

[54] **BUILDING CONSTRUCTION AND PROCESS FOR PRODUCING STRUCTURAL ELEMENTS FOR SUCH CONSTRUCTION**

[76] Inventor: **Paul Artmann**, Maingstrassa 38, Vienna 13, Austria

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Related U.S. Application Data

[63] Continuation of Ser. No. 849,343, Aug. 12, 1969, abandoned.

[52] U.S. Cl. **52/417, 52/432, 52/438, 52/587**

[51] Int. Cl. **E04b 2/34**

[58] Field of Search **52/432, 438, 587, 234, 52/417, 486, 437, 309**

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Primary Examiner—Henry C. Sutherland

Attorney, Agent, or Firm—Waters, Roditi, Schwartz & Nissen

[57] **ABSTRACT**

A building construction is provided in which walls are

formed of prefabricated elements. These elements consist of standard elements of predetermined width and fitting elements of substantially lesser width. The standard and fitting elements are provided with identical joint configurations so that the elements can be connected together to form walls of discrete length. A common integral and joint-free facing layer extends as an outer skin over the entire wall surface thus formed. The standard elements constitute at least three-quarters of the total construction, whereas the fitting elements constitute no more than 25 percent of the construction. The elements are provided on their abutting edges with longitudinal recesses which cooperatively form a hollow space into which a sealing compound can be inserted. Moreover, there can be provided steel reinforcements which are extended through these hollow spaces to be anchored in the sealing compound. In addition the invention contemplates the use of brackets having connection with the elements and including loops extending into the aforesaid hollow space so that these loops are anchored in the sealing compound. The loops can be placed in overlapping relationship to form an opening through which a reinforcing rod can be vertically inserted. Moreover, the elements can be provided inside their lateral recesses with a toothed configuration to improve the bond with the sealing compound. In the process of manufacturing such prefabricated elements, a homogeneous mass can be charged into a vibratable mold for forming the supporting body of an element. On the free top surface of this mass there is strewn a dry mixture of fine sand and binder which is bound up by moisture rising from the supporting body. Offsets can be formed in the outer layer.

