

[54] ACOUSTICALLY ABSORBENT SHEET
METAL STRUCTURAL BUILDING UNITS

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[58] Field of Search 52/671, 673, 674, 675,
52/334, 735, 144, 145; 181/33 G; 98/40 D,
31, 32

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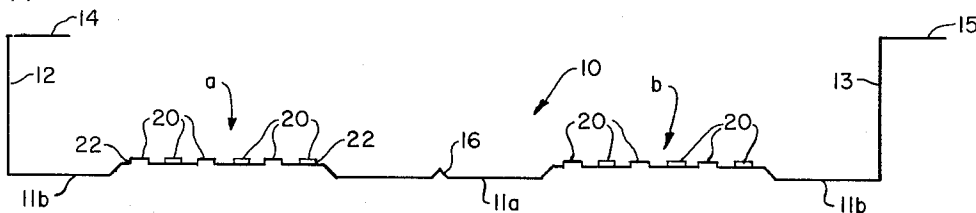
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Primary Examiner—John E. Murtagh
Attorney, Agent, or Firm—Harry B. Keck; George E.
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[57] ABSTRACT

Corrugated sheet metal structural building elements are provided which have a tension flange and a compression flange. A multiplicity of offset segments is provided in that portion of the compression flange. The offset segments are provided in plural, parallel ribbons and are formed by deforming a segment of the sheet metal between a pair of parallel slits.

