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BUILDING CONSTRUCTION

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Fig. 1.

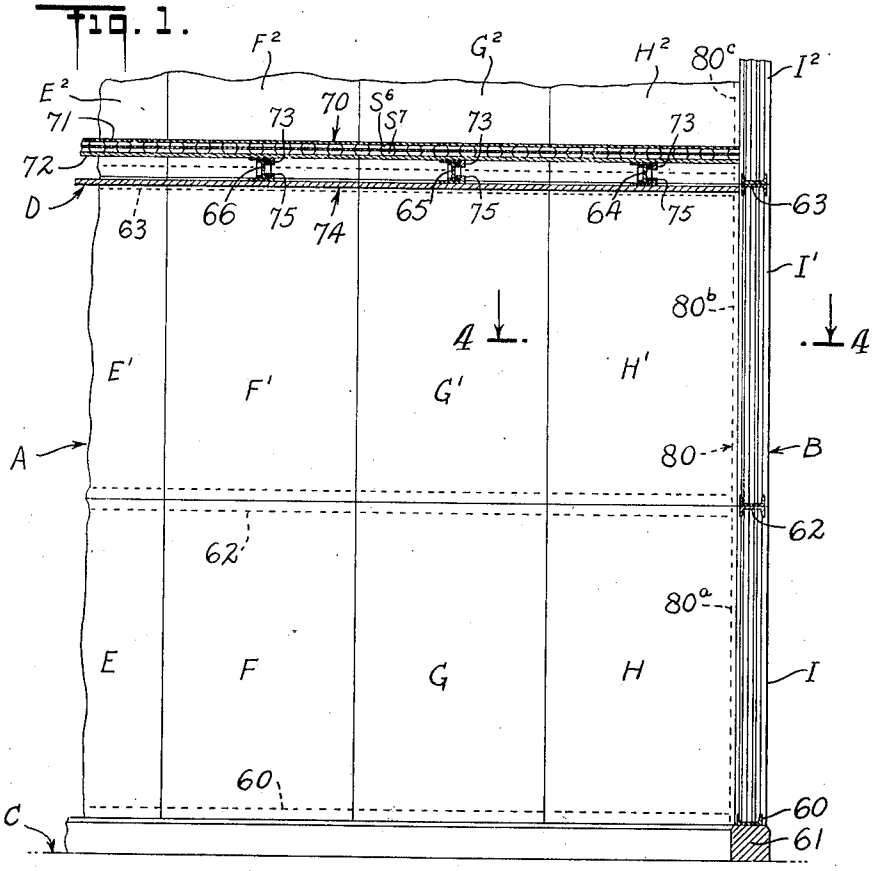


Fig. 2.

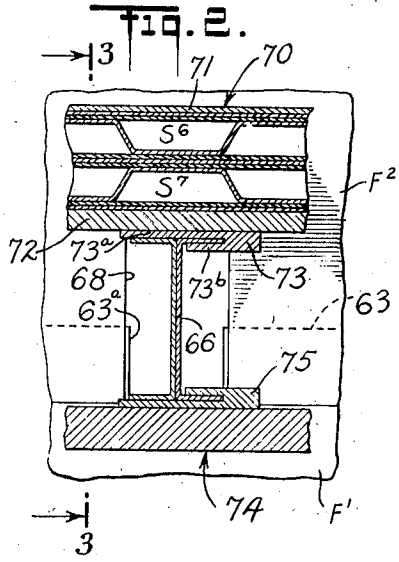
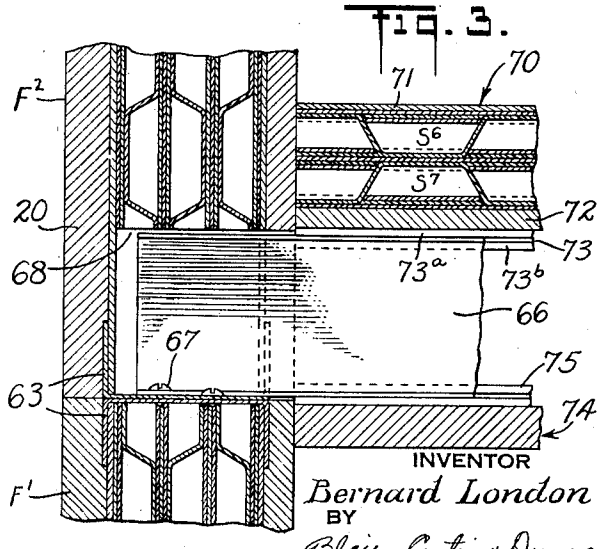


Fig. 3.



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Fig. 4.

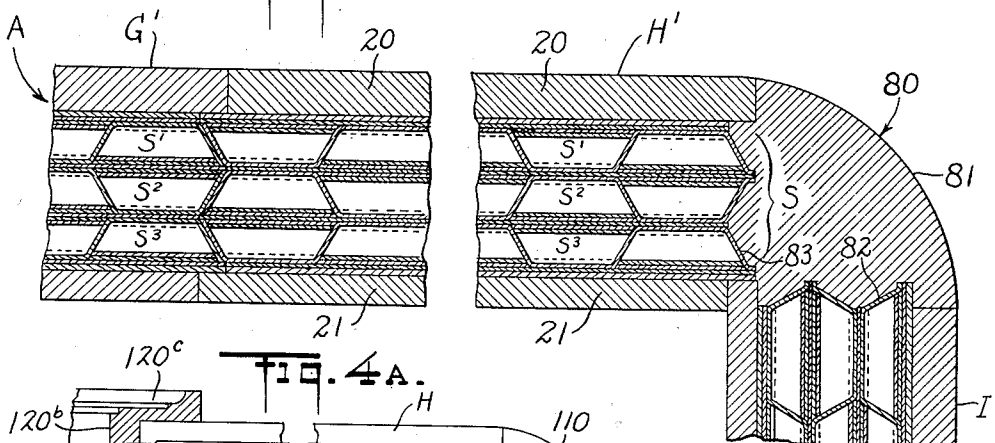


Fig. 4A.

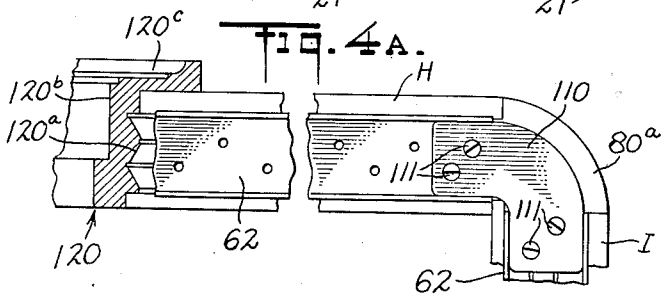


Fig. 5.

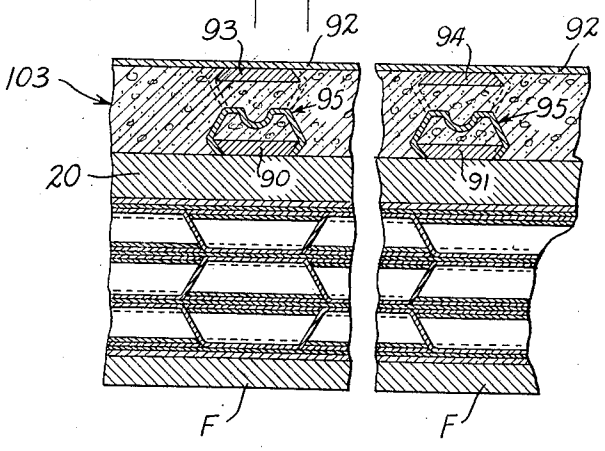
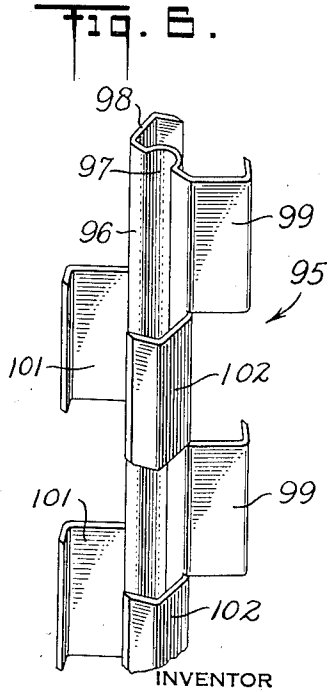


Fig. 6.



