Jan. 10, 1967 J. PAVLECKA 3,296,759

INTERLOCKED HOLLOW PANEL STRUCTURE

Filed Dec. 7, 1964 3 Sheets-Sheet 1

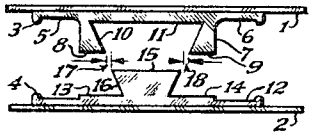


Fig. 1.

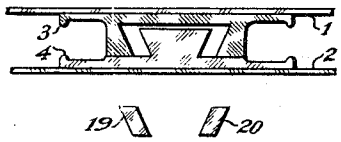


Fig. 2.

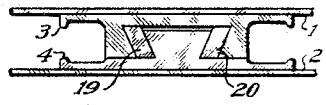


Fig. 3.

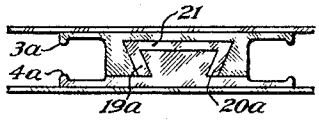


Fig. 4.

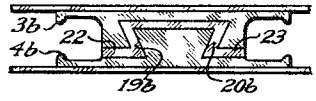


Fig. 5.

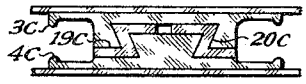


Fig. 6.

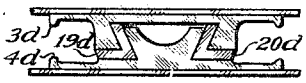


Fig. 7.

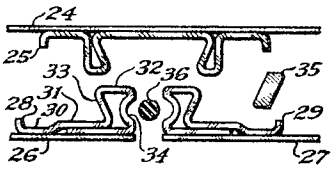


Fig. 8.



Fig. 9.

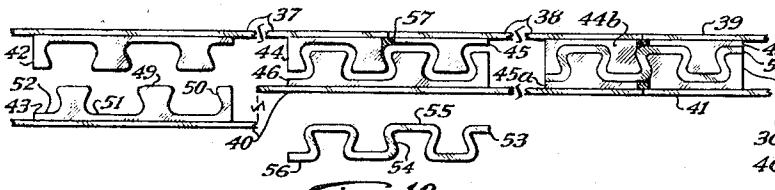


Fig. 10.

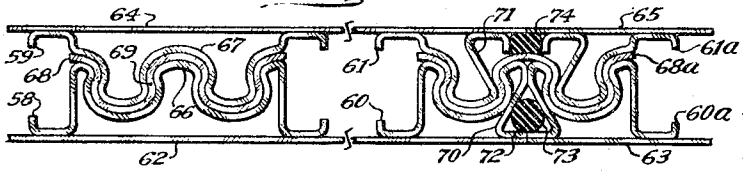


Fig. 11.

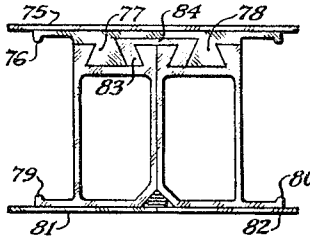


Fig. 12.

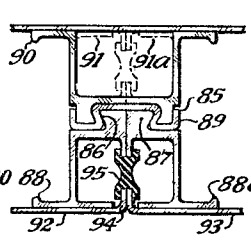


Fig. 13.

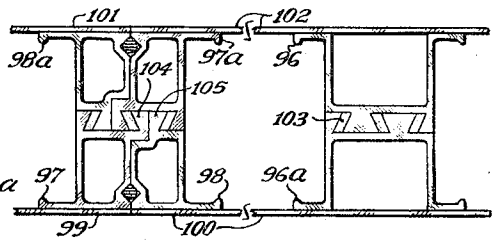


Fig. 14.

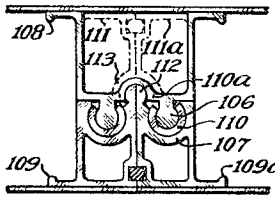


Fig. 15.

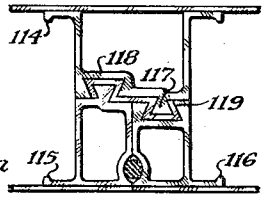


Fig. 16.

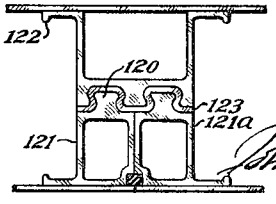


Fig. 17.

INVENTOR:

John Pavlecka

Jan. 10, 1967 J. PAVLECKA 3,296,759

INTERLOCKED HOLLOW PANEL STRUCTURE

Filed Dec. 7, 1964 3 Sheets-Sheet 2

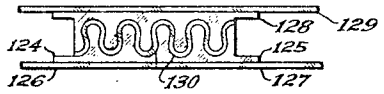


Fig. 18.

Fig. 20.

Fig. 19.

Fig. 21.

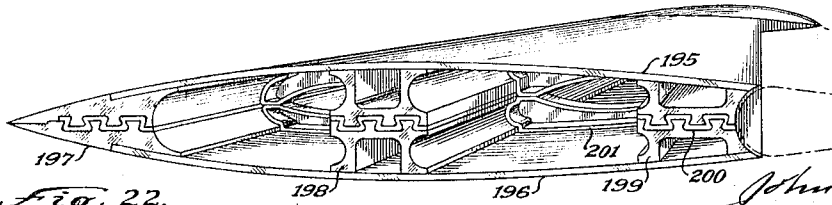


Fig. 22.

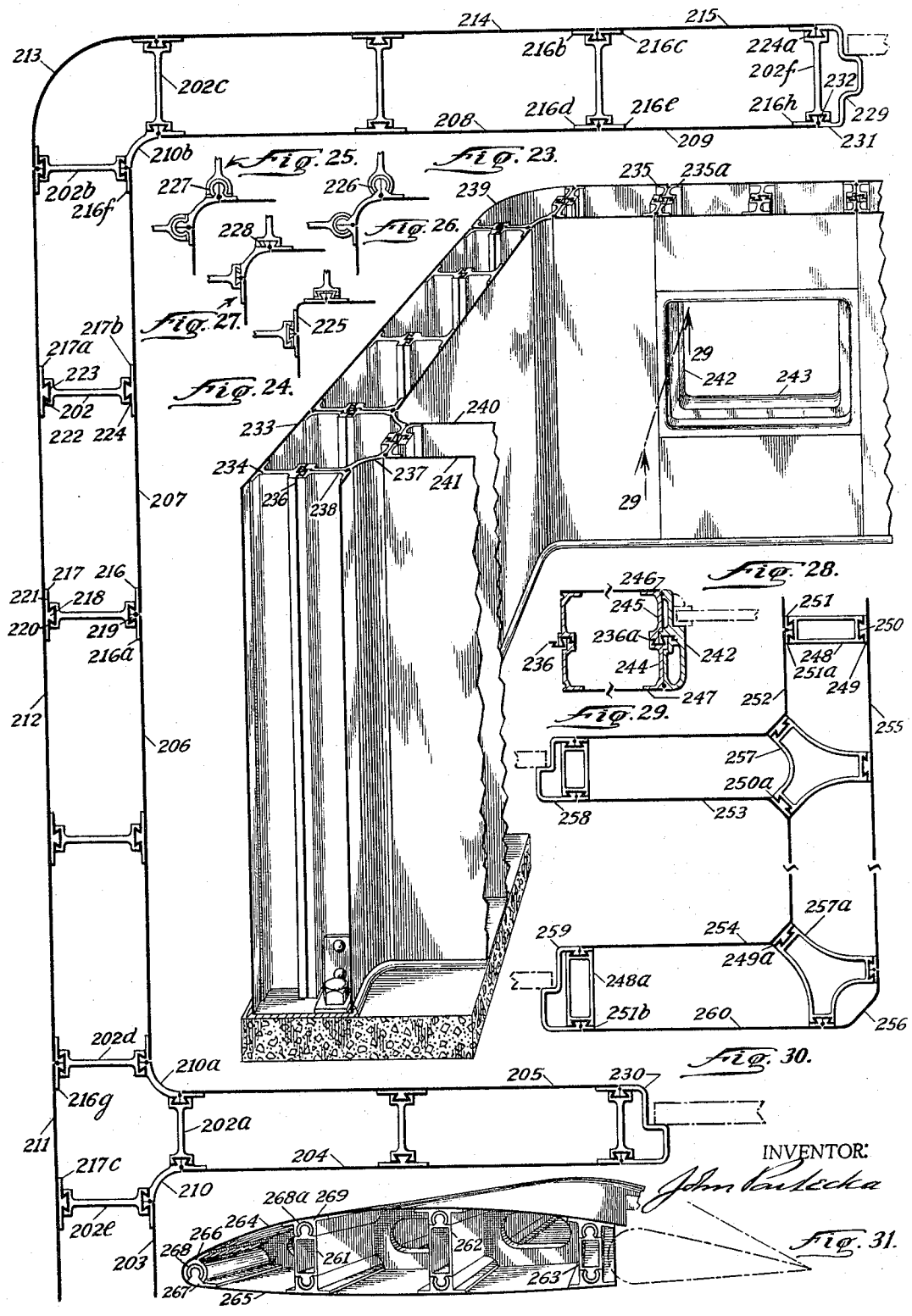
INVENTOR.

John Pavlecka

Jan. 10, 1967 J. PAVLECKA 3,296,759

INTERLOCKED HOLLOW PANEL STRUCTURE

Filed Dec. 7, 1964 3 Sheets-Sheet 3



United States Patent Office 3,296,759 Patented Jan. 10, 1967

3,296,759

INTERLOCKED HOLLOW PANEL STRUCTURE

John Pavlecka, 8797 Capital, Oak Park, Mich. 48237

Filed Dec. 7, 1964, Ser. No. 423,887
35 Claims. (Cl. 52—236)

The structure of this invention was first disclosed in my application for "Interlocked Panel Structure," Serial No. 311,575, filed September 26th, 1952, now abandoned, of which a continuation application, bearing the same title, was filed under Serial No. 632,601, on January 4, 1957; the instant application is a continuation-in-part of the latter application and now abandoned.

