Oct. 21, 1969 D. GUNKEL 3,473,273

PRE-ASSEMBLED, SUB-ENCLOSURE, BUILDING SECTION

Filed July 9, 1965

FIG. 1

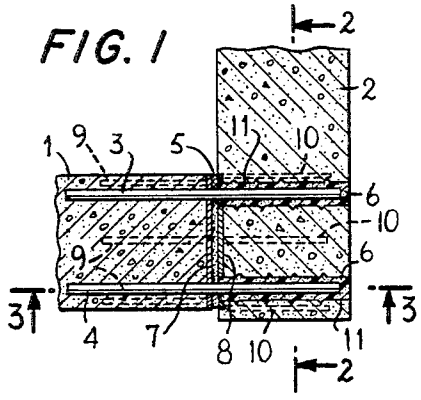


FIG. 2

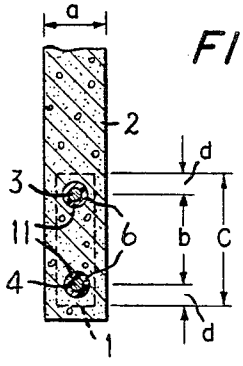
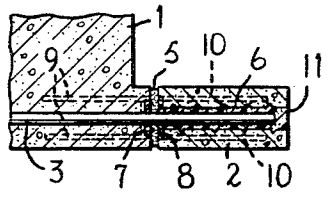


FIG. 3



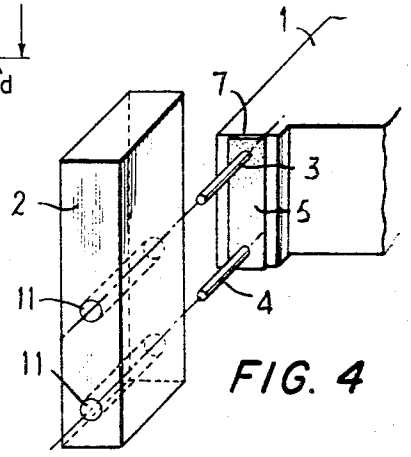


FIG. 4

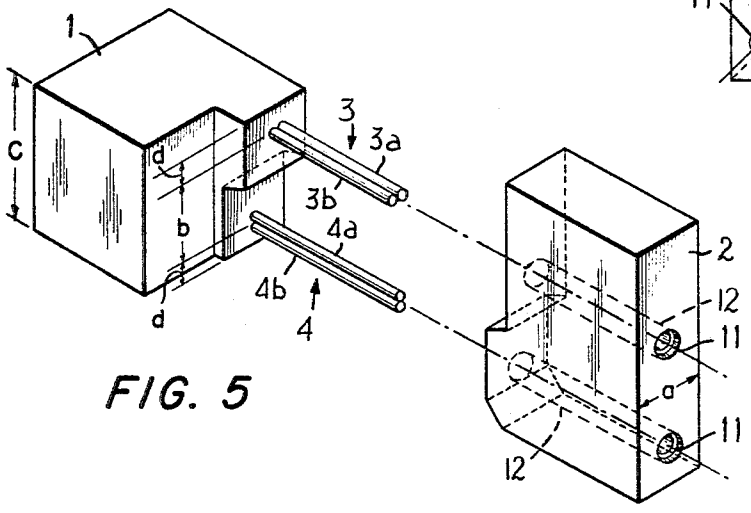


FIG. 5

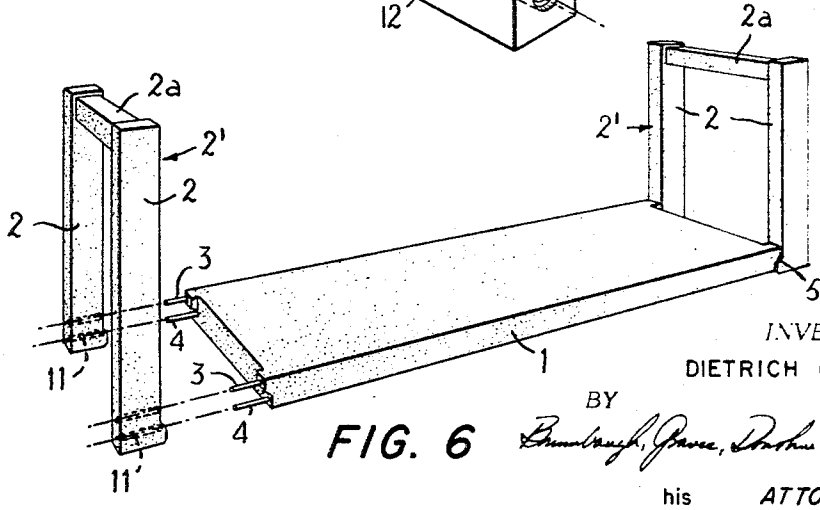


FIG. 6

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United States Patent Office 3,473,273 Patented Oct. 21, 1969