7 Claims, 17 Drawing Figures



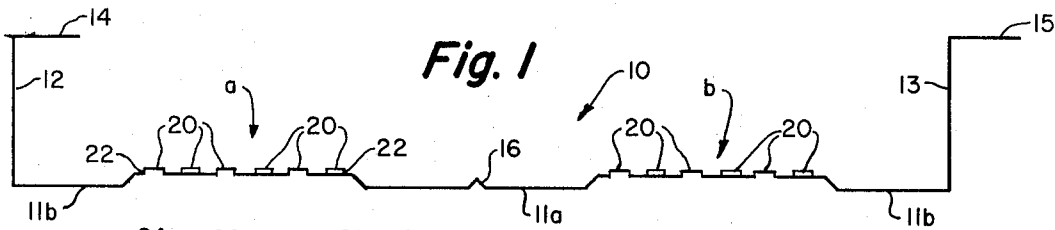


Fig. 1

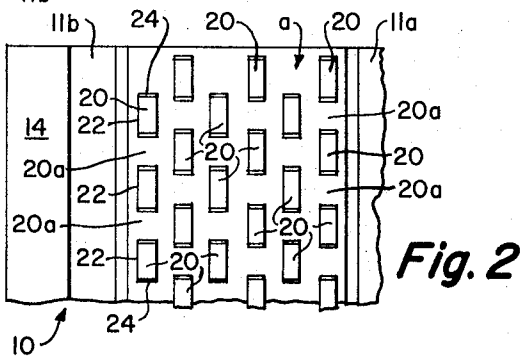


Fig. 2

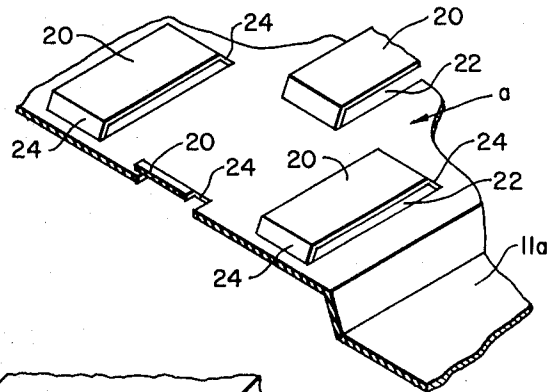


Fig. 3

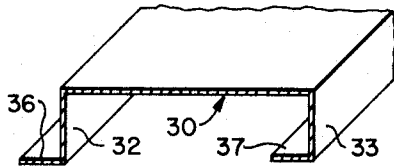


Fig. 4

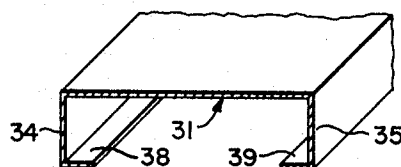


Fig. 5

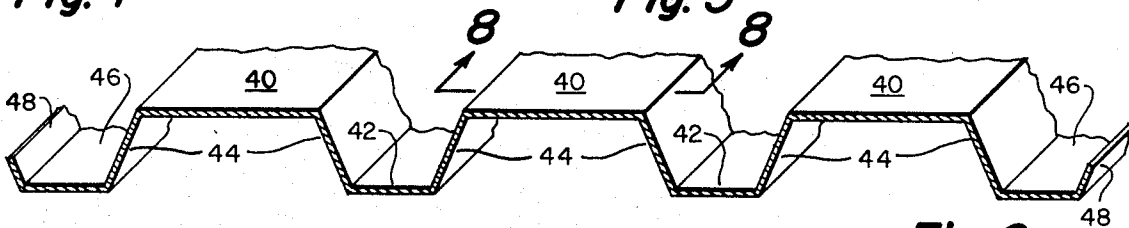


Fig. 6

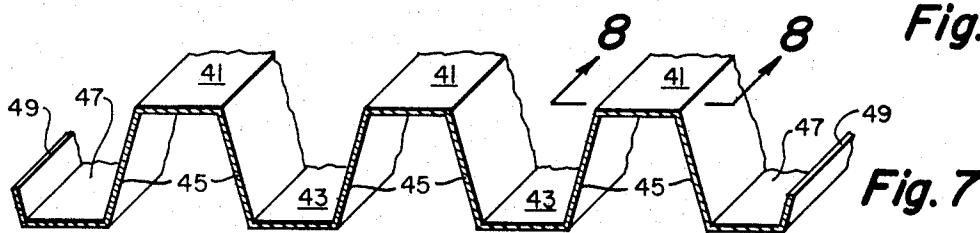


Fig. 7

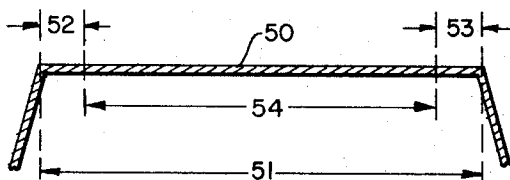


Fig. 8

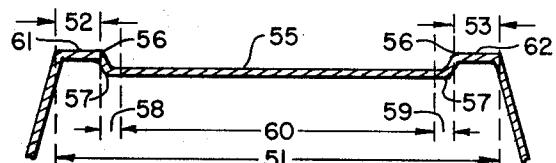


Fig. 9

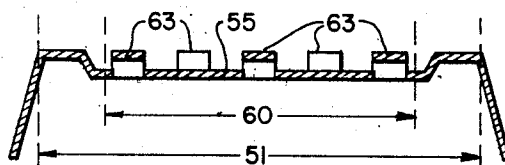
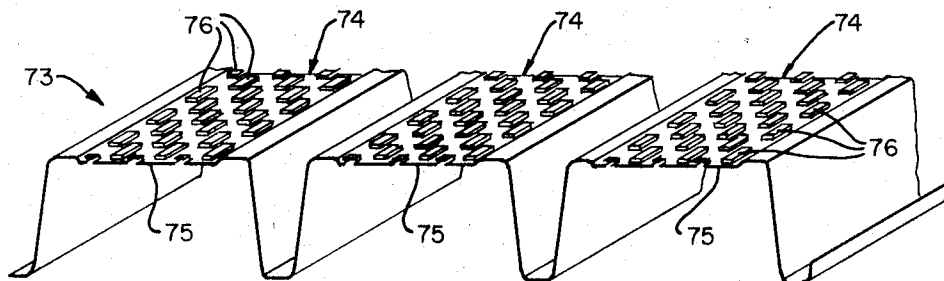
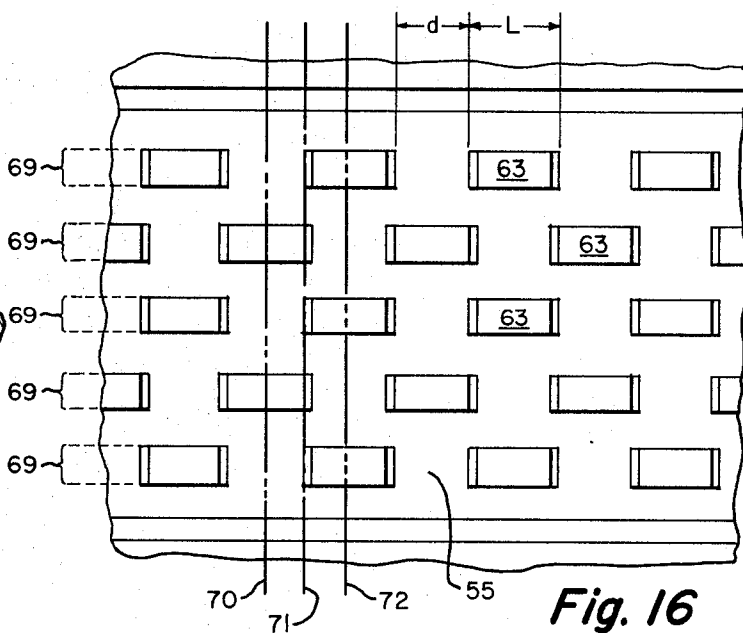
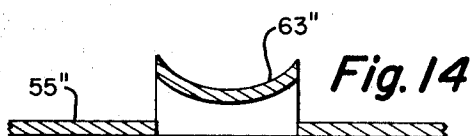
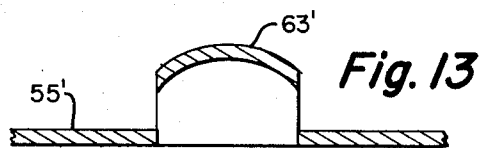
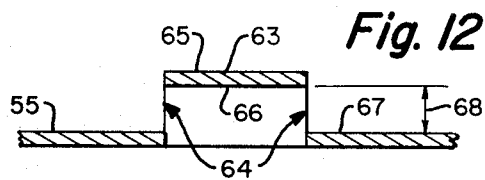
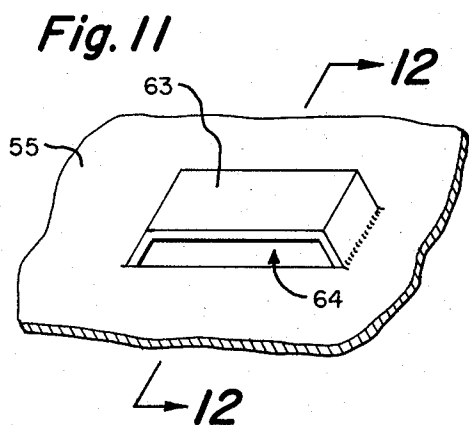


