Nov. 24, 1942. G. V. PALMER 2,302,949

STEEL BUILDING CONSTRUCTION

Filed March 3, 1941 4 Sheets-Sheet 1

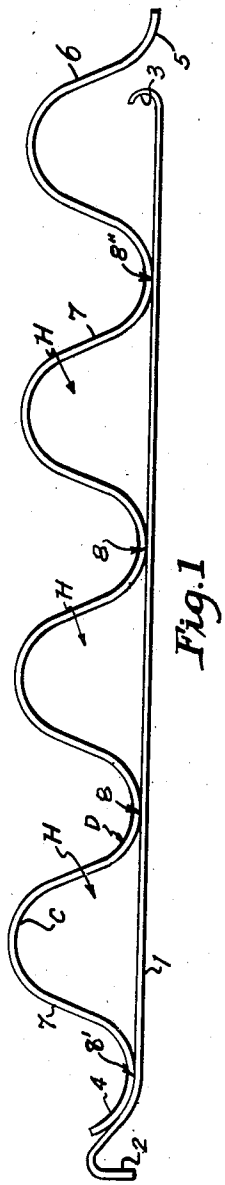


Fig. 1

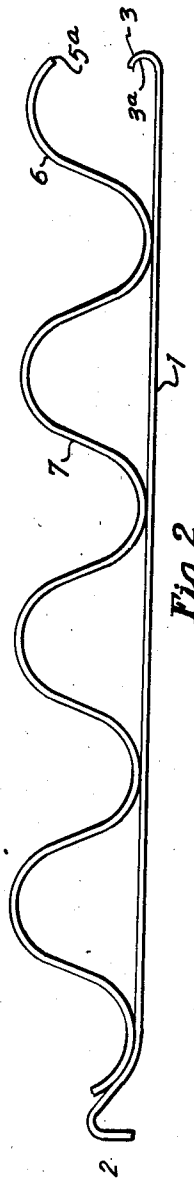


Fig. 2

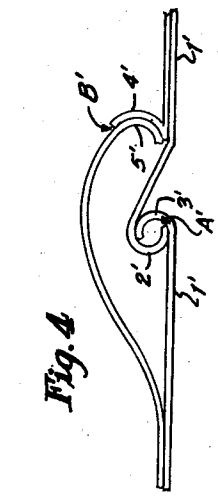


Fig. 4

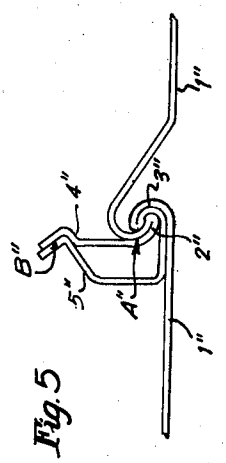


Fig. 5

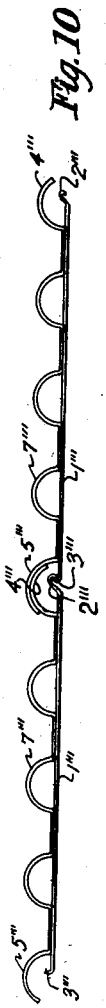


Fig. 10

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STEEL BUILDING CONSTRUCTION

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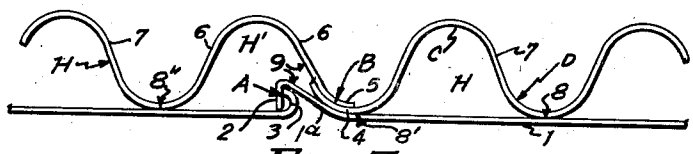


