Jan. 26, 1943. S. M. WOOD ET AL 2,309,149

BUILDING

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Fig. 1.

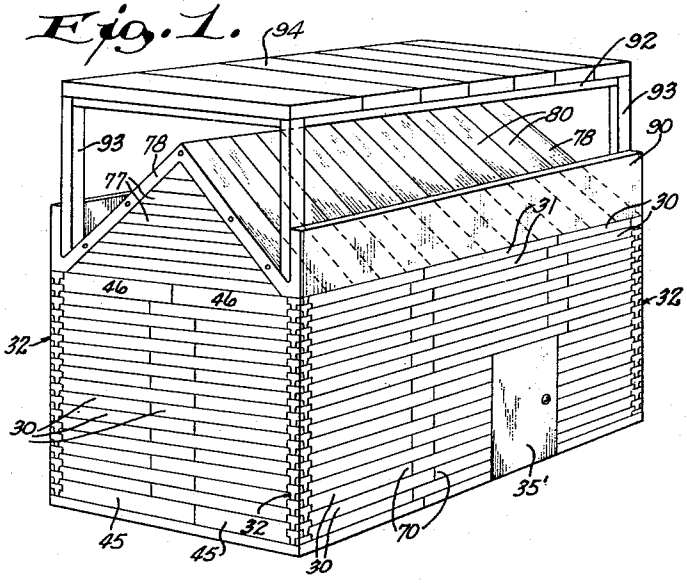
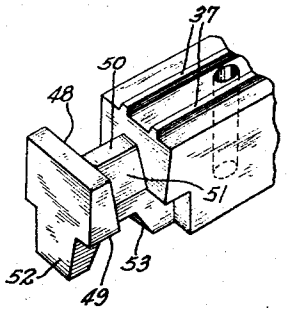


Fig. 7.



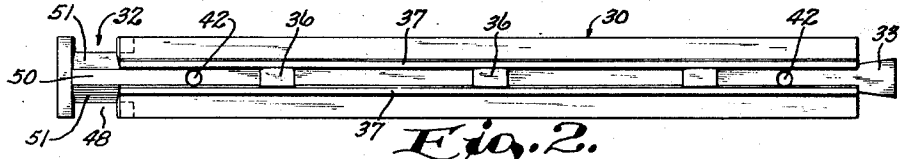


Fig. 2.

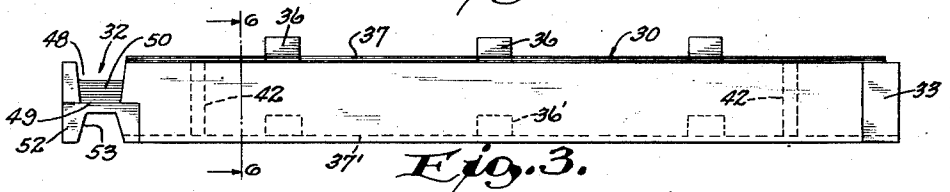


Fig. 3.

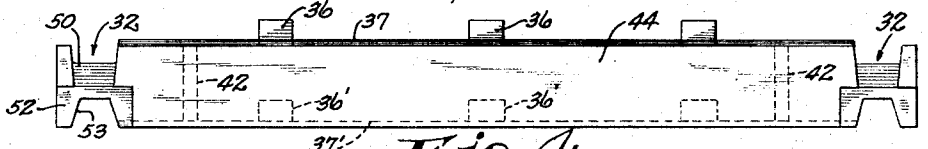


Fig. 4.

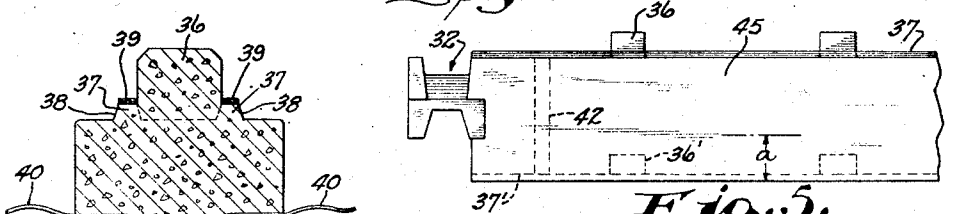


Fig. 5.

Fig. 6.

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Fig. 8.

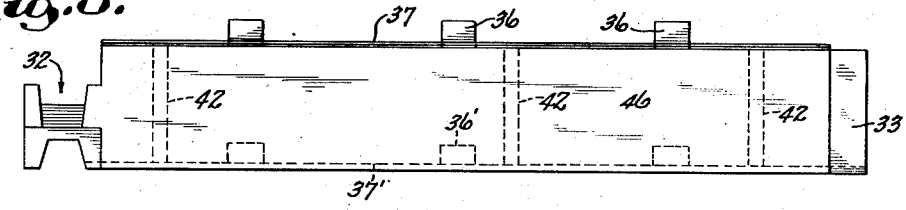
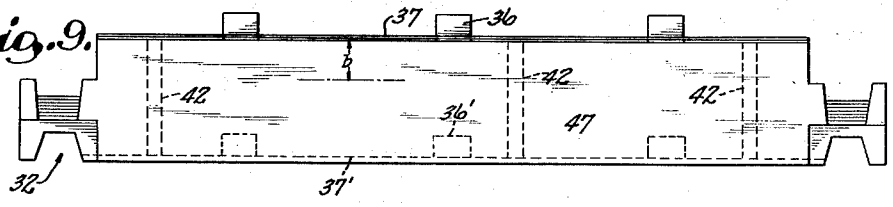


Fig. 9.