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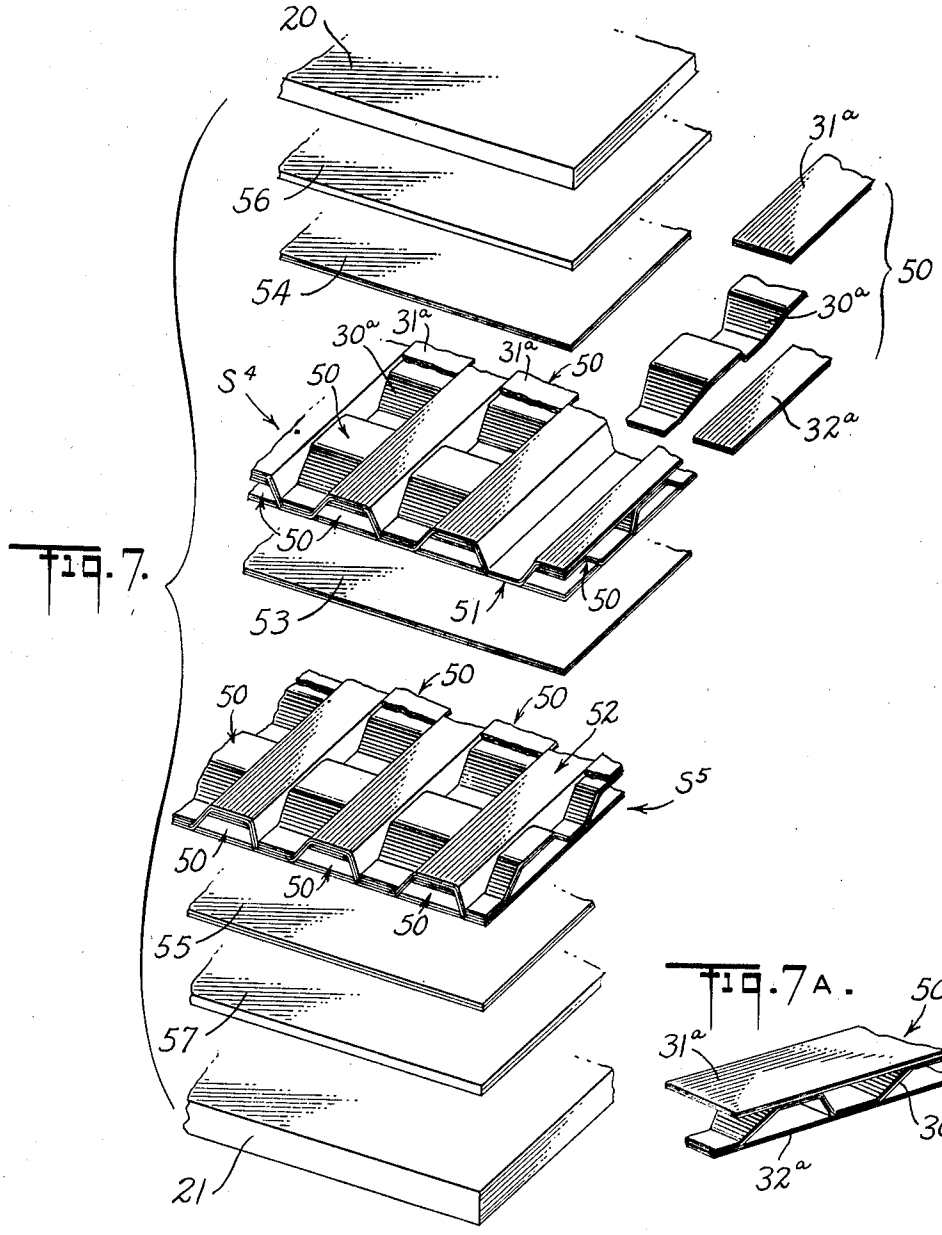


Fig. 7.

Fig. 7A.

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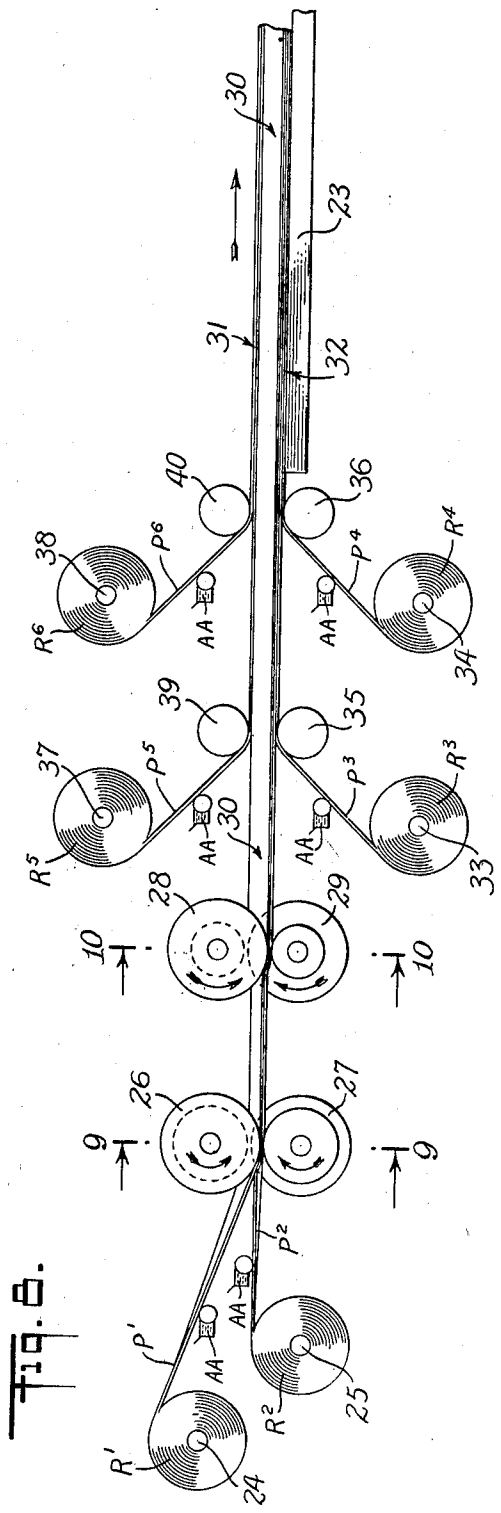


Fig. 8.

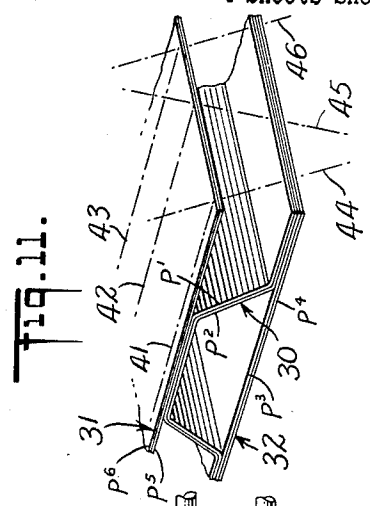


Fig. 11.

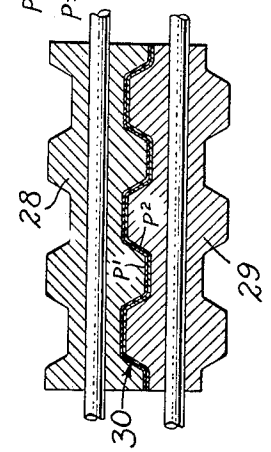


Fig. 10.