8 Claims, 18 Drawing Figures

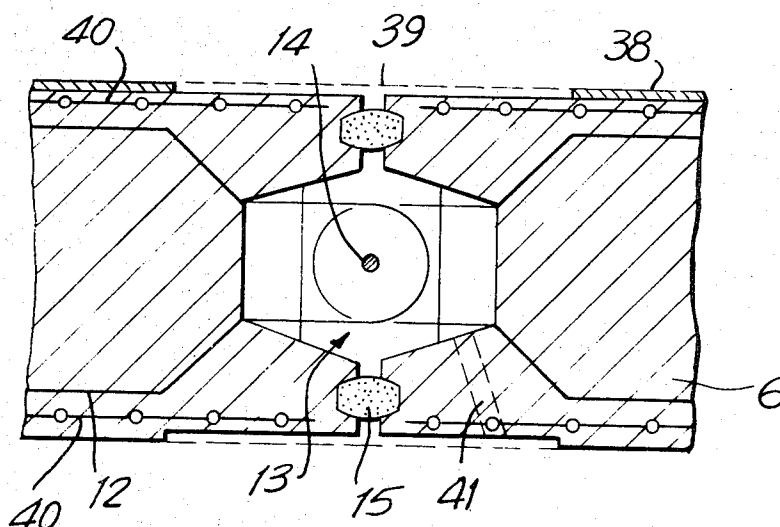


FIG. 1

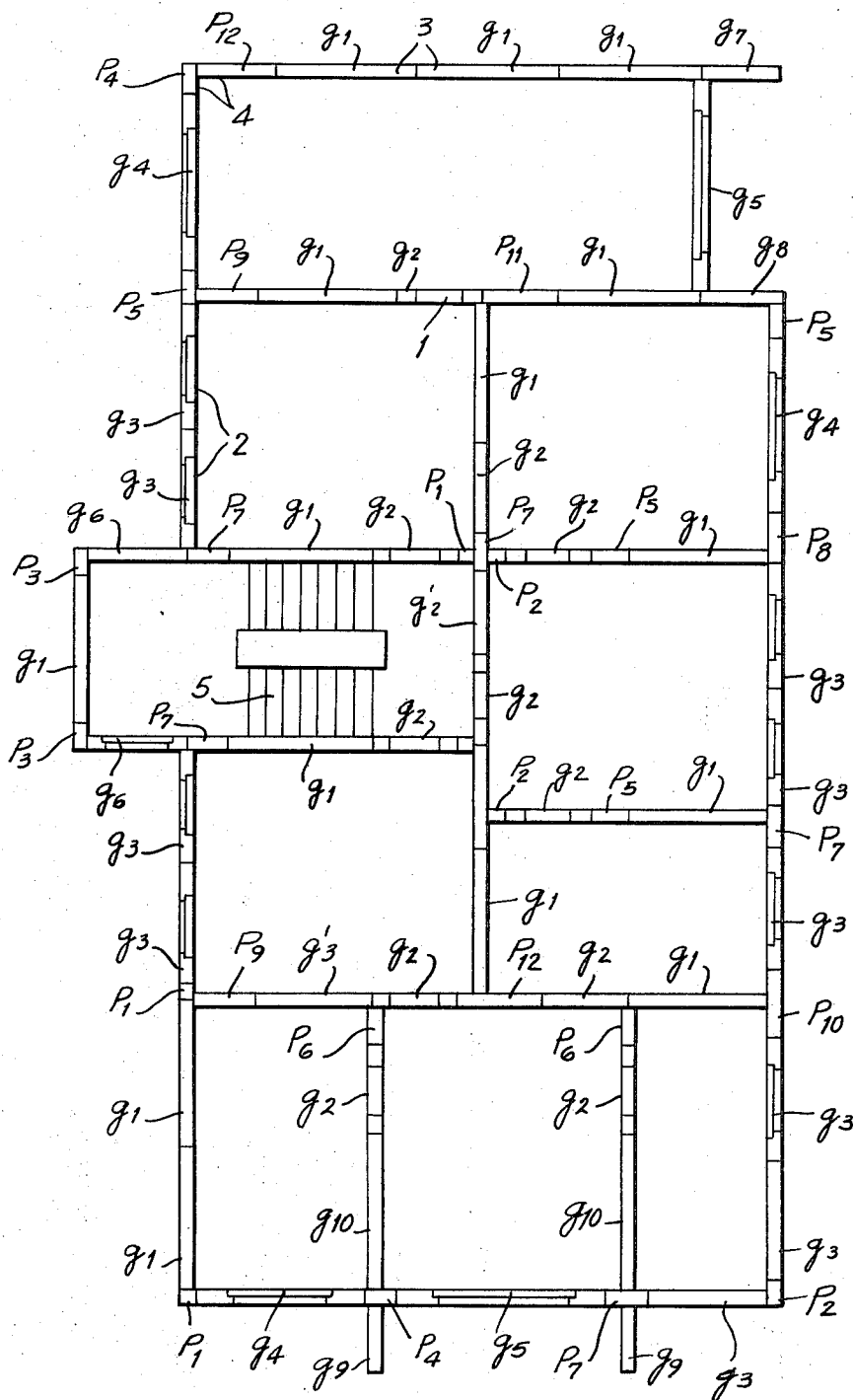


FIG. 2

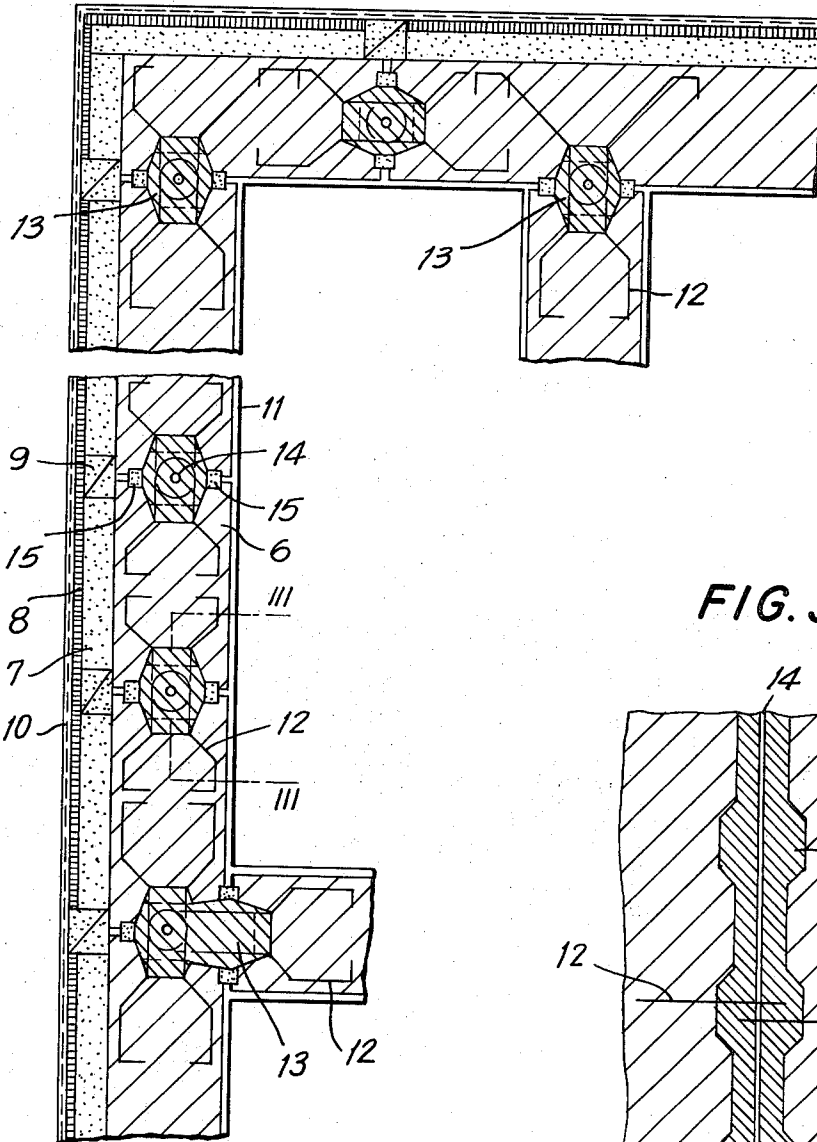


FIG. 3

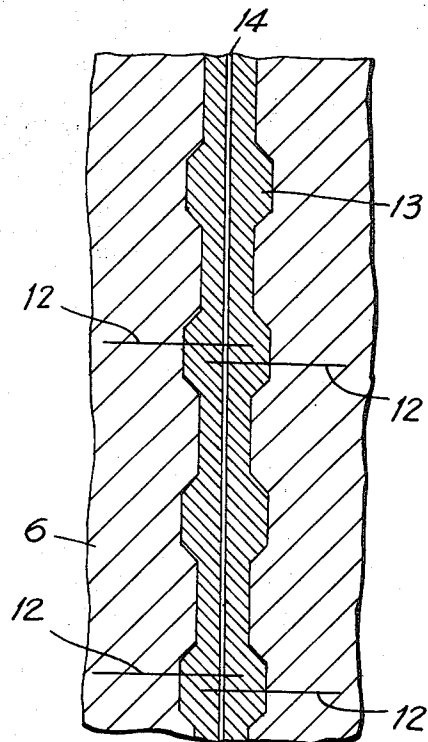


FIG. 4

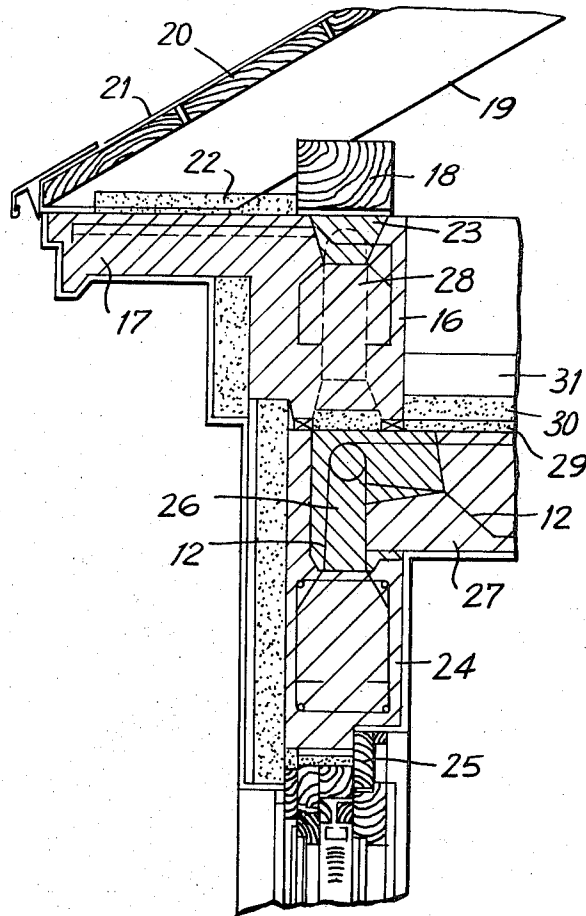


FIG. 5

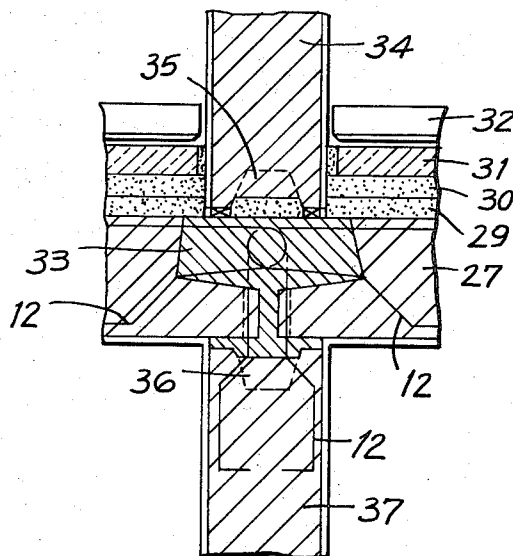


FIG. 6

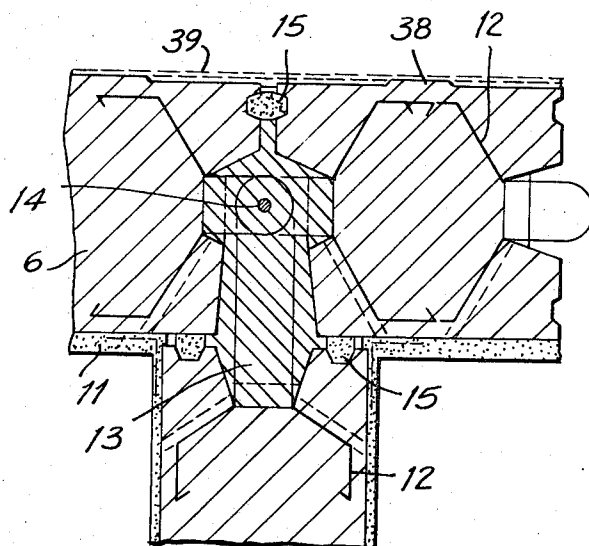


FIG. 7