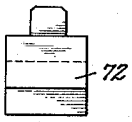


Fig. 10.

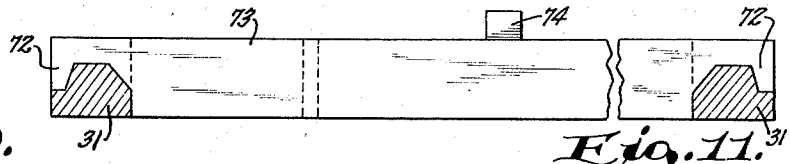


Fig. 11.

Fig. 12.

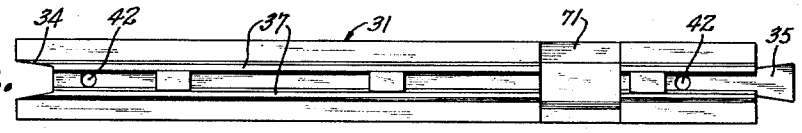
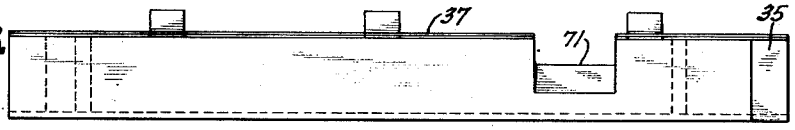


Fig. 13.



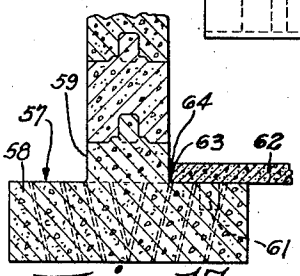


Fig. 17.

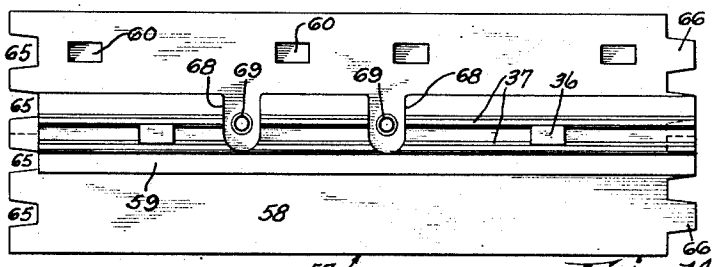


Fig. 14.

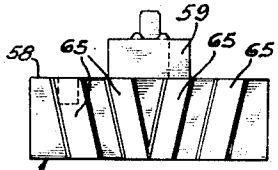


Fig. 16.

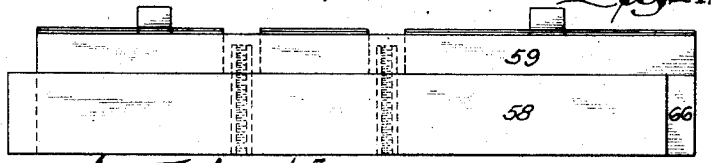


Fig. 15.

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Fig. 20.

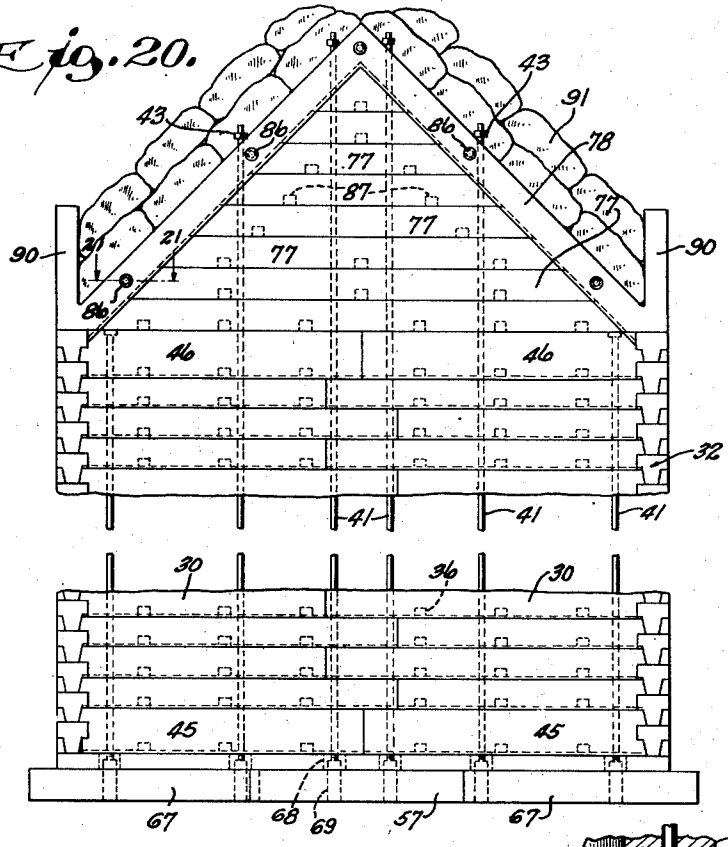
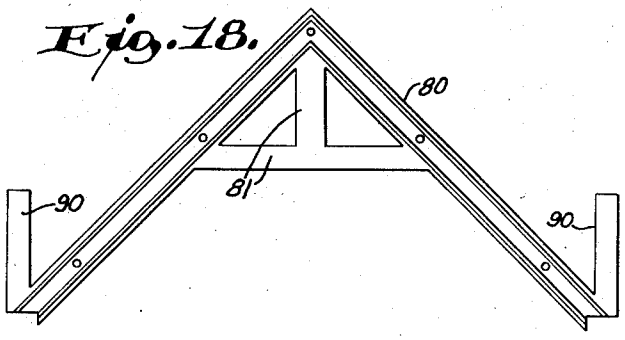


Fig. 18.