This invention relates to a structure for falls, floors, and partitions for buildings and dwellings, and for decks, van and bus bodies, bill boards, aircraft wings, etc., and more particularly to a panel structure the components of which are interlocked into unity by linear slidably engaging keys of the blocking species.

One object of this invention resides in a structure with an inaccessible interior, either closed or of an indefinite extent, which is assembled or erected of panel units, or of panel units and stress members therebetween, by slidably inserted blocking keys from one open end of the structure, and which can be disassembled with equal facility for repair or relocation by withdrawing the keys.

Another object is a structure of a flawless exterior such as is essential for appearance in all shell structures and for smoothness and accuracy in airfoil bodies, in which the widest available panels can be used for the shell and the number of the seams or parting lines reduced thereby, and such panels can be prefabricated with full accessibility by attaching interlocking stringers or formations to them by processes such as adhesive bonding or resistance welding.

Another object is a hollow wall or body consisting of a shell and supporting stress members in it, the shell being assembled of panel units which consist of thin panels and stringers on them, the stringers being key-locked to each other side-by-side on adjoining panel units and in opposition on spaced apart facing panel units, in the latter case either key-locked directly to one another or to interjacent stress members; the stringers not only eliminate stress concentration in the panels but carry key-engaging formations on them and along and besides these formations carry flat lands for abutment with each other, or with the stress members, or with interposed key webs, whereby the interlocked parts are rendered relatively immobile for coaction as a unitary stress member for the panels locally and for the whole structure in unison with the other parts so interlocked and abuted.

Another object resides in making possible the use of panels of different modular widths compatibly with one another in walls, in making the panel parting lines occur either at random or by plan at any one modular interval, and in making the parting lines in the facing panel rows in hollow walls occur indiscriminately in coincident or non-coincident relationships, by providing the panels with only two types of stringers, one type at intermediate intervals between the panel parting lines, and the other type consisting of two juxtaposed stringers on each two meeting panels and being jointly equivalent to one intermediate stringer in the matter of the keying formations thereon; these two stringer types occuring on the facing wall sides in opposition one type with either the same type, or with the other type, and thereby giving rise to the three basic panel unions vital for assembly of walls from panel units, i.e., apart from the parting lines, at coincident lines, and at non-coincident lines.

Another object is to devise interlocking formations for the two aforementioned stringer types, and for stress

members used between them in certain embodiments, which formations on the opposed stringers, or stringers and stress members, are correlated to interfit freely and loosely in the frontal or panel-to-panel direction and thereby make it possible to set the panel units up in their relative positions without lifting them or pushing them forcibly against one another, and only light-weight linear keys are handled and inserted inbetween the interfitted formations for interlocking the panel units.

Another object is to devise interlocking keys for panel units and stringers of the aforementioned two types thereon in their juxtaposed and opposed relationships, and for interjacent stress members in certain embodiments, which keys function by blocking interfitted mortise and tenon formations on the parts, at obliquely disposed opposite flanks thereon, against frontal, or frontal and lateral separation, and are inserted endwise into place; the keys being of a constant cross-section throughout their length for a uniform engagement with the parts, which length is substantially that of the parts themselves, and their engagement with the formations being a slidable one for easy assembly or disassembly.

Another object resides in asymmetrical reentrant mortise and tenon formations for the aforementioned two stringer types, one result of which is that each two intermediate stringers in opposition to each other can be identical with each other, as can each pair of juxtaposed edge stringers be identical with a pair in opposition to it; moreover, complete panel units provided with such stringers bearing a symmetrical keying formations can be identical with each other, and are compatibly associable with each other not only in full facing but in overlapping and adjoining relationships as well.

Yet another object is to devise panel units whose stringers bear symmetrical keying formations correlated so that the panel units become identical with each other and are compatibly associable with each other in at least a number of overlapping relationships besides the full facing and adjoining ones.

An object of vital importance is a solution of the construction of intersections between walls by means of stringers of both the aforementioned two equivalent types disposed diagonally on the inner wall side panel units in opposition to either stringers diagonally or squarely disposed on the outer wall side panel units, or to a stress member of a trifurcate profile.

The parts and constructions accomplishing the above objects are disclosed hereinfurther first in a general outline, and then as applied to specific embodiments in the drawings which form an integral part of this specification.

All embodiments of the structure of this invention make use of the same basic type of interlocked union between their components, which type is modified in the different embodiments shown in the drawings with distinctive new features for specific useful purposes and novel results; in all embodiments at least one, and usually several panels form the exterior of a structure; proximate to the inward face of the panels extend structural members which may be either individual stress members, such as joists, studs, beams, spars, etc., or they may be panels in a row parallel to the first one; when individual stress members are associated with one panel row, another such row may also run proximate to their other profile extremity and form a hollow all or body jointly with the first row; each panel is provided with auxiliary stress members or stringers which extend lengthwise thereon, one at along each panel edge or parting line—hereinafter referred to as the "edge" type; one or more of stringers extend on each panel wider than one module at each intermediate modular interval apart from the panel edges, and are referred to as the "intermediate" type.

Besides functioning in their usual way, i.e., as auxiliary stress members for the panels, the stringers of both types serve also as carriers of interlocking formations for them; each intermediate stringer in a pair of two of them in opposition carries at least one lengthwise tenon on its profile extremity, the tenon having obliquely reentrant flanks such as obtain on a dovetail or bulbous profile; its opposite mate is formed with a lengthwise mortise of an analogous profile but of a larger size and having a throat wider than the tenon crest whereby the tenon can enter the mortise freely in the frontal or in-and-out direction and occupy it loosely with a clearance either all around or at least between the confronting obliquely reentrant flanks; into this clearance is telescoped endwise a linear key which may consist of a chock in each reentrant clearance, or of two such chocks connected by a chordal web for rigidity and simultaneous handling of the chocks as one piece; this web is assigned other vital functions in connection with the edge type stringers as well as with both stringer types; the chocks block the tenon from being withdrawn from the mortise, thus locking the stringers, or a stringer and a stress member, carrying these formations into unity with each other; a useful modification resides in employing such formations in multiples, i.e., two or more tenons and an equal number of opposite mortises, with plural chocks in the reentrant clearances therebetween, preferably interconnected by webs into a continuous section.

One essential characteristic of the interlocking keys, whether they include in their profile only one angled blocking chock or several web-connected such chocks, is their linear extent throughout which their section is constant; their length is substantially the same as that of the parts which they interlock, and because of their constant section and a snug but slidable fit in them, they engage the parts uniformly throughout their length without any stress concentration or wedge fit, and because of these structural and functional properties not only lock the parts together so that they become virtually a single stress member, but the keys themselves cooperate with the parts as a substantial contribution to such a member.

The edge type stringers are devised so that each two juxtaposed ones represent an equivalent of the keying formations of one intermediate stringer; accordingly, each edge stringer in one pair carries on it one lateral half of an obliquely reentrant tenon and complements the other stringer to provide a full tenon, and each stringer in the opposite pair is formed with a half-mortise so that both of them create a single obliquely reentrant and oversize mortise; inasmuch as two such mortised stringers would not be locked to each other laterally, means are devised to lock them so, one of the most useful such means being a linear key which has two blocking chocks interconnected by a web across the panel parting line.

The function of the stringers, or stringers and interjacent stress members, and of the linear keys locking them into unity, is, first, to join the panel units to form a shell or body, and, second, to give rise to the essential stress members within that shell or body; in performing the latter function it is to be expected that the more cohesive the keyed union of the parts is the better their coaction as a single member in stress resisting; the closer the tolerances of the parts will be the tighter will be their union; in order to improve the relative immobility of the parts and thereby bring about a better coaction between them in resisting stresses, the stringers, or the stringers and the individual stress members interjacent them, are provided with flat lands along and beyond the width of their keying formations; such lands on two opposite stringers, or on a stringer and a stress member, are either in direct contiguity with each other whereby they can abut against each other initially, and will abut against each other under strain due to the least deflection by laterally or axially applied forces, or, the linear key locking them to each other can be formed with marginal webs which are interposed between such opposed lands and contiguity and abutment take place against the key webs. The edge stringers are provided each with one flat land and each two such stringers equal the lands on one intermediate one.

The stringers can have different height in different embodiments, depending upon whether they are key-locked directly in opposition to one another, or whether additional stress members are employed between the wall sides and the stringers thereon, such as are needed in wide walls or walls heavily loaded; in the latter case, the stringers are of a minimal height, their profile consisting of the keying formations and attaching flanges therealong, which flanges provide advantageously the abutment lands in opposition to those on the stress members; even though such low stringers could be made in one piece with the panels, it is essential that the abutment lands be raised away somewhat from the panel face unless the panel is relatively thick.

In walls wherein the opposite stringers are keyed directly to one another, a reduction in the number of different stringer profiles and, moreover, completely universal associability of the opposite panel units with one another at any one interval will result from employing asymmetrically arranged keying mortise and tenon formations on the stringers; such formations—and the abutment lands therealong—on each two opposed stringers of the intermediate type, and the same formations on each pair of the opposed stringers, will be identical, therefore, the stringers can be identical with each other, and so can the complete panel units bearing them.

The unions of panel units, or of panel units and stress members, by means of stringers of the two equivalent types, and by identical linear keys, as disclosed hereinabove, are useful for constructing either simple structures such as a one-panel bill-board backed up by stanchions, or complex hollow walls for buildings and houses wherein the stringers are made use of to construct intersections between angularly meeting walls; such intersections are assembled from flat panel units and units joined at right angles to each other, or bent ones, by stringers on them directed either squarely or at an inclination into opposition and interfit with each other and for an interlock by one or more linear keys; if stress members interjacent the panel rows are used, one such member of a tri-furcate profile is keyed to diagonally laid stringers on the inner wall sides and to normally placed stringers on the outer wall side; another type of intersection construction employs bent or right-angle panel units or transition members between straight wall courses assembled by means of the stringers of the two equivalent types on modular panel units.