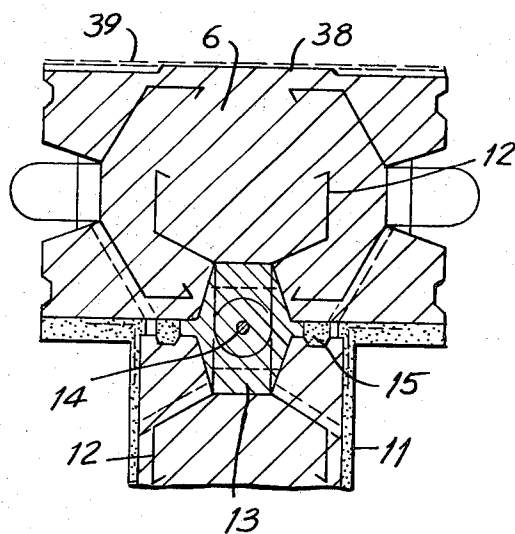


FIG. 8

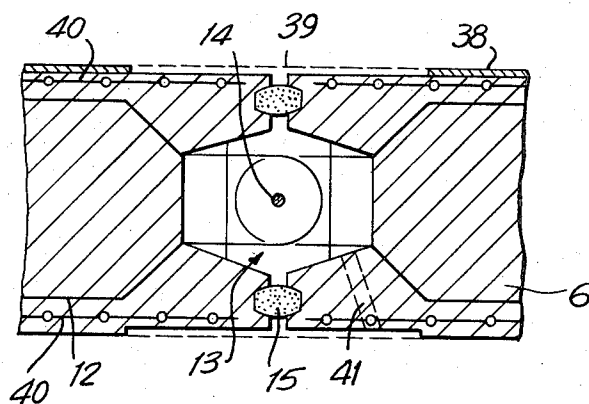


FIG. 9

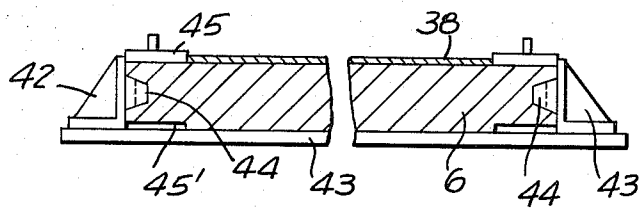


FIG. 10

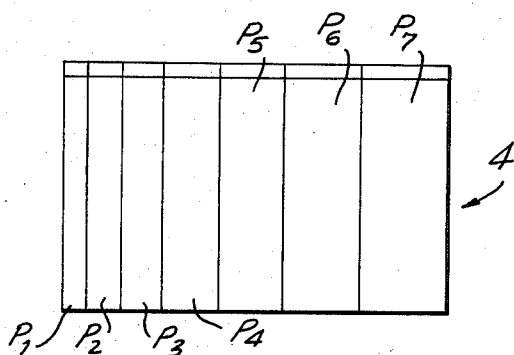


FIG. 11

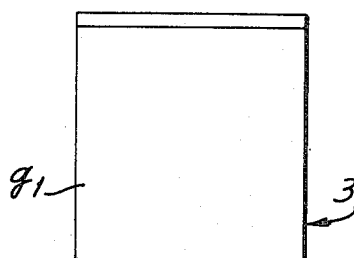


FIG. 12

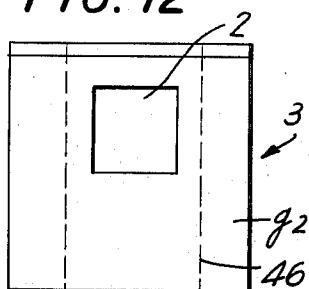


FIG. 14

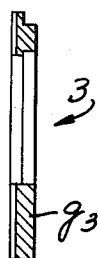


FIG. 13

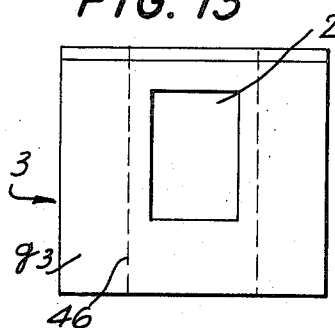


FIG. 15