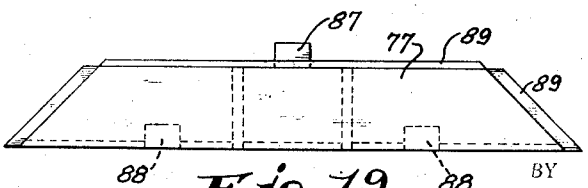


Fig. 19.

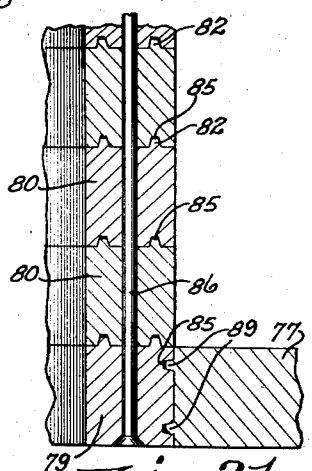


Fig. 21.

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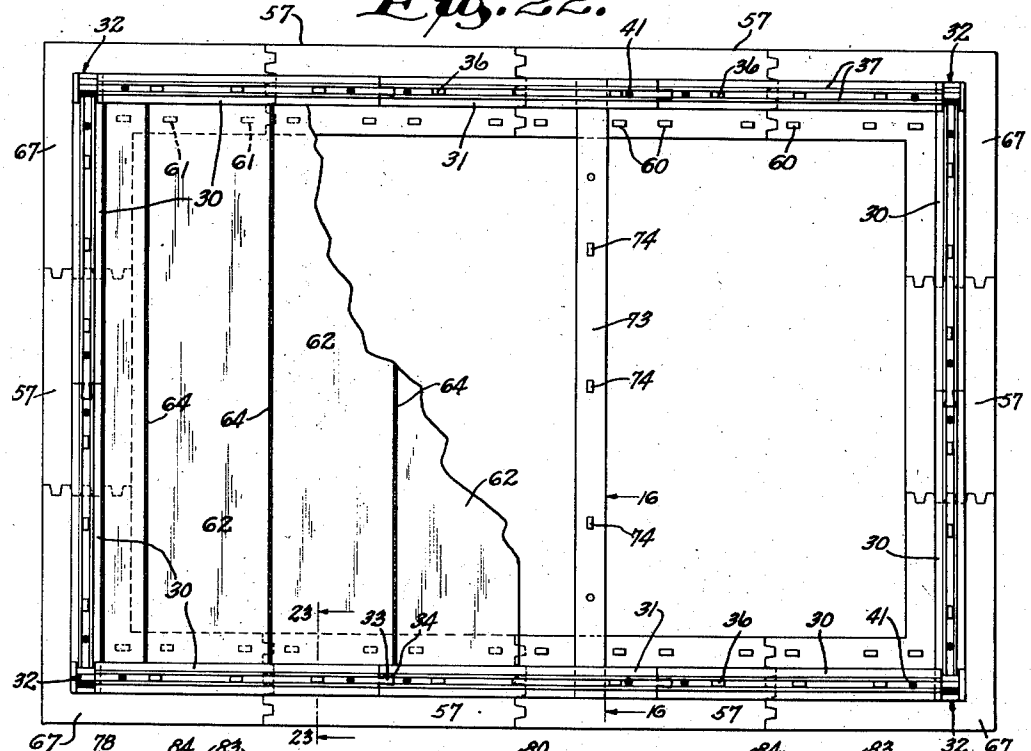
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Fig. 22.



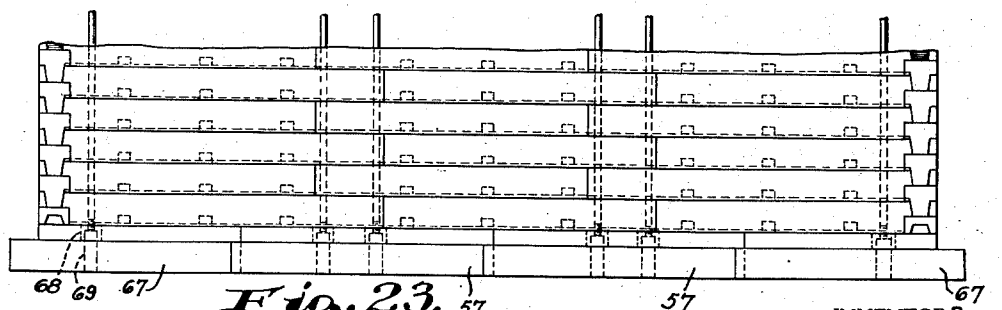


Fig. 23.

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Fig. 24.