The two equivalent stringer types, normal or inclined, with or without interjacent stress members, and identical linear blocking keys, in abutment with one another at marginal lands, are thus capable of producing a house or building wall plan of any shape or extent mostly from duplicate parts, and give rise to the necessary primary stress members therein because of the cooperation between the two stringer types and because of the cooperation of the interlocked parts in abutment with each other; similar parts and the same kinds of cooperation will produce an airplane wing wherein different panel units and stringers on them are key-locked and cooperate to form a unitary airfoil shell.

A number of key-locked panel unions suitable for various purposes and products as well as complete structures making use of them are described in the following paragraphs with reference to the drawings, in which:

FIG. 1 is a profile view of two spaced apart panels with stringers on them, in a disassembled condition, the stringers bearing reentrant mortise and tenon formations freely insertable into each other in the frontal direction, and abutment lands along and beside them;

FIG. 2 shows the same panels and stringers with their formations interfitted to produce clearances at their reentrant flanks, and chocks or blocking keys for insertion into the clearances;

FIG. 3 is a completed union of the panels of FIGS. 1 and 2 by means of the chocks slid into place endwise and locking the parts to each other;

FIGS. 4 to 7 illustrate each a variant of the blocking key or keys in a union analogous to that of FIG. 3;

FIGS. 8 and 9 represent, respectively, a disassembled and assembled union of edge and intermediate types of stringers on adjoining and on facing panels by only one chock or blocking key;

FIG. 10 shows panels in two rows in three assembly stages, i.e., separate, interfitted and interlocked, the mortise and tenon formations on the stringers being asymmetrical about the panel parting line;

FIG. 11 shows key-locked unions of stringers of the same type, the two pairs of the edge stringers being locked together laterally as well as frontally by multiple formations and by a cross-web as a part of the key;

FIG. 12 is a union of stringers of unequal height by a key having a cross-web for holding the two edge stringers together independently of the opposite stringer and for holding together two pairs of such stringers if one pair takes the place of the single stringer;

FIG. 13 shows a linear key formed with side flanges for lateral locking of two edge stringers;

FIG. 14 represents key-locked unions of two stringer types by means of asymmetrical formations and blocking chocks therein, and demonstrates the identity of the opposite single and paired stringers;

FIG. 15 shows projections on two edge stringers for a lateral interlock with one opposite stringer;

FIG. 16 is a variant of the asymmetrical keying formations derived from the one in FIG. 14;

FIG. 17 is a union of parts by formations of a modified dovetail shape and a conforming webbed key;

FIG. 18 shows multiple mortise and tenon reentrant formations of the asymmetrical species;

FIG. 19 is a dovetail configuration of asymmetrical keying formations on wooden stringers;

FIG. 20 is a perspective view of a portion of a wall showing a disposition of stringers for identity and congruency of the facing panel units;

FIG. 21 is a portion of a hollow wall structure including L- and T-intersections between right-angle walls by means of inclined stringers;

FIG. 22 is a perspective view of an airplane wing, the shell and the spars therein being produced from two panel units and key-locked opposed stringers thereon;

FIG. 23 is a plan view of a house peripheral wall and of a partition wall branching from it, with studs in the walls key-locked to stringers of the two types on the panel units, and L- and T-intersections between wall sides effected by curved panel units and transition members;

FIGS. 24 and 27 are detail views of modified transition members and various species of the blocking keys locking them to the panel units and to the studs;

FIG. 28 is a perspective view of a similar portion of a house wall as FIG. 23, with stringers on the panel units key-locked directly to one another, and transition members providing cove corners at the intersections;

FIG. 29 is a sectional view of a terminal member, stringers, and asymmetrical keys and formations therefor taken in FIG. 28 at a location designated **29—29**;

FIG. 30 is a plan view of another wall structure distinguished by diagonally inclined stringers on beveled panel units at L- and T-intersections, and by tri-furcate studs joining the inner and the outer wall sides at the intersections; and

FIG. 31 is a perspective view of an airplane wing with individual spars key-locked to stringers on the dorsal and ventral panel units.

Certain primary components of my new structure prior to their assembly are shown in FIG. 1, and include panels **1** and **2** in a spaced apart relationship, each one of which has a stringer **3** and **4**, respectively, on it, and may have a number of such stringers on it at equal intervals apart from its edges; panels bearing such stringers and others become panel units although the term "panel" is often applied to them; stringer **3** has a profile defined by attaching flanges **5** and **6**, and walls **7** standing thereon and rising to shoulders **8** and **9** between which runs lengthwise a mortise; its shape in this and all other embodiments includes inwardly divergent or obliquely reentrant flanks **10** which, in this embodiment, are flat and part of a dovetail shape with a flat bottom **11** on a cross-web which intervenes between the flanges **5** and **6** to provide a wide base for the stringer on its panel. The companion stringer **4** has attaching flanges **12**, and between them ledges **13** and **14** at a distance from the panel **2**, astride a tenon **15** and reentrant flanks **16** on it; a basic relationship is that between the throat of the mortise and the crest of the tenon, the former being wider by amounts **17** and **18** on the sides so that the tenon can enter the mortise freely in the normal or in-and-out direction, and becomes interfitted with it as the shoulders and ledges **8–13** and **9–14** abut against each other; in this relationship, shown in FIG. 2, slanted clearances are formed between the confronting mortise and tenon flanks, into each of which is inserted endwise and slidably a chock or linear key so that a pair of them, **19** and **20**, interfere with or block tenon from disengagement with the mortise, as shown in FIG. 3, and for that reason are referred to as blocking keys.

An important feature in the union of the stringers in FIG. 3 is in that the depth of the mortise is greater than the height of the tenon so that a clearance separates the tenon crest from the mortise bottom, and contact between the stringers takes place on a wide base at their opposite shoulders and ledges **8–13** and **9–14**; because of the engagement of the keys **19** and **20** at the angled or obliquely slanted dovetail flanks, a force component is produced which tends to draw or wedge the tenon into the mortise, thereby urging the stringers into abutment with each other at their shoulders and ledges; this abutment is obtained either initially or when the stringers are subjected to loading forces, either transversely or axially, or both, and their least deflection causes binding between the keys and the stringers' flanks, reactive components of which are applied at the shoulders and ledges; the result is relative immobility of the stringers and their consequent cooperation with each other as a single stress member for the panels and for the wall.

The stringer and panel union of FIG. 3 may be modified for additional advantages in several ways, shown in FIGS. 4–7; in FIG. 4, chocks **19***a* and **20***a* are connected with each other through a clearance between the tenon and the mortise bottom by a web **21** to form a single key; in FIG. 5, marginal flanges or webs **22** and **23** are added to the key profile alongside the chocks **19***a* and **20***b* whereby the opposite shoulders and ledges on the stringers abut the key webs; this type of the key is best suited to function as a heat barrier in the wall by being made of a non-conductive material; instead of a single key of FIG. 5, two Z-shapes **19***c* and **20***c*, shown in FIG. 6, may be adopted; in FIG. 7 two V-shaped keys result by eliminating the connecting web completely.

In certain embodiments only one blocking chock **35**, shown in FIGS. 8 and 9, may be used for a union of two of three panels, as shown; a panel **24** has an intermediate stringer **25** on it with a dovetail mortise between two shoulders; panels **26** and **27** meet at a parting line with each other and have their respective stringers **28** and **29** on them at and along their edges; each of these stringers amounts to one half of a split stringer with a tenon on it, and includes a flange **30**, a raised ledge **31** next to it, and one half-tenon at the panel edge; this half-tenon has a

crest 32 and a reentrant flank 33 away from the panel edge, and at this edge has a flank with a groove 34 in it; in juxtaposition, the stringers 28–29 jointly amount to an equivalent of one intermediate stringer, its tenon and ledges therealong, and can take the place of such a stringer at any interval in a wall. The combined stringers 28–29 are interfitted with the opposite stringer 25 first inwardly into its mortise, and then sidewise into a flank-to-flank contact with the mortise therein so that one clearance appears as a slanted gap between the other flanks; a blocking chock 36 is slid endwise into this gap and causes the two edge type stringers and their combined half-tenons to be jammed against the opposite mortise flank as well as against each other, thereby locking the panels 26–27 edge-to-edge laterally, and locking them both frontally into unity with the panel 24 through its stringer 25; a sealing strip 36 is compressed by the blocking action of the key 35 between the stringers 28–29.

The significance of the equivalency between the intermediate type stringer and two juxtaposed edge type stringers is manifest from FIG. 10; panels 37–38–39 and 40–41 are provided with opposed intermediate stringers 42–43, with juxtaposed edge stringers 44–45 in opposition to an intermediate stringer 46, and with two opposed pairs of edge stringers 45*a*–44*a* and 44*b*–45*b*; the mortise and tenon keying formations on both stringer types are identical with each other, as they are on the opposed stringers regardless of their type, by virtue of being asymmetrical about the stringer median plane; this asymmetry requires multiple formations, i.e., at least one full tenon 49 and a half-tenon 50, and a full mortise 51 and one half-mortise 52 on each stringer; the result is that the intermediate stringers 42, 43 and 46 are all of the same profile and are interfitted and key-locked in opposition of one to another; the edge stringers in each pair, such as 44–45, are of different profiles, but each pair is identical with the opposed pair; the immediate advantage of this is that the two stringer types can occur on the facing panel units in opposition one type to either the same type, or to the other type, at random or by design; moreover, by providing panels with one of the edge stringers at one edge, and with its complemental mate at the other edge, and with any number of modularly spaced intermediate stringers apart from the edges, the panels become compatibly associable with each other in facing positions, or in overlapping positions by any number of intervals, and panels of the same modular width become identical with each other; a further result is in that the panels of different modular widths are compatibly associable with each other by means of their complemental edge stringers, at any one interval in a wall; yet another result is in that the panel parting lines in facing panel rows need not be in predetermined relationship with one another but can be either coincident or non-coincident at random or by plan.