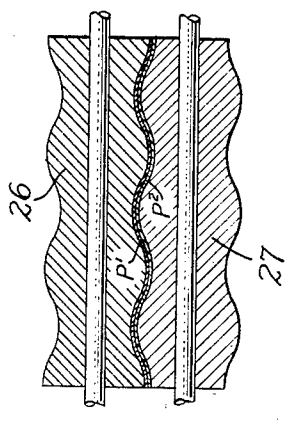


Fig. 9.

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UNITED STATES PATENT OFFICE

2,122,479

BUILDING CONSTRUCTION

Bernard London, New York, N. Y.

Application May 25, 1935, Serial No. 23,369

9 Claims. (Cl. 154—28)

This invention relates to building construction.

This application is a continuation in part of my application Serial No. 752,969, entitled "Building construction", filed November 14, 1934 and one of the dominant aims of this invention is to improve upon certain features of the building construction therein disclosed and particularly to provide a simple and less expensive method of constructing building units of the general character disclosed in my aforesaid application.

Another object of this invention is to facilitate the construction of fire-resistant, water-proof, sound-proof and heat-insulating building construction units or building units, and particularly to provide a method of constructing such units which may be more readily and inexpensively suited to quantity or mass production. Another object is to provide building unit constructions that may be more readily assembled to form the walls or other portions of a building. Another object is to provide a building unit construction of the general type or character as disclosed in my above-mentioned application but in which numerous additional practical and economic advantages may be inexpensively and dependably achieved. Another object of my invention is to provide a building construction of the above-mentioned character which will lend itself to wider variety or diversification of installation or interrelation as, for example, with certain other methods of building construction or of wall surfacing, and thus to provide a wider and greater range or flexibility of use or application of the building units of my invention. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which are shown certain of the various possible embodiments of certain mechanical features of my invention,

Figure 1 is a vertical sectional view through a side wall and ceiling (or floor) of a building, showing the rear wall, which may be an inside or an outside wall, in front elevation;

Figure 2 is a reproduction on an enlarged scale of a portion of Figure 1, showing more particularly certain features of the ceiling and floor construction;

Figure 3 is a sectional view as seen along the line 3—3 of Figure 2;

Figure 4 is a horizontal sectional view on an enlarged scale as seen along the line 4—4 of Figure 1, showing a possible arrangement for connecting two vertical walls together at a corner;

Figure 5 is a horizontal sectional view on an enlarged scale through a wall, such as an outside wall, showing certain features of my invention as carried out when it is desired to embody, in constructing the building, means such as poured concrete;

Figure 6 is a perspective view on an enlarged scale of a spacer employed in the construction of Figure 5;

Figure 7 is an exploded perspective view, showing in perspective, the several parts that may be interrelated to each other to construct a single building unit;

Figure 8 is a diagrammatic representation of the mechanical features that may be employed in carrying out certain steps in the construction of the building unit of Figure 7;

Figure 9 is a vertical sectional view as seen along the line 9—9 of Figure 8;

Figure 10 is a vertical sectional view as seen along the line 10—10 of Figure 8;

Figure 11 is a perspective view of a corner fragment of the construction resulting from the steps carried out by way of the apparatus of Figure 8.

Similar reference characters refer to similar parts throughout the several views of the drawings.

As conducive to a readier and clearer understanding of certain features of my invention about to be described, it might first at this point be noted that in Figure 1 there are shown two vertical walls A and B of a building, extending at right angles to each other, and made up of what I term building construction "units" or "building units" which are preferably of substantial dimensions as to length or breadth or height or breadth; for example, they may be of a length or vertical height of 10′ and a width of 5′. Or as is suggested in Figure 1 they may be of a height approximating 5′ or 6′ and of a width approximating 3′, 4′ or 5′, and accordingly between the floor line C and the ceiling D two courses of such building units will suffice to build up such extent of wall as is necessary to reach from the floor line to the ceiling line. The lower course of the wall A comprises building

units E, F, G and H; the next course comprises the building units E^1, F^1, G^1 and H^1; and extending above the ceiling line or the line of the ceiling D, additional such courses are carried of which only one, comprising the building units E^2, F^2, G^2 and H^2 may be shown. The wall B is similarly arranged or constructed and of the various courses of building units embodied therein it is sufficient to point out the building units I, I^1 and I^2.

In so far as certain features of my invention are concerned, the above-mentioned building units of the various courses embodied in the construction of Figure 1 may be made in accordance with my aforesaid co-pending application and of the various materials or combinations of materials therein set forth. However, and in accordance with certain other features of my invention, I prefer to construct the above-mentioned building units in a manner and embodying structural features now to be described.

Accordingly, reference might now be made to Figure 4 in which building unit H^1 of Figure 1 is shown in horizontal section and on an enlarged scale. It comprises slab-like inner and outer members **20** and **21** which may be cast or formed of materials like cement, materials such as are used in tiles and including glaze, any other appropriate material capable of fabrication into the sizes and shapes desired, such as asbestos composition, fiber-board, so-called sheetrock, plaster-board, maze-wood, cardboard, or the like, or they may be cut or sheet stone, marble, or the like; in general, they may per se be constructed of materials as set forth in my above-mentioned application, and as will now be clear, they are preferably dimensioned as to length and breadth as are the ultimate building units themselves to be dimensioned.

These outer and inner members **20** and **21** are united to an interposed sealed cellular construction S which preferably takes the form and which illustratively may be constructed in the manner better shown in Figure 7 and in Figures 9–11, being made of a suitable sheet material and preferably of what I shall term "fibrous paper" but which preferably has characteristics later described in detail.

Though, as will presently be understood, the component members of sheet material making up the interposed cellular structure S may be individually fabricated (and then assembled) out of sheets initially cut or prepared to the right or desired size, I prefer to achieve greater speed and less expense of production by achieving substantial continuity of production of the major elements of the interposed cellular construction S by utilizing rolls of fibrous paper and from which rolls the latter may be drawn as the processing thereof proceeds, and I have therefore diagrammatically indicated in Figures 8, 9 and 10 a preferred arrangement for so constructing certain elements or parts of the interposed cellular construction S.

Referring then first to Figure 8, there is shown at **23** a table or platen of suitable width to accommodate the width of the web or fibrous paper operated upon illustratively (at least as wide as the width of a building unit), the table **23** being of any suitable length, preferably greater than the length of a building unit. Onto this table **23** and in a direction from left to right, as indicated by the arrow, movement of the element of the cellular structure S is to take place, that movement being preferably intermittent.

To the left of the table **23** I provide suitable supports **24**, **25** for rotatably supporting rolls R^1 and R^2 of fibrous paper; I have shown two such supports to illustrate how certain elements of the construction may be laminated as by the use of two thicknesses of fibrous paper and it is to be understood that that arrangement is illustrative and that more than two thicknesses of web and a corresponding number of supply rolls of paper may be provided if desired.

From roll R^1 the fibrous paper P^1 and from the supply R^2 the fibrous paper P^2, each of a width later set forth, pass between suitable corrugating means arranged, if desired, to operate in a series of suitable successive steps or stages. Illustratively, I may employ rollers **26** and **27**, shaped as is better shown in Figure 9, to start the corrugating of the two webs P^1 and P^2 as they continue to be drawn through the rolls **26—27**. The latter are peripherally shaped to approximate the ultimate corrugations and thus to prepare the web or webs operated upon for the succeeding corrugating operations of which, depending upon the type or character of fibrous paper employed, only one step might suffice. Accordingly, the webs P^1 and P^2, after leaving the rollers **26—27**, pass in between rollers **28—29** which are preferably shaped as is better shown in Figure 10, that shape being that which the web or webs are finally to have, and in Figure 10 it will be seen that the webs P^1 and P^2 are made in cross-section to be regularly reentrant, preferably along straight lines, though, of course, and preferably providing appropriate arcs of curvature where any one straight line of the cross-section merges into the next with which it makes an angle.