Fig. 10



ACOUSTICALLY ABSORBENT SHEET METAL STRUCTURAL BUILDING UNITS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to sheet metal building units and more particularly to roofing and wall construction components. Specifically the invention concerns corrugated sheet metal roof deck and inner wall sheathing elements which are employed in double sheathing wall construction.

The invention is further related to structural sheet metal building units which are adapted to absorb acoustical energy originating within the building. All such structural sheet metal building units have at least one compression flange.

2. Description of the Prior Art

Prior art sheet metal building units have been provided with perforations distributed in patterns over their exposed surfaces including the compression flange of structural units to absorb acoustic energy which originates within the building. Introducing such perforations greatly increases the cost of the sheet metal units and significantly reduces the load bearing capacity of the resulting units.

SUMMARY OF THE INVENTION

The present invention provides a plurality of offset segments in certain portions of the compression flange of the sheet metal building units which introduce acoustic absorbing capability. The offset segments increase the spanning capabilities of the sheet metal units. Specifically the offset segments are presented solely in the ineffective strips of the compression flanges. The offset segments are struckout preferably in a direction away from the source of acoustical energy which the units are intended to absorb.

In calculating the load bearing capability of a structural sheet metal unit, certain design standards are currently accepted, as set forth by the American Iron and Steel Institute in a book entitled SPECIFICATIONS FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS, 1968. According to the A.I.S.I. code only a fraction of the sheet metal which appears in the compression flange may be credited in calculation of the strength properties of the member. This fraction of the total width of the compression flange is identified as the effective width of the flange. The difference between the actual compression flange width and the effective width may be characterized as the ineffective width of the compression flange. In any sheet metal structural building unit there is a strip of effective metal along the entire length of the compression flange; likewise there is at least one strip of ineffective metal along the entire length of the compression flange. The offset segments are provided in a plurality of parallel, spaced-apart ribbons extending lengthwise along the ineffective strips. Each individual offset segment is formed between a pair of parallel slits which are cut into the sheet metal in the ineffective strip. Each offset segment is deformed from the level of sheet metal whereby both surfaces of the offset segment are presented on the same side of the sheet metal strip. Preferably the distance between the rear surface of the offset segment and the sheet metal is from one to three metal thicknesses. In a preferred embodiment of the invention the offset segments are provided with a con-

cave cross sectional profile to improve the acoustical absorbing properties of the sheet.