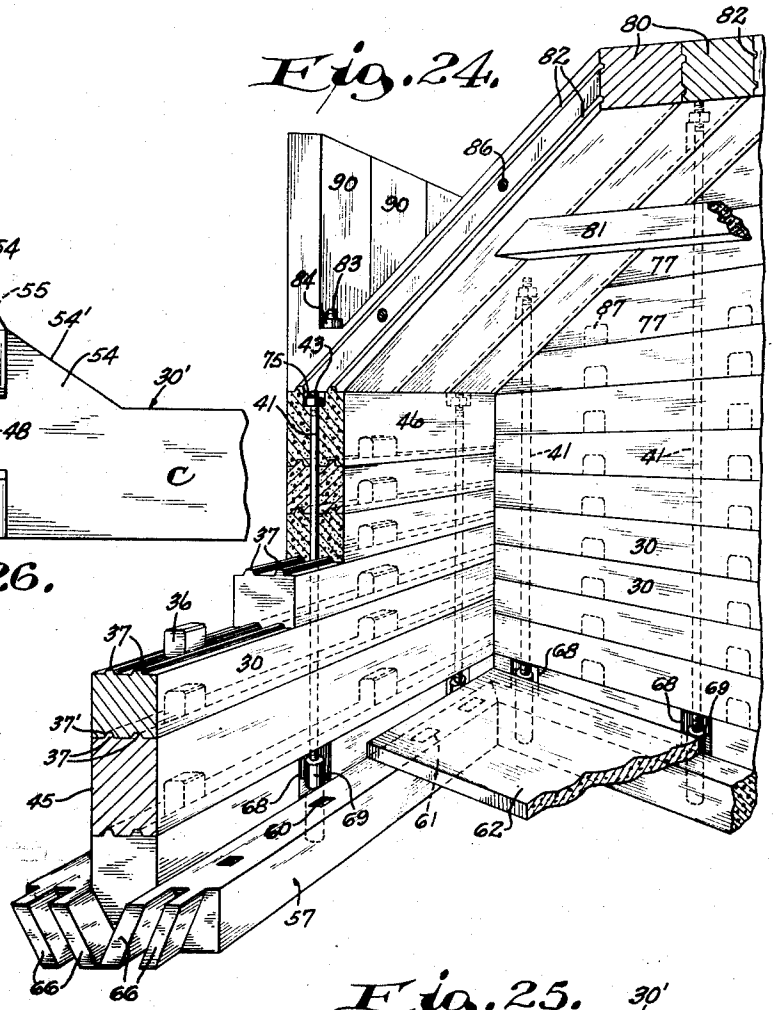


Fig. 26.

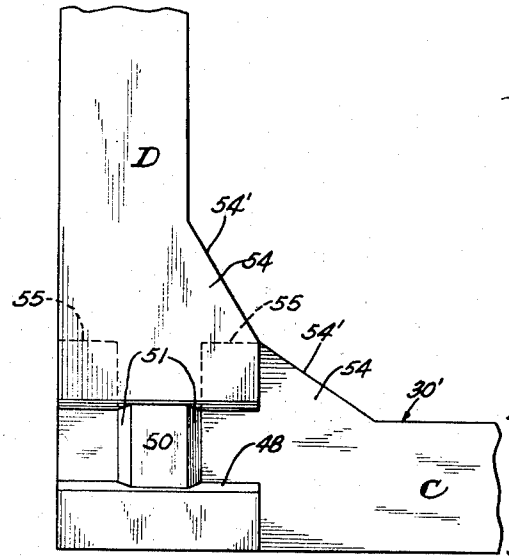


Fig. 25.

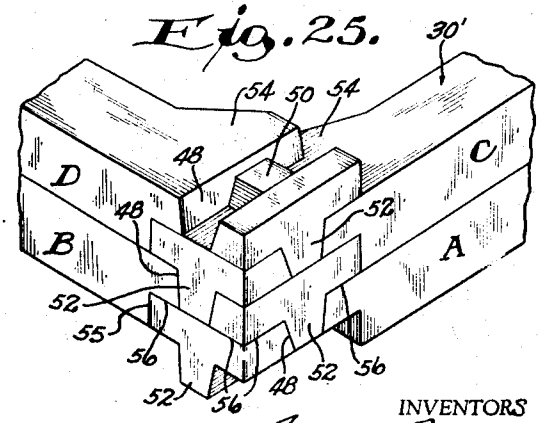
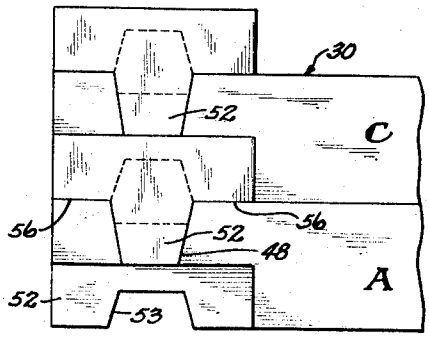


Fig. 27.



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UNITED STATES PATENT OFFICE

2,309,149

BUILDING

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Application March 29, 1941, Serial No. 385,804

9 Claims. (Cl. 72—1)

This invention relates to improvements in the art of fabricating buildings or the like.

While the present invention has broad applicability to the fabrication of various conventional structures such as houses, garages, and factories, it is a particular object to provide a building construction capable of withstanding to a maximum extent the rigors of modern warfare. The invention is therefore particularly suited for use in constructing air raid shelters, light forts, pillboxes, and ordnance and munition buildings.