3,473,273

PRE-ASSEMBLED, SUB-ENCLOSURE, BUILDING SECTION

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Filed July 9, 1965, Ser. No. 470,815
Claims priority, application Great Britain, July 11, 1964, 28,736/64
Int. Cl. E04b 1/348, 1/41
U.S. Cl. 52—79 11 Claims

ABSTRACT OF THE DISCLOSURE

In the typical embodiment of the invention described herein and shown in the accompanying drawings, a structural unit for a transportable room element comprises a floor panel member, two end members disposed at opposite ends of the floor panel member, and rigid joints connecting the end members to the floor panel member at locations spaced widthwise of the floor panel member. Each joint is composed of a projecting element, such as one or more reinforcing rods, extending from one of the members into a clearance hole in the other member, a setting adhesive filling occupying the clearance space between and forming a bond with both the element and the walls of the hole. The adhesive filling also occupies any gap between the faces of the members at the joint. With this utilization of adhesive to fill gaps and clearance spaces, the entire structural unit can be assembled to very close tolerances, even though the components thereof are made with loose tolerances.

This invention concerns a joint between two members, primarily structural members such for example as structural components of buildings or of prefabricated units for assembly into buildings and a method of making such joints.

An important application of the invention is to the construction of prefabricated building units in, or for use in, transportable room elements. The expression "transportable room element" 'is employed herein to define a transportable cell-like structure having two opposed sides and two opposed ends, a floor a roof or ceiling, and load-bearing end-wall-forming members, forming or adapted to support an end wall, rigidly connected to the floor at each said ends, which room element is adapted to be mounted, at one or each of its sides, side-by-side with a further such room element in building up a one storey building or a storey of a plural-storey building from a succession of such elements; the expression "end-wall-forming members" includes a complete end wall and also includes vertical loading-bearing pillars or columns adapted to have fill-in panelling applied to, or formed integrally with them. The expression "fill-in panelling" includes a wall, and a door or window. Such room elements form the subject of British patent applications Nos. 31,161/61 and 14,137/62 (cognate); No. 3,197/62; No. 3,200/62; No. 26,234/63; Nos. 3,020/63 and 39,914/63 (cognate); and No. 44,293/63, to which reference may be made as disclosing constructions to which this invention is applicable. Said building units are best built up from initially separate components (e.g. the end walls, floor and in some instances the roof or ceiling also) permanently connected together. They are of substantial size and difficulties therefore arise in manufacturing them to close dimensional and angular tolerances, particularly if the components are precast concrete components. Yet the cumulative effect of such tolerances may be substantial and serious and to attain the best results in a system of building constructions using such units requires a manufacturing accuracy surpassing that so far achieved in the building industry. The present invention may be employed to achieve such accuracy.

The present invention provides a joint between two members comprising at least one projecting element on one member received in a clearance hole in the other member and an adhesive filling, primarily one consisting of a mixture of an aggregate in a matrix of a setting adhesive, occupying the clearance between each said element and the peripheral surface of its hole and having a bond with said element and surface. The expression "adhesive filling" includes a quick setting cement; by a setting adhesive is meant a substance capable of setting or hardening from a soft or pasty state and, which when so set or hardened, forms a permanent bond with said surfaces.

The invention also provides a method of joining two members in a predetermined spatial relation one of which members has at least one projecting element and the other has a clearance hole for receiving each said projecting element, which consists in effecting relative movement between the two members and thereby inserting each said projecting element into its clearance hole and bringing the two members into their predetermined relation, and permanently fixing them in that relation by an adhesive filling, primarily one consisting of a mixture of an aggregate in a matrix of a setting adhesive, introduced into said hole to occupy the clearance between, and to bond with, the peripheral surface of each said hole and the projecting element received therein.