Fig. 3

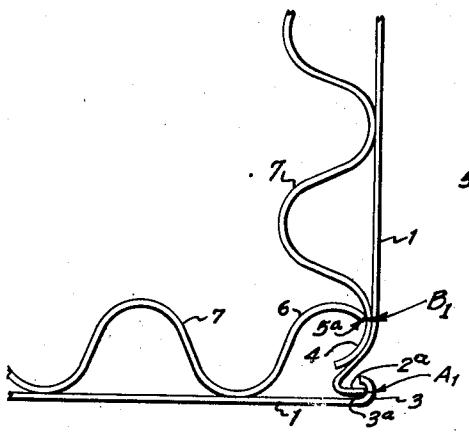


Fig. 6

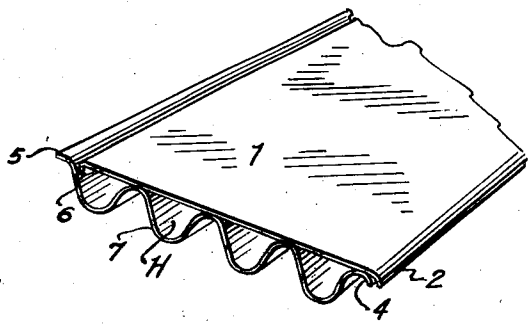


Fig. 7

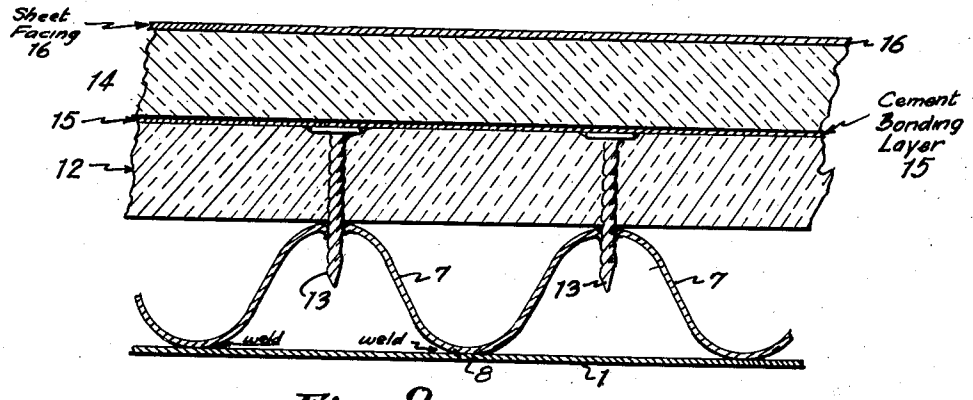


Fig. 8

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STEEL BUILDING CONSTRUCTION

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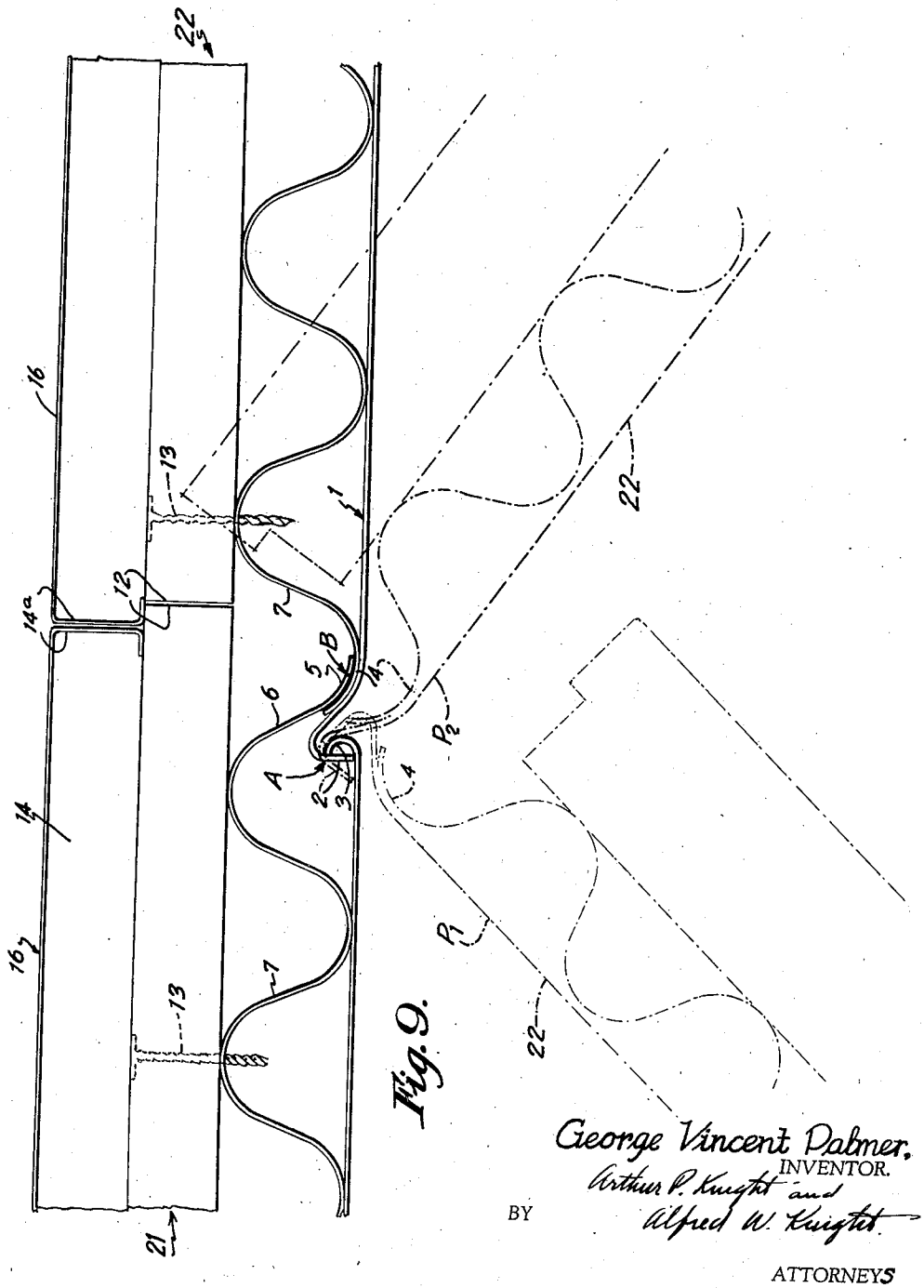


