March 16, 1965 R. F. MOTE 3,173,523

WALL CONSTRUCTION

Filed Jan. 12, 1962 2 Sheets-Sheet 1

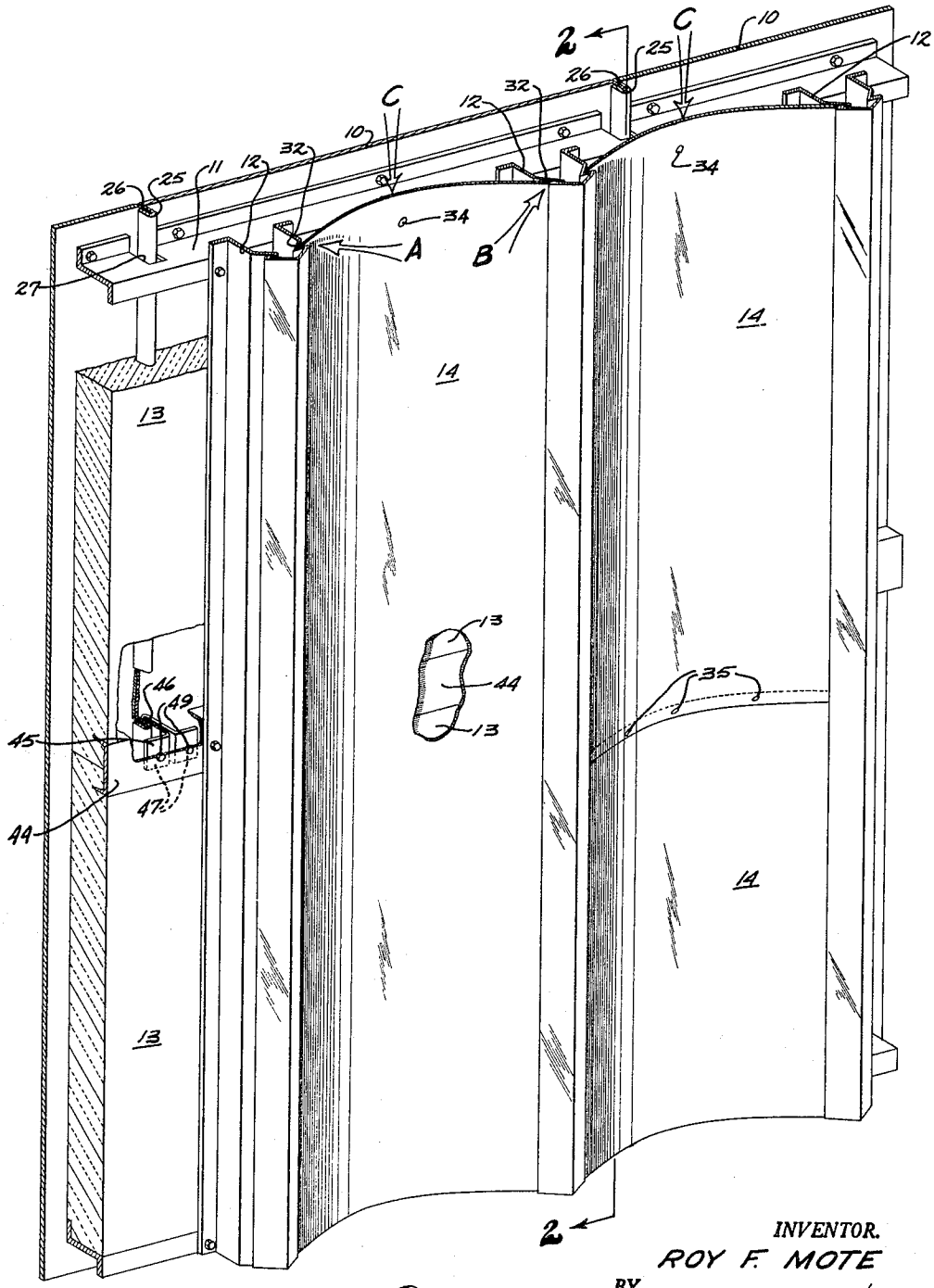


Fig. 1

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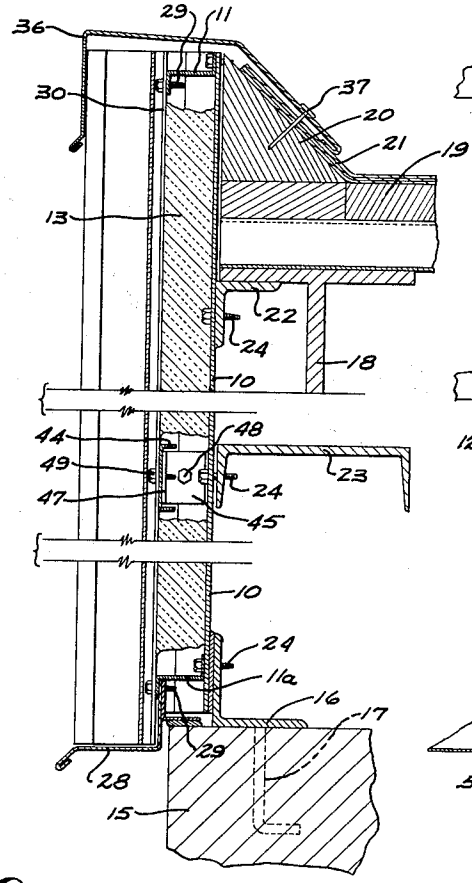


Fig. 2

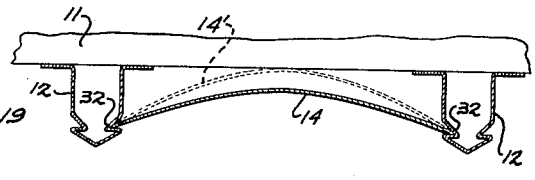


Fig. 3

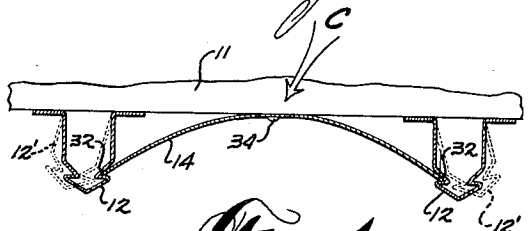


Fig. 4

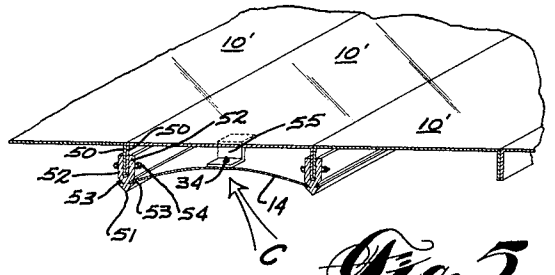


Fig. 5

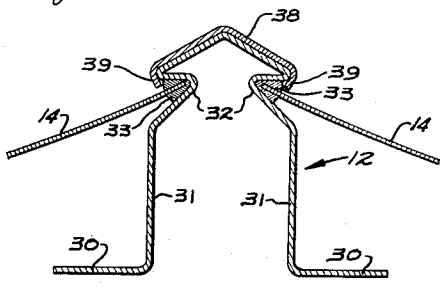


Fig. 6

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3,173,523

WALL CONSTRUCTION

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2 Claims. (Cl. 189—85)

The present invention relates to a wall construction particularly adapted for the external sheathing of buildings.

This application is a continuation-in-part of my abandoned co-pending application S.N. 70,311, filed November 18, 1960.

The principal object of this invention is to provide a wall construction which can be easily fabricated and installed.

A further object of this invention is to provide a wall construction permitting maximum surface covering with relatively valuable sheathing materials.

Another object of this invention is to provide a wall construction which can utilize relatively inexpensive construction materials such as protected metals as substitutes for premium construction materials.

A still further object of this invention is to provide a structurally sound wall construction utilizing normally flat sheets of construction materials which require no preliminary fabrication out of their normally flat configuration.