In the course of transforming the plane sheet-like material as it comes off of the roll or rolls into the above-suggested cross-section and which for convenience I have termed "corrugated" or repeatedly reentrant, the width of the sheet material has, of course, been reduced, and its initial width is so chosen and the corrugating operations so carried out that its final width, as it emerges from the corrugating rollers **28—29**, closely approximates the width of the ultimate building unit.

In cross-section, as is better seen in Figure 10, the webs P^1—P^2 will be seen to form what might be termed a series of open trapezoids, open at their longer base; depending upon various factors, including the characteristics of the fibrous material or fibrous paper, the dimensions of these trapezoids may, of course, widely vary, but I prefer to give them dimensions approximating the following order of magnitude:—The short base of the trapezoid can be about 2'', the long or open base about 3'', and the altitude (the spacing between the two bases) about 1''.

It will, of course, also be understood that this corrugated element need not be laminated and might be made of a single web, such as the web P^1 from the roll R^1 of Figure 8. Where, however, and as is preferred, the element is to be laminated or made of several thicknesses, these several layers are secured together by a suitable adhesive and in Figure 8 I have indicated at AA adhesive applicators of any suitable construction for applying a suitable adhesive preferably to each of the contiguous faces of the webs P^1 and P^2 so that the faces of the latter that are to be brought into contact are appropriately supplied with the adhesive and hence preferably prior to their entry into the corrugating mechanisms. Accord-

ingly, the latter may and preferably does also act to press the several webs together and thus also to insure the desired and a secure interaction between the adhesive and the several faces of the several webs that are thus to be secured together. Where the corrugating mechanism takes the form of successive sets of rollers, the latter may be pressed toward each other by any suitable means (not shown) to apply the required pressure to bring about an intimate union, through the adhesive of the several laminations.

Also, by applying the adhesive prior to corrugating I facilitate the corrugating steps in that the adhesive can be suited to the material of the fibrous paper and can act to soften the latter up somewhat and take out of it any such brittleness as might tend to cause rupture or breakage of the web or webs.

As the webs P^1—P^2 emerge from the steps of corrugating, they are, therefore, in the form better shown in Figure 10, and for convenience I shall designate the resultant corrugated and laminated element by the reference character **30**, and in Figure 11 a fragment of that element **30** is shown in perspective.

It is this element **30** (see Figure 8) which emerges from the corrugating mechanism and which is to continue in its movement toward the right onto and across the table **23**, but as that movement proceeds, I relate to the available upper and lower faces of the corrugated element plane elements **31** and **32**, respectively (see Figure 11), made preferably of the same sheet material or fibrous paper as constitutes the webs P^1 and P^2. Thus plane elements **31** and **32** may also be and preferably are laminated. To form and interrelate the lower plane element **32**, I provide a suitable number of supports, illustratively two, as shown at **33** and **34**, for rolls R^3 and R^4 of fibrous paper P^3 and P^4, respectively, but of a width now equal to the width of the corrugated element **30** and alined therewith. Web P^3 passes over a roller **35** immediately underneath the moving corrugated element **30**, thus to feed the web P^3 into contact with the longitudinally extending strip-like under faces of the corrugated element **30**, an adhesive applicator AA first operating to interpose between the web P^3 and the element **30** a suitable adhesive, as by applying the latter to the web P^3.

Web P^4 passes over a roller **36** thus to bring the fibrous paper P^4 into alinement and contact with the under face of the web or layer P^3 which has already, as just described, been applied to the under side of the corrugated element **30**, and adhesive applicator AA applying a suitable adhesive, illustratively to the upper face of the web P^4, for interposing between the contacting faces of the webs P^3 and P^4 and thus to secure them together. Of course, if it is not desired to laminate the lower plane element **32**, only one supply roll and web need be employed while if more than two laminations are required, more than the two illustratively above described are, of course, employed.

The upper plane element **31** is applied to the corrugated element **30** in a similar manner and illustratively that also is to be two-ply or of two laminations. Accordingly, I provide supports **37** and **38** for supply rolls R^5 and R^6 of fibrous paper or webs P^5 and P^6 which are led down under rolls **39** and **40**, respectively, for applying the web P^5, after adhesive application thereto by adhesive applicator AA, to the upper available faces of the corrugated element **30** and for applying the web P^6 to the upper face of the web P^5 after application thereto of adhesive by the applicator AA.

The rollers **35** and **39** will be seen to be juxtaposed as is also the case with respect to rollers **36** and **40**; the rollers of these two sets are appropriately spaced and preferably suitably pressed toward each other to insure that the webs and/or laminations of the upper and lower plane elements **31** and **32** are suitably pressed together and to the corrugated central element **30**, by any suitable means (not shown).

Emerging from the last set of rollers **36—40**, therefore, is the construction **31—30—32** (see Figures 8 and 11) sliding onto and along the table **23** as the process continues. Any suitable means (not shown) may be employed to drive the various rollers or devices and to feed the various webs or resultant structural elements at appropriate speed or speeds.

As the resultant sub-assembly **31—30—32** is thus produced, it is cut up transversely by any suitable means, such as preferably a saw, into suitable lengths. The cutting means is not shown and it may operate in conjunction with the continued movement of the sub-assembly along the table **23** or the movement of the sub-assembly may be interrupted or made intermittent to permit the cutting off of successive appropriate lengths of the sub-assembly.

The above described sub-assembly may, in so far as certain features of my invention are concerned, be embodied per se or in its existing form into the structure which is interposed between the inner and outer members **20** and **21** of the building units (see Figure 4), but since I prefer to give the cellular structure S (Figure 4) a construction embodying numerous sealed or closed seals or pockets, I utilize the sub-assembly **32—30—31**, made as above described, to coact with other sub-assemblies to form such sealed or closed seals. For this purpose, therefore, I cut the sub-assembly **32—30—31** (Figure 11) transversely of its length and along planes or lines that are oblique, subtending therebetween the same angle as is subtended by the inclined sides of the above-described trapezoidal corrugations of the element **30**; in Figure 11 three successive lines of transverse cutting are indicated at **41**, **42** and **43**, but the planes along which the cutting instrument, such as a saw, operates, are alternately inclined to the general plane of the sub-assembly **32—30—31**.

For example, the plane of cutting along line **41** is indicated by the oblique line **44**, the plane of the cutting along the line **42** is also oblique but inclined in the opposite direction and is indicated by the line **45**; the plane of the cutting along line **43** is indicated by the line **46** and is also oblique but inclined oppositely to the plane of the last cutting; this procedure is repeated.

As above indicated, the angle between the planes **44** and **45** and the angle between planes **45** and **46**, and so on, are equal to the angle subtended by the inclined sides of the above-mentioned trapezoidal cross-section of the element **30**. Moreover, the spacing between the lines of cutting **41** and **42** is equal to the length of the longer (open) base of the trapezoidal corrugation, and accordingly the resultant dimension of the plane element **32** (Figure 11) is equal to the length of the shorter base of the trapezoid. The spacing between the lines of cutting **42** and **43** is equal to the length of the shorter base of the trapezoid and since the angles of inclination are

as above stated, the resultant dimension of the plane element **32** where it is intersected by the planes of cutting **45** and **46** is equal to the long (or open) base of the trapezoid.

Thereby I form strip-like transverse sections of the sub-assembly **32—30—31** and in Figure 7[a] I have shown in perspective and indicated generally by the reference character **50** one of the resultant strips, whose upper plane element comprises the element **31[a]**, being a section of the element **31** of Figure 11, whose lower strip-like element **32[a]** being a narrower strip of the plane element **32** of Figure 11, and holding these strips in spaced relation and secured thereto in the manner above described is the corrugated element **30[a]**, being a transverse strip of the element **30** of Figure 11 but trapezoidal when viewed from one end. In Figure 7 these component parts are shown in exploded perspective. With the dimensions given the member **50** of Figure 7[a] as above described, it is brought into unique coaction with other elements of my cellular construction, as is now to be described.