Fig. 9.

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STEEL BUILDING CONSTRUCTION

Filed March 3, 1941 4 Sheets-Sheet 4

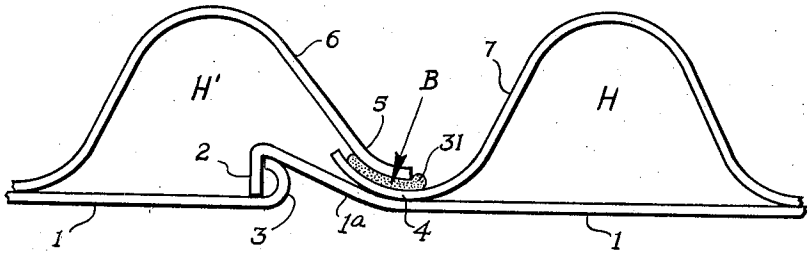


Fig. 11.

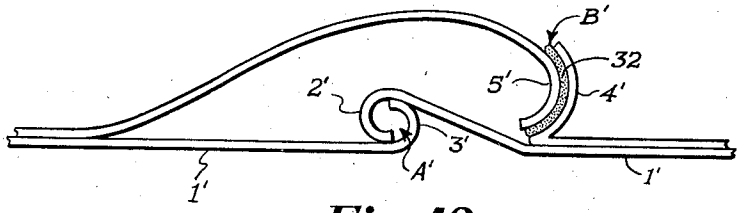


Fig. 12.

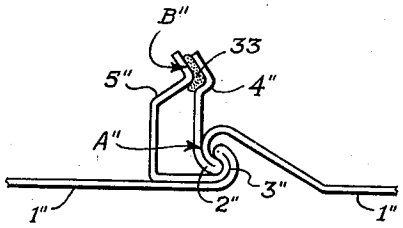


Fig. 13.

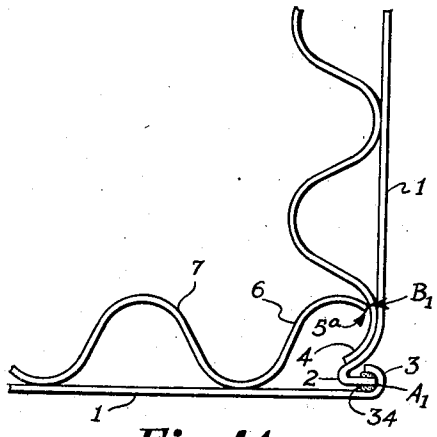


Fig. 14.

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Patented Nov. 24, 1942

2,302,949

UNITED STATES PATENT OFFICE

2,302,949

STEEL BUILDING CONSTRUCTION

George Vincent Palmer, Los Angeles, Calif.

Application March 3, 1941, Serial No. 381,561

7 Claims. (Cl. 189—34)

This invention relates to steel building construction and pertains particularly to a sectional panel construction adapted for use in the construction of demountable buildings, particularly in regions which are subject to earthquake shocks, heavy wind loads, or the like, which create appreciable lateral loads. This application is a continuation-in-part of my earlier filed application Serial Number 289,489, filed August 10, 1939, allowed September 4, 1940, for "Steel building construction."