These and other objects of the present invention will become apparent from the following detailed description by reference to the accompanying drawings in which:

FIGURE 1 is a perspective illustration of the wall construction according to a preferred embodiment of this invention;

FIGURE 2 is a cross-section illustration of the wall construction of FIGURE 1 taken along the line 2—2 of FIGURE 1 and including in addition typical sill and head details;

FIGURES 3 and 4 are cross-section views of a single module of the present wall construction illustrating effects of applying positive loading to similar wall constructions;

FIGURE 5 is a fragmentary perspective illustration of a modification of the present wall construction; and

FIGURE 6 is a fragmentary cross-section illustration of a modification of the present wall construction.

According to the present invention, a building framework is provided initially with a plurality of horizontal sub-girts secured in outboard relation to the building structure. Preferably a relatively inexpensive sheet metal lining is provided between the outboard horizontal subgirts and the building structure. Secured to the outboard horizontal subgirts are a plurality of spaced vertical surface support elements or mullions which are fabricated from relatively inexpensive construction materials such as aluminum extrusions, steel cheets, or sheets of protected metals. The vertical mullions are formed by extruding, rolling or pressing the selected construction material. Each of the vertical mullions has a pair of lengthwise opposed inset grooves adapted to receive an edge of a sheet of infill material such as stainless steel, aluminum, and similar sheets, for example. The infill material is provided in flat, rectangular sheets which are fitted into position between adjacent vertical mullions and are inwardly bowed. A bead of caulking material may be provided along the longitudinal grooves of the vertical mullions to render the exposed surface weather-resistant. If desired, a suitable snap-on cover cap may be provided over the remaining externally exposed portion of the vertical mullion.

According to the present improvement, a plurality of

vertical surface back-up elements is secured to the building framework in outboard relation. These vertical surface back-up elements are presented midway between adjacent vertical mullions and serve as an abutment surface for selected points along the vertical center line of each infill sheet. Thus each of the bowed infill sheets is distorted from its natural bowed configuration as a result of being in abutment with at least one of the vertical surface back-up elements. This construction permits the resulting wall to withstand substantial positive and negative wind loads. In addition, at least one fastener is extended through the center line of each infill sheet into a vertical surface back-up element. The fasteners provide a more uniform application of lateral stresses from the infill sheets to the vertcal mullions.

The present wall construction will be described generally by reference to FIGURES 1 and 2. The present wall construction is applied to a building framework having a plurality of connected vertical columns and horizontal beams. One such horizontal beam is indicated by the numeral 18 in FIGURE 2. Secured to the structural framework of the building is a plurality of substantially flat, inner sheathing sheets 10. A plurality of horizontal Z-bars 11 is secured to the inner sheathing sheets 10 (and hence to the building framework) in outboard relation. A plurality of vertical mullions 12 is secured to the outboard flange of the Z-bars 11. Insulation batts 13 are positioned in outboard relation to the inner sheathing sheets 10. A plurality of generally rectangular infill sheets 14 is fitted between adjacent vertical mullions 12. It will be observed that the infill sheets 14 are inwardly bowed.

VERTICAL MULLIONS

The vertical mullions 12 have a generally U-shaped configuration as shown specifically in FIGURE 6 and include generally parallel leg members 31 which terminate in opposed outward flanges 30. Each of the leg members 31 has an internal lengthwise inset groove 32 adapted to receive a straight edge of an infill sheet 14. A bead of caulking material 33 preferably is provided along the length of each groove 32 which receives a straight edge of the infill sheet 14. The vertical mullions 12 as shown in FIGURE 6 are preferably formed by rolling or bending strips of metal such as steel or asphalt-asbestos-covered steel sheets. The spacing of the vertical mullions 12 is critical in the present invention. They should preferably be aligned by means of a suitable jig. The center-to-center spacing of the vertical mullions 12 corresponds to the width of the infill sheets 14. Hence the groove-to-groove spacing is less than the width of the infill sheets 14 to provide the essential inward curvature in the infill sheets 14.