By following the steps outlined above in connection with Figure 8, but omitting the application of the webs which form the upper and lower plane elements **31** and **32**, I now corrugate, from the rolls R^1 and R^2 and cause to be adhered together by a suitable adhesive, webs P^1 and P^2 (if only two laminations are desired) and thus produce substantially continuously trapezoidal elements **30** (Figure 11) alone, devoid of the upper and lower plane elements **31** and **32**, preferably, however, as by changing the shape of the rollers **28** and **29** or changing their adjustment, increasing somewhat, at least by the thicknesses of the elements **31** and **32**, the depth or altitude of the trapezoidal corrugations. Thus, the table **23**, in carrying out these operations, receives a continuous strip of element **30** alone; that continuous strip is cut transversely into lengths equivalent to the width or length of the building unit that is intended to be made, illustrative dimensions of which were earlier above set forth.

In Figure 7 I have indicated at **51** one of the thus resulting sheet members and another at **52**. Into the trapezoidal corrugations or hollows of members **51** and **52** are now laid and interfitted the strip-like members **50**, the lateral or side edges of the elements **31[a]—30[a]—32[a]** and the outer or exposed face of the narrower strip or plane element **32[a]** (Figure 7[a]) thereof, having first applied to them a suitable adhesive. Due to the dimensioning of the various trapezoidal cross-sections as above described, these cross-strips **50** are snugly received in the hollows or trapezoidal corrugations on both sides of each member **51** and **52**, are snugly interfitted therewith and become strongly and securely united thereto by the adhesive.

As a result, the trapezoidal open-ended pockets (see Figure 7[a]) of the cross-strip or element **50** are closed by the inclined side walls of the trapezoidal corrugations with which they are thus interfitted and thus there results a composite sub-structure, relatively thin-walled throughout, containing numerous closed and sealed cells or air pockets, but of exceeding strength, due to the unique interactions of the various parts of which it is made up.

For example, and still referring to Figure 7, the cross-members **50** definitely retain the corrugated sheet member **51** (and member **52** as well) against distortion out of its corrugated shape and also against distortion out of its general plane about an axis parallel to the direction of the corrugations. For example, any tendency to warp or bend the corrugated member **51** about the axis of a corrugation is resisted by the corrugated element **30[a]** of the cross-member **50** but that resistance is exerted in the direction of the length of the corrugations in the member **30[a]**, being thus structurally well suited to assume forces of compression. Any tendency to warp the sheet **51** (or sheet **52**) about an axis transverse to the direction of the corrugations therein is, of course, well resisted by the cross-section of the corrugations and of the sheet itself.

Furthermore, and considering the element **50** again (see Figure 7[a]) the upper and lower plane strip elements **31[a]** and **32[a]** thereof, securely anchored to the intermediate element **30[a]** dependably coact with the latter to resist any tendencies to flatten out the member **30[a]** itself.

In effect there results a criss-cross arrangement of truss structures, one truss-like element reinforcing the other in such a way and in that direction in which that other truss element might have a weaker or weakest truss effect or strength.

When the cross-elements **50**, of trapezoidal cross-section, are set into the transverse hollows on each side of the corrugated sheets **51** and **52**, due to the dimensionings above described, the wider plane element **31[a]** (Figures 7 and 7[a]) of each cross-element **50** line up with or are bridged between the rear faces of the bottoms of the hollows in these corrugated sheets, forming continuations thereof and giving the thus resulting sub-assembly side faces, substantially continuous or plane, and substantially of a length and breadth equal to the length and breadth of the ultimate building construction unit.

It has a thickness on the order of 1¼" or 1½" (by way of illustration), and though it appears solid, is, however, replete with sealed air cells as will now be plain and is relatively light in weight.

As many of such sub-assemblies or sub-units as is desired may now be related to each other, face to face, and to suitable inner and outer members like the members **20** and **21** above described in connection with Figure 4. In Figure 4 three such cellular sub-units are shown at S^1, S^2 and S^3, being interposed between the inner and outer members **21** and **20**, all secured together by a suitable adhesive.

In Figure 7, and solely by way of illustration, I have shown the parts of only two such sub-assemblies at S^4 and S^5, and though they may be directly secured to each other and directly secured to the inner and outer members, yet I prefer to proceed as follows:—

I preferably interpose between the sub-units S^4 and S^5 a sheet **53** of suitable material; it may be made up of the above-mentioned fibrous paper and may be laminated, and hence constructed similarly as are the illustrative forms of the elements of the sub-assemblies themselves. The sheet member **53**, however, may be made of any other suitable material, such as fiber-board, asbestos composition, sheet-rock, or other natural or artificial sheet material. This is interposed between the two sub-units S^4 and S^5 and the three are secured together by a suitable adhesive.

To the remaining face of sub-unit S^4 is secured in a similar way a sheet **54** similar to the sheet **53** above described and to the remaining or under face of the sub-unit S^5 is similarly secured a sheet **55** of similar characteristics.

The sheets 53, 54 and 55 dependably unify or unite the lateral (upper and lower as viewed in Figure 7) faces of the sub-units S^4 and S^5 and greatly reinforce the adhesive joints between the cross-strips 50 and the inclined side walls of the trapezoidal corrugations of the sheets 51 and 52.

Where, as may be desired under some circumstances, the sheets 53, 54 and 55 comprise relatively thin sheet material, such as fibrous paper, I may and preferably do desire to superimpose upon the remaining exposed faces of the sheets 54 and 55 sheet-like sections 56 and 57, respectively, made of a material of good stiffness and tensile strength, illustratively so-called sheetrock, secured thereto by suitable adhesive or cement.

The outer and inner members 20 and 21, earlier above described as to their possible composition or construction, are now cemented to the sheets 56 and 57, respectively, where the latter are employed, or are cemented directly to the sheets 54 and 55, respectively, where the latter are employed, or may be cemented directly to the faces of one or more sub-units like the units S^4 and S^5.

The inner and outer slab-like members 21 and 20 are, however, staggered in two directions relative to the parts to which they are secured; this relation of the parts is better shown in Figure 4. Thus the outer member 20 of the unit G^1 overlaps or projects to the right of the alined and mated cellular sub-units S^1, S^2 and S^3 at the right-hand end of the building unit G^1 while the inner member 21 of that unit G^1 falls short of the right-hand end of the alined cellular sub-units S^1, S^2, S^3; at their left-hand ends the outer members 20 and 21 of the unit G^1 have a reverse relation, a relation better shown at the left-hand end of unit H^1 where it will be seen (Figure 4) that outer member 20 terminates at its left-hand end short of the interposed cellular structure S, while the inner member 21 of unit H^1, at its left-hand end, extends beyond or overlaps the interposed cellular structure S.

Furthermore, the cellular structure S due to the way it is constructed as was described above in connection with Figure 7, presents, at the vertical edges of the building units, a zigzag-like form or shape, where two or more sub-units are employed to make up the cellular structure S.

As a result, successive building units in a given course, such as units E, F, G, etc., and E^1, F^1, G^1, etc., of Figure 1, interlock and interfit neatly and snugly. As they are thus interfitted, a suitable cement or adhesive is employed to the contiguous or adjacent faces of the interfitting parts, and thus a secure mechanical and sealed interconnection is achieved. The interfitting of the parts not only facilitates the assembly of the units into a wall but also adds to the mechanical rigidity and strength of the resultant wall. Certain parts of each building unit are thus allowed to project beyond the end edge to be interlocked and interfitted with other staggered parts of the adjacent building unit.

Any suitable material that lends itself to handling in sheet form and to treatment as was described above in connection with Figure 7 may be employed in making up the cellular sub-assemblies and some of the materials already above-mentioned may be used for that purpose. I prefer, however, to use a fibrous paper having a pulp whose principal base is straw and such sheet-like material or fibrous paper may be produced in accordance, for example, with United States Letters Patent Nos. 1,924,815, 1,924,660 and 1,865,649. Such fibrous material is water-proof, fire-resisting and, when embodied in such forms as the sub-units S^4 or S^5 of Figure 7, results in a construction which is relatively light but of great strength and rigidity. Moreover, that material is inexpensive.