When applied to any sheathing element for double wall building sheathings, the invention is applied to a formed sheet which is commonly referred to as a 'tray' unit, and which comprises a flat rectangular base, known as a compression flange; two parallel side walls extending in the same direction one from each longitudinal edge of the base; one side wall having a flange which extends inwardly over the base, and the other side wall having a flange which extends outwardly away from the base. The width of such tray elements may be selected as a convenient construction module and the length thereof may be commensurate with handling capabilities.

When applied to roof decking units, the elements have a plurality of alternating coplanar crests and coplanar valleys joined together by sloping webs. The crests constitute the compression flanges; the valleys constitute the tension flanges. In roof decking, the acoustical absorption offset segments are provided in the crest elements which constitute the compression flange.

Importantly the compression flanges are initially formed with coplanar edge ribbons and with at least one medial strip which is offset from the coplanar edge ribbons. The medial strip is formed predominantly from the sheet metal of the ineffective strip, and preferably coincides with the ineffective strip.

The offset segments have individually a length which is greater than the segment-to-segment spacing in each ribbon. The offset segments preferably are arranged in a staggered disposition so that all perpendicular transverse lines across the compression flange include at least one offset segment. This feature achieves added spanning capabilities. Also this feature introduces an aesthetically attractive appearance to the acoustic offset segments. The feature further permits relatively inexpensive forming of the offset segments by a slitting and drawing process.

The resulting building units have effective sound absorbing qualities when compared with those acoustical decking and sheathing units of the prior art which achieve acoustic absorbing properties from perforations in the sheet metal. The present building units have increased spanning capability when compared with similar acoustically absorbing units which utilize perforated sheet metal.

A further advantage of the sheet metal units of this invention is the elimination of pillowing and oil-canning in the resulting wall surfaces. Still further because the sheet metal units of this invention are produced by slitting and drawing operations, the manufacturing cost of the present units is significantly lower than the manufacturing costs of similar units fabricated from perforated sheet metal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic end elevation of a sheet metal building inner wall or roof sheathing element according to this invention.

FIG. 2 is a fragmentary plan view of the sheathing element of FIG. 1.

FIG. 3 is a fragmentary perspective view showing several offset segments.

FIGS. 4 and 5 are fragmentary perspective illustrations of typical sheet metal sheathing elements.

FIGS. 6 and 7 are fragmentary illustrations of typical sheet metal roof decking elements.

FIG. 8 is a cross sectional illustration of a compression flange of a sheet metal building element.

FIG. 9 is a cross sectional illustration of a compression flange of a building element having an offset medial strip.

FIG. 10 is a cross sectional illustration of a compression flange of FIG. 9 with an offset medial strip including plural offset segments according to the present invention.

FIG. 11 is a perspective illustration of a fragment of a sheet metal building unit showing one embodiment of the offset segment.

FIG. 12 is a cross sectional illustration taken along the line 12—12 of FIG. 11.

FIGS. 13 and 14 are cross sectional illustrations similar to FIG. 12 showing alternative constructions of the offset segments.

FIG. 15 is a perspective illustration of a fragment of a metal sheet having an offset segment of the type illustrated in FIG. 14.

FIG. 16 is a plan view of a fragment of a compression flange illustrating certain properties of the offset segments.

FIG. 17 is a perspective illustration of a fragment of a roof decking unit according to the invention.

Referring to FIGS. 4 and 5, typical sheet metal building elements include a central compression flange 30 and 31; upstanding side walls 32, 33 and 34, 35; and generally parallel flanges 36, 37 and 38, 39.

The roof decking units of FIGS. 6 and 7 are similar in that each contains three crests 40, 41; two intermediate valleys 42, 43; and generally sloping webs 44, 45. The roof decking units also contain lateral valleys 46, 47 and fragmentary end webs 48, 49.

The crests 40, 41 constitute the compression flanges of the roof decking units in FIGS. 6 and 7 as they are presented. The essential difference between the roof decking elements of FIG. 6 and FIG. 7 is in the relative widths of the crests 40, 41 and valleys 42, 43 and in the angle of inclination of the sloping webs 44, 45.