INFILL SHEETS

The infill sheets 14 are normally flat rectangular sheets of construction material such as stainless steel, aluminum, plastic coated carbon steel, asbestos-asphalt-covered steel, glass-fiber-reinforced polyester resin sheets and similar materials. The infill sheets of this invention require no shop or site fabrication whatsoever since they are utilized in their normally flat condition. The infill sheets of the present invention have a width which is greater than the length of a smooth, concave arc whose ends terminate in the bottoms of the inset grooves 32 of adjacent vertical mullions 12 and which is tangent to the vertical surface back-up members at a point midway between the adjacent vertical mullions. The infill sheets have a width in the range of 15 to 36 inches, preferably from about 18 to 30 inches. Where the infill sheets are less than about 15 inches wide, an undue number of vertical mullions is required in the wall. Where the infill sheets exceed 36 inches in width, buckling tendencies are evident in the

assembled sheets. With sheets from 18 to 30 inches in width, excellent load transfer from the sheets to the vertical mullions is achieved with an economical use of vertical mullions.

Where desired, the infill sheets **14** may be alternated to provide pleasing architectural effects. That is, sheets of different widths may be interposed in suitably spaced vertical mullions.

INNER SHEATHING SHEETS

The inner sheathing sheets **10** preferably are provided with a female lip **25** along one side and a male lip **26** along the other side to facilitate their assembly on the building structure. While the inner sheathing sheets **10** are not essential to the assembly of the present wall, their employment serves to provide a double surface wall construction in which the batts **13** of thermal insulating materials may be suitably confined.

VERTICAL SURFACE BACK-UP MEMBERS

A plurality of vertical surface back-up members is provided in the present wall construction. These may take the form of the Z-bars **11**, or the channel members **44** shown in FIGURES 1 and 2. Alternatively or in addition, the vertical surface back-up members may comprise Z-brackets **55** as shown in FIGURE 5 to be hereinafter described.

ASSEMBLY

A typical wall assembly according to this invention will be described by reference to FIGURES 1 and 2. As seen in FIGURE 2, the typical building includes a masonry sill **15** having a sill angle **16** secured thereto by means of a suitable anchor bolt **17**. Forming a part of the structural framework of the building is a plurality of structural columns (not shown) and horizontal beams **18**. A suitable roof **19** may comprise wood, metal, concrete, gypsum and the like. A cant **20** extends around the perimeter of the roof **19**. A plurality of roofing plies **21** forms the weather resistant upper surface of the building. Secured to the horizontal beam **18** is an angle **22**. Various horizontal channels **23** are provided between the head and sill of the building and they comprise structural beams or girts of the building structure. The inner sheathing sheets **10** are secured to the angles **22, 16** and the channels **23** by means of suitable bolts **24**.

Suitable notches **27** are cut into the Z-bars **11** to accommodate the male and female lips **25, 26** of the inner sheathing sheets **10**. The Z-bars **11** are secured in outboard relation to the inner sheathing sheets **10** preferably by means of bolts **24** which may serve the dual function of supporting certain metal Z-bars **11** and also the inner sheathing sheets **10**.

A sill flashing **28** is bolted to the bottom Z-bar **11***a*. Thereupon, the vertical mullions **12** are bolted to the outboard flange of the Z-bars **11** by means of bolts **29** extending through flanges **30** of the vertical mullions **12**.

After the vertical mullions **12** have been secured to the outboard flanges of the Z-bars **11**, suitable batts of insulation **13** may be positioned between adjacent vertical mullions **12** (along the batt edges) and the inner sheathing sheets **10** (along a flat surface). The insulation batts **13** may comprise glass wool, rock wool and the like. Preferably the insulation batts **13** are precut to extend over the entire width of each individual inner sheathing sheet **10** between adjacent Z-bars **11**. The outboard flanges of the Z-bars **11** serve as vertical back-up members.

ALTERNATIVE BACK-UP MEMBERS

In place of the horizontal Z-bars **11** heretofore described, it is possible to employ a horizontally extending channel **44** as the vertical surface back-up member. The horizontal channels **44** may be conveniently installed as follows.