The cements or adhesives that may be employed may be of any suitable character and may take the form of any appropriate or suitable glue, cellulose compounds, rubber cements, or the like.

In carrying on the building construction with my building construction units, I prefer, referring now to Figure 1, to run an upwardly facing channel iron 60 along a suitable foundation or support 61, the building units having, along their upper and lower edges longitudinally extending slots into which the flanges of the channel 60 interfit, the channel 60 being anchored to the support 61 in any suitable way. The slots in the building units for receiving these flanges may be provided in any suitable way as, for example, by milling, cutting, or sawing such slots closely adjacent the inner and outer members 21 and 20 or into the members 21 and 20 themselves; I may, however, also, where I employ the members 56 and 57 of Figure 7 provide such slots by making these sheets 56 and 57 of lesser length than the parts with which they are related and to an extent commensurate with the depth of the flanges, thus providing space or slots for the reception of the latter.

Having completed the first course E, F, G, etc., an I-beam or two joined channels, as is indicated at 62, is now set into the upwardly exposed slots along the alined upper edges of the units of the first course; the downwardly projecting flanges take into those slots while the upwardly directed flanges are received into the slots of the bottom faces of the building units E^1, F^1, G^1, etc., of the second course, and so on. Thus, an I-beam or two channel members secured together, shown at 63, are similarly related to the upper alined edges of the units of the second course, and to the upwardly directed flanges the units E^2, F^2, G^2, etc. of the second course are interfitted and related.

To provide for the ceiling, and prior to running the third course E^2, F^2, G^2, etc., I provide, at suitable spaced intervals, I-beams 64, 65, 66, etc., these I-beams resting at their respective ends upon the I-beam or channel construction 63. In Figure 3 is shown this interrelation, on an enlarged scale. Thus, the I-beam or double channel construction 63 is shown with its downwardly directed flanges received in appropriate slots, as above described, in, for example, the building unit F^1 of Figure 1; the innermost (right-hand) of the two upwardly directed flanges is cut away as at 63^a so as to receive the I-beam 66 which thus is made to rest flat against the cross-web of the I-beam structure 63, and to which it may be secured in any suitable manner, as by the device 67. The building unit F^2 of the third course is cut away, as with a saw, or the like, as at 68, preferably by cutting out of its lower end edge a rectangular recess of sufficient height and breadth to accommodate the cross-section of the beam 66, the outer member 20 of the building unit F^2, however, remaining uncut and thus externally of the building closing off or covering over the end of the beam 66.

With a suitable number of flanged cross-beams 64, 65, 66, etc., thus bridged across from wall to wall, I now proceed to provide a ceiling surfacing

on the under side of the beams and a flooring on the upper side thereof.

The flooring is generally indicated in Figure 1 at **70** and in Figures 2 and 3 sectional fragments of it are shown on a larger scale. The flooring **70** is made of building units constructed as earlier above described, comprising, briefly, an upper surfacing sheet member **71**, a lower sheet member **72**, and an interposed cellular structure which, illustratively, comprises two cellular sub-units S^6 and S^7 constructed like the units S^4 and S^5 etc., above described in connection with Figure 7 and joined to the sheet members **71** and **72** as already above described in connection with the other building units.

The members **71** and **72** of the flooring **70** may be made of any suitable material, such as those earlier mentioned and the material of the upper member **71** is selected to give it good resistance to wear and substantial hardness and rigidity. Illustratively, artificial composition board, such as sheet-rock, may be employed.

The building or floor units are made of a sufficient dimension in a direction crosswise of the beams **64**, **65**, etc., so as to bridge over at least two beams, and assembly thereof to the building construction as the latter proceeds is preferably achieved by means carried by the floor units themselves and arranged for interengagement or interlocking action with the beams upon which they are to rest. For example, secured to the under member **72** of the floor units and spaced apart by the same distance as the spacing of the beams **64**, **65**, etc., are members **73** preferably of the same length as the width of the floor units themselves and shaped as is better shown in Figures 2 and 3. These members **73** comprise a base portion 73^a of sufficient expanse to overlie the upper face or webs of the beam (beam **66** in Figures 2 and 3) and a horizontally extending but downwardly spaced lip or hook-shaped part 73^b (Figure 2), in the space or slot between which parts 73^a and 73^b one of the horizontally extending flanges of the beam **66** is received.

In Figures 2 and 3 these relations between the part **73** and the beam **66** are shown while in Figure 1 the parts **73** of one of the floor units are shown in interengaged or interlocked relation to beams **64** and **65**, and one of the several members **73** of the floor unit immediately to the left of the one just mentioned, is shown in similar relation to the beam **66**.

The floor units are thus related to the beams respectively supporting them by simply laying the floor units down on their respective beams so that the parts 73^a of the members **73** rest upon the respective beams and then, by sliding the floor units toward the left as viewed in Figures 1 and 2, the hook-like lip 73^b of the members **73** is made to take in under the beam flange; the floor units of a run are therefore successively laid down in a direction beginning at the left and proceeding toward the right as viewed in Figure 1, so that, when the right-hand end wall units corresponding to the building unit I^2 are set in place, the entire run of floor units is blocked against movement toward the right and hence disengagement of the members **73** from the various beams precluded and the above-described interlocking action is dependably and permanently maintained.

The ceiling construction generally indicated at **74** in Figures 1, 2 and 3 proceeds in a somewhat similar manner and may be made up of ceiling units corresponding in construction to that of the above-described floor units; but since the cellular construction of the floor units of the flooring **70** is sufficient to provide the desired heat insulation, sound insulation, resistance to fire transmission, and other mechanical or physical properties that are desirable as between the rooms or spaces above or below the ceiling, I may and preferably do make the ceiling **74** of any suitable sheet material of any suitable thickness; it may, for example, comprise suitable block or sheet-like sections of suitable composition sheet material, such as plaster-board, fiber-board, asbestos composition, and the like, preferably of dimensions commensurate with the dimensions of the floor units employed, immediately above the ceiling. These sheet-like sections of the ceiling structure **74** are provided with cross-members **75** (Figures 1, 2 and 3) which may be constructed exactly as the members **73** above described, though they are related to the upper side of the ceiling units. Here again the sheet-like sections or ceiling units, each thus provided with at least two members **75**, are successively related to the beams in a direction from the left to the right, each being given a slight sliding movement toward the left to interengage the hook-shaped member **75** with the right-hand lower flange of the beam or beams. The last ceiling section (the right-hand one as viewed in Figure 1) is shown with its members **75** interlocked with the beams **64** and **65**, movement thereof to the right and hence movement of the entire run of ceiling units in that direction being prevented by the positioning of the upper run of side wall building units corresponding to the unit I^1 of Figure 1, the interlocking engagement of the ceiling units to the beams being thus permanently maintained. Of course, where the floor units and ceiling units are thus made to depend upon the end wall units I^2 and I^1, respectively, for holding them against displacement, it will be understood that the ceiling units are first put in place, then the run of end wall units corresponding to building unit I^1, then the double channel member **63** put in place, then the floor units, and then the run of end wall units corresponding to the building unit I^2 of Figure 1.

The members **73** and **75** may be integrally formed with the members **72** and **74**, respectively, or they may be secured thereto in any suitable manner, as by a suitable cement or adhesive; likewise these members **73** and **75** may be made of any suitable material and may even be molded. In the case of the ceiling units, the slight load of the latter is by the members **75** uniformly distributed throughout the beams and in the case of the floor units, the members **73** aid in insuring a uniform distribution of that load to and throughout the beams, the load of the latter that is transmitted to the side walls which carry them being in turn uniformly distributed throughout the latter by the I-beam or double channel construction **63** upon which the I-beam rests (see Figure 3).