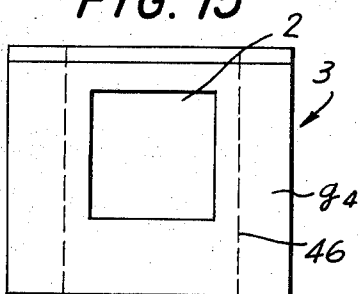


FIG. 16

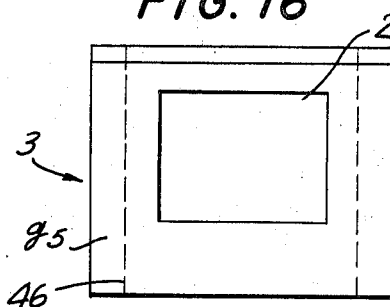


FIG. 17

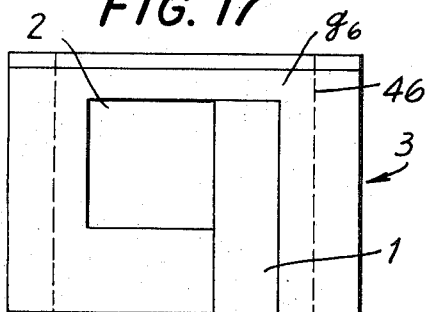
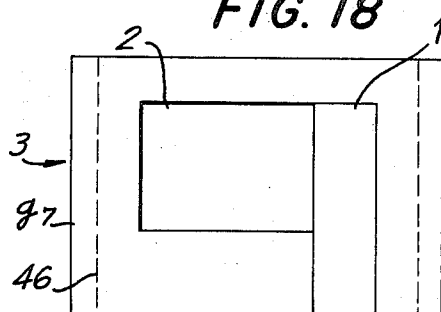


FIG. 18



BUILDING CONSTRUCTION AND PROCESS FOR PRODUCING STRUCTURAL ELEMENTS FOR SUCH CONSTRUCTION

OTHER APPLICATIONS

This is a continuation of application Ser. No. 849,343 filed Aug. 12, 1969 and now abandoned.