In connection with this type of use, while it is not possible to devise a construction which will withstand all direct bomb hits, nevertheless such direct hits are relatively rare and a great majority of damage from bombs affects structures which are near to or in the general region of the explosion. Such damage results from the excessive pressures in one direction created by the explosion itself, and from forces acting in a reverse direction immediately after the explosion when the air rushes in to fill the void or vacuum caused by the explosion.

It is an object of the present invention to provide a building construction of preformed, interfitting elements capable of withstanding said abnormal and excessive pressure conditions ceated by nearby bomb explosions, and also capable of withstanding glancing hits and hits from shrapnel, the said resistance of the improved construction being due to a combination of features including stress lugs, stress bolts, and a novel corner interlock resistant to stresses from all directions and adapted to distribute such stresses to a plurality of units to minimize the strain which might otherwise have to be borne by a single unit.

A further object of the invention is to provide a construction as above described wherein the corner interlock is free of exterior projections.

A further object of the invention is to provide means whereby a building may be fabricated from preformed units of concrete or the like in a few hours' time, the units being equipped with interlocking features which permit the use of inexperienced labor.

A still further object of the invention is to provide a building construction fabricated from interlocking and cooperating units, which construction permits quick disassembly of the units and transportation to a new location for further use; the invention is thus well adapted for use in connection with modern warfare.

A further object of the invention is to provide in a building construction, novel footing units having joints designed to equalize stresses on the units.

Other objects of the invention are to provide in a building construction means for preventing the entrance of poison gas between the assembled units; means adapted to aid in the support of sandbags or the like on the roof; and means spaced upwardly above the roof for receiving the main force of direct hits to thereby protect the roof proper.

With the above and other objects in view, the invention consists of the improvements in the art of fabricating buildings, or the like, and all its parts and combinations as set forth in the claims, and all equivalents thereof. In the accompanying drawings, in which the same reference numerals designate the same parts in all of the views,

Fig. 1 is a perspective view of an air raid shelter;

Fig. 2 is a top view of one of the wall elements;

Fig. 3 is a side view of said element;

Fig. 4 is a side view of a different wall element, where the dimensions of the building are such that the element can extend from one corner to the other;

Fig. 5 is a fragmentary side view of a starting wall element having increased width;

Fig. 6 is an enlarged sectional view taken on line 6—6 of Fig. 3;

Fig. 7 is a fragmentary perspective view of one of the wall elements, showing the formation at the end of said element for use in the novel corner interlock;

Fig. 8 is a side view of a special finishing wall element of increased thickness having only one end adapted for use at a corner;

Fig. 9 is a side view of a similar element having both ends adapted for use at corners;

Fig. 10 is an end view of an interior crossbeam for use in forming partitions within a building;

Fig. 11 is a side view of said beam showing the method of interlocking its ends with a wall member of the type shown in Figs. 12 and 13;

Fig. 12 is a top view of a stretcher wall element;

Fig. 13 is a side view of said element;

Fig. 14 is a top view of one of the footing members;

Fig. 15 is a front elevational view of said footing member;

Fig. 16 is an end view of the footing member;

Fig. 17 is a transverse sectional view through

one of the footing members showing wall elements and a floor unit assembled thereon;

Fig. 18 is an elevational view of one of the inner roof units;

Fig. 19 is a side view of a gable filler unit;

Fig. 20 is an end view of a building structure, part being broken away;

Fig. 21 is an enlarged fragmentary sectional view taken on line 21—21 of Fig. 20 showing details of the roof assembly;

Fig. 22 is a horizontal sectional view through a building showing the footing units, wall units assembled thereon, partition beams, and floor units, parts being broken away;

Fig. 23 is a side elevational view of a building utilizing the improved construction, parts being broken away;

Fig. 24 is a perspective view looking from the interior of a building incorporating the improved construction;

Fig. 25 is a fragmentary perspective view showing a number of assembled wall units to illustrate a slightly modified form of corner interlock;

Fig. 26 is a fragmentary plan view on an enlarged scale of the group of elements shown in Fig. 25; and

Fig. 27 is a fragmentary side elevational view of the group of elements of Fig. 26.

In carrying out the present invention there are a limited number of elements or units which are necesssary in the formation of a building, and by having a supply of these elements various different buildings may be erected. It is also possible to quickly disassemble any of the structures and to use the units either in the same location for building a different structure, or in a different location for erecting any desired type of building. The standard units are all preferably formed of cast reinforced concrete, but for some purposes other materials are obviously suitable.

Wall elements

Referring to Fig. 1, illustrating one type of air raid shelter, a long side wall consists of tiers of wall elements, each tier comprising an element **30** (Fig. 2) at each end and an element **31** (Fig. 12) in between the two elements **30**. The element **30** has one end specially formed as at **32** to cooperate with similar elements in providing an unusual form of corner interlock particularly adapted for use in resisting strains in all directions, such as the elements of an air raid shelter might be subjected to. The other end of the element **30** has a dovetail projection **33** for cooperation with the dovetail recess **34** of the element **31**. The other end of the element **31** may be equipped with a dovetail projection **35** for cooperation with a second element **30**. The second element **30**, however, differs from the element of Fig. 2 in that in lieu of the dovetail projection **33** it must have a dovetail recess like the recess **34** of Fig. 12.

Tiers of the elements thus arranged are built up to desired height, and if a door is desired such as the door **35'**, certain of the wall forming elements must be of special length to cooperate in leaving a suitable opening.