The three phases in the assembly of the structure of FIG. 10 are represented by the separate stringers 42 and 43, by the interfitted stringers 44–45 and 46, and by the stringers interlocked by a key 53*a*; the profile of this key consists of plural chocks 54, webs 55 interconnecting each two of them into continuity with one another, and marginal webs 56; the webs 55 assume a new function in the cluster of the edge stringers 44*b*–45*b* and 45*a*–44*a* in that they lock them to each other in juxtaposition, and thereby also subject a sealing strip 57 between each two stringers to compression.

In FIG. 11, symmetrical mortise and tenon formations on the opposed intermediate stringers 58–59 require two different stringer profiles, but the edge stringers in each pair 60–60*a* and 61–61*a* are of an identical profile; another distinctive feature is the bulbous profile of the tenons 66 and mortises 67 which parallel one another with a constant clearance into which is inserted a blocking key 68 of a continuous corrugated profile with retrorse lateral portions 69 functioning as chocks that lock the stringers into unity frontally; the edge stringers in each pair are locked into unity laterally by the webbed portions of the key between its blocking portions 69, and sealing strips 73 and 74 are compressed by the same webbed portions.

In consequence of the principle of the equivalency of the intermediate and the juxtaposed edge stringer types in the matter of their keying formations, as disclosed in FIGS. 8–10, a key-locked union between three such stringers on one panel in opposition to two meeting panels, represents the basic components from which a whole hollow wall structure can be assembled; the next FIGS. 12 to 19 show such unions and illustrate further modifications of the blocking keys and of the stringers interlocked thereby.

In FIG. 12 the mortise and tenon formations 77–78 on the stringers 76 and 79–80 are offset toward the upper panel row 75 which is subjected to compression, as in a floor; the tenons 77 and 78 are blocked each in one mortise in each of the stringers 81–82 by one chock 83 in the manner disclosed in FIG. 9; the two chocks are connected by a web 84 which performs a vital function in holding the stringers 79–80 together laterally when two edge stringers are key-locked in opposition to them in place of the stringer 76, and through the former stringers also holds the latter stringers together laterally.

Another species of lateral locking means capable of holding together two pairs of edge stringers 88–88*a* and 91–91*a*, when the latter take the place of the intermediate stringer 90, is shown in FIG. 13; a connecting web between two blocking portions 86 of a key 89 locks two of the edge stringers laterally to each other, and marginal flanges 85 astride the stringers 91–91*a* lock them to each other laterally.

Yet another species of lateral locking means for two juxtaposed edge stringers is shown in FIG. 14, and is applicable to asymmetrical keying formations; such formations make the opposed intermediate stringers 96–96*a* duplicates of each other and interlockable by chocks 103; edge stringers 97–98 of two complemental profiles on panels 99–100 are identical with a pair 98*a*–97*a* opposite to them on panels 101–102; inasmuch as the keying formations consists of a minimum of one tenon and one half-tenon, the edge stringer in each pair carrying the half-tenon would not be locked laterally to its mate whose tenon would interfit with a divided mortise in the opposed stringers; in order to effect such lateral locking, the dividing plane through each pair of the stringers is offset from the median parting line plane so that it bisects the tenon on one side of that plane into half-tenons 104–105, each of which becomes a part of one stringer, and the mortise remains complete in one of the stringers to lock the combined half-tenons and their stringers laterally to each other.

The species of lateral locking means employed in the stringer union of FIG. 15 resides in projections 112 on the edge stringers 109–109*a*, which projections are accommodated in a recess in an opposite intermediate stringer 108; when two edge stringers replace the one, as shown by 111–111*a* in dotted lines, a mortise in a wall 113 in those stringers forms an annular clearance around the projections or half-tenons 112, and a linear key 110*a* is telescoped therein and grips the half-tenons laterally; frontally, the union of the stringers is effected by bulbous tenons 106 blocked in mortises of like shape and increased size by annular keys 110 which consist essentially of two reentrant portions connected by a web, all of them of a uniform thickness.

In the union of stringers and panels in FIG. 16 asymmetrical keying formations are used, consisting of a tenon 117 and mortise 118 on the intermediate stringer 114; for locking a pair of edge stringers identical with 115–116 in opposition to the latter in place of the single stringer 114, the key 119 includes four chocks and chordal webs between them as well as a central web across the parting line plane, which web provides the same species of lateral

lock as analogous webs do in FIGS. 10–13 for the juxtaposed and opposed edge stringers therein.

A cross-web in a key **123** is used for the same function in the stringer and panel union of FIG. 17; dual tenons **120** between marginal ledges and conforming enlarged mortises between shoulders on the respective stringers **121–121***a* and **122** are blocked against separation frontally, and two edge stringers taking the place of **122** as well as **121–121***a* would be blocked laterally by the plural chocks and the central web of the key **123**.

Further examples of webbed one-piece linear keys capable of functioning as insulators in a wall as well as for both frontal and lateral interlocking of stringers are shown in FIGS. 18 and 19; stringers **124–125** and **128** in FIG. 18 have asymmetrically disposed formations of a serpentine shape and a constant clearance between them, into which is slid endwise a linear key **130** whose lateral oblique portions perform frontal blocking of the stringers, and round connecting portions perform lateral locking of opposite pairs of the same edge stringers as **124–125**, each such pair being an equivalent of the intermediate stringer **128**.

The stringers and the key of FIG. 19 differ from those of FIG. 18 in the dovetail form of the mortise and tenon formations on the stringers **131–132** and **133** wherein the bottom of the mortises **134** is recessed down to the base **135**, leaving abutment ledges along the tenons; webs interconnecting the blocking portions of the key **136** on both sides of the dividing plane through the stringers **131–132** provide lateral locking when a pair of like stringers occurs in opposition to them.

Applications of the preceding key-locked panel unit joints to various and divers structures are illustrated in most of the following figures; in FIG. 20, a building wall includes spaced apart panel unit rows **137–138–139** and **140–141–142** each of which is provided with edge stringers **143** and **144**, and at equal intervals intermediate them with stringers **145** and **146**; the latter are in opposition, by way of an example, with other intermediate stringers **147** and **148**, respectively, on a facing panel unit, and are of two complemental profiles; one carries a dovetail tenon **149** between ledges **150** on side walls **151** and flanges **152**; its mate is formed with shoulders **153** atop side walls **154**, based on flanges **155**, and on a cross-web **156** is formed with a dovetail mortise; into a clearance between these formations is telescoped a linear key **157**, which can be made of a non-conductive material to function as an insulator against heat flow through the wall.

At panel parting lines juxtaposed edge stringers **143–158** and their opposites **159–160** constitute full equivalents of each pair **145–147** of intermediate stringers; a key **157***a* locks two of the stringers, **143–158**, laterally to each other besides locking the two pairs of them into unity frontally; the stringers **159–160** are prevented from parting laterally by the intermediate stringers apart from them keyed to their opposites; any one of the several species of positive lateral locking means for the juxtaposed edge stringers disclosed in the preceding figures could be applied to the stringers of FIG. 20.

The profile of the edge stringers, in addition to their divided formations, includes side walls standing on a base **164**, the wall at the dividing plane being slotted lengthwise and a sealing strip **165** is slid therein, and by overlapping the walls of both stringers effects a closure at the parting plane.

The erection of this wall is facilitated in that the panel units do not have to be raised one above the other for an interlock between them, nor do they have to be pushed face-to-face for snapping into each other as in certain prior structures, but are rested on a sill **166** and foundation **167**, first one row which is bolted down by bolts **169**, then the other row, and the keys **157** and sealing strips **165** are inserted into their places to complete the assembly.

Besides documenting the advantages of the particular panel union by blocking keys which allows the panels to be placed in their final positions without lifting them one above the other or pushing them "flat-wise" into engagement, and raising only light-weight keys for their assembly, FIG. 20 also documents that even with symmetrical keying formations on the stringers panels of the same modular width can be identical with each other and be interlockable with each other, as panels **138** and **141** are, if an even number of intermediate stringers is used on them; it is achieved by using one half of the stringers of the tenon-bearing kind **147**, and the other half of the mortise-bearing kind **145**, and disposing each kind at alternate intervals; stringers of both kinds so disposed will interfit with each other in opposition when the identical panels face each other, as shown, and the panels can be used in overlapping relationships by two intervals in order to make the opposed stringers thereon interfit with each other.

The utility of the wall construction of FIG. 20 is greatly increased when joined by interlocked stringers with other walls at L- and T-intersections; FIG. 21 shows the construction of such intersections; at an L-intersection between right-angle sides of a peripheral wall, panels **170–171** and **172–173** in such right-angle sides are provided with respective edge stringers **174–175** and **176–177**, locked in juxtaposition and in opposition with one another by multiple formations and a webbed linear key **178**; stringers **176–177** are the normal edge stringers such as used throughout the walls as equivalents of one intermediate stringer **179** or **180**, and one such stringer could take their place if a continuous panel were used instead of panels **172–173**; whichever stringer type is used, it is directed diagonally across the intersection by standing on a beveled panel portion at the corner; the opposite paired stringers **174–175** embody a further innovation in that, besides being directed diagonally towards the first pair, they are mounted on their respective right-angle flanges **181** and **182** and panels **170–171** at an inclination, their walls **174** and **175** including an angle of 45 degrees with each flange.