DRAWING

FIG. 1 is a ground plan schematic of a building according to the invention;

FIG. 2 is a horizontal cross-sectional view through a number of interconnected wall elements;

FIG. 3 is a vertical cross-sectional view along line III-III in FIG. 2;

FIGS. 4 and 5 show details of the configuration of the building in the form of vertical sections through the wall crown and through the bearing surface for partition walls, respectively;

FIGS. 6-8 show a modified embodiment of the interconnection of two differently configured wall elements;

FIG. 9 shows a mold casing, partially omitted, for producing a wall element according to FIGS. 6-8; and

FIGS. 10-18 show wall elements which, as standard and fitting elements, pertain to a complete system.

DETAILED DESCRIPTION

The invention relates to a building, in which at least the walls consist of pre-fabricated members.

Building with prefabricated members are already known in a great variety of construction systems. Among the many variations, there exist buildings which are put together from space-limiting wall or ceiling components of considerable size and corresponding weight, and in a size roughly corresponding to the size of one building cell, and chosen in consideration of the space division and the more or less uniform cell size of the building according to a predetermined tabulation.

Regardless of the fact that such building elements, on account of their weight and size, require very onerous facilities at the site of construction, so that they can be rationally employed only on large scale construction sites, they do not permit any individualized architectural work so that they are suitable only for the erection of series constructions, but not for individual constructions which should in each case be worked out aesthetically in consideration of the size and shape of the ground site and surroundings.

Additionally, there do already exist buildings which use small prefabricated elements for permitting individually configured constructions. These construction systems, however, all suffer from various disadvantages. For example, there is the necessity of supplying and holding in readiness too many different kinds of structural elements whereby stockkeeping becomes difficult. Also, there is the placing and assembling of these different elements which requires too much time and labor and special craftsmanship. Moreover, building members constituted by such elements do not satisfy structural requirements with regard to static stability or to thermal or sound insulation, especially on account of the creation of too dense a network of butt joints.

An objective pursued by the present invention consists of creating a type of building construction from plantmade prefabricated structural elements, which, on the one hand, are large enough to justify their prefabrication and to limit the need for labor expenditure at the construction site to a minimum and, on the other hand, not so heavy individually, that their utilization would necessitate an extraordinary application of lifting, handling and transportation equipment.

In connection with the above, a further objective of the invention aims at opening up the possibility of utilizing prefabricated-component construction in the erection of residential buildings which are to be individually designed such as, especially, individual homes.

A further object is to provide for developing a construction system for this purpose, which is capable of adapting to the individual's requirements in each case.

Further goals of the invention, in addition to the above, are to provide the outer walls of the building with the necessary capabilities of thermal and noise insulation by appropriate configuration of the structural wall members and their closest possible mutual assembly, in which arrangement the making of the joints shall be as simple as possible and not require special craftsmanship.

Finally, as one of the most important problems requiring solution, the invention assures that the visible outer surface of the completed building walls results in a completely uniform aspect and in fully weather-tight properties without the presence of undesirable gaps for which allowance would have to be made in the architectural design, and without any risk that, for example, due to moisture saturation or to unequal settling the subdivision of the wall would appear in a visual manner on the outside surface, eventually even penetrating through a facing layer.

For this purpose, care is taken to avoid the formation of cold bridges in the area of the butt joints of wall elements and to achieve in these butt-joint areas a thermal insulation and thermal storage capability, possibly equal to that of the wall segments themselves.

All of these objectives of the invention, according to its most essential characteristics, are achieved in that the walls, formed exclusively from story-high elements, consist for the major part of about 75 percent of standard elements, for example, of a width in accordance with a certain tabulation, and for a minor part, not exceeding 25 percent, of so-called fitting elements of considerably lesser width, in which arrangement both the standard and the fitting elements have identical butt-joint configurations, so that they can be assembled to walls of discrete length, and can be covered by an outside facing layer extending integrally over the entire wall surface.

Through this arrangement, it becomes possible, on the one hand, to conserve all the advantages of the large-plate construction system and of the utilization of large-surface wall members provided with prefabricated door and window openings and, on the other hand, not to incur the disadvantages of these construction systems resulting from the rigid servitudes imposed by the grid of a standardized ground plan.

Moreover, with this construction system, it is possible to meet all individual requirements without having to forego the utilization of large-surface construction members which can be rationally produced in a plant at low cost.

On the other hand, through appropriate design and configuration of the individual wall elements, it is not difficult to meet satisfactorily all demands imposed for good building with regard to thermal insulation, noise insulation, and so forth.

In order to avoid major difficulties with transportation and installation the maximum piece weight of the wall elements should not exceed 1,300 to 1,500 kg (2,870 - 3,300 lbs.), whereas the fitting elements are of course much lighter.

This construction system is rational especially if the standard elements have a width B of at least 2.00 m (78.74 inches) and the fitting elements, on the one hand, a width b of at least 25 cm (10 inches) whereas they do not exceed a width b_{max} amounting to approximately one-half of the smallest width B_{min} of the standard elements, i.e. the condition: $b_{max} \leq \frac{1}{2}B_{min}$ must be satisfied.

As previously mentioned, the connection of the wall elements to each other, which must be uniform throughout, is of particular importance and, according to a preferred embodiment of the invention, both the standard and the fitting elements are provided on their bluntly abutting long sides with a recess. The hollow space formed by the recesses of two adjacent wall elements can, for the purpose of joining these elements together, be filled with a sealing compound such as, preferably, concrete.