Desirably the two members have adjacent faces spaced apart by a small gap also containing said adhesive filling, which faces are bonded together by said filling. The provision of this gap is useful in permitting the members to be brought to the predetermined spatial relation such, for example, as angular relation between them and a relation ensuring that the finished article has the desired dimensions.

The setting adhesive is conveniently an epoxy resin, such as that made and sold under the name "Aderit Special" by Firma Meynadier. To form a quick setting cement this resin is mixed with quartz sand as an aggregate, substantially in the proportion of one to one by weight.

Other quick setting cements may be employed, particularly those having good fire-resistant or heat-resistant properties.

The present invention is particularly applicable when the members are made of concrete, primarily reinforced concrete. The projecting elements may be made of metal. The hole may be constituted by the bore of a metal tube embedded in the said other member. The surface of said element and the peripheral surface of the hole are desirably such as to provide, at least in part, a mechanical bond between them and the filling.

While it is within the scope of this invention to introduce the adhesive filling into the clearance hole before the projecting element is inserted in the latter, yet preferably the adhesive is introduced into the hole subsequent to the insertion of the projecting element—for example by injecting it into the clearance while in its soft or pasty state by the use of a suitable pressure gun.

The invention is applicable to structural members of a building or other civil engineering structure. In the case of members connected to occupy transverse planes (as in the case of a floor panel and an end-wall-forming member) the members should be connected, at each of a plurality of locations spaced apart in the width-wise direction of these members, by at least two joints according to this invention spaced apart in a direction transverse to said width-wise direction. Specifically the invention provides a structural unit in or for a trans-

portable room element, comprising three initially-separate members, viz a floor panel member and two end-wall-forming members rigidly connected to the panel member one at each of two opposite ends of the latter, wherein the floor panel member is connected to each end-wall-forming member at locations spaced apart width-wise of the panel member by a plurality of joints which are spaced apart transversely to the width of the panel member, each of which joints comprises a projecting element in one of the two members which is received in a clearance hole in the other of the two members, and an adhesive filling, primarily one consisting of an aggregate in a matrix of a setting adhesive, occupying the clearance between said element and the peripheral surface of its hole and having a bond with said element and surface.

The projecting elements are preferably provided in the panel member, and although it is within the scope of this invention to dispose the end-wall-forming members on top of the panel member so that underneath surfaces of the end-wall-forming members are presented to the upper surface of the panel member (in which case the elements are preferably provided on the end-wall-forming members and project downwards into the clearance holes which are formed in the panel member), yet in the preferred construction of structural unit the panel member is disposed between the end-wall-forming members with its end faces presented to the inner faces of the end-wall-forming members, the projecting elements project from said end faces of the panel, and the clearance holes in which said elements are received are formed in the end-wall-forming members.

In order that the invention may be better understood reference will now be made to the accompanying drawings, in which:

FIGURE 1 is the sectional view showing the joint between two structural members at, for example, the corner of a room element;

FIGURE 2 is a section taken on the line A—A in FIGURE 1;

FIGURE 3 is a section taken on the line B—B in FIGURE 1;

FIGURE 4 is a perspective view of the two components prior to their being brought together;

FIGURE 5 is a perspective view of a joint suitable for use in a structural unit for a transportable room element while;

FIGURE 6 is an exploded view of a structural unit incorporating joints according to this invention.

In the construction shown in FIGS. 1–5 of the drawings the components **1** and **2** may be respectively the floor plate or panel and an upright of an end frame (i.e. an end-wall-forming member) of the wall of a transportable room element and particularly the floor and end frame of a building unit according to patent applications Nos. 3,020/63 and 39,914/63. This is illustrated in FIG. 6 which shows a structural unit, for a transportable room element, comprising three initially-separate members, viz the floor panel **1** and two end-wall-forming members **2'** rigidly connected to the panel one at each of two opposite ends of the latter, each member **2'** consisting of two uprights **2** connected at the top by a cross member **2***a*. The components **1** and **2** (or **2'**) are desirably made of reinforced concrete and may, if necessary, be prestressed.

The floor component **2** contains (at each of two locations spaced width-wise of said component) two rods **3** and **4**, the ends of which project at opposite end faces of the component. These projecting ends constitute the projecting elements aforesaid. There are two rods **3** and **4**, one near the upper surface and one near the lower surface of the floor component **1** because the joint is assumed to have to withstand the moments e.g. due to winds acting upon the building in opposing directions. Thus, one of the two rods will be under tension, and the other under compression, depending on the wind direction, or on the direction in which any other force acts upon the building. Normally due to the weight of the floor plate **1**, together with its dead and live load, in use the rod **3** will be under tension.