Panels **187–188** and **189–190** identical with the panels **170–171**, and respective stringers **183–184** and **185–186** on them and identical with the stringers **174–175**, are used for constructing a T-intersection between the peripheral wall and a partiton wall, the panels in each case forming portions of the walls themselves as well as their intersection; it is, of course, only a matter of a substitution of equivalents if the inner wall side panels are made continuous around the corners between the walls, and intermediate type stringers are used at an inclination to them; an intermediate stringer **192** on a continuous panel **191** is formed with a peaked cross-web **193** and a set of asymmetrical multiple formations thereon in opposition to each of the two pairs of the inclined stringers converging towards the center of the intersection; linear keys **187***a* and **187***b* interlock all five of the stringers and their panels into unity and compress sealing strips **194** between each juxtaposed pair.

Equally novel results obtain from an application of the disclosed key-locked panel unions to closed bodies, of which airplane wings are a useful example; in such a wing in FIG. 22 two panels **195** and **196** jointly form an airfoil shell and stringers on them provide spars therein; each panel has three spanwise stringers **197**, **198** and **199** mounted on it, their profiles and proportions being designed to suit their locations and strength requirements; reentrant mortise and tenon formations on the opposed stringers are interlocked by keys **200** with multiple chocking portions on them whereby each two such stringers function as a spar; chordwise bulkheads **201** provide bridging between the stringers on each panel.

In the key-locked panel unions and structures of the preceding figures stringers on the panels are locked to one another in opposition, and the stringers are abutted against each other or against the locking keys for coaction as unitary stress members; in wide walls and in heavily loaded walls in general, it may be advantageous to adopt special-

ized stress members interjacent the panel rows and inbetween the opposed stringers thereon, and key-lock the stringers to them relatively immovably: FIG. 23 represents such a hollow wall structure with studs **202** interposed between the stringers of the two equivalent types, panel units **203, 204, 205–206** and **207–209**, and transition members **210, 210***a* and **210***b* at intersection corners form the inner wall sides, and panel units **211–215** form the exterior wall sides of a house or building peripheral wall and a partition wall merging with it; the straight wall courses between the intersections and in the partition wall are assembled of panel units of modular widths; each panel unit wider than one module has one or more stringers **217** on it at intermediate intervals apart from the edges, and each two meeting panel units have edge type stringers **216–216***a* on them juxtaposed to form jointly an equivalent of one intermediate stringer; a dovetail tenon **218** on each intermediate stringer is duplicated by the combined half-tenons **219** on the paired edge stringers, as are lands **220** along and beyond the width of the tenon **218**, which lands are carried at a distance from the panel face, in this case on flanges **221** of the stringers.

The equivalent stringer types **217** and **216–216***a* would ordinarily have for their only consequence that the studs **202** could be all alike; however, those two types in combination with their modular spacing bring forth a number of advancements in wall construction by their cooperation with each other at anyone modular interval; that cooperation resides in that the two types can occur on the facing panel rows one type in indiscriminate opposition with either the same type, or with the other type; this permutative associability of the two types at modular intervals yields the three basic panel unions indispensable for the necessary panel relationships in wall construction; thus, two intermediate stringers **217***a* and **217***b* join the panels with the studs **202** apart from the panel parting lines; two pairs of edge stringers **216***b***–216***c* and **216***d***–216***e* join the components at coincident parting lines, and a pair of such stringers **216–216***a* in opposition to a single stringer **217** join them at non-coincident parting lines; this cooperation of the two stringer types makes it possible to use panels of different modular widths in compatible association with each other for assembling walls of any predetermined length, makes it possible to let the parting lines occur at any one modular interval or be eliminated where not wanted, and no special provision on the panel units need be made for coincidental and non-coincidental occurrence in the opposite wall sides, such occurrence being a matter of chance or choice.

The studs **202** in the peripheral wall and **202***a* in the partition wall carry on each profile extremity two flat lands **222** at a distance from the panel face and from the lands on the stringers, and a mortise **223** larger than the stringer tenon **218**; into clearances so created between these parts are inserted linear keys **224** of a profile analogous to that of the key **23** in FIG. 5, or key **157** in FIG. 20; the key chordal web, besides serving as a heat insulator, performs an important function during the assembly when the adjoining panel units must be held together temporarily before the studs are lowered into place.

The particular intersection construction in FIG. 23 by means of the transitions **210, 210***a* and **210***b* is disclosed in my application for Interlocked Panel Structure, Serial No. 414,105, filed November 27, 1964; these transitions are of a quadrantal span, and are in flush continuity with the straight wall courses by bearing keying formations on them at two right angle planes, and at those planes are juxtaposed to edge stringers **216***f* on the wall panel units, and are engaged by the keys that interlock these stringers with two modularly placed studs **202***b* and **202***c* at the L-intersection and **202***d* and **202***e* at the "T"; at the "L" outer side, panel unit **213** keyed to the two wall studs thereat functions as a transition in a manner similar to the one at the inner corner; at the "T," panel unit **211** in the outer wall side is keyed to the two studs thereat by an intermediate stringer **217***c* and a non-modularly spaced edge stringer **216***g*; a narrow panel unit could be used between the two studs. Panel units could also be used as corner transitions as shown in FIG. 24 where a panel **225** bent to a right angle has edge type stringers on it; however, at this vital location the rigid transitions **210** of a substantial section are essential; they not only eliminate flexibility between the wall sides but are capable of coacting with the stringers, the keys, and the studs as a unitary stress member, as these parts do with each other in the walls to provide a stress member at each modular interval therein, mainly because of their abutment with each other at their marginal lands.

Others of the disclosed keying formations could be used in this application, such as the bulbous profile shown in FIGS. 25 and 26; the annular keys therein can be either without abutment flanges, as keys **226** in FIG. 26 are, which type is disclosed in FIG. 15; or they can be formed with such flanges as keys **227** in FIG. 25 are; in the former case, abutment between the stringers and the studs takes place at slanted lands along and beside their mortise and tenon. In FIG. 27 the blocking keys **228** are of the single blocking chock type disclosed in FIGS. 8 and 9, their application being to a wall where heat transfer through it need not be taken into account.

A complete wall structure embodies doors and windows the frame of which are assembled into the walls and their jambs are key-locked to the panel units as terminal members **229** and **230**; these members include a transverse web and two lateral webs **231** in alinement with the wall panel units at parting lines whereat they carry a half-tenon **232** in juxtaposition to that on a stringer **216***h* on each panel unit; keys **224***a* lock the terminal member to the stringers, and lock these parts to one of the wall studs **202***f*.

A wall structure making use of the construction of FIG. 20, wherein the two equivalent stringer types are keyed in opposition with one another without interjacent stress members, in shown in FIG. 28; it also embodies the intersection construction analogous to that of FIG. 23 as well as terminal members at door and window openings; it is assembled of panel units **233** on which extend intermediate stringers **234** and juxtaposed edge stringers **235–235***a* of a tall height, and occur in opposition one type with either the same type, or with the other types; the mortise and tenon keying formations carried on the stringers in close proximity of each other are of the unsymmetrical species shown in FIG. 14, with an offset dividing plane between the juxtaposed stringers for a lateral interlock with each other in addition to that provides by webbed keys **236**, whose chordal webs serve primarily to provide one-piece keys and as heat barriers in the walls; one advantageous result of these keying formations is the identity of the intermediate stringers and of the paired edge stringers with their opposites on the facing panel units, and the possibility of keying the facing panel units in overlapping relationships by any number of modular intervals.

The intersection construction in the wall of FIG. 28 with the stringers key-locked directly to each other, by means of transition members **237**, is disclosed in my application for Interlocked Panel Structure, Serial No. 414,670, filed November 30, 1964; each such member is formed with two right-angle edge type stringers **238**, juxtaposed to their own type and keyed thereto and to like pairs of stringers in opposition to them at the L-intersection where a transition panel unit **239** complements the outer panel unit row at the corner; at the "T," the transition member stringers are keyed in juxtaposition and opposition to stringers in the peripheral wall, and in opposition to each other in the partition wall and in juxtaposition to stringers therein on panel units **240** and **241**. Assembly of terminal members to the walls is exemplified

by a jamb 242 of a window frame 243, shown in cross-section in FIG. 29; keying formations carried on the member and equal to those on two opposed edge stringers, and juxtaposed to two such stringers 244 and 245, lock the terminal member to the panel units 246 and 247 by means of a key 236*a*.

The type of intersection construction of FIG. 21 by means of diagonally inclined stringers is made use of in the wall structure in FIG. 30; studs 248 are deployed at modular intervals throughout the straight walls, and are keyed by linear keys 250 to intermediate stringers 249, and to edge stringers 251–251*a*, occurring at random or by plan in permutative combination of one type in opposition with either the same type, or with the other type in the walls as well as at the intersections; the intersection construction is distinguished in that the panel units 252 and 253 at the T-intersection, and panel unit 254 at the "L," are continuous around the inner corners and on beveled portions thereof carry intermediate stringers 249*a* thereat, the stringers being directed diagonally across the intersections; the outer row panel units 255 and 256 at the respective intersections can be either continuous through those locations, or parted thereat, with either stringer type on them according to the principle of stringer type equivalency; studs 257 and 257*a* at the intersections have an identical tri-furcate profile and keying formations with flat lands therealong on each profile extremity; they are applied in inverse positions in their locations with one extremity keyed to the inner panel unit 254 at the "L," and two of them keyed to inner panel units 252 and 253 at the "T," while the reverse is true with respect to the outer panel units 256 and 255 thereat; three linear keys 250*a* complete the assembly of each intersection.

Terminal members 258 and 259 are interlocked with the facing panel units, such as 254 and 260, and with one stud 248*a* by means of keying formations on each side web thereof juxtaposed to edge stringers 251*b* on the panel units.

Spars 261, 262 and 263 interjacent shell sides are made use of in the wing structure of FIG. 31, in distinction to the wing of FIG. 22 where the interlocked opposed stringers jointly provide the spars; the wing shell is formed by panel units 264 and 265, joined by stringers 266 and 267 and a key 268 at the leading edge, and apart from it by stringers 269 keyed to the spars by keys 268*a*; the keys are of an annular section conforming to bulbous tenons and mortises on the parts, which formations and keys are the same as shown in the panel and stringer union of FIG. 15.