Moreover, it is very important that a satisfactory flush covering of the joints between the elements is assured, in order to permit the addition of a jointless finishing facing.

According to a preferred embodiment of the invention, this joint covering consists of an elastic carriage material embedded in a bonding base of mortar, for example, a glass fiber fabric which, together with the balance of the visible surface of the elements serves as carrier for the finish facing extending over the entire wall surface and consisting, for example, of a cover layer of mortar.

Numerous further characteristics of the invention, especially relative to the configuration of the individual elements, as well as to their inter-connection, are explained below for the purpose of providing a better understanding, on basis of the drawings, which represent examples of the invention.

In the ground plan schematic of FIG. 1, standard elements 3 of various widths are referenced as g_1 through g_{10} , whereas the fitting elements 4 of various widths are referenced as P_1 through P_{12} .

The large standard elements, in door openings manner in itself known, can be provided with prefabricated dooropenings 1 or window openings 2, as will be explained in greater detail on basis of FIGS. 10-18.

The representation in FIG. 1 shows very clearly that, with the aid of only a few fitting elements 4 ($P_1 - P_{12}$), it becomes possible to realize individually any desired wall length and any desired building ground plan, even with stair wells 5, without having to forego the extensive and predominant utilization of large standard elements 3 ($g_1 - g_{10}$). In the example shown, the surface area quota of the standard elements amounts to more than 83 percent.

It is important, as already emphasized, that the interconnection of individual standard and fitting elements be homogeneous. This interconnection, which will be

explained hereinafter uses a sealer or filling component incorporated into the butt joint.

In FIG. 2, there are represented in a horizontal section two walls abutting to form a corner, each of which consists of a number of standard and fitting elements 3 or 4 together with the associated wall connections. All of these, without exception, are wall elements consisting of several different materials, namely, of a supporting body of light-weight concrete or a similar material and of two insulating outer layers 7 and 8 arranged on the outer wall side. The one layer 7 may, for example, consist of foamed resin. The other layer 8 may consist of fiberboard, for example, wood fiber hard board. In the butt-joint area of the layers 7 and 8, there are wedge-shaped compensating pieces 9 in contact with each other and which preferably consist of the material of layer 7 and are thus of foamed resin.

The joint-free facing, which extends over the entire wall surface, is referenced as 10 and consists of a cement-plastics mortar. This facing 10 contains, as its carrier, an elastic fiber fabric or felt such as, for example, a glass-fiber felt. In cases where this facing forms part of the prefabricated wall element and, at the construction site, is only completed in the butt-joint areas of the wall elements, it is advantageous to arrange the fabric liners overlapping on all sides, whereupon they are jointly coated with a bonding course. For this purpose, the fabric liner protrudes on all sides over the rims of the individual prefabricated wall elements in order to let them overlap each other in installation, whereafter they can receive the outer facing.

On the inner side of the wall, there is likewise provided a jointless facing 11, which may consist of a fine stucco-mortar or a similar material.

The material forming the supporting body 6 of the individual elements advantageously consists of a light-weight concrete, the fine components of which are constituted by one third each of fine sand, brick chips of up to 5 mm. (0.2 inch) grain size and of brick flower of up to 2 mm. (0.08 inch grain size). The coarser aggregate, the total dosage of which corresponds to at least one-half by volume, consists preferentially of granulated material having a glassy, sintered, porous surface, preferably bloated clay, in 5 - 20 mm. (0.2 inch - 0.8 inch) granulation.

The individual wall elements 3 and 4 (standard and fitting elements) are all provided with bracket-shaped reinforcing wires 12 which form single loops on the long sides of the element which protrude into the hollow butt-joint recesses. Moreover, the wall elements may be reinforced across their broadsides with structural steel mesh.

On their face-to-face long sides, all adjacent wall elements, regardless of whether they are standard elements 3 or fitting elements 4, possess a longitudinal recess which is completed by its facing counterpart to form a hollow space for filling with a hard-setting material such as, for example, a sealing compound 13 of concrete or a similar material. The loops of the bracket-shaped reinforcing wires are anchored in this sealing compound 13, in which arrangement on rod 14 placed at the center of the joint recess traverses all wire loops vertically, securing the anchoring of the wall elements in the filler or sealing compound of the joints, whereas this rod 14 may also be used for stoking, jolting and vibrating the sealing compound as a help for its introduction and compaction.

The hollow space, which receives the sealing compound 13, is closed off on both sides by insert strips 15 of an insulating material placed into notches so that the sealing compound, applied in fairly liquid state, cannot flow out through the butt joints.

FIG. 2 shows various kinds of elements such as, at the top left, a fitting element configured as a corner element, on which one of the recesses destined for forming a joint hollow is arranged on one of the long-side rims, as usual, whereas the other recess is on the long side itself. FIG. 2 further shows at the top right a standard element which, in addition to the two recesses along its side rims, also has a lateral recess along its side for accommodating a partition wall. Finally, in the bottom left of FIG. 2 there is additionally shown a partition wall connecting up with a butt-joint of the outer wall. In order that a common hollow space can be formed, the recesses between the two wall elements abutting together in the same plane are open on one side, and the hollow space, in this case, is formed by the recesses of all three abutting wall elements.