The component **2** is provided with two clearance holes **11** for receiving the protruding ends of the rods **3** and **4** and the clearance between the peripheries of these protruding ends when received in the holes and the peripheral surfaces of the holes is filled with an adhesive filling (or quick setting cement) **6** consisting of a mixture of an aggregate (such as quartz sand) in a matrix of a setting adhesive (such for example, as an epoxy resin). Other quick setting cements may be employed, particularly those having good fire-resistant or heat-resistant properties. It will be appreciated that the provision of the clearance provides for considerable latitude in the relative positioning of the two components, and although in the drawing the protruding ends of the rods are shown as being concentrically disposed within the holes, this is for the sake of illustration only and in practice the rods will not necessarily be concentrically disposed in the holes.

Since the adhesive filling must make an effective bond between the protruding ends of the rods and the surfaces of the holes, the surfaces of the holes are suitably shaped or roughened so as to assist in such a bond, and in particular so as to produce, at least in part, a mechanical bond. Thus, in FIGS. 1 and 3 the holes are shown as being provided with a groove or grooves into which the cement may key. Alternatively, the holes may be stepped or tapered. The protruding ends of the rods are likewise formed to facilitate the bond. For example, the rods may be of square cross-sectional shape but may be twisted. The holes may be formed by metal tubes cast into the member **2**.

Desirably there is a small gap between adjacent faces of the two components. This gap permits the two components to be adjusted into the desired relationship before the joint is completed and when this relationship has been achieved the gap is filled with the adhesive filling as indicated at **5**. The adhesive filling may be sandwiched between two metal plates **7** and **8** which are welded to the reinforcement rods **9** and **10** of the two components. If such plates are provided their adjacent surfaces are preferably slightly corrugated or roughened so as to provide a better key with the adhesive filling.

Each rod should be cemented into its hole over a length corresponding to about twelve times its approximate diameter. The minimum thickness of the annular layer of adhesive filling surrounding each protruding rod and of the layer **5** is preferably about 3 mm.

It is of course important that, in order to provide a locked joint between members **1** and **2** when disposed as shown, there shall be two protruding rods **3**, **4** spaced apart height-wise of these members. The distance between the centres of these rods should be as great as possible within the limits imposed by the vertical thickness of floor panel **1** and having regard to the fact that these rods and their clearance holes be adequately buried in members **1**, **2** so as to prevent their breaking-out. Desirably, this distance is not less than 20 cm. In a specific example of a joint between the floor plate and the U-like end wall element according to patent applications Nos. 3,020/63 and 39,914/63, the following dimensions may apply:

Minimum width, a, of upright 2=16 cm.

Minimum distance between centres of rods=$b=c/2$ (c being the thickness of the floor plate).

Minimum distance of centres of rods from top and bottom of floor plate, $d=5$ cm.

Sectional dimensions of rods 2.7 x 2.7 cm.

It will be noticed that the underneath surfaces of the uprights **2** protrude below the underneath surface of the panel.

There should be a joint arrangement, as illustrated in FIGS. 1–4 or FIG. 5, at each of at least two locations

spaced width-wise of panel 1 to the maximum practicable extent so that, viewing in plan a unit such as is shown in FIG. 6, there is a joint arrangement adjacent each corner.

In the joint shown in FIG. 5, each of the projecting elements 3, 4 consists of two rods respectively numbered 3*a*, 3*b*, 4*a*, 4*b*. Rods 3*a*, 3*b* are arranged side-by-side while rods 4*a*, 4*b* are arranged one above the other, but this is a matter of convenience. The clearance holes **11** are provided by the fluted bores of tubular metal liners **12** cast into the member **2**.

In this joint, the dimensions may be as follows:

a=16 cm.
b=25 cm.
c=35 cm.
d=5 cm.

Referring to FIG. 6, it will be appreciated that the floor panel **1** is connected to each end-wall-forming member **2'** at a plurality of locations spaced apart width-wise of the panel by a plurality of joints according to this invention which are themselves spaced apart transversely to the width of the panel member **2'**.

In the illustrated example there are two such locations, and at each location there are two joints. Since the floor panel **1** is disposed between members **2'** with its end faces (from which elements **3**, **4**, protrude) presented to the inner faces of members **2'**, at each location the two joints are spaced apart height-wise of members **1** and **2'**. The arrangement is preferably such that the underneath surfaces of members **2'** protrude below the underneath surface of member **1**.