One of the particular objects of the invention is to provide a panel construction characterized by its light weight in relation to its load-sustaining powers, its low cost of fabrication, and its facile assembly and demountability in the field.

A further particular object of the invention is to provide a sectional panel element adapted to be disposed in interlocked contiguous alined relationship with adjacent panels to form a structural surface, such as a wall, roof, floor, ceiling, or the like, characterized by the provision of a resilient type of compound interlocking means which is adapted to maintain an effective and substantially weather-tight interlock of adjacent panels in spite of minor relative movement of the adjacent panels under load deflections.

A further object of the invention is to provide a structure which adapts itself to the provision of an integral caulking preliminarily applied at the position of mating of the interlocking means wherefore when the adjacent panels are assembled the caulking material is disposed within the interlock to further weatherproof the structure.

In the employment of sectional prefabricated panels for the construction of steel buildings, it has hitherto been the practice to provide male-and-female interlocking joints between the adjacent panels in a structural surface, or to abut the panels and intersecure the same through the agency of bolts, screws, welding or the like. Where a male-and-female interlocking arrangement has been used, it has for the most part been essential to provide some form of caulking at all joints which are exposed at one side to the weather, in order to prevent the ingress of moisture, dust, vermin and the like. Where welding has been used, caulking is also necessary unless the welding is carried throughout the length of the joint. The use of bolts and screws also requires some form of caulking. Considerable difficulty has been encountered in keeping the caulking in place where the customary male-and-female joint is used, inasmuch as minor relative movement of the panels toward and away from the line of the joint (which cannot economically be prevented) has been found to loosen the caulking sufficiently to render it inadequate after a period of time. Both the "setting" or cementitious type, and the "mastic" or non-setting type of caulking material have been employed for the purpose, and both of these types have been found inadequate to solve the problem.

According to the present invention, I provide a panel construction in which comparatively thin sheet metal surfaces are brought together in interlocking relation, under resilient compression between adjacent surfaces, so that a weather-tight interlock is maintained during any relative movement of the panels which may occur in use, short of a movement sufficient to produce a permanent deformation or distortion of the panels themselves. To accomplish this object, the respective sides of the panels are so formed as to provide complementary shoulder means defining engaging surfaces which interengage when the panels are brought into the desired contiguous alined relationship, whereby separate compression seals spaced by a zone inimical to the conduction of moisture by capillarity are provided at each joint between adjacent panels, the separate seals being arranged in stressed relation to one another whereby each seal tends to maintain the other seal in operative relation. I further provide, where the utmost weather-sealing is desired, a layer of preferably plastic caulking material secured to one of the shoulder means at one side of the panel in position to be compressively engaged by the complementary shoulder means of an adjacent panel when brought into the desired contiguous alined relationship.

The panel of the present invention may comprise a flat plate body member adapted to define the plane of the surface within which a plurality of such panels are arranged in contiguous alined relationship, the respective lateral edge portions of this body member being provided with flange members defining shoulder means adapted to coact in interlocking relationship to form a positive tension-resisting joint, and with a second group of flange members defining interlocking shoulder means adapted to establish a second interlocking joint in spaced relation to the first-mentioned joint, the position and character of the second-mentioned joint being such as to establish (when two panels are brought into interlocking relation) a tension stress in the body portion intermediate the two joints, wherefore the

respective first-mentioned flange members (of adjacent panels) are maintained in compressive engagement with one another. The panel member is preferably provided with stiffening means adapted to impart structural rigidity thereto, and is preferably also provided with a suitable insulating layer secured to the stiffening means at the side thereof opposite the position of the flat plate body member. In its preferred embodiment, the stiffening member is formed as a uniformly undulating corrugated member, secured to the body member at its crests on one side (and to which the insulating layer is secured at the crests on the other side), and the second-mentioned interlocking flange means are preferably formed as overlapped continuations of this undulating corrugated member. The above-described caulking material may be applied to one of said flange members on each panel, in position to be engaged by the shoulder means of an adjacent panel when the above-described spaced interlocking joints are established by bringing two adjoining panels into contiguous interlocked relation.

Other objects and features of the invention will be brought out in the ensuing description of certain preferred embodiments thereof, or will be apparent therefrom; the accompanying drawings illustrate such embodiments, and referring thereto:

Figs. 1 and 2 illustrate, respectively, end elevations of panels which may be employed as intermediate and corner panels in a composite structural surface;

Fig. 3 is a fragmentary detail in end elevation, showing the interlock of two abutting panels;

Figs. 4 and 5 are enlarged fragmentary details of two modified forms of interlock useful according to this invention;

Fig. 6 is a fragmentary detail corresponding to Fig. 3, showing the manner in which two adjacent panels are arranged to form a corner construction;

Fig. 7 is a partly broken-away perspective view of a panel of the type shown in Fig. 1;

Fig. 8 is a fragmentary enlarged transverse section of a panel member provided with an insulating layer according to this invention;

Fig. 9 is a view corresponding to Fig. 3, on somewhat enlarged scale, showing a panel construction including the preferred form of insulating layer, and illustrating one method of assembling adjacent panels in the formation of a structural surface;

Fig. 10 is a fragmentary detail showing the "hinge" action of two interlocking panels provided with a further modified form of interlocking flange members; and

Figs. 11 through 14 illustrate the employment of integral caulking means with the structures of Figs. 3 through 6, respectively.

Referring particularly to Figs. 1, 3 and 7, the panel construction of this invention may comprise a flat body portion or plate 1 adapted to form one surface of a finished structural plane surface, for example, when used in a wall the plate 1 may define the outwardly directed wall surface. The flat plate body portion 1 is provided at one lateral edge (as at the left-hand edge in Fig. 1) with an outwardly directed flange member 2 defining shoulder means extending along the length of the panel and constituting one interlocking member, and an inwardly directed flange member 3 defining shoulder means at the other lateral edge, constituting another interlocking member extending parallel to the flange 2. The flanges 2 and 3 cooperate, as shown in Figs. 3, 4, 5, 9 and 10, to produce an interlock A of two adjacent panels, such interlock being adapted to persist in compressive engagement under lateral tension stresses applied in the plane of the panels.

In order that the planes of the flat plate portions of adjacent panels may be disposed substantially in a common plane, wherefore a finished appearance is obtained in a wall for example, the portion of the plate 1 adjacent the position of the outwardly directed flange 2 may be deformed inwardly, after the manner shown at 1a, which locates the flange 2 somewhat inwardly of the plane defined by said plate portion.

Cooperating with the flange members defining the interlock A, and serving to maintain such flanges in compressive engagement with one another, I provide a second interlock B for the two panels, disposed in spaced relation to the interlock A. The interlock B may comprise a substantially rigid flange 4 secured to or forming a part of the plate 1 and extending inwardly therefrom towards the first-mentioned lateral edge from a position closely adjacent such lateral edge, and a cooperating resiliently deformable flange 5 at the other lateral edge. The flange 5 is secured to or may form a part of the flat plate portion 1, and is preferably provided with a lever arm longer than that provided for the flange 2, wherefore the support portion 6 for the flange 5 is more readily deformable under stress than is the support portion for the flange 2, which restricts the deformation of the panel structure in the interlocking procedure to a portion which is removed from view.

The relatively rigid and resiliently deformable flanges 4 and 5 are adapted to extend in overlapping relation when two adjacent panels are disposed in interlocking relation, and are provided with coactingly shaped portions defining the actual interlock B.

As will be apparent from a consideration of Figs. 4, 5 and 10, some latitude is available in the actual construction of the several flanges without departing from the contemplation of the invention, and these flanges may be made in a variety of shapes to define the spaced compressive interlocks A and B, as shown by the application of the same reference numerals to these figures of the drawings, the corresponding reference numerals being provided with prime marks in Fig. 4, with double prime marks in Fig. 5, and with triple prime marks in Fig. 10.

A suitable form of stiffening member is preferably provided for the plate portion 1, in order to establish a structural type of panel, and for simplicity in fabrication I preferably form the flange portions 4 and 5 from this stiffening member. Referring again to Figs. 1 and 3, I have illustrated a stiffening member comprising an undulating or corrugated strip 7 secured at its points of contact 8 with the plate portion 1 in any suitable manner, as by spot-welding, line-welding, or the like, to define a plurality of longitudinally extending cells H, which contribute to the structural integrity of the panel. The undulations or corrugations of the strip or sheet 7 are preferably of uniform curvature, as at C and D, and at one lateral edge of the panel the sheet 7 may be carried up slightly past the left-hand point of contact 8' to form the flange portion 4, and at the other lateral edge the strip 7 may be carried past the right-hand point of

contact 8'' to provide the lever-arm 6 and the flange 5.

In this construction the overlapping interlock B is formed by the partial overlap of two corrugations of the sheet 7, and the right-hand end of the strip 7 may be terminated so as to be disposed substantially adjacent the bottom of the partial undulation forming the flange 4. In the interlocked relation shown in Fig. 3 the flange 5 is deformed out of its normal or unstressed condition due to the presence of the additional thickness of metal represented by the flange 4, and this deformation results in stresses being built up within the lever arm portion 6. These stresses, taken with the actual bearing of the outer edge portion of the flange 5 upon the adjacent corrugation, establishes a force tending to crowd the flange 2 against the flange 3, contributing to the formation of a weather-tight joint at A, and these stresses also cause a compressive engagement of the flanges 4 and 5, producing a second weather-tight joint at the interlock B. In other words, the resilient deformation of the flange 5 produced by the compressive engagement of the flanges 4 and 5, produces stresses in the members which contribute to the maintenance of the interlock A in weather-tight relation. The greater the transverse tension stress in the panel assembly (in the plane of the structure defined by the panels) the tighter the interlock at A becomes, up to the point where the flange members are subjected to permanent deformation. It will be appreciated that the structure will be so designed that such permanent deformation will not be realized under the loadings which may be expected.

In order for rain, dust, or the like to enter the building through a joint formed according to this invention, it would be necessary for such rain or the like to pass through the seal provided at A, thence into the hollow cell H', thence through the seal provided at B. It will be noted that the metal portions intermediate the positions of the seals or interlocks A and B are spaced from one another, as at 9, to eliminate the formation of a continuous abutting contact of metal surfaces which extend through the plane of the wall surface, thereby preventing direct conduction of moisture through the wall by capillarity.

It will be appreciated that various alternative forms of stiffening members or sheets (corresponding to the sheet 7) may be provided for the panel, with varying degrees of attainment of the several objects of this invention, without departing from the spirit and scope hereof, such as stiffening sheets of the type shown at 18 in Fig. 8, or at 19 in Figs. 6, 8 and 10 of the patent of J. H. Young, No. 1,867,433, issued July 12, 1932, for example.

In Figs. 2 and 6 I have illustrated a suitable modification of the panels for the purpose of accommodating the compound seal structure to the formation of corners, wherein the edge portion 2a of the flange 2 is shown as disposed within the inside curve portion 3a of the flange 3, and the flanges 2 and 3 thus employed without modification to establish the interlock A_1, which corresponds to the interlock A. To establish the interlock B_1, corresponding to the interlock B, the lever arm portion 6 may be cut back as at 5A to such position as to engage the sheet 7 of the cooperating panel, under resilient compressive deformation, when the two panels are brought into the desired position to define the corner.

I prefer to provide the panels with a layer of heat and sound insulating material, such as the fibrous material obtainable under the trade name of "Celotex," for example. My preferred method of attachment of this insulating layer contemplates the provision of a compound layer assembly, as is particularly illustrated in Fig. 8. In this construction, an inner insulating layer 12 is mounted securely upon the crests of the several salient curves of the corrugated sheet 7, as through the agency of a plurality of "sheet-metal drive-screws" 13, and the outer insulating layer 14 is secured to the inner layer through the agency of a layer 15 of cementitious or adhesive material. Ordinary linoleum cement has been found entirely satisfactory for this purpose.

The exposed surface of the outer insulating layer 15 is preferably provided with a facing layer 16 of sheet metal or the like, and such layer may be secured in place by folding the lateral edges thereof over the lateral edges of the layer 15, as shown more particularly in Fig. 9. The provision of screws as at 13 to hold the inner insulating layer in place, taken with the use of the adhesive layer 15 to hold the insulating layer 14 in place, insures that no direct metallic conduction of heat may take place transversely through the panel construction.

The panels of the present invention, and as illustrated in Figs. 1 to 8, may be placed in their alined interlocking relation by sliding one panel longitudinally into engagement with the flange members of two spaced panel members disposed in the desired plane, much as one would slide a tongued lid of a box into a coactingly shaped pair of grooves. For the most part, all of the panels illustrated are conveniently brought into their interlocked alined relation after the manner particularly illustrated in Fig. 9, wherein one panel 21 may be considered to have been placed in the desired plane, and a second panel 22 is moved into interlocked relation with the panel 21 and in the same plane with such panel by placing the flange 2 thereof within the space between the flange 3 and the flange 5 of the panel 21, after the manner indicated in light dot-dash lines at P_1. When the flange 2 has been "hooked" over the flange 3, the panel 22 is rotated counter-clockwise towards the position P_2, shown in heavier dot-dash lines, in which position the flange 2 is well-hooked over the flange 3, and the flange 4 is brought towards the flange 5. When the full-line position P_3 is reached, the flanges 4 and 5 are in full compressive engagement, and the flange 2 is drawn tightly against the flange 3, completely closing the compound seal.

When the panels are subjected to a tension stress in the plane of the structural surface defined by the panels, the joints or interlocks A and B will both be tightened, as above brought out. When the panels are subjected to an opposite loading, tending to open the interlocked joint A, the flange 5 will be crowded along the slope of the adjacent corrugation of the sheet 7, building up a restoring force in the lever-arm portion 6 of the flange 5 tending to return the panels to their original position upon withdrawal of the load. It will be appreciated that tension loads are substantially the only loads which are imposed upon a surface such as a wall for any significant length of time, during which it would be essential to maintain the weather-tightness of the joint, and when the panels are under a tension load, both interlocks are functioning. The interlock B will function during all conditions of loading.

When the panels are subjected to ununiform transverse loads, as may occur in the use of panels for floors, the compressive relation of the flange members of the respective interlocks A and B serves to transmit these loads from the more heavily loaded panel to the adjacent less heavily loaded panel, and an unequal loading of either of two adjacent panels will cause one or the other of the interlocks A or B to come into closer compressive engagement, thus rendering the seal more effective.

As shown in Fig. 9, I prefer to stagger the abutting lateral edge portions of the layers **12** and **14**, after the manner illustrated at **12***a* and **14***a*, this staggering resulting in a more effective heat-and-sound seal at the position of the joint between panels.

In Figs. 11–14 I have illustrated the employment of a preformed or integral caulking strip along one of the flange members forming a shoulder for the cooperating interlocks on the respective panels, whereby a more effective weather sealing is established. Such a construction is of particular value where close manufacturing tolerances are not adhered to in the production of the panels, resulting in an uneven fit along the interlocks.

In Fig. 11 I have illustrated a caulked joint of the type shown in Fig. 3, wherein a strip of preferably plastic but at least compressively deformable caulking material **31** is adhesively or otherwise secured to one of the shoulder members of the interlock B, preferably the reentrant shoulder provided on the flange **4**.

In Fig. 12 I have shown the integral caulking provided at the interlock B′, interiorly of the reentrant flange member **4′**, as at **32**. In Fig. 13 the caulking is shown at **33**, preferably secured to the reentrant shoulder member **4″** and engaged by the salient flange member **5″** at the interlock B″. In Fig. 14, showing the corner construction of Fig. 6, the caulking **34** is shown applied to the interlock A_1, as to the inwardly directed flange member **3** of the plate **1**.

The caulking material may comprise a so-called "mastic," or may comprise an asphalt of suitable penetration, depending upon the extremes of temperature to which the structure is adapted. It will further be appreciated that the caulking may be provided at both of the interlocks A and B (A′ and B′, etc.) if desired.

Other modifications and features of the invention will occur to those skilled in the art, and I do not consider myself limited to those herein described and delineated, but rather to the scope of the subjoined claims.

I claim:

1. A sectional panel element for use in steel building construction, which comprises: a flat plate body portion having a longitudinal axis and defining a plane; shoulder means disposed longitudinally of and secured to one lateral edge of said body portion, and extending transversely outwardly with respect to said plane; a second shoulder means secured to said body portion along the opposite lateral edge thereof in spaced parallel relation to said first-named shoulder means and extending transversely inwardly with respect to said plane; a third shoulder means secured to said body portion adjacent said one lateral edge thereof in spaced parallel relation to said first-named shoulder means; a fourth shoulder means secured to said body portion adjacent said opposite lateral edge thereof in spaced parallel relation to said third-named shoulder means, the spacing of said first and second-named shoulder means and the spacing of said third and fourth-named shoulder means being substantially equivalent, and said two last-named shoulder means comprising relatively resiliently deformable shoulder means; and a stiffening member secured to said body portion and defining therewith a plurality of longitudinally extending hollow cells at the inward side thereof with respect to said plane, and said two last-named shoulder means being formed of laterally extending portions of said stiffening member.

2. A sectional panel element for use in steel building construction, which comprises: a flat plate body portion having a longitudinal axis and defining a plane; shoulder means disposed longitudinally of and secured to one lateral edge of said body portion, and extending transversely outwardly with respect to said plane; a second shoulder means secured to said body portion along the opposite lateral edge thereof in spaced parallel relation to said first-named shoulder means and extending transversely inwardly with respect to said plane; a third shoulder means secured to said body portion adjacent said one lateral edge thereof in spaced parallel relation to said first-named shoulder means; a fourth shoulder means secured to said body portion adjacent said opposite lateral edge thereof in spaced parallel relation to said third-named shoulder means, the spacing of said first and second-named shoulder means and the spacing of said third and fourth-named shoulder means being substantially equivalent, and said two last-named shoulder means comprising relatively resilient deformable shoulder means; and a stiffening member secured to said body portion, said stiffening member comprising an undulating sheet member and being secured to said body portion at the crests of the undulations at one face thereof, and the undulations of said stiffening member at the lateral edges of said element being of comparable curvature and having portions defining said two last-named shoulder means.

3. A sectional panel element for use in steel building construction, which comprises: a flat plate body portion having a longitudinal axis and defining a plane; flange members on the respective lateral edge portions of said body member defining shoulder means adapted to coact in interlocking relationship with corresponding flange members on additional elements of the same construction disposed in contiguous alined relationship, to establish a tension-resisting joint; a second group of flange members secured to said body portion adjacent the respective lateral edge portions thereof in respective spaced parallel relation to the first-named flange members and adapted to establish a second interlocking joint at the juncture of two adjacent panels, in spaced relation to said first-named joint; and a stiffening member secured to said body portion and defining therewith a plurality of longitudinally extending hollow cells at one side thereof with respect to said plane, the flange members of said second group being formed of laterally extending portions of said stiffening member.

4. A sectional panel element as set forth in claim 3, said stiffening member comprising an undulating sheet member and being secured to said body portion at the crests of the undulations at one face thereof, and the undulations in said stiffening member at the lateral edges of said element being of comparable curvature at the

position of the portion thereof defining the flange members of said second group.

5. A sectional panel element as set forth in claim 3, and comprising in addition, a layer of insulating material secured to said stiffening member at the opposite face thereof from the attachment of said stiffening member to said body portion, said layer being secured to the stiffening member through the agency of a positive metallic tie, and a second layer of insulating material overlying and adhesively secured to said first layer.

6. A sectional panel element for use in steel building construction, which comprises: a flat plate body portion having a longitudinal axis and defining a plane; a group of flange members secured to the respective lateral edge portions of said body member defining shoulder means adapted to coact in interlocking relationship with corresponding flange members on additional elements of the same construction disposed in contiguous alined relationship, to establish a tension-resisting joint; a second group of flange members secured to said body portion adjacent the respective lateral edge portions thereof in respective spaced parallel relation to the first-named flange members and adapted to establish a second joint at the juncture of two adjacent panels, in spaced relation to said first-named joint; and a stiffening member secured to said body portion and defining therewith a plurality of longitudinally extending hollow cells at one side thereof with respect to said plane, the flange members of at least one of said groups being formed of laterally extending portions of said stiffening member.

7. A sectional panel element for use in steel building construction, which comprises: a flat plate body portion having a longitudinal axis and defining a plane; a group of flange members secured to the respective lateral edge portions of said body member defining shoulder means adapted to coact in interlocking relationship with corresponding flange members on additional elements of the same construction disposed in contiguous alined relationship, to establish a tension-resisting joint; a second group of flange members secured to said body portion adjacent the respective lateral edge portions thereof in respective spaced parallel relation to the first-named flange members and adapted to establish a second joint at the juncture of two adjacent panels, in spaced relation to said first-named joint; a stiffening member secured to said body portion and defining therewith a plurality of longitudinally extending hollow cells at one side thereof with respect to said plane, the flange members of at least one of said groups being formed of laterally extending portions of said stiffening member, and a layer of compressibly deformable caulking material secured to one of said flange members forming one of said joints, and positioned to be compressibly engaged by the other of said flange members forming said one joint.

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