FIG. 3 is a longitudinal section through a butt-joint of the wall shown in FIG. 2 and shows the tooth-like configuration inside the recesses of two adjoining elements. This tooth-like configuration assures an extremely intimate bond between the sealing compound 13 of the hollow space with the adjacent elements and thus securely prevents unequal setting and vertical displacements of the adjacent wall elements relative to each other. Both the standard elements and the fitting elements are provided with this tooth configuration.

In FIG. 4, a special prefabricated element 16 is provided as a wall crown which includes a jutting out eaves portion 17 and which carries the base purlin 18 of the roof framing of which a spar 19, the roof boarding 20 and the roof covering 21 can be seen in this Figure. An insulating plate 22 made of foamed resin covers the prefab wall-crown element 16 at the top. A concrete filler 23 below the base purlin 18 of the roof framing serves for reinforcement and inter-connection of these prefabricated elements 16.

The wall element 24 shown in FIG. 4 is an element of the type provided with a window opening and carrying a built-in sash frame 25. A concrete filler 26 forms a continuous capping of the wall, the connection of same to the adjoining ceiling consisting of light-weight concrete prefabricated elements 27.

The concrete-filler areas 23 and 26 are monolithically inter-connected by the recesses 28, indicated by dotted lines, of the wall-crown prefabricated element 16. The ceiling carries a compensating layer 29 of sand and a footstep insulating layer 30, as well as a special finish flooring 31. The ceiling elements 27 are prestressed by means of their reinforcing steel.

According to FIG. 5, such a ceiling likewise consists of light-weight concrete elements 27 and carries, in addition to the layers enumerated above, a floor covering 32.

On this ceiling, and specifically on top of a reinforced concrete filler 33 poured in between two neighboring ceiling elements 27, there is supported a partition-wall element 34, the bottom rim of which is provided with a toothed configuration 35 similar to that of the wall elements in their side-rim recesses. Moreover, the ceiling, below these partition-wall elements 34, is supported by a similar partition wall 37 which, on its upper rim, also possesses a toothed recess 36. Bracket-shaped

reinforcing wires 12 are provided on all ceiling elements 27 and in the partition-wall elements 34 and 37 and protrude, as in the case of the outer-wall elements, into the concrete fillers in which they are anchored.

The slightly modified wall elements according to another embodiment of the invention shown in FIGS. 6-8 have a supporting body consisting essentially homogeneously of a light-weight concrete of the kind described previously, which has only on the outer surface a thin facing 38 consisting of a resin-cement mortar. This facing layer forms in the rim areas of both long-side surfaces of the wall plate an offset of about 10 cm. (4 inches) width towards both sides, i.e. for a total of about 20 cm. (8 inches). For the purpose of permitting a joint-free coating of the entire wall surface, this offset is filled with a bonding base, for example, also with cement mortar, or similar material or, on the inner side of the wall, with a stucco mortar. This joint is covered by an elastic carrier 39 consisting, for example, of a fiberglass felt. Thereafter, the joint-free coating for the entire wall surface can be applied.

When the standard and fitting elements consist of several layers of different materials, i.e. in the case of elements consisting of a supporting body covered on one or both sides by one or more insulating layers, the offset (step) can, at least on one of the visible surfaces, be formed by the outermost layer not extending all the way to the rim.

In addition to the bracket-shaped reinforcements 12, the individual wall elements may also possess a reinforcement 40 extending over their broadsides and consisting of structural steel mesh or equivalent material. Inside their blunt butt-joint surfaces, these wall elements are each provided with a notch serving to accommodate the insulating strip 15 which bridges the butt-joint and closes off the hollow space formed by the recesses of the two adjoining elements, which are to be filled with the sealing compound 13.

At varying height, the wall elements are provided with channels 41, indicated by broken lines in FIG. 8, which connect the recesses to be filled with sealing compound to one of the outer side surfaces of the wall formed by the elements so that during installation the filling of the recess hollow with the poured-in, preferably highly liquid, sealing compound can be supervised and the filling level ascertained through these channels.

FIG. 9 finally shows a device, for producing a wall element according to FIGS. 6-8, consisting of a mold casing which can be vibrated and which possesses laterally displaceable casing walls 42 attached to the casing base 43, as well as inwardly protruding, profiled projections 44, which serve for producing the longitudinal-rim recesses of the wall elements.

Immediately after pouring the homogeneous mass intended for forming the supporting body of the wall element into this vibratable mold casing, the free upper surface of this mass is strewn with a dry mixture of fine sand and binder over an area limited by laterally applied upper-rim rails 45. This mixture absorbs the moisture rising up out of the support-body mass during vibration of the mold, is bonded together by this moisture and becomes intimately bound to the mass of the support body, while offsets are being formed in the areas of the upper and lower rim rails.

For producing compound wall elements composed of various layers, such an insulating layer, prefabricated, can be placed on the base of the mold casing prior to

the pouring of the concrete with which it becomes intimately combined during vibration.