The vertical spacing between the centres of projecting rods **3**, **4** is determined by the vertical depth of the floor panel **1** and can vary between x—10 cm. and $\frac{1}{2}x$, where x is the vertical depth of the floor panel. The horizontal spacing between the protruding rods should be as great as is practicable; it chiefly depends upon the design of the floor panel **1** and of the lower ends of uprights **2** and may vary between y—16 cm. and $\frac{2}{3}y$, where y is the width of the panel. It is, of course, desirable that the protruding rods **3**, **4** shall be substantially aligned with the vertical centre lines of the uprights **2**.

What we claim is:

1. A structural unit for a transportable room element comprising a floor panel member, two end members disposed at opposite ends of the floor panel member with the end faces of the floor panel member being presented to the inner faces of the end members and the said faces of the members being spaced apart to form a gap between them, rigid joints connecting the end members to the floor panel member at locations spaced-apart widthwise of the floor panel, each joint including a projecting element on one of the members, a clearance hole in the other of the members, and a setting adhesive filling occupying the clearance between and forming a connection between the projecting elements and the peripheral surface of the hole, and an adhesive filling material occupying the gap between the said faces of the members and forming a bond with them to supplement the rigid joint in securing the floor panel member and end members together to form a load-carrying unitary structure and affording precise relative location of the members at predetermined dimensions and angular relationships.

2. A structural unit according to claim **1** wherein the projecting element projects from the end faces of the floor panel member and clearance holes in which the projecting elements are received are formed in the end members.

3. A structural unit according to claim **1** wherein the projecting elements and the clearance holes receiving them are aligned generally perpendicular to the major planes of the respective end members.

4. A structural unit according to claim **1** wherein there are at least two joints between the floor panel and each end member at each of the said widthwise spaced-apart locations, the two joints being spaced from each other and lying in a common generally vertical plane.

5. A structural unit according to claim **4** wherein each of the said two joints is spaced at least five centimeters from the nearer surface of the floor panel.

6. A structural unit according to claim **4** wherein the vertical spacing between the said two joints is at least twenty centimeters.

7. A structural unit according to claim **4** wherein the floor panel has a thickness A, and wherein the vertical spacing between the said two joints is between the value of A minus ten centimeters and the value of A divided by two.

8. A structural unit according to claim **4** wherein the projecting element is a rod of generally circular cross-sectional shape and the rod and clearance holes have axial lengths of about twelve times the diameter of the rod.

9. A structural unit according to claim **4** wherein the said end face of the floor panel member is formed in the region surrounding each pair of joints with a lower undercut portion and the opposed face of each end member is formed with a companion projection received in the undercut, whereby the projection on the end members provides vertical bearing support for the floor panel member.

10. A structural unit for a transportable room element comprising a reinforced concrete floor panel member, two reinforced concrete end members disposed at opposite ends of the floor panel member with the floor panel member being disposed between the end members with its end faces presented to the lower ends of the inner faces of the end members, and two pairs of rigid joints connecting each end member to the floor panel member, the two pairs of joints at each respective end member being spaced-apart transversely of the floor panel member, the joints of each pair being spaced-apart from each other and disposed one over the other in a generally vertical plane, and each joint including a reinforcing rod projecting from one of the members, a clearance hole in the other of the members, the rod and hole being aligned axially substantially perpendicular to the major planes of the end members, and a setting adhesive filling occupying the clearance between and forming a bond with both the reinforcing rod and the peripheral surface of the clearance hole.

11. A structural unit according to claim **10** wherein the opposed facing surfaces of each end member and of the floor panel member are spaced apart, and wherein the setting adhesive filling occupies the gap between the said faces and bonds them together.

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HENRY C. SUTHERLAND, Primary Examiner

U.S. Cl. X.R.

52—259, 285, 432, 585

PO-1050
(5/69)

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,473,273 Dated October 21, 1969

Inventor(s) Dietrich Gunkel

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 42, before "is" delete the apostrophe -- ' --;

Column 5, line 57, (claim 1) "elements" should be -- element --;

Column 6, line 22, (claim 8) "holes" should be -- hole --;

The references listed below have been omitted from the list of references cited:

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SIGNED AND
SEALED
MAY 12 1970

(SEAL)
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