In cross-sectional view all of the wall forming elements are like or similar to the showing of Fig. 6. In this figure it may be seen that from the top of each element are spaced stress distributing lugs **36** for cooperation with similarly shaped recesses **36'** in the bottom of an element thereabove. Also on the top of each element are spaced elongated tongues **37** (see also Fig. 2) having upwardly converging sides **38**. These tongues are received in elongated grooves **37'** formed on the lower side of an element thereabove. Where the construction is desired for war-time use soft mastic strips **39** may be employed on top of the tongues **37**. These strips may be formed of any material which is inexpensive, compressible, and mastic, such as rubber or rubber compositions, asphalt, or asphalt treated fabric. The use of strips of this type form a seal extending throughout the major portion of the length of each element to prevent gas from entering between the elements, because when one unit is placed on top of another the weight of the unit above compresses the mastic material, making a gas-tight seal. Also entering into the combination for producing an effective seal between the elements are stress distributing bolts **41** (see Figs. 20 and 23) which extend through suitably located openings **42** in the wall elements, and which may continue to the top of a side wall as in Fig. 23, or to the roof as in Fig. 20. The lower ends of these bolts are suitably anchored in a manner to be hereinafter explained, and the upper ends may be provided with nuts **43** which may be tightened to further compress the mastic material and aid in perfecting the seal.

Where the building is to be semi-permanent in character, wire ties **40** may be cast into the sides of the elements to facilitate the attachment of furring strips. This, therefore, makes it possible to apply plaster if desired.

Where a wall of a building is of limited length, a single element **44** (see Fig. 4) may be employed to extend the entire length of the wall. In such case both ends of the element are provided with means for effecting a corner interlock, as indicated at **32** in Fig. 4.

Inasmuch as two of the elements when interlocked at the corners by the means **32** are in offset horizontal planes, it is necessary when starting a building to use as a starting element on one wall, an element of special thickness such as the element **45** of Fig. 5. The extra material at *a* in said element will extend downwardly to meet the footings and prevent a gap which would otherwise occur. The use of these elements **45** of special thickness on the end walls is indicated in Figs. 1 and 20. Similarly, at the top of the wall a special condition arises necessitating the use of a special finishing element **46** or **47** (Figs. 8 and 9). These elements **46** or **47** have the extra thickness at *b* so that the top of the wall in which they are employed will be flush with the top of a wall at right angles thereto.

Corner interlock

The novel corner interlock which is of such importance in the present invention effectively interlocks a plurality of elements so that the stresses upon any one element are distributed to other adjacent elements. The corner is also arranged so that there are no projecting ends.

Referring first to Figs. 2, 3, and 7, the upper surface has a transverse notch or recess **48** therein adjacent an end. The recess **48** extends at right angles to the longitudinal axis of the element. The recess **48** is preferably tapered downwardly in width, as is clear from Fig. 3, and the bottom of the recess terminates at **49**, approximately midway of the thickness of the element. Intermediate the length of the recess or notch **48** is a projection **50** having upwardly tapering sides **51**. This projection extends transversely of

the recess 48 and substantially in line with the longitudinal axis of the element. The top of the projection 50 terminates short of the top surface of the element, as is clear from Figs. 3 and 7.

The lower side of the element adjacent the end is shaped to provide a tongue 52 which extends in the direction of the longitudinal axis of the element and at right angles to the direction of extent of the recess or notch 48. The tongue 52 is complemental in shape to the recess 48 and has its lower side formed intermediate the length of said tongue, with a recess 53 which is complemental in shape to the projection 50.

A modified form of corner interlock is illustrated in Figs. 25, 26, and 27, wherein the elements 30' have end portions of increased width as at 54 with angular surfaces 54' leading to said portions of increased width, which, as shown in Fig. 26, form an interior reinforcing web at the corner. The only other difference in the construction of Fig. 25 and the construction of Fig. 7 resides in the length of the interlocking parts, such length being obviously greater in the form of Figs. 25, 26, and 27 because of the increased width of the elements 30'. The same reference numerals are applied to the interlocking portions in Figs. 25, 26 and 27 as are applied to the corresponding parts in Figs. 2, 3, and 7.

The method of assembling the elements at the corners is the same for the form of invention of Figs. 2, 3 and 7 as for the form of invention of Fig. 25, and reference is therefore made to said latter figure as well as to Figs. 26 and 27. The lowermost element, designated A, has its transverse recess 48 engaged by the tongue 52 of an element B extending at right angles to the element A. In fitting into the recess 48, the central recess 53 of the tongue 52 obviously engages the complementally shaped projection 50 within the recess 48. At the same time there is a bracing engagement at 55, see Fig. 26, and at 56. The tongue 52 interlocking with the recess 48 provides an unusually firm interlock because there is a close interlock at right angles between the projection 50 and the recess 53 of the tongue 52. After the elements A and B are connected, an element C is superimposed on the element A, and the tongue 52 of the element C engages with the recess 48 of the element B and also with the projection 50 within the recess 48. Similarly another element D is superimposed on the element B, and the wall is built up to a desired height.

During such building up of the walls, the lugs 36, see Figs. 3 and 6, and the elongated tongues 37 are, of course, engaged with the recesses 36' and elongated grooves 37' of the superimposed element, as is clear from Figs. 3 and 6. This type of engagement between the members 37 and 37' is also clearly shown in Fig. 24.