The inner sheathing sheets **10**, provided with male and female lips **26, 25**, are secured to the building framework by means of bolts **24** fastened to the angles **16, 22** and channels **23**. The female and male lips **25, 26** serve to join adjacent inner sheathing sheets **10** and also serve as a support for a plurality of the horizontally extending channels **44**. An A-clip **45** is formed by bending a strip of metal or protected metal as clearly seen in FIGURE 1. The A-clip **45** has a double web **46** in its center portion and a pair of outwardly opposed flanges **47**. A fastener such as a screw **48** extends through the double web **46** and through the female and male lips **25, 26** whereby the A-clip **45** is secured in outboard relation to the inner sheathing sheets **10**. A plurality of the A-clips **45** is provided along the length of each of the female lips **25**. A horizontal channel **44** is secured to the outwardly opposed flanges **47** and the A-clip **45** by means of bolts **49**. The horizontal channels **44** serve the same function as the outboard flange of the Z-bars **11** already described in connection with the preferred embodiment. That is, the horizontal channels **44** receive fasteners such as screws **29** which extend through opposed flanges **30** of the vertical mullions **12**. In addition, the horizontal channels **44** serve as the vertical surface back-up members to be hereinafter described. By eliminating the inner sheathing sheets **10**, the horizontal subgirts of the building may serve as a support means for the vertical mullion **12** and also may serve as the vertical back-up elements for the infill sheets **14**.

INSTALLING INFILL SHEETS

After two or more vertical mullions **12** have been installed on the building structure, the installation of infill sheets **14** can commence. Each of the individual infill sheets **14** is a generally rectangular sheet of construction material such as stainless steel, aluminum, plastics, protected metal and the like. One side edge of an infill sheet **14** is inserted into a groove **32** of one vertical mullion **12** as shown by the arrow A in FIGURE 1. The infill sheet **14** then is urged inwardly by applied pressure until the other side edge is snapped into position into the vertical groove **32** of the adjacent vertical mullion **12** as indicated by the arrow B. The natural bowing or arching of the normally flat infill sheet **14** provides a compressive force for securing the infill sheet **14** in the wall construction. Where the infill sheets **14** are of a sufficient thickness, the resulting wall will withstand reasonable positive and negative pressure loading. The term "positive pressure" loading refers to the application of wind pressures to the external surface of the resulting wall. The term "negative pressure" loading refers to suction pressures established by wind turbulence which is a commonplace factor in building construction.

In FIGURE 3, the essential elements of the present wall as thus far described, including a Z-bar **11**, vertical mullions **12** having grooves **32**, and an infill sheet **14**, are illustrated. It will be seen that the infill sheet **14** is naturally arched between the grooves **32** which receive the opposed edges of the infill sheet **14**. The infill sheet **14** is unsupported at its center. So long as no positive or negative pressure is applied to the infill sheet **14**, it will remain in the indicated position. Thin-gauge infill sheets (e.g., 26-gauge aluminum sheets) will offer no effective resistance to positive or negative loads when unsupported along their central portion. Heavier gauge infill sheets (e.g., 18-gauge steel sheets) offer increased resistance to loading, but perform unsatisfactorily. Only a very slight positive pressure will cause the infill sheet **14** to move inwardly as indicated in phantom outline by the numeral **14'** (FIGURE 3). Inward movement of the infill sheet **14** is accompanied by a withdrawal of the edges of the infill sheet **14** from the grooves **32** which may allow the infill sheet **14** to be totally removed.

This lack of resistance to positive pressure loading can be avoided according to the present invention by abutting the infill sheets **14** along their vertical centered line with a vertical surface back-up member. As defined above,

the width of each of the infill sheets 14 is such that upon installation it will abut the vertical surface back-up member and be flattened along its vertical center line. Referring to the arrows C in FIGURE 1 and FIGURE 4, the infill panels 14 are flattened against Z-bars 11 in their center portions. Hence the resulting arc of the infill sheets 14 is not a natural arc but instead is distorted from the natural arc in the region of the arrows C, i.e., the vertical centerline of the sheet 14. This construction, I have found, greatly increases the strength of the resulting wall. The added strengthening serves to resist not only positive but negative pressure loading. Infill sheets of 22-gauge steel, when properly distributed along their vertical centerline, will resist positive loads of 40 pounds per square foot.