The various above disclosed structures demonstrate the unique advantages of the blocking keys of constant section, endwise insertable and removable, and having a uniform slidable engagement with the interlocked parts throughout their length; these properties make those structures possible, particularly the airfoil ones of FIGS. 22 and 31 in which, even though the shells taper both in thickness and in width, the tenons are interfitted with the mortises frontally while the keys are inserted lengthwise from one open shell end to give rise to converging and tapering spars therein.

I claim:

1. In a structure, two panels spaced apart from each other, a number of stringers extending on said panels at modular intervals apart from each other and in opposition with each other, each stringer bearing a marginal shoulder and a ledge and reentrant mortise and tenon means therebetween, said mortise and tenon means being asymmetrical about the stringer median plane and each mortise being wider than each tenon, said mortise and tenon means on said stringers in opposition being identical with each other and being interfitted with each shoulder opposite each ledge thereof and with gaps between at least the reentrant portions of each mortise and each tenon thereof, and linear keys slid endwise into said gaps for blocking said stringers in opposition against separation from each other, said stringers on each panel having said shoulder and ledge thereof on corresponding sides whereby said panels may be identical with each other and may be faced with each other by any number of said modular intervals.

2. In a structure, two panels meeting with each other at a parting line, two other panels meeting with each other at a parting line coextensive with and distanced from said first parting line, stringers extending on said meeting panels in juxtaposition to each other at and along said parting line therein and in opposition to the stringers on the other two panels, each two of said stringers in juxtaposition bearing complemental portions of obliquely reentrant mortise and tenon formations, said formations having each mortise wider at the throat thereof than each tenon full width and being interfitted on said stringers in opposition with slanted gaps of a constant section throughout their extent between said reentrant portions thereof, linear chocks telescoped endwise into said gaps blocking said stringers in opposition and panels thereof against frontal separation, and means locking each two of said stringers in juxtaposition and said meeting panels thereof against lateral separation.

3. In a structure, components and their relationships as set forth in claim 2, said mortise and tenon formations on said stringers in opposition to one another consisting of plural mortises and tenons, two of said stringers in juxtaposition carrying each one half-tenon at the dividing plane therethrough, said plural mortises and tenons on said stringers in opposition being interfitted with a chordal gap intervening between said slanted gaps, and a web connecting each two of said linear chocks through said chordal gap, one such chordal web locking said half-tenon carrying stringers laterally to each other, and said plural mortises and tenons and said chocks therebetween locking the other two stringers frontally and laterally to said laterally web-locked stringers.

4. In a structure, components and their relationships as set forth in claim 2, said mortise and tenon formations on said stringers in juxtaposition and in opposition consisting of plural mortises and tenons and being disposed asymmetrically with respect to a plane through said panel parting line, the dividing plane through each set of formations being offset from said parting line plane to bisect a tenon on one side thereof, each two of said stringers in juxtaposition having said formations thereof identical with the other two stringer formations and being interfitted therewith in opposition, the halves of said bisected tenon being carried each on one of said stringers in juxtaposition and being fitted jointly into a mortise in one of said stringers in opposition thereto for a lateral lock by said chocks in said mortise.

5. In a structure, components and their relationships as set forth in claim 2, at least two of said meeting panels being set at an angle to each other, said stringers on said angularly set panels being juxtaposed to each other at a plane bisecting the angle between said panels and bearing said mortise and tenon formations thereof crosswise of said bisecting plane and being interfitted with said stringers in opposition thereto in the direction of said plane.

6. In a structure, panels in two distanced rows meeting with one another at parting lines, stringers extending on said panels along the edges thereof at said parting lines, said stringers reaching from both panel rows into opposition with each other and bearing obliquely reentrant mortise and tenon formations thereon, said formations on the stringer along one edge of each panel being oppositely interfittable with the formations on the stringer along the other edge of said panel, the facing panels in said two rows being in inverted positions with respect to each other and the meeting panels in each row being placed to complement the formations of said edge stringers on each other, said complemental formations having each

mortise thereof wider at the throat thereof than the full width of the tenon therein and said stringers bearing the same being interfitted with complementing stringers in opposition thereto on the other panel row and forming slanted gaps of a lengthwise constant section between the reentrant flanks of each mortise and tenon, linear chocks telescoped endwise into said gaps blocking said interfitted formations and said stringers in opposition and said facing panels thereof against frontal separation, and means locking each two of said complementing edge stringers and said meeting panels in each row against lateral separation.

7. In a structure, components and their relationships as set forth in claim 6, said formations on the stringer along one edge of each panel including a half-tenon at a dividing plane between said complementing stringers thereat and on the stringer along the other edge of said panel said formation including a half-mortise at said dividing plane, said meeting panels in each row being placed with said half-tenon-bearing stringer thereon complementing a like stringer on an adjoining panel and with said half-mortise-bearing stringer complementing a like stringer on the other adjoining panel, said complementing stringers on each panel row being interfitted with and locked by said chocks in opposition to complementing stringers on the other panel row.

8. In a structure, components and their relationships as set forth in claim 7, intermediate stringers extending on said panels in both panel rows at intervals apart from said panel edge stringers thereon, each of said panels being provided with an even number of said intermediate stringers one half of which bearing obliquely reentrant mortise and tenon formations equivalent to said formations on each two half-tenon-bearing complementing stringers and the other half bearing obliquely reentrant mortise and tenon formations equivalent to said formations on each two half-mortise-bearing stringers, said intermediate stringers on the opposite panels in both rows being interfitted with each other and forming slanted gaps between the reentrant flanks of the interfitted tenons and mortises thereof, and linear chocks telescoped endwise into said gaps blocking said intermediate stringers and facing panels thereof against frontal separation.

9. In a structure, components and their relationships as set forth in claim 6, one or more of intermediate stringers extending on certain of said panels in both rows at equal intervals apart from said edge stringers thereof and bearing reentrant mortise and tenon formations thereon, said formations being asymmetrical about a central plane through said stringers, said formations on said stringer along one panel edge being a segment of divided intermediate stringer formations and on said stringer along the other edge being a complemental segment thereto, said panels in each row being placed with said edge stringers thereof complementing each other in forming an equivalent of said intermediate stringer formations, said complementing edge stringers and said intermediate stringers on one panel row having said formations thereof identical and inversely interfittable with the formations on both types of like stringers on the other panel row, said stringers of both types and said panels in both rows being in random opposition with each other and having said formations thereof interfitted with reentrant gaps therebetween, said formations and stringers being blocked against frontal separation by said chocks in said gaps.

10. In a structure, panels in coextensive spaced apart straight and angular rows meeting at parting lines, said panel rows forming hollow walls and at least one intersection therebetween, stringers extending on said panels at intermediate intervals apart from said parting lines and on panels wider than two intervals apart from each other, stringers extending juxtaposed to each other on said meeting panels at and along each parting line therein, reentrant mortise and tenon formations borne on said stringers of both of the intermediate and the juxtaposed type, said formations on each two juxtaposed stringers being jointly equivalent to one intermediate stringer formations, said stringers of both types reaching from said panels in both rows in said walls and at said intersection into opposition with each other indiscriminately one type with either the same type or with the other type, those of said stringers at said intersection reaching into said opposition from each angular panel row diagonally across the intersection and bearing said formations thereof crosswise to the diagonal direction thereof, said formations on said stringers in opposition in said walls and at said intersection having each mortise thereof wider than each tenon and being interfitted with gaps between the reentrant flanks thereof, linear chocks telescoped into said gaps blocking said stringers of both types against frontal separation, and means locking each two of said juxtaposed stringers and said meeting panels thereof against lateral separation.

11. In a structure, panel units in straight and angular coextensive spaced apart rows meeting at parting lines and forming hollow walls and intersections therebetween, certain of said panel units forming said walls forming said intersections by being continuous therethrough and others by meeting with one another thereat, reentrant mortise and tenon formations borne on said panel units at intermediate intervals apart from said parting lines and on panel units wider than two intervals apart from each other, reentrant mortise and tenon formations borne juxtaposed to each other on each two meeting panel units at and along the parting line therein, said juxtaposed formations being jointly equivalent to one intermediate formation, said intermediate and said juxtaposed formations being borne on said panel units in said coextensive rows in said walls and at said intersections in indiscriminate opposition of the one to the same one apart from the parting lines and in opposition of the other one to the same one at coincident parting lines in said rows and in opposition of the one to the other one at non-coincident parting lines in said rows, said formations on the panel units forming the inner angular rows at said intersections being borne thereon cross-wise of a diagonal direction through the intersections into opposition with the formations on the panel units forming the outer row, said formations borne in opposition to one another having the mortises therein wider than the tenons and being interfitted with gaps between the reentrant portions thereof, linear chocks telescoped into said gaps blocking said tenons and formations and panel units against frontal separation, and means locking each two of said juxtaposed formations and said meeting panel units thereof against lateral separation.

12. In a structure, two panels spaced apart from each other, stringers extending on said panels in opposition to each other, correlated obliquely reentrant mortise and tenon formations borne on said stringers, marginal lands borne on said stringers along said formations, said formations having each mortise wider at the throat thereof than the tenon full width and being interfitted with angled spaces between each mortise and the tenon therein and with a clearance connecting each two spaces and with clearances between said marginal lands, and a linear key inserted slidably inbetween said formations, said key having a profile consisting of angled blocking portions in said reentrant spaces and a web therebetween in said connecting clearance and marginal webs between said lands along two of said blocking portions thereof.

