaces of said wall portions.

18. A prefabricated building in accordance with claim **15,** wherein said beams are substantially rectangular in cross section and are in continuous contact along a side of each.

19. A prefabricated building in accordance with claim **15,** wherein said insulation layers are composed of an expanded polystyrene material.

20. A prefabricated building in accordance with claim **19,** wherein said wall portions are composed of a concrete type material and said beams each have interior walls connected thereto, said interior walls also being composed of a concrete type material.

21. A building in accordance with claim **20** wherein a further layer of water proof synthetic plastic foil is disposed between said interior walls and said insulating layers.

22. A prefabricated building comprising a plurality of interconnecting prefabricated box-shaped sections, two of said sections being side by side and having outer walls with outer surfaces which are coplanar and connect at a vertical joint, said joint comprising a recess defined by the portions of said wall adjacent to the location of the joint, said recess having a substantially uniform cross-section and including two spaced enlarged areas one of which is defined by each said wall portion, each said enlarged area as seen in cross-section including a portion having a greater depth relative to the non-enlarged areas of said recess, each said portion having two opposed edges, said edges diverging outwardly relative to and towards the plane containing the outer surfaces of said outer walls, said recess being filled with a hardenable plastic material the outer surface of which is coplanar with said outer surfaces of said outer walls.

23. A prefabricated building in accordance with claim **22,** wherein a reinforcement member is embedded in said recess, said reinforcement member being curved as seen in said cross-section and extending into each said enlarged area.

24. A prefabricated building in accordance with claim **23,** wherein said walls are composed of a concrete type material.

25. A prefabricated building in accordance with claim **24,** wherein the rear of said recess between two enlarged areas is parallel to said plane containing said outer surfaces.

26. A prefabricated building comprising a plurality of interconnecting prefabricated box-shaped section, two of said sections being side-by-side and having outer walls with outer surfaces which are coplanar and connect at a vertical joint, said joint comprising a recess defined by the portions of said wall adjacent to the location of said joint, said recess having substantially uniform cross-section and including two enlarged areas one of which is defined by each said wall portion, each said enlarged area as seen in cross-section having two edges, said edges diverging outwardly relative to and towards the plane containing the outer surfaces of said outer walls, said recess being filled with a hardenable plastic material the outer surface of which is coplanar with said outer surfaces of said outer walls, a reinforcement member being embedded in said recess, said reinforcement member being curved as seen in said cross-section and extending into each said enlarged area, each said section including to the rear of said outer walls a vertical beam which has a rectangular cross-section with two of its sides parallel to said plane containing said outer wall surfaces and two of its further sides perpendicular to said plane, said vertical beam of each said section in an abutting relationship with the other, insulation and waterproofing material provided between said beams and said walls of each of said sections.

27. A prefabricated building in accordance with claim **26** wherein a protective layer is provided over said outer wall surfaces and the outer surface of said material filling said recess.

28. A prefabricated building in accordance with claim **27,** wherein said protective layer is composed of emulsion paint.

29. In a building, a pair of prefabricated box-shaped space enclosing sections which are connected in a side-to-side relationship, a junction line between said pair of said sections which is contained in whole in a first vertical plane, vertical beams in each section, each said beam having a flat area received in said first plane and being connected to inner wall panels which extend perpendicularly away from said first plane, heat and sound insulating material extending over the outer surfaces of said inner wall panels and each said beam to the location of said first plane, outer wall panels applied to the outer surfaces of said insulating material which are perpendicular to and extend to said first plane, said beams, said inner wall panels, said insulating material and said outer panels being symmetrical in the region of said first plane, said outer wall panels defining a recess which is bisected by said first plane, said recess being filled with a plastic material which hardens in place, the outer surface of said outer wall panels and said plastic material falling in a second vertical plane which is perpendicular to said first plane, a protective layer coincident with said second plane applied over the outer surfaces of said outer wall panels and said plastic material.

30. Prefabricated sections in accordance with claim **29,** wherein said recess has a uniform cross-section, portions of said recess farther from said first plane extending a greater distance into said outer wall panels than the portion of said recess coincident with and proximate to said first plane.

31. Prefabricated sections in accordance with claim **29,** wherein said recess contains a pair of spaced apart enlarged portions, one said enlarged portion defined by each outer wall panel.

32. Prefabricated sections in accordance with claim **31,** wherein said recess contains a vertically disposed reinforcement member which is curved as seen from above, extends between said enlarged portions and is embedded in said material filling said recess.

33. In a building, a pair of prefabricated box-shaped space enclosing sections which are adjoined and connected in a substantially contacting side-to-side relationship, the area of the junction between said pair of

said sections being completely coincident with a vertically disposed plane, vertical beams in each said section, each said beam being connected to part of a wall of each said section and being situated behind an outer wall part of each said section, said outer wall parts extending perpendicularly away from said plane, said outer wall parts being symmetrical in the region of said plane, said outer wall parts together defining a recess, said recess being filled with a finishing material and a support being provided which is arranged in said finishing material to support said material in said recess.

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