Unfortunately, the introduction of thicker infill sheets 14 coupled with the described central abutment distortion tends to twist the vertical mullions 12. The edges of the facing sheets 14 exert lateral pressure against the vertical mullions 12 which actually produces a twist in those mullions 12. This is indicated schematically in FIGURE 4 by the twisted mullions 12' shown in phantom outline. Thus when a succeeding infill sheet 14 is positioned against a mullion which is already twisted, the available groove-to-groove distance is less than that specified. Thus a greater distortion is required to insert the subsequent infill sheet 14 between the grooves 32 and the subsequent sheet is more difficult to install. The difficulty of installation becomes cumulatively greater as additional infill sheets are inserted. The second infill sheet, as a result of its greater distortions than the first, presents greater stress against its vertical mullion whereby that mullion is strained to a greater twist which makes the insertion of the next facing sheet even more difficult. The increasing stresses accumulate undesirably.

According to the present invention, the difficulty has been resolved. In addition to distorting each infill sheet out of its normal arc configuration by placing it in abutment at a plurality of points along its vertical centerline, each infill sheet 14 is secured along its vertical center line by means of at least one fastener extended through the vertical center line of the infill sheet into the vertical surface back-up member. For this purpose, pop rivets 34 are a preferred fastener although self-tapping metal screws may be employed by securing each infill sheet along its vertical center line where it is in abutment with a vertical surface back-up member, the lateral stresses of the infill sheet edges are equalized. Thus the lateral stresses do not accumulate with the insertion of successive infill sheets.

Where the vertical span of the present wall exceeds the available length of the infill sheets 14, several infill sheets 14*a*, 14*b* (FIGURE 1) may be inserted in the manner described with the topmost sheet 14*a* lapping externally over the subjacent sheet 14*b*. One or more fasteners such as rivets 35 may be extended through the overlapping portions to render the joint more watertight. Pleasing architectural effects may be achieved by employing infill sheets 14*a*, 14*b* of differing colors or textures.

ROOF ASSEMBLY

A suitable flashing strip 36 is secured to the roofing cant 20 (FIGURE 2) by conventional means such as nails 37. The flashing strip 36 extends over and beyond the front of the vertical mullions 12 to prevent the entry of moisture into the space between the infill sheets 14 and the inner sheathing sheets 10.

For decorative effects, a suitable cover strip may be snapped over the outwardly exposed portion of the vertical mullion 12 as shown in FIGURE 6. The snap on cover strip 38 in general conforms to the exposed portion of the vertical mullions 12 and has entrant flanges 39 which enter into the longitudinal grooves 32. It should be apparent from inspection of FIGURE 6 that the only exposed materials of the present wall construction are the infill sheets 14 and the snap-on-cover strip 38, both of which may be fabricated from relatively inexpensive attractive construction materials since one feature of the present construction is a maximum external exposure of such materials.

ALTERNATIVE VERTICAL MULLION CONSTRUCTION

In FIGURE 5 there is illustrated an alternative mounting means for the vertical mullions of this invention. It will be seen that the inner sheathing sheets 10' have lateral flanges 50 which are in side-by-side abutment. A forked vertical mullion 51 has a pair of parallel legs 52 and opposed inset longitudinal grooves 53. The parallel legs 52 are fitted over the flanges 50 and the vertical mullion 51 is secured to the flanges 50 by means of suitable bolts 54. This construction avoids the need for outboard Z-bars and channels since the vertical mullions may be secured directly to the flange joints between inner sheathing sheets 10. Nevertheless a vertical surface element will be required to provide abutment for the infill sheet 14. A suitable vertical backing member shown in FIGURE 5 is a Z-bracket 55 which is secured to the inner sheathing sheets 10, for example, by welding, and provides a vertical surface on the outboard flange in abutment with the vertical center line of the infill sheet 14 at the region C. A suitable pop rivet 34 or similar fastener is provided to secure the infill sheet 14 to the Z-bracket 55.