13. In a structure, a panel, a structural member extending along said panel at a distance therefrom, a stringer extending on said panel in opposition to said member, longitudinal obliquely reentrant mortise and tenon formations borne on said stringer and on said member, said formations including each at least one mortise and one half-mortise and one tenon and one half-tenon and being

asymmetrical about a central plane, said stringer and said member formations being identical with each other and having each mortise larger than each tenon, said formations being interfitted and forming angled spaces between each mortise and tenon therein, and a linear chock inserted endwise into each of said spaces blocking said formations and said stringer and structural member into unity.

14. In a structure as set forth in claim 13, said interfitted mortise and tenon formations forming gap alongside the angled spaces located furthest apart from each other, and a linear key inserted endwise inbetween said formations, said key having a section including chocking portions in said angled spaces and a web connecting each two of said portions through said clearance therebetween and having marginal webs in said gaps.

15. In a structure, two panels meeting with each other at a parting line, a number of structural members extending along said parting lines at a distance from said panels, stringers extending on said panels in juxtaposition to each other and in joint opposition to said number of members, correlated obliquely reentrant mortise and tenon formations borne on said stringers and on said number of members, said formations having each mortise wider at the throat thereof than the tenon full width and being interfitted with angled spaces therebetween and with a clearance across the stringer dividing plane between two spaces astride said plane, linear chocks inserted endwise in said spaces blocking said interfitted formations against frontal separation of said stringers from said number of members, and a web connecting two of said chocks through said clearance and holding said stringers and panels thereof laterally against separation at said dividing plane and parting line thereof independently of said number of members.

16. In a structure, two panels meeting with each other at a parting line, a number of structural members extending along said parting line at a distance from said panels, stringers extending on said panels in juxtaposition to each other and in joint opposition to said number of members, correlated reentrant mortise and tenon formations borne on said stringers and on said number of members, said formations having each mortise thereof larger than each tenon and being interfitted with reentrant spaces therebetween and with gaps marginally along two of said spaces furthest apart from each other, linear chocks inserted endwise in said spaces blocking said formations and said stringers and said number of members against frontal separation, webs in said gaps integral with two of said chocks thereat, and flanges integral with said webs astride said stringers holding said stringers laterally against separation thereof and of said panels at said parting line independently of said number of members.

17. In a structure, two panels meeting with each other at a parting line, a number of structural members extending along said parting line at a distance from said panels, stringers extending on said panels in juxtaposition to each other and in joint opposition to said number of members, correlated reentrant mortise and tenon formations borne on said stringers and on said number of members, said formations having each mortise thereof larger than each tenon and being interfitted with reentrant spaces therebetween, linear chocks inserted endwise in said spaces blocking said stringers against frontal separation from said members, and frontal projections borne on said stringers at the dividing plane therethrough, one of said number of members having a recess in engagement with said stringer projections for holding said stringers laterally against separation thereof and of said panels at said parting line.

18. In a structure, two panels meeting with each other angularly at a parting line, a number of structural members extending along said parting line at a distance from said panels, stringers extending on said panels in juxtaposition to each other at said parting line and having walls at an inclination to said panels and directed toward said number of structural members, marginal lands borne on said stringer walls and on said number of structural members in opposition to each other astride a plane bisecting the angle between said panels, correlated longitudinal mortise and tenon formations borne on said stringers and on said number of structural members between said marginal lands thereof, said stringer and member formations being sized to interfit frontally with each other and shaped to form reentrant spaces between the flanks thereof, linear chocks inserted in said reentrant spaces for blocking said interfitted formations for a frontal union of said stringers with said number of structural members, and means locking said stringers to each other for a lateral union thereof and of said panels at said parting line.

19. In a structure, two panels meeting with each other at a parting line, a number of structural members extending along said parting line at a distance from said panels, stringers extending on said panels in juxtaposition to each other at said parting line and in joint opposition to said number of structural members, correlated longitudinal mortise and tenon formations and marginal lands therealong borne on said stringers and on said number of structural members, said formations being sized to have each mortise thereof larger than each tenon, said stringer and member formations being interfitted with each other with reentrant spaces between the sides thereof and a clearance connecting each two spaces and clearances between said marginal lands, and a linear key having a profile including angled blocking portions in said reentrant spaces and a web therebetween in said clearance therein and marginal webs along two of said blocking portions in said clearances between said lands, two of said key blocking portions being astride the stringer dividing plane and said key web therebetween holding said stringers and panels thereof together laterally independently of said number of structural members.

20. In a structure, two panels meeting with each other at a parting line, two other panels meeting with each other at a parting line coextensive with and distanced from said first parting line, stringers juxtaposed to each other extending on each two meeting panels at the parting line thereof in opposition to the other two stringers, two of said juxtaposed stringers bearing each an obliquely reentrant tenon lengthwise thereon, the other two juxtaposed stringers having each an obliquely reentrant mortise extending therein and wider on the side next to the stringer dividing plane than said tenon, said mortise having a throat wider than the tenon full width, said stringers in opposition being interfitted into contiguity of said mortise and tenon thereof on the side away from said dividing plane and forming an angled space next to said plane and forming a clearance across said plane between both angled spaces, and a linear key inserted endwise slidably between said stringers, said key having a profile including angular blocking portions in said angled spaces and a web therebetween in said connecting clearance, said key blocking portions holding said stringers together in opposition and said key web holding said mortised stringers together in juxtaposition, said tenon-bearing stringers being held together in juxtaposition by said contiguity thereof with said mortised stringers side away from said dividing plane.

21. In a structure, two panels meeting with each other at a parting line, a structural member extending along said parting line at a distance from said panels, stringers extending on said panels in juxtaposition to each other at said parting line and in joint opposition to said member, said member having an obliquely reentrant lengthwise mortise therein, half-tenons obliquely reentrant on the side away from said parting line borne on said stringers along said parting line, flat lands borne on said panel

units along and beyond the width of said half-tenons thereof in opposition to said member lands, said half-tenons being interfitted with said member mortise and being in contact therewith at one reentrant side thereof and forming a reentrant space at the other side, and a linear chock inserted endwise slidably into said space blocking said stringers and panels thereof against disengagement from said member and into contiguity of said opposite lands thereof and blocking said stringers and panels against a lateral disengagement from each other.

22. In a structure, a panel unit, a structural member extending along said panel unit at a distance therefrom, correlated obliquely reentrant mortise and tenon formations borne on said panel unit and on said member, flat lands borne on said panel unit and on said member in spaced apart facing positions of each other along and beyond the width of said formations thereof, said panel unit and said member formations having the throat of each mortise thereof wider than the full tenon width and being interfitted with angled spaces formed between the sides thereof and with a clearance connecting each two spaces, and a linear key inserted slidably endwise in between said formations, said key having a profile consisting of angled blocking portions in said spaces and a web therebetween in said connecting clearance and marginal webs between said spaced apart lands.

23. In a structure, a panel unit, a structural member extending along said panel unit at a distance therefrom, obliquely reentrant mortise and tenon formations extending lengthwise on said member, obliquely reentrant mortise and tenon formations borne on said panel unit in opposition to said member formations, flat lands extending on said member along and beyond the width of said formations thereof, flat lands borne on said panel unit at a distance from the face thereof along and beyond the width of said formations thereof in contiguity with said member lands, said panel unit and member formations having each mortise thereof wider than the full tenon width and being interfitted with an angled space formed between each mortise and tenon side thereof, said space being of a constant section throughout substantially the extent of said formations, and a linear key having a constant section corresponding substantially to each space, said key being insertable into and withdrawable from the spaces endwise at either end of said formations and being in a uniformly slidable engagement therewith throughout substantially the extent of said formations.

24. In a structure as set forth in claim 23, said panel unit including a relatively thin panel and a stringer on said face thereof, said stringer bearing said mortise and tenon formations in opposition to said structural member, attaching flanges as a part of said stringer extending astride said formations thereof on said panel unit face, said lands on said panel unit borne distantly in contiguity with said member lands being borne on said stringer flanges.

25. In a structure, two thin panel units meeting with each other at a parting line, a structural member extending at a distance from one face of said panel units and bearing an obliquely reentrant mortise in opposition to said parting line, tenons obliquely reentrant on the side away from said parting line borne on said panel units therealong and jointly forming an obliquely reentrant tenon and being fitted into said mortise with angled clearances between the reentrant sides thereof, said clearances being of a constant section throughout substantially the length of said panel units, lands borne on said panel units and lands borne on said structural member astride said tenons and said mortise in contiguity of one another at a distance from said panel face, and linear chocks having a constant section corresponding substantially to one of said clearances, said chocks being insertable into and removable from said clearances endwise at either end of said panel units and structural member and having a uniformly slidable fit between said mortise and tenon sides throughout substantially the extent of said sides for relative immobility of said panel units and member and for urging said lands thereof into said contiguity.

26. In a structure as set forth in claim 25, said panel units including each a relatively thin panel and a stringer on the face thereof, the stringers on both panels being juxtaposed to each other at said parting line therein and bearing said panel unit tenons thereat, attaching flanges as a part of said stringers extending on said panel face, said panel unit lands borne in contiguity with said member lands being borne on said stringer flanges.

27. In a structure, a panel unit, a structrual member extending along said panel unit at a distance therefrom, correlated reentrant mortise and tenon formations borne on said panel unit and on said member, lands borne on said panel unit and on said member in facing positions of each other along and beside said formations thereof, said formations being of a bulbous shape and having each mortise thereof larger than each tenon and being interfitted with reentrant clearances formed between the retrorse flanks thereof and with a clearance intervening between said reentrant clearances and following said bulbous shape, and a linear key insert slidably endwise in-between said formations, said key having an annular profile corresponding to said reentrant and intervening clearances.

28. In a structure as set forth in claim 27, said lands on said panel unit and on said structural member being spaced apart from each other in said facing positions of each other, and marginal webs as parts of said key annular profile extending along the reentrant portions thereof between said spaced apart lands.