Footing units

It is preferred, in order to rigidly support the structure in an efficient manner, to employ specially formed footing units 57, of concrete or other suitable material. These footing units are best illustrated in Figs. 14 to 17 and Fig. 24. Each footing member comprises a base portion 58 having an elongated upstanding projection 59 thereon which renders the units substantially an inverted T in cross-section, as shown in Figs. 16 and 17. The portion of the base 58 which extends inwardly of the building is formed with openings 60 for the reception of stress lugs 61 which extend downwardly from flooring sections 62, whereby the flooring is supported on the base portions 58 of the footings. The side and end edges of the flooring sections may be tapered, as at 63, to provide a space for the reception of a sealing mastic 64, as shown in Fig. 17. The material 64 may be similar to the material of 39, shown and described in connection with Fig. 6. Mastic material 64 may also be employed between the meeting edges of adjacent flooring sections, as shown in Fig. 22.

One end of each footing unit is formed with downwardly converging mortises 65 for the reception of complemental tenons 66 on the end of an adjacent footing unit. This special type of joint between the ends of the footing units is effective in carrying the stresses from one unit to the next. For the corners of a building structure the footing units may be L-shaped, as at 67, Fig. 22.

The inner side of the upstanding part of each footing unit may be recessed, as at 68 (see Figs. 14 and 24), and projecting into each recess from the base of the footing unit is an internally threaded sleeve 69. The sleeves 69 are preferably loose in the footings so that they may be moved laterally to some extent for proper alinement with the lower ends of the stress bolts 41. By inserting the hand into the recesses 68 such alinement can be readily effected, and the lower threaded ends of the stress bolts 41 can be readily anchored to the footing units, as is clearly shown in Fig. 24.

In assembling the walls, the wall elements are preferably formed in several lengths so that on long walls the meeting ends may be staggered, as at 70 (Fig. 1), to prevent undue weakening.

Partitions and roof

If it is desired to have partitions within the building, some of the wall elements may be notched, as at 71 (Figs. 12 and 13), for interlocking engagement with specially formed ends 72 of interior beams 73, as shown in Figs. 11 and 22. One or more of said beams 73 may be employed in anchored relationship with the walls to support other partition forming members, which may have recesses for interlocking engagement with the lugs 74 of the beams 73. At the top of the longer side walls the stress bolts 41 may terminate in recesses 75, see Fig. 24, and the nuts 43 may be applied to the threaded upper ends of said bolts. The stress bolts on the end walls may extend upwardly through gable filler elements 77 (see Fig. 20), and through the endmost roof units 78, where nuts 43 may be applied to the threaded upper ends. The endmost roof-forming units 78, shown in Fig. 20, are assembled in conjunction with other inner roof-forming units 80 (see Fig. 18), and some or all of these inner units may be trussed as at 81. The roof units 78 and 80 are assembled, as shown in Figs. 1, 21, 23 and 24, there being a tongue and groove engagement, as at 82 (Fig. 21), between the sides of the roof-forming units. The topmost wall-forming elements 30 on the long walls of the structure, and which form bearings for the roof members, may have anchoring bolts 83 projecting upwardly therefrom, as shown in Fig. 23, and extending through openings in the roof-forming units 78 and 80. Nuts 84 may be threaded on the projecting threaded ends of the bolts 83, whereby the roof units may be tightly connected to the upper edges of the side walls.

As shown in Fig. 21, mastic material 85 forming a seal against poison gas, similar to that described in connection with Fig. 6, may be em-

ployed in the tongue and groove connections between the roof units. Horizontal stress bolts **86** may also be employed to additionally connect the roof-forming units and may be provided with the usual nuts which, when tightened, will compress the mastic material **85** and insure an effective seal against gas.

The gable filler units **77** shown in Figs. 19 and 20 are of decreasing length and are placed in superimposed position as illustrated. Stress lugs **87** on the upper edges of the filler units **77** are cooperable with stress lug recesses **88** in the lower sides. In addition there may be a tongue and groove engagement between the superimposed gable filler units, as well as between the ends of the gable filler units and the roof-forming units **78**, as indicated at **89** in Fig. 21.

Special roof protection features

Where the roof units are for use in an air raid shelter or the like the lower ends of the units may be formed with upstanding projections **90** which cooperate in assembly to provide a parapet wall for holding sand bags **91**, or other like material, in position on the roof, as shown in Fig. 20. In addition, in order to protect the roof proper from direct hits it is advantageous to have a frame **92** supported on corner uprights **93**, as shown in Fig. 1. Auxiliary roof members **94** may then be laid on the frame **92** to receive the direct results of a hit and probably save the roof proper.

From the above it is believed clear that the construction is unique in its strength and ability to withstand strains in all directions. The combination of the stress lugs fitting in recesses, the stress bolts which extend vertically through all of the wall elements, and the unusual corner interlock, serves to distribute stresses on any one element to a plurality of elements so that no great forces will have to be borne by any single unit. The unusual footing units with the stress equalizing end joints are so designed that regardless of the direction of the stress placed upon a single unit a portion of said stress will be passed on to the adjacent units. The end connections between the footings are so designed that alinement of the footings is automatic. The manner in which the inside beams **73** are anchored to the walls and the use of stress lugs on the flooring, which lugs are engageable with recesses in the footings, creates a spreading effect to aid the walls in resisting exterior stresses.