SPECIFIC EMBODIMENT

In a specific embodiment of the present invention, the center-to-center spacing of vertical mullions 12 was 18.0 inches. The vertical mullions 12 had a thickness of 0.625 inch between the longitudinal grooves 32. Infill sheets 14 were 18 inches wide and 10 feet long. The infill sheets 14 were readily installed with the inward bow having a subtended cord which was 17.375 inches long. That is, the distance between adjacent longitudinal grooves 32 was 17.375 inches.

As infill sheets, the following materials have been employed successfully:

(1) Stainless steel.

(2) Aluminum.

(3) Metal sheets coated with porcelainized enamel.

(4) Metal sheets coated with asbestos felt and a tough outer plastic covering available under the trade name GALBESTOS.

(5) Sheets of translucent glass-fiber-reinforced polyester resins.

Since the center-to-center spacing of vertical mullions 12 corresponds to the width of the infill sheet 14, the 18 inches wide sheets cover an 18 inch sector of a building wall with the exception of the actual vertical mullion 12 itself. Hence relatively valuable sheathing materials are utilized with a maximum exposure according to the present construction.

By virtue of the edge protection provided for the flat infill sheets 14 in the present construction, it is possible to upgrade relatively inexpensive construction material into premium applications. For example, sheets of carbon steel or other metals covered with a weather resistant coating of plastic, plastic films, asphalt-asbestos, and the like, have in the past found only a limited application in premium construction because of their tendencies to deteriorate along their exposed edges. Such materials frequently possess excellent weather resistant properties over their flat surfaces. In the present wall construction the edge surfaces of such sheets are protected from deteriorating exposures. Accordingly such relatively inexpensive construction materials may be utilized acceptably in the present wall construction.

According to the provisions of the patent statutes, I have explained the principle, preferred embodiment and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood

that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A wall construction for a building having a structural framework, comprising:

a plurality of spaced vertical mullions each having two vertical lengthwise opposed inset grooves, fastening means which secure each of said vertical mullions to the said framework in outboard relation;

a plurality of rectangular normally flat sheets each being engaged along opposed vertical sides thereof in adjacent grooves of adjacent vertical mullions, and being inwardly bowed between its said opposed vertical sides;

a plurality of vertical surface elements secured to said framework midway between said vertical mullions;

the width of each of said flat sheets being greater than the length of a smooth, concave arc whose ends terminate in the bottoms of the inset grooves of adjacent vertical mullions and which is tangent to said vertical surface elements at a point midway between said vertical mullions whereby each of said flat sheets is in abutment along its vertical center line with at least one of said vertical surface elements and is flattened along its vertical center line out of the natural bowed configuration which the sheet would assume in the absence of said abutment;

and at least one fastener extended through each of the said flat sheets at a point on its vertical center line into said vertical surface element.

2. A wall construction for a building having a structural framework, comprising:

a metal inner sheath assembled from aligned sections of generally flat metal sheets secured to the said framework in outboard relation;

a plurality of Z-bars secured to said framework in horizontal outboard relation to the said metal inner sheath;

a plurality of spaced vertical mullions secured to said Z-bars in outboard relation and having two lengthwise opposed inset grooves;

a plurality of rectangular normally flat sheets each being engaged along opposed vertical sides thereof in adjacent grooves of adjacent vertical mullions and being inwardly bowed between its said opposed vertical sides;

the width of each of said flat sheets being greater than the length of a smooth, concave arc whose ends terminate in the bottoms of the inset grooves of adjacent vertical mullions and which is tangent to said Z-bars at a point midway between said vertical mullions whereby each of said flat sheets is in abutment along its vertical center line with at least one of said Z-bars and is flattened along its vertical center line out of the natural bowed configuration which the sheet would assume in the absence of said abutment;

and at least one fastener extended through each of said flat sheets at a point on its vertical centerline into one of said Z-bars.

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