29. In a structure, panel units of at least two different modular widths meeting with each other at parting lines and forming a wall, structural members extending along said panel units at modular intervals coinciding with said parting lines and at intermediate intervals therebetween along panel units wider than one module, obliquely reentrant mortise and tenon formations borne on said structural members at a distance from said panel units, obliquely reentrant mortise and tenon formations borne on said panel units at said intermediate intervals in opposition to said member formations, reentrant mortise and tenon formations borne on said panel units juxtaposed to each other at each parting line in joint opposition to said members thereat, said juxtaposed formations complementing each other in forming an equivalent of one of said intermediate formations, said parting lines and said juxtaposed formations thereat occurring indiscriminately at any one of said intervals according to the different panel widths, lands borne on said panel units and lands borne on said members along and beyond the width of said formations thereof in facing positions of each other at a distance from the panel unit face, said panel unit and member formations having each mortise throat wider than the full tenon width and being interfitted to form an angled space between each mortise and tenon side, said space being of a constant section throughout substantially the extent of said formations, and linear keys having a constant section corresponding substantially to said space, said keys being insertable into and removable from said space endwise at either end of said panel units, at least one of said keys being in a uniformly slidable engagement with each of said interfitted panel unit and member formations.

30. In a structure, two panel units meeting with each other at a parting line, a third panel unit facing said meeting panel units at a distance therefrom, a structural member extending interjacent said panel units along said parting line obliquely reentrant mortise and tenon formations borne on said member at a distance from said meeting panel units and from said third panel unit, obliquely reentrant mortise and tenon formations borne on said third panel unit in opposition thereto, obliquely reentrant mortise and tenon formations borne on said meeting panel units juxtaposed to each other at said parting line in joint

opposition to said member formations thereat, said juxtaposed formations complementing each other in forming an equivalent of said third panel unit formations, lands borne on said member and on said panel units along and beyond the width of said formations thereof in facing positions of each other at a distance from the face of said panel units, said panel unit and member formations having each mortise throat wider than the full tenon width and being interfitted with an angled space formed between each mortise and tenon side, said space being of a constant section throughout substantially the extent of said formations, and linear keys having a constant section corresponding substantially to said space, said keys being insertable into and removable from said space endwise at either end of said panel units, at least one of said keys being in a uniformly slidable engagement with each of said interfitted panel unit and member formations.

31. In a structure, four panels meeting in two pairs at two coextensive parting lines spaced apart from each other, a structural member extending interjacent said panel units along said parting lines, obliquely reentrant mortise and tenon formations borne on said member at a distance from said panel units, obliquely reentrant mortise and tenon formations borne on said panel units juxtaposed to each other at each parting line in opposition to said member formations thereat, lands borne on said member and on said panel units along and beyond the width of said formations thereof in facing positions of each other at a distance from the face of said panel units, said panel unit and member formations having each mortise throat wider than the full tenon width and being interfitted with an angled space formed between each mortise and tenon side, said space being of a constant section throughout substantially the extent of said formations, and linear keys having a constant section corresponding substantially to said space, said keys being insertable into and removable from said space endwise at either end of said panel units, at least one of said keys being in a uniformly slidable engagement with each of said interfitted panel unit and member formations.

32. A wall structure including, panel units of at least two different modular widths meeting at parting lines in two spaced apart rows and forming a hollow wall, structural members extending interjacent said panel unit rows at modular intervals coinciding with said parting lines and at intermediate intervals apart therefrom, obliquely reentrant mortise and tenon formations borne on said members at a distance from said panel units, obliquely reentrant mortise and tenon formations borne on said panel units at said intermediate intervals in opposition to said member formations thereat, obliquely reentrant mortise and tenon formations borne on said panel units juxtaposed to each other at each parting line in opposition to said member formations thereat, said juxtaposed formations complementing each other in forming an equivalent of said panel unit intermediate formations, said intermediate and said juxtaposed formations being borne on said panel units in said rows thereof in indiscriminate opposition of the one to the same one apart from said parting lines and of the other one to the same one at coincident parting lines and of the one to the other one at non-coincident parting lines according to different panel unit widths and the overlap thereof by any random number of intervals, lands borne on said members and on said panel units along and beyond the width of said formations thereof in facing positions of each other at a distance from the panel unit face, said panel unit and member formations having each mortise throat wider than the full tenon width and being interfitted with an angled space formed between each mortise and tenon side, said space being of a constant section throughout substantially the extent of said formations, and linear keys having a constant section corresponding substantially to said space, said keys being insertable into and removable from said space endwise at either panel unit end, at least one of said keys being in a uniformly slidable engagement with each of said interfitted panel unit and member formations.

33. In a wall structure, a panel unit having a lengthwise edge, a structural member extending along said panel unit edge, said member having a portion at right angles to said panel unit at a distance from said edge and having a portion meeting said panel unit at said edge, a stress member extending along said panel unit edge at a distance from one face of said panel unit and bearing an obliquely reentrant mortise in opposition to said edge, tenons obliquely reentrant on the side away from said edge borne on said panel unit and on said structural member and jointly forming a tenon of a height smaller than said mortise and of a width narrower than the mortise throat and being fitted thereinto with angled clearances at the reentrant sides thereof and with a clearance intervening therebetween, lands borne on said panel unit and on said structural member astride and beyond the width of said reentrant sides of said tenons thereof at a distance from said panel unit face, lands borne on said stress member astride said mortise thereof in opposition to said panel unit and structural member lands, and a linear key having a constant section throughout substantially the length of said panel unit and structural member and including blocking portions in said angled clearances and a chordal web in said intervening clearance for locking said panel unit and structural member frontally to said stress member and for locking said panel unit laterally to said structural member independently of said stress member.

34. In a wall structure, panel units of at least two different modular widths meeting with each other edge-to-edge at parting lines and forming two walls at right angles to each other, said parting lines occurring in both walls at any one modular interval according to said panel unit widths, the panel units in both walls at the corner between said walls being spaced apart from each other by less than one module, a transition member of a quadrantal span meeting said spaced apart panel units edge-to-edge at two parting lines, structural members extending along said panel unit parting lines and at modular intervals apart therefrom along panel units wider than one module, obliquely reentrant tenons borne on said panel units at said intermediate intervals, obliquely reentrant tenons borne on said panel units and on said transition member juxtaposed to each other at each parting line and jointly forming an equivalent of one of said intermediate tenons, said structural members having obliquely reentrant mortises the throat of which being wider than the full tenon width, said intermediate and said juxtaposed tenons being fitted into said mortises with angled clearances at the reentrant sides thereof and with a clearance intervening therebetween, lands borne on said panel units and on said transtion member astride and beyond the width of said tenons thereof at a distance from the face of said panel units, lands borne on said structural members in opposition to said panel unit and transition member lands for abutment thereat, and linear keys having a constant section through substantially the extent of said panel units, each of said keys including blocking portions in said angled clearances and a chordal web in said intervening clearance, said blocking portions locking said panel units and transition member to said structural members frontally and said web locking said panel units and said transition member to one another laterally independently of said structural members.

35. A wall structure including, panel units in spaced apart straight and angular coextensive rows meeting at parting lines and forming hollow walls of a building and a hollow partition therein and forming L-intersections between converging walls and a T-intersection between a wall and said partition, said parting lines occurring indiscriminately at any one of substantially equal intervals in

said walls and in said partition and at said L- and T-intersections, structural members extending in said walls and in said partition and at said intersections along each parting line and at said intervals apart therefrom, said members bearing obliquely reentrant mortises in two profile extremities thereof in opposition to two spaced panel units in both rows thereof apart from said parting lines, in opposition to one panel unit in one row and to two meeting panel units at non-coincident parting lines, in opposition to two meeting panel units in both rows thereof at coincident parting lines, obliquely reentrant tenons borne on said panel units at intermediate intervals apart from said parting lines, obliquely reentrant tenons borne on each two meeting panel units at each parting line and jointly forming an equivalent of one of said intermediate tenons, each of said structural members at said L- and T-intersections having three profile extremities and bearing obliquely reentrant mortises therein, one extremity being in opposition to the angular inner panel unit row and two to converging sides of the outer panel unit row at each L-intersection, two extremities being in opposition to the two angular inner panel unit rows and one to the outer panel unit row at said T-intersection, said tenons on said angular inner panel unit rows at said intersections being borne in a direction diagonally across the intersections, said tenons being interfitted with said

mortises and creating angled clearances at the reentrant sides thereof and a clearance intervening therebetween, and linear keys having a constant section throughout substantially the extent of said panel unit, each of said keys including blocking portions in said angled clearances and a chordal web in said intervening clearance, said blocking portions locking said panel units to said structural members frontally and said web locking each two meeting panel units to each other laterally independently of said structural members.

References Cited by the Examiner

UNITED STATES PATENTS

1,388,181	8/1921	Guimonneau	52—571
2,103,407	12/1937	Dean	52—408
2,164,138	6/1939	London	52—407

FOREIGN PATENTS

924,327	8/1947	France.
121,639	4/1948	Sweden.

FRANK L. ABBOTT, *Primary Examiner.*

RICHARD W. COOKE, JR., *Examiner.*

R. S. VERMUT, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,296,759 January 10, 1967

John Pavlecka

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the drawings, sheet 3, "FIG. 23" (upper left portion), add a lead line between numeral 222 and the vertical line, or "land", directly above the terminus of the lead line from 224; column 1, line 13, for "application and now" read -- application, now --; line 14, for "falls" read -- walls --; column 2, line 30, for "a symmetrical" read -- asymmetrical --; column 6, lines 29 and 30, for "block tenon" read -- block the tenon --; column 7, lines 52 and 53, for "in predetermined" read -- in any predetermined --; column 12, line 30, for "frame" read -- frames --; line 41, for "in", first occurrence, read -- is --; line 52, for "provides" read -- provided --; column 17, line 10, for "gap" read -- gaps --; column 20, line 23, for "insert" read -- inserted --; line 69, for "line obliquely" read -- line, obliquely --.

Signed and sealed this 26th day of September 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents