Aug. 25, 1959 H. E. VOEGELI 2,901,063

METAL WALL CONSTRUCTION

Filed Oct. 11, 1956

FIG. 1

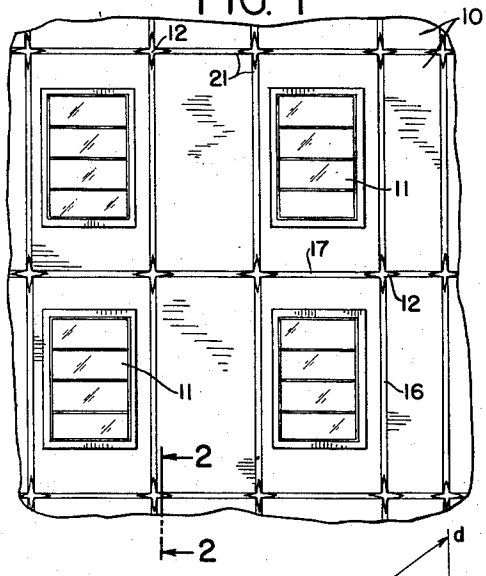


FIG. 2

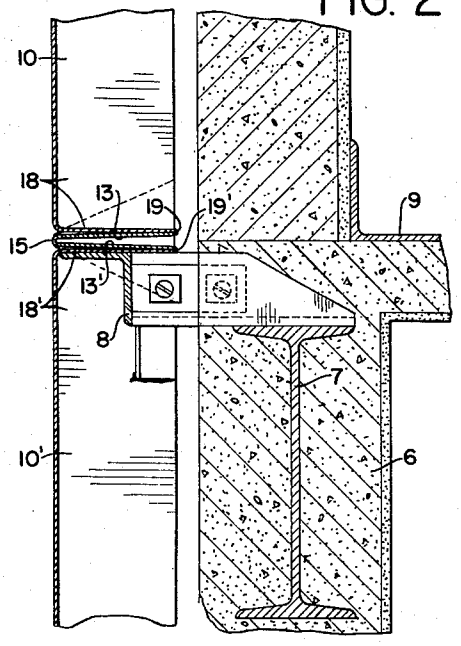


FIG. 3

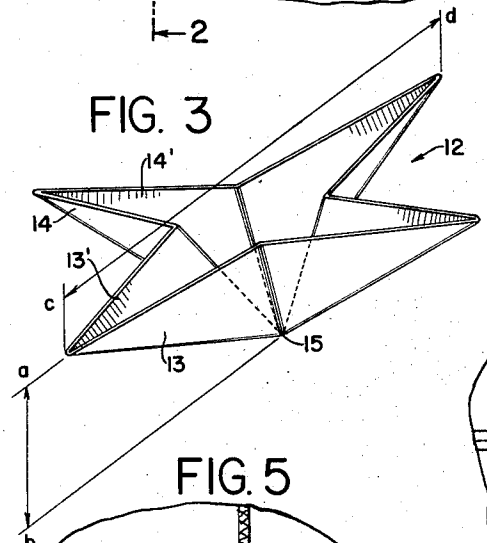


FIG. 4

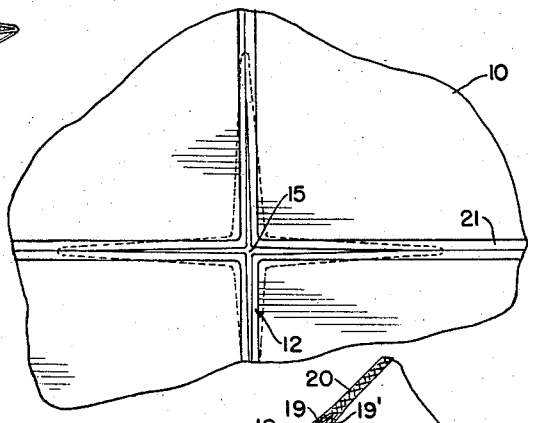


FIG. 5

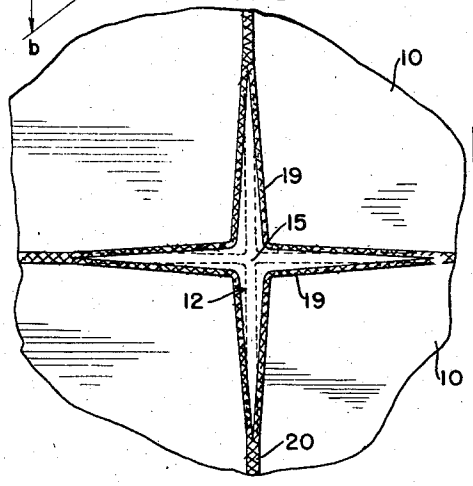
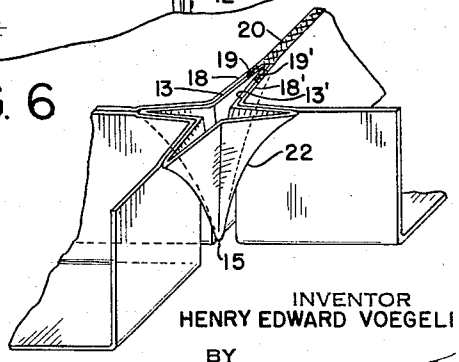


FIG. 6



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METAL WALL CONSTRUCTION

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9 Claims. (Cl. 189—34)

This invention relates to the construction of metal curtain walls for skeleton frame buildings, and has for its object the provision of improved means for weatherproofing the joint intersections in an assembly of metal wall panels while permitting expansion and contraction of the panels as the result of changes in temperature. The invention further contemplates the provision, as a new article of manufacture, of a metal expansion unit for permitting expansion and contraction of a group of contiguous metal panels in a metal curtain wall.

The principal obstacle in the development of the skeleton frame building has been the inability to provide a weathertight metal curtain wall and at the same time avoid unsightly buckling and damage of the metal panels from expansion and contraction. It has heretofore been the general practice to prevent moisture leakage and to allow freedom of movement of the panels by caulking the joint intersections with a weatherproof compound or by the use of gaskets of synthetic rubber or the like. The limited service life of these materials and the inevitable expense of maintenance have been a serious deterrent in the exploitation of the skeleton frame building.

The present invention provides a metal curtain wall construction which is permanently weathertight requiring little, if any, maintenance, and in which the tendency to buckle with temperature changes is reduced to a minimum. This is accomplished, according to the invention, by the provision of a metal expansion unit or insert at each joint intersection in an assembly of metal wall panels. The metal expansion unit is generally of pyramidal form with a star-shaped base, and has a plurality, usually four, two-sided expansible elements equally spaced circumferentially about the pyramidal apex. In the assembly of metal wall panels, a metal expansion unit is positioned with its apex coincident with the center of the joint intersection and each expansible element is positioned in the joint intersection between two adjacent panels with the two sides of the element respectively secured (preferably by welding) to the adjacent panels. The metal panels have flanges extending inwardly from each side of the panel face, generally perpendicular thereto. By skewing the corners of such flanges and positioning the expansion unit in a joint intersection with the two sides of each expansible element, respectively, adjacent the flanges of two adjacent panels, a weathertight union of the unit and adjacent panels is advantageously effected by welding together the edges of contiguous flanges and element sides. Beyond the end of each expansible element of the unit the contiguous edges of each pair of adjacent flanges are secured together, preferably by welding.

The invention will be better understood from the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 is a front elevation of a metal curtain wall embodying the invention,

Fig. 2 is a vertical sectional detail on the section line 2—2 of Fig. 1;

Fig. 3 is a perspective view of a metal expansion unit or insert embodying the invention,

Fig. 4 is a front elevation of a joint intersection showing the expansion unit in operative position,

Fig. 5 is a rear elevation of the joint intersection of Fig. 4, and

Fig. 6 is a modified form of the metal expansion unit.

Figs. 1 and 2 of the drawings represent, somewhat diagrammatically, the front and a sectional detail of a skeleton frame building in which the beam fireproofing **6**, structural and spandrel beams **7** and **8** and floor **9** are of conventional construction and form no part of the invention.

The outside metal curtain wall of the building is constructed of metal panels or sheets **10**, usually rectangular in shape, assembled side by side and supported by the spandrel beams. Fig. 1 of the drawings shows the front or outside of the curtain wall, with suitable openings for windows **11** in certain panels, and the metal expansion unit **12** of the invention operatively positioned in each joint intersection of the panels for permitting expansion and contraction of the panels with changes of temperature. The panels may be made of any suitable metal such, for example, as copper, bronze, brass, aluminum, steel, zinc etc.

The metal expansion unit **12** (best shown in Fig. 3) is a unitary structure of resilient sheet metal of generally pyramidal form with a star-like base, usually a four-pointed star. It may conveniently be made from a suitably-creased metal blank or a metal cone. Each star-ilke point consists of a two-sided expansible element **13—13′**, **14—14′** etc., with the elements equally spaced circumferentially about the pyramidal apex **15**. Each expansible element (**13—13′** etc.) is generally of triangular prismatic form, and structurally is in the nature of an accordion or bellows permitting expansion and contraction of the space between the two sides. The inner or top points of the expansible elements (**13—13′** etc.) meet at the pyramidal apex **15**, and the outer or lower points are the points of the star-like base. Two of the three radial spines or edges of the triangular prismatic form of each element are integrally united, respectively, with the contiguous spine of the adjacent element. The common or united spines are the troughs or inner limits and the third spines the crests or outer limits of the star-like pyramidal form of the expansion unit. Merely by way of illustration, the length of the crest spines (*a—b* in Fig. 3) of each expansible element may conveniently be about 5 inches, and the span between the outer tips of the star-points (*c—d* in Fig. 3) may then be (normally) about 12 inches. As shown in Fig. 3, the crest spines are straight-lined, while in Fig. 6 the crest spines (**22**) have a concave curvature as hereinafter more fully explained.

The metal expansion units **12** are operatively positioned in each intersection of the vertical (**16**) and horizontal (**17**) joints in the assembly of the wall panels **10**. Each panel **10** has on each side thereof an inwardly projecting flange **18** of approximately the same depth as the length of the radial spines of the expansible elements (e.g. 5 inches with respect to the dimension hereinbefore recited). The flanges are generally perpendicular to the plane of the panel face, and at the corners of the panel are skewed to suitably mate with the adjacent sides of the expansion unit. In assembling, an expansion unit **12** is positioned in each joint intersection with its apex **15** coincident with the center point of the intersection, and its two-sided expansible elements between the flanges of the adjacent panels. The edge of one side (e.g. **13**) of the expansible element is secured by a weld **19** (or the like) to the con-

tiguous edge of the adjacent flange (e.g. 18) of the panel 10, while the edge of the other side (e.g. 13') of the element is secured by a weld 19' (or the like) to the contiguous edge of the adjacent flange (e.g. 18') of an adjacent panel 10', as best seen in Fig. 2. The edges of the two adjacent sides of adjacent elements are thus welded, or otherwise suitably secured, to the contiguous edges of the two corner flanges, respectively, of a metal panel, and in this manner all metal panels grouped about the common joint intersection have a weathertight union with the metal expansion unit positioned in the joint intersection. Beyond the end of each expansible element of the unit 12, the contiguous edges of each pair of adjacent flanges are united by a continuous weld 20, thus completing the weathertight union of all the panels in the metal curtain wall.

The welded edge 20 of each pair of adjacent flanges provides a hinge-like union between the metal panels, and the metal expansion unit 12 absorbs any force that is transmitted from flange to flange as a consequence of the expansion or contraction of the panels. The accordion- or bellows-like union between the expansion units and the panel flanges grouped about a joint intersection provides a weathertight and expansible connection of the flanges permitting both expansion and contraction. With the expansion units 12 operatively positioned at joint intersections and with the hinge-like union of the panels, a space 21 is present on the front or outside face of the curtain wall. With rectangular panels of about 4 feet by 10 feet, this space under normal conditions may advantageously be about 3/8 inch wide at the front, and of course narrows down to the hinge-like welded union 20. Such a space assures adequate facility for expansion and contraction of the panels without buckling. For convenience in assembling the curtain wall with a metal expansion unit 12 in each joint intersection, the flanges 18 may advantageously be slightly inclined outwardly (from the perpendicular), say 3/16 inch at the outer edge where the space 21 is 3/8 inch wide under normal conditions.

The flange may be integral with the face of the panel, but preferably the flange and face are separate pieces of sheet metal suitably joined, as for example by welding. The face of the panel should be of heavy gauge for stiffness and to avoid unsightly buckling. The flanges may conveniently be in the form of a multilateral (e.g. rectangular) frame to which the panel face is welded, such as the so-called breadpan type of curtain wall panel. The flange is preferably of somewhat lighter gauge than the panel face to facilitate the hinge action of closing (or opening) the joint space (21) between any two adjacent panels upon expansion (or contraction) of the panel face.

The expansion unit or insert 12 may be made from a unitary blank or piece of any suitable resilient metal, such as copper, bronze, brass, aluminum, steel, zinc etc. The gauge of the metal is preferably of minimum thickness, being only heavy enough to be safe against corrosion. The metal should possess the most suitable temper so that it can be flexed the very small amount required for an indefinite time without fatigue.

When the metal expansion unit 12 is welded to the several flanges of the metal panels grouped about the joint intersection, it introduces a certain stiffness that may tend to impair the contemplated hinge action between the panels. Such stiffness may be minimized by concavely curving the crest spine of each expansible element (13—13' etc.) as shown at 22 in Fig. 6, where corresponding parts are indicated by the same reference character as in Fig. 2. This concave curvature produces a neck of relative weakness as the four crest spines approach the apex 15 which must yield only the slighest amount to permit hinge action for the closing or opening of the joint spaces 21. The curvature of the crest spines is thus beneficial so far as flexure is concerned and permits a certain amount of bending in the expansible joint intersection to allow optimum functioning of the hinge action. Inserts or units in which the expansible elements have curved crest spines may conveniently be made by first suitably folding a square metal blank to produce the pyramidal form of Fig. 3, and then drawing and stamping the piece to impart the desired concave curvature to the crest spines of the expansible elements.

The metal expansion unit of the invention permits the construction of an exterior wall facing of a skeleton frame building that is permanently weathertight and which permits expansion and contraction without buckling of the metal panels. The bellows or accordion type expansion elements of the unit prevent the transmission of stress from one panel to another and eliminate danger of accumulated pulling and wrenching of the panels.

I claim:

1. An expansion unit for permitting expansion and contraction of a group of contiguous metal panels in a metal curtain wall characterized by a plurality of bellows-like expansible elements equally spaced circumferentially about a common apex and fabricated from a unitary sheet of resilient metal, each of said expansible elements having two substantially triangular planar side surfaces integrally joined along a fold line extending outwardly from said apex, and each of said side surfaces being integrally joined to the contiguous side surface of the adjacent expansible element along another fold line extending outwardly from said apex.

2. An expansion unit for permitting expansion and contraction of a group of contiguous metal panels in a metal curtain wall characterized by four bellows-like expansible elements equally spaced circumferentially about a common apex, said expansion unit being generally of pyramidal form with a star-like base and fabricated from a unitary sheet of resilient metal, each of said expansible elements having two substantially triangular planar side surfaces integrally joined along a fold line extending outwardly from said apex to a point of said star-like base, and each of said side surfaces being integrally joined to the contiguous side surface of the adjacent expansible element along another fold line extending outwardly from said apex.

3. An expansion unit for permitting expansion and contraction of a group of contiguous metal panels in a metal curtain wall comprising a unitary structure of resilient sheet metal of generally pyramidal form with a star-like base and having a plurality of two-sided expansible elements equally spaced circumferentially about the pyramidal apex, the two sides of each of said expansible elements being integrally joined together along a fold line extending outwardly from said apex and curved concavely toward said base, and each of said sides being integrally joined to the contiguous side surface of the adjacent expansible element along another fold line extending outwardly from said apex.

4. An expansion unit for permitting expansion and contraction of a group of contiguous metal panels in a metal curtain wall comprising a unitary structure of resilient metal of generally pyramidal form with a star-like base and having four contiguous bellows-like expansible elements equally spaced circumferentially about the pyramidal apex, each of said expansible elements being generally of triangular prismatic form having two substantially triangular planar side surfaces integrally joined along a fold line extending outwardly from said apex, said fold line being curved concavely toward said base, and each of said side surfaces being integrally joined to the contiguous side surface of the adjacent expansible element along another fold line extending outwardly from said apex.

5. An expansion unit for permitting expansion and contraction of a group of contiguous metal panels in a metal curtain wall comprising a unitary structure of resilient sheet metal of generally pyramidal form with a star-like base and having a plurality of two-sided expansible elements equally spaced circumferentially about the pyramidal apex, each of said expansible elements be-

ing generally of triangular prismatic form having three radial spines defined by fold lines extending uninterruptedly from said apex to said base, each side of each expansible element being integrally joined to the contiguous side of the adjacent element along one of said fold lines which forms the bottom of one of the troughs of the star-like pyramidal form of the unit, and the two surfaces of each of said elements being integrally joined together along the third of said fold lines which forms a crest of the star-like pyramidal form.

6. An expansion unit according to claim 5 further characterized in that the crest fold lines of the expansible elements have a concave curvature toward the base.

7. In a metal curtain wall construction, a group of four rectangular metal panels arranged in the form of a rectangle with two sides of each panel contiguous respectively to one side of the two adjacent panels and with all such pairs of contiguous sides terminating proximate a common joint intersection, and a metal expansion insert having four two-sided expansible elements equally spaced circumferentially about a common apex coincident with said joint intersection, each of said expansible elements being positioned between the ends of and secured to a pair of said contiguous sides for permitting expansion and contraction of said panels and each pair of said contiguous sides being secured together beyond the end of the expansible element therebetween.

8. In a metal curtain wall construction, a group of metal panels each having side flanges arranged with two adjacent sides of each panel respectively adjacent to one side of two other adjacent panels and with said adjacent sides meeting in a common joint intersection, and

a metal expansion insert operatively positioned in the joint intersection and characterized by a plurality of two-sided expansible elements equally spaced circumferentially about the joint intersection with the two sides of each element positioned between the end portions of adjacent flanges, the edge of each element side being welded to the edge of the adjacent flange and the edges of adjacent pairs of flanges being welded together beyond the end of the expansible element therebetween.

9. In a metal curtain wall construction, a group of four rectangular metal panels each having side flanges arranged with two adjacent sides of each panel respectively adjacent to one side of two other adjacent panels and with said adjacent sides meeting in a common joint intersection, and a metal expansion insert having four two-sided bellows-like expansible elements equally spaced circumferentially about the joint intersection with the two sides of each element positioned between the end portions of adjacent flanges, the edge of each element side being welded to the edge of the adjacent flange and the edges of adjacent pairs of flanges being welded together beyond the end of the expansible element therebetween.

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