The floor units are interfitted, as will now be understood, just as the wall building units interfit as was above described in detail with respect to units G^1 and H^1 of Figure 4. Such interfitting, in the case of all of the cellular building units, achieves a large area of end or edge face of contact with each other and it is between these zigzag and interfitting edge or end faces that I inject, as the building construction proceeds, a suitable cement or adhesive and thus achieve not only a good mechanical bond between adjacent

units but also a sealing of the joints as against weather, water, air, vermin, heat, etc., and the like. Preferably, also, such cement or adhesive is employed in interrelating the wall units to the structural steel members, such as the horizontal channel members **60**, **62**, **63**, etc. (Figure 1). Similarly, the junctions between sections of the ceiling **74** as well as the junction between the ceiling units (and also of the floor units) with the side or end walls, are sealed by an appropriate cement or adhesive.

To achieve a dependable and inexpensive and quickly installed mechanical junction between, for example, two outside walls that extend at right angles to each other, I provide sectionalized vertical columns **80** (Figure 4) shaped to provide an outer and preferably curved face **81** and two faces generally indicated at **82** and **83** which are shaped as better shown in Figure 4 to interfit and interengage with the building unit, a suitable cement or adhesive being interposed between the resultant contacting surfaces.

The column sections are conveniently of the same height as the height of the building units employed and in Figure 1 three such sections are shown at **80a**, **80b** and **80c**. The sections may be made of any suitable material and will be seen to be in a form or shape susceptible of easy and inexpensive fabrication; if desired, for example, they may be made of molded concrete or any other suitable moldable composition.

Where it is desired to achieve, in building construction, certain advantages of concrete, I make it possible to do so while eliminating numerous disadvantages thereof and at the same time achieving advantages which have heretofore been incapable of achievement in concrete construction. In Figures 5 and 6 I have indicated features of my invention whereby such advantages may be achieved.

In Figure 5 there is shown in horizontal section a portion of a vertical wall made up of building units of the character already above described and hence embodying the numerous advantages as to inexpensiveness of construction, lightness of weight, speed of assembly, heat insulation, sound-proofness, fire-resistance, and the like, and it may be assumed that, in Figure 5, building unit F of Figure 1 is shown in horizontal cross-section. To the outer member **20** of building unit F and which outer member **20** may, by the way, be made of much thinner sheet material than shown in the drawings, there are secured in any suitable manner or integrally formed therewith vertically extending a suitable number of preferably closely spaced dovetail members, two of which are shown in Figure 5 at **90** and **91**. The spacing may be on the order of 1' or so. I then provide for each building unit, and hence for building unit F' of Figure 5, a sheet member **92** of the same area as the member **20** thereof; sheet member **92**, illustratively of sheet-rock or other suitable sheet material well adapted to withstand weather, and the like, has secured thereto or integrally formed therewith a suitable number of vertically extending dovetails **93** and **94**, the spacing of which from left to right as viewed in Figure 5, is similar to the spacing of members **90**, **91**, etc., of the building unit F.

I then provide spacers preferably taking the form as is better shown at **95** in perspective in Figure 6. The spacer **95** is preferably made of sheet metal, thus lending itself to speedy and inexpensive fabrication and has other features giving it substantial strength and rigidity.

For example, it has a central strip-like portion **96** which is stamped or formed, as at **97**, preferably along its median or center line to bulge out of the plane of the central portion **96**, thereby giving the lengthwise extending portion **96—97** adequate strength and resistance to bending.

At appropriate intervals along its length, the member **95** is cut or slit transversely, and the resultant pairs of members are bent alternately in opposite directions out of the plane of the portion **96**; thereby are formed pairs **98—99** of arms directed to the right of the plane of the portion **96** and spaced vertically and pairs of arms **101** and **102** extending to the left of the plane of the portion **96** and also spaced vertically but alternated with the pairs of arms that extend to the right. These various arms are, furthermore, bent again, as shown, to provide extreme end portions inclined to each other and spaced apart to substantially mate with the angles and spacing of the inclined vertical faces of the dovetails **90**, **91**, etc., on the building units and dovetails **93**, **94**, etc. of the outer sheet members **92**.

Accordingly, having assembled a suitable number of building units in the manner already above described, I then assemble to the exterior thereof a corresponding number of sheet members **92**, utilizing spacer members **95** to interengage with the respective dovetails, resulting in the relation better shown in Figure 5, and thereby mechanically and securely holding the member or members **92** parallel and in accurate alinement with each other and with respect to the interfitted wall units.

Into the space thus provided between the wall units and the sheet members **92** I now pour concrete or other appropriate plastic material, indicated at **103** in Figure 5. Material **103** is of a thickness commensurate with the spacing between the wall units and the sheet members **92** and that, of course, may be made whatever it is desired by correspondingly constructing the spacers **95**. The poured concrete bonds itself to the wall units and also to the sheet members **92** and, furthermore, interlocks with the various dovetails on both the outside sheet members **92** and on the building units, for, it will be noted, the alternate arrangement of the pairs of gripping arms of the spacers **95** insures a free flow of the concrete into interlocking engagement with the thereby exposed portions of the various dovetails.

By suitably selecting the material of which the external sheet members **92** are made, illustratively sheet-rock, or like composition, the external face of the wall is neat and smooth and requires no patching up or surface finishing, as is the case with present-day methods of pouring concrete structures, where the forms are subsequently removed and the impressions left by the forms, usually of timber, in the exposed surfaces of the concrete have to be gone over or otherwise surfaced or finished.

The resultant construction as shown in Figure 5 will thus be seen to combine the advantages of concrete and of my building unit construction, while dependably eliminating numerous disadvantages inherent in present-day concrete construction and practice.

It will thus be seen that there has been provided in this invention a building construction, a building unit, and method of achieving the same, in which the various objects hereinbefore noted together with many thoroughly practical advantages are successfully achieved. It will be seen that the invention may in practice be carried out

speedily and inexpensively, that inexpensive materials may be employed, that quantity production may be easily carried on, that the building unit can be made in relatively large sizes and easily shipped, being light yet strong and durable, and that the assembly thereof may be carried on speedily and inexpensively.

The cellular construction of the spacer units achieves numerous thoroughly practical advantages among which may be mentioned these:—Transmission of heat through the wall or building portion which is constructed in this manner is effectively retarded, dependable insulation against the transmission of sound is achieved, and the mechanical interrelation of the various elements that go to make up the cellular units provides great strength and rigidity and permits the employment of surprisingly small thicknesses of sheet material in making them up. The cellular construction in particular provides a vast multitude of sealed air cells or pockets in which correspondingly relatively small quantities of air are respectively trapped, and hence any such circulation of air as would be materially effective in the transfer of heat, as by convexion currents, or the like, is dependably precluded. By the structural features of my invention, these air cells can be made of any desired size and number while at the same time retaining the above-mentioned dependable rigidity, strength, and load-carrying capacity of the resultant building unit; the various elements that go to make up the cellular spacer units act, as earlier set forth, somewhat like trusses and do so in virtually all directions, thereby achieving great strength with the employment of a minimum of material.

While I have above described and set forth the making up of certain of the elements or parts of the cellular spacer units out of web-like fibrous material or paper, I wish it to be understood that, in so far as certain other features of my invention are concerned, these elements or parts may be constructed in other ways. For example, the elements **51** and **52** of Figure 7 can be individually built up out of successive laminations, or these elements may be made of a moldable material and pressed somewhat as is described in my above-mentioned co-pending application with respect to other forms of cellular construction; and the same is true of the various parts that go to make up the cross-members **50** of Figures 7 and 7ª.

My invention, furthermore, is, in so far as certain features are concerned, capable of being carried out in various ways; for example, the manner of laying the flooring **70** and of applying the ceiling **74** of Figure 1 may be proceeded with as follows:—Instead of having the hook-like members **73** and **75** secured to the floor and ceiling sections, respectively, as was above-described, I may furnish such strip-like hook-shaped members separately and relate them individually to the flanges of the beam members, such as beams **64, 65, 66**, etc., of Figures 1, 2 and 3; to the upper and lower faces of the members **73** and **75**, respectively, I may then apply a suitable cement or adhesive and then lay the floor units of the floor **70** down upon the members **73** and lay the ceiling units of the ceiling **74** up against the members **75**. Any suitable means may be employed to apply a suitable pressure to these floor and ceiling units for a suitable period of time to let the cement or adhesive set. This method may be advantageous where circumstances may require a peculiar fitting of floor or ceiling units to peculiarly shaped angles, corners, or the like, of the building and also has advantages in that greater adaptability to various flange lengths or thicknesses of the beams is made possible.

In carrying out this last-mentioned method of securing the floor and/or ceiling units to the beams, I am enabled also, and in a simple manner, to insure a secure fastening of the units to their respective beams. For example, and let it be assumed that a single floor unit (see Figure 1) rests upon beams **64** and **65**, I relate the hook-like members **73** to the two beams so that the hook-like members face toward each other; thus the member **73** is related to the right-hand upper flange of the beam **64**, as shown in Figure 1, but the other member **73** is related to the left-hand upper flange of the beam **65** so that, when the floor unit is now secured to the two members **63**, movement of the floor unit in a direction to the right or left is positively prevented. A similar procedure may be adopted with respect to the ceiling units.

The upright corner member **80** (Figure 4) is, as above noted, preferably in sections of appropriate vertical lengths, lengths that preferably coincide with the heights of the wall or building units. In Figure 1 it has been assumed that the required room height is gained by two building units or two runs of building units, stacked one upon the other, and the corner is completed by two correspondingly dimensioned corner units **80ª** and **80ᵇ**. However, the wall units may be of such a vertical dimension, and so also the corner units, that a single horizontal run of building units gives the required or desired height from floor to ceiling.

In Figure 4ª is shown on a smaller scale a horizontal section along the junction of two horizontal runs of a side and end wall, joined at the corner by a corner unit. The view in Figure 4 shows the channel or I-beam construction **62** already above described, terminating preferably in interlocking engagement with the corner unit **80ª**, the latter being provided with suitable slots or recesses for receiving the downwardly directed flanges of the members **62, 62**. Preferably, I provide a curved or suitably shaped metal plate member **110** which is secured at its two ends as by bolts, screws or rivets **111—111**, to the central or horizontal web or webs of the structural steel members **62, 62**, thereby insuring a permanent unity of the corner junctions of the walls, suitable provision being, of course, made, as by appropriate recesses, in the adjoining faces of the successive corner units and building units to accommodate the corner angle or junction plate **110**.

It will, of course, be understood that the above suggested dimensions for the various parts of the construction are illustrative and that they may, of course, be varied without departing from the spirit of my invention. For example, I may find it desirable to so proportion the corner units **80** with respect to the heights of the building units that the dimension of the former is several times the dimension of the latter; for example, I may dimension the building units so that two runs are needed to provide the vertical dimension equivalent to one story of the building while the corresponding corner unit **80** may be of a vertical height equal to the height of the story itself.

In Figure 4ª I have also shown a vertical or upright member **120**, in some respects like the above-mentioned corner unit **80**, but illustrating other features of my invention and showing how members or a member like the part **120** is con-

structed and shaped and interrelated to the building units to form, for example, a doorframe, or windowframe. It will be noted that the member or members 120 which, by the way, may be made of any suitable material and may be molded or cast, as of cement, or may be made of other suitable materials, compositions, fabrications, or the like, is shaped as at 120a to interfit with the adjacent building unit or units, and may be shaped as at 120b to receive a window or windows, or door, or the like, the member or members 120 being decoratively shaped, if desired, to simulate moldings, or the like, as is indicated at 120c.

The resultant doorframe, windowframe, or the like, may be made of a single member 120 in its vertical sides, or the member 120 may be built up of several frame units, much as in the manner above indicated or described with respect to the corner units 80.

Also, it will be understood that the flooring above described in connection with Figure 1 is to be considered as illustrative of a roof construction, though in most instances the latter will have an incline or slope.

Likewise, the materials employed, particularly in the inner and outer sheet-like members 20 and 21 may be widely varied to meet the conditions desired. For example, the outer member may be, as above already suggested, of sheetrock, artificial stone, concrete or cement in sheet form, composition material like trancite, and the like. The inner member may be made of such materials as just mentioned or of other materials which need not have good weather-resisting qualities such as plaster-board, fiber-board, sheet-wood, impregnated sheet-wood, mazewood, and also and desirably, for better protection against fire, asbestos sheet compositions. These and related variations of materials and various purposes and objectives thereby to be achieved may be pursued in a manner as is outlined in greater detail in my above-mentioned co-pending application to which reference may therefore be had for further details.

Furthermore, the construction will be seen to be of a thoroughly practical character and well adapted to meet the varying conditions of hard practical use.

As many possible embodiments may be made of the mechanical features of the above invention and as the art described herein might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:—

1. In construction of the character described, in combination, a building unit comprising two spaced outer sheet-like members of suitable material and means interposed therebetween comprising a sheet-like member substantially corrugated and having seated lengthwise in the longitudinally extending hollows on both sides thereof as formed by the corrugations thereof corrugated strip-like members, the corrugations of which extend in a direction transversely to the direction in which the corrugations of said sheet-like member extend.

2. A construction as claimed in claim 1 in which the strip-like corrugated members and the corrugated sheet-like member have secured thereto and on each side of the latter sheet-like means to which said two spaced outer sheet-like members are respectively secured.

3. A construction as claimed in claim 1 in which each strip-like corrugated member that is seated in a corrugation of said corrugated sheet member has bridged across and secured to the outer faces of the corrugated portions a sheet-like strip.

4. A construction as claimed in claim 1 in which the strip-like corrugated members that are seated in the corrugations of said sheet-like member each has on both sides thereof and secured to the external high parts of its corrugations a strip-like bridging member, having the resultant effect of a truss-like structure.

5. In a method of constructing building parts of the character described, the combination of steps which comprises forming a plurality of corrugated sheet members having troughs on at least one side thereof of substantially the same transverse cross-section, cutting one of said corrugated sheets transversely of the corrugations therein into a plurality of strips along planes defining a cross-section to substantially mate said first-mentioned cross-section, and securing said corrugated strips into correspondingly cross-sectioned troughs of another of said corrugated sheet members.

6. In a method of constructing building parts of the character described, the combination of steps which comprises forming a plurality of corrugated sheet members having troughs on at least one side thereof of substantially the same transverse cross-section, cutting one of said corrugated sheets transversely of the corrugations therein into a plurality of strips along planes defining a cross-section to substantially mate said first-mentioned cross-section, securing strip-like sheet members to said corrugated strips to give the latter a truss-like effect, and mounting the resultant strip-like parts in correspondingly cross-sectioned corrugations of another of said corrugated members.

7. In a method of constructing building parts of the character described, the combination of steps which comprises forming a plurality of corrugated sheet members having troughs on at least one side thereof of substantially the same transverse cross-section, cutting one of said corrugated sheets transversely of the corrugations therein into a plurality of strips along planes defining a cross-section to substantially mate said first-mentioned cross-section, securing strip-like sheet members to both top and bottom of said strip-like members to substantially close over the corrugations in the latter and to give the latter a truss-like effect, and mounting the composite strip members in correspondingly cross-sectioned troughs of another of said members.

8. In construction of the character described, in combination, a multicellular sub-unit structure comprising sheet-like means presenting at least on one side thereof a plurality of transversely extending troughs, there being seated and secured in each of the latter and extending lengthwise thereof a truss-like structure comprising a corrugated strip-like member and two substantially flat strip-like members between which is interposed said corrugated strip-like member whose troughs are thereby closed and bridged over, giving said three members a truss-like effect.

9. In construction of the character described, in combination, a multi-cellular sub-unit struc-

ture comprising sheet-like means presenting at least on one side thereof a plurality of transversely extending troughs, there being seated and secured in each of the latter and extending lengthwise thereof a truss-like structure comprising a corrugated strip-like member and a substantially flat strip-like member extending along and secured to said corrugated strip-like member whose troughs at one side thereof are closed and bridged over by said flat strip-like member, giving successive portions of said two members a truss-like effect.

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