In conclusion, FIGS. 10-18 demonstrate the manner in which a kit of standard and fitting elements 3 and 4 can be constituted for the realization of outer walls. In this example, however, the elements used are not the ones shown in FIG. 1, but correspond to a different embodiment comprising seven fitting elements $P_1 - P_7$, and seven standard elements $g_1 - g_7$, some of which are provided with door openings 1 or window openings 2. The fitting elements have widths b of 25, 37.5, 50, 62.5, 75, 82.5, and 100 cm. (equal approx. to 10, 15, 20, 25, 30, 35 and 40 inches), the standard elements widths B of 2.50, 2.75, 3.00, 3.25, 3.50, 4.00 and 4.25 m (= approx. 100, 110, 120, 130, 140, 160 and 170 inches). This kit makes it possible to constitute outer walls having always approximately the same piece weight of 1,500 kg (3,300 lbs.) for a total thickness of 21 cm. (0.83 inches). The possibilities of variations are so numerous, that it is actually possible with this kit of wall elements to constitute buildings of any ground plan desired. The dotted lines 46 in FIGS. 10-18 show what minimum width an element provided with door or window openings must possess in order to have a sufficient carrying capacity.

What is claimed is:

1. A building comprising walls including juxtaposed story-high and homogenous prefabricated elements of light concrete, said elements having outer and facing surfaces and being provided on the facing surfaces and along their entire height with recesses having facing openings, cast-in-situ concrete partly filling said recesses and constituting a rigid connection between adjacent of said prefabricated elements to form an assembly, said connection having outer surfaces, means for sealing the outer surfaces of said connection, rigid insulating inserts, said cast-in-situ concrete being shielded on the outer surfaces thereof by said rigid insulating inserts which also provide for the shaping of the cast-in-situ concrete and for maintaining a uniform thermal insulation within the assembly, said inserts being fitted into grooves extending transversely of the facing surfaces of the prefabricated elements, the prefabricated elements being of selected predetermined widths and being adapted for being assembled to form building walls of optional length, having edges and being provided with recesses extending along said edges, groove covers, each common to adjacent of said prefabricated elements, inserted in the latter said recesses, a jointless surface coating covering surfaces of the prefabricated elements and said groove cover and a layer of foamed resin between said surface coating and said elements.

2. A building as claimed in claim 1 further comprising fiberboard between said surface coating and said elements.

3. A building as claimed in claim 1 wherein said surface coating includes a fabric carrier.

4. A building as claimed in claim 1 wherein said surface coating includes a glass-fiber felt.

5. A building comprising walls including juxtaposed story-high and homogenous prefabricated elements of light concrete; said elements having outer and facing surfaces and being provided on the facing surfaces and along their entire height with recesses having facing openings, said elements including a toothing within said facing openings, cast-in-situ concrete partly filling said

recesses and constituting a rigid connection between adjacent of said prefabricated elements to form an assembly, said connection having outer surfaces, means for sealing the outer surfaces of said connection, rigid insulating inserts, said cast-in-situ concrete being shielded on the outer surfaces thereof by said rigid insulating inserts which also provide for the shaping of the cast-in-situ concrete and for maintaining a uniform thermal insulation within the assembly, said inserts being fitted into grooves extending transversely of the facing surfaces of the prefabricated elements, the prefabricated elements being of selected predetermined widths and being adapted for being assembled to form building walls of optional length, having edges and being provided with recesses extending along said edges, groove covers, each common to adjacent of said prefabricated elements, inserted in the latter said recesses, and a jointless surface coating covering surfaces of the prefabricated elements and said groove cover.

6. A building comprising walls including juxtaposed story-high and homogenous prefabricated elements of light concrete, said elements having outer and facing surfaces and being provided on the facing surfaces and along their entire height with recesses having facing openings, cast-in-situ concrete partly filling said recesses and constituting a rigid connection between adjacent of said prefabricated elements to form an assembly, bracket-shaped reinforcing wires in said facing openings and anchored in said prefabricated elements, said reinforcing wires facing alternately in opposite directions and including overlapping loops, a rod in said facing openings extending through said loops, said connection having outer surfaces, means for sealing the outer surfaces of said connection, rigid insulating inserts, said cast-in-situ concrete being shielded on the outer surfaces thereof by said rigid insulating inserts which also provide for the shaping of the cast-in-situ concrete and for maintaining a uniform thermal insulation within the assembly, said inserts being fitted into grooves extending transversely of the facing surfaces of the prefabricated elements the prefabricated elements being of selected predetermined widths and being adapted for being assembled to form building walls of optional length, having edges and being provided with recesses extending along said edges, groove covers, each common to adjacent of said prefabricated elements, inserted in the latter said recesses, and a jointless surface coating covering surfaces of the prefabricated elements and said groove cover.

7. A building as claimed in claim 6 comprising insulating strips extending being adjacent of said elements and cooperatively isolating said facing recesses.

8. A building comprising walls including juxtaposed story-high and homogenous prefabricated elements of light concrete, said elements having outer and facing surfaces and being provided on the facing surfaces and along their entire height with recesses having facing openings, cast-in-situ concrete partly filling said recesses and constituting a rigid connection between adjacent of said prefabricated elements to form an assembly, said connection having outer surfaces, means for sealing the outer surfaces of said connection, rigid insulating inserts, said cast-in-situ concrete being shielded on the outer surfaces thereof by said rigid insulating inserts which also provide for the shaping of the cast-in-situ concrete and for maintaining a uniform thermal insulating within the assembly, said inserts being fitted

9

into grooves extending transversely of the facing surfaces of the prefabricated elements, the prefabricated elements being of selected predetermined widths and being adapted for being assembled to form building walls of optional length, having edges and being provided with recesses extending along said edges, groove covers, each common to adjacent of said prefabricated

10

elements, inserted in the latter said recesses, a jointless surface coating covering surfaces of the prefabricated elements and said groove cover, insulating layers in sections between said surface coating and said elements and wedge-shaped compensating pieces between said sections.

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