It is obvious that the building constructions illustrated in Figs. 1, 20, 22, 23 and 24 are merely illustrative and that various types of structures of different size and shape may be formed. The various building units and elements may also be varied in size and proportions to suit requirements.

For small air raid shelters or the like the roof units, together with the gable filler units, may be employed alone without any supporting walls. This makes an inexpensive, quickly erected shelter. In connection with such use, the parapet walls **90** for holding sand bags and the auxiliary roof **94** are desirable additions. The unusual corner interlock shown in Figs. 7, 25, 26 and 27 is applicable for use in any type of construction work wherein extra strength and rigidity are important and may be used advantageously in the building of furniture or other articles out of wood.

Various other adaptations may occur to those skilled in the art, as well as additional changes and modifications, and all of such changes are contemplated as may come within the scope of the claims.

What we claim is:

1. Elements for use in construction work, each comprising an elongated member having a recess extending into one side thereof, and having an opposite side formed to provide a tongue of less width than the element and which is complemental in shape to said recess, said tongue extending in a direction at right angles to the direction of extent of the recess and the top of the tongue meeting the bottom of the recess on a line midway of the vertical thickness of the element, the tongue of one element being adapted to engage the recess of an element at right angles thereto.

2. Elements for use in construction work, each comprising an elongated member having a recess extending into one side thereof transversely of the element and having an opposite side formed to provide a tongue of less width than the element, said tongue being complemental in shape to said recess and extending in the direction of the longitudinal axis of the element, the top of the tongue meeting the bottom of the recess on a line midway of the vertical thickness of the element, the tongue of one element being adapted to engage the recess of an element at right angles thereto.

3. Elements for use in construction work, each comprising an elongated member having a transverse recess extending into one side thereof a short distance from an end of the element and having an opposite side formed to provide a tongue of less width than the element, said tongue being complemental in shape to said recess and extending in the direction of the longitudinal axis of the element with one end of the tongue terminating at the end of the element, the top of the tongue meeting the bottom of the recess on a line midway of the vertical thickness of the element, the tongue and recess being positioned in bisecting relationship with one another whereby when the tongue of one element is engaged in the recess of another element at right angles to said first element a strong flush corner is formed.

4. Elements for use in construction work, each comprising an elongated member having a recess extending into one side thereof and having an opposite side formed to provide a tongue which is complemental in shape to said recess and which tongue extends at right angles to the direction of extent of said recess, there being a projection extending transversely of an intermediate portion of said recess, and said tongue being of bifurcated form to provide a recess intermediate the length of said tongue which is complemental in shape to the projection in the first-mentioned recess, the bifurcated tongue of one element being adapted to engage the recess and projection of an element at right angles to said first element.

5. Elements for use in construction work, each comprising an elongated member having a transverse recess extending into one side thereof and having an opposite side formed to provide a tongue of less width than the element, said tongue being complemental in shape to said recess and extending in the direction of the longitudinal axis of the element, there being a projection extending transversely of an intermediate portion of said recess, and said tongue being of bifurcated form to provide a recess intermediate the length of said tongue which is complemental in shape to the projection in the first-mentioned recess, the bifurcated tongue of one element being adapted to engage the recess and projection of an element at right angles to said first element.

6. Elements for use in construction work, each comprising an elongated member having a transverse recess extending into one side thereof a short distance from an end of the element and having an opposite side formed to provide a tongue of less width than the element which is complemental in shape to said recess, said tongue extending in the direction of the longitudinal axis of the element with one end of the tongue terminating at the end of the element, there being a projection extending transversely of the center portion of said recess, and said tongue being of bifurcated form to provide a recess which is central in the length of said tongue and which is complemental in shape to the projection in the first-mentioned recess, the bifurcated tongue of one element being adapted to engage the recess and projection of an element at right angles to said first element to provide a strong flush corner.

7. Elements for use in construction work, each comprising an elongated member having a transverse recess extending into one side thereof a short distance from an end of the element and having an opposite side formed to provide a tongue of less width than the element, said tongue being complemental in shape to said recess and extending in the direction of the longitudinal axis of the element with one end of the tongue terminating at the end of the element, the tongue and recess being positioned in bisecting relationship with one another whereby when the tongue of one element is engaged in the recess of another element at right angles to said first element a strong flush corner is formed, the portion of each element in which said corner interlocking means is formed being of increased width with respect to the rest of the element.

8. Elements for use in construction work, each comprising an elongated member having a transverse recess extending into one side thereof a short distance from an end of the element and having an opposite side formed to provide a tongue of less width than the element, said tongue being complemental in shape to said recess and extending in the direction of the longitudinal axis of the element with one end of the tongue terminating at the end of the element, the tongue and recess being positioned in bisecting relationship with one another whereby when the tongue of one element is engaged in the recess of another element at right angles to said first element a strong flush corner is formed, the portion of each element in which said corner interlocking means is formed being of increased width, and there being an angular surface leading into said portion of increased width, the angular surfaces of interlocking elements cooperating to form an interior reinforcing web at the corner.

9. Elements for use in construction work, each comprising an elongated member having a portion adjacent an end cut out to provide interlocking means, said interlocking means being cooperable with complementary interlocking means formed adjacent the end of another element at right angles to said first element, the portion of each element in which said interlocking means is formed being of increased width, and there being an angular surface leading into said portion of increased width, the angular surfaces of interlocking elements cooperating to form an interior reinforcing web at the corner.

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