The compression flanges 30, 31, 40, 41 of the sheet metal building units of FIGS. 4, 5, 6, 7 can be illustrated schematically as shown in FIG. 8 wherein the compression flange 50 has a width 51. According to the A.I.S.I. code, only a fraction of the width 51 may be considered as "effective" metal when calculating the structural properties of the sheet metal unit. That effective metal extends for a calculated distance 52, 53 inwardly from the corners which define the limits of the compression flange 50. Accordingly the distance 54 is the "ineffective" width of the compression flange 50.

As a first feature of the present invention, an offset medial strip 55 is provided as shown in FIG. 9. The compression flange has the same width 51 and has the same effective width strips 52, 53. The offset medial strip 55 presents two stiffening bends 56, 57 along each side which serve to increase the amount of effective metal by an increment indicated at 58, 59. As a consequence, the ineffective metal remaining in the compression flange of FIG. 9 is reduced to the width 60. The compression flange of FIG. 9 is now comprised of the medial strip 55 which includes the ineffective metal 60 and also comprised of two ribbons 61, 62 which include the effective metal.

As shown in FIG. 10, the present offset segments, identified by the numeral 63, are provided in the medial strip 55 which includes the ineffective strip 60. The offset segments are better shown in FIG. 11. The preferred offset segments 63 are formed by a slit-and-draw operation in which a portion of the sheet metal between the pair of slits 64 is drawn out of the plane of the medial strip 55. The offset segment 63 has two surfaces 65, 66. Both of the surfaces 65, 66 are drawn out to the same side of the medial strip 55. The spacing between the surface 66, nearest the medial strip 55 and the adjacent surface 67 of the medial strip 55 is preferably from one to three metal thicknesses. This spacing is indicated at 68 in FIG. 12. The width of the offset segments is preferably at least two times the metal thickness.

There is a tendency for the offset segments to develop a rounded configuration as shown in FIG. 13 wherein the offset segment 63' presents a concave surface to the medial strip 55'. Such concave configurations are not preferred. Instead the preferred offset segment configuration is shown in FIG. 14 and 15 wherein the offset segment 63'' presents a convex surface to the medial strip 55''. The concave arcuate cross section of the offset segment 63'' tends to improve the acoustical absorbing properties of the resulting structure.

Referring to FIG. 16, it will be observed that the length of the offset segments indicated by L is greater than the segment-to-segment spacing between the offset segments in the same row, indicated by d.

So long as L is greater than d, the desired stiffening of the resulting structural building unit is achieved.

The arrangement of the offset segments is such that any transverse line, e.g., 70, 71, 72, will intercept at least one and preferably at least two of the offset segments. Alternatively stated, no transverse line will encounter flat sheet metal only which might serve as a hinge axis to admit localized flexure of the compression flange.

It will be observed, FIG. 16, that the offset segments 63 are presented in plural parallel ribbons 69. The spacing between the ribbons 69 is preferably about the same as the width of the ribbons 69. The number of offset segments 63 and the amount of their offset from the medial strip 55 is determined to provide cumulative aperture area corresponding to 10 to 15 percent of the total area covered by the structural unit. By providing 10 to 15 percent aperture area, acoustical energy absorption is optimized.

As shown in FIG. 17, a roof decking unit 73 has three compression flanges 74, each having an offset medial strip 75 containing plural ribbons of offset segments 76.

The disposition of the offset segments within the medial strip of ineffective metal somewhat unexpectedly increases the spanning capability of the resulting building unit. This is particularly so in comparison with prior art acoustical absorbing building units which employ plural perforations. In general, plural perforations in sheet metal building elements reduces the spanning capability by about 10 percent. The present offset segments do not decrease the spanning capability, but instead actually increase the spanning capability.

Referring now to the particular embodiments shown in FIGS. 1, 2, 3, an inner sheathing element 10 is fabricated from mild steel sheet having a thickness of 0.75 to 1.25 millimeters. The element 10 has a profiled shape including a rectangular base 11 and side walls 12,

13 with a flange 14 extending inwardly over the base 11 from the side wall 12 and a flange 15 extending outwardly from the side wall 13 away from the base 11. Preferably the undersurface of the flange 15 is coplanar with the upper surface of the flange 14 so that the elements can be assembled in overlapping relation with an adjoining element.

The base 11 includes two longitudinally extending areas *a*, *b*. Intermediate strip 11*a* and lateral strips 11*b* are coplanar valleys whereas the strips *a*, *b* comprise coplanar crests or compression flanges. A stiffening rib 16 may be provided in the intermediate strip 11*a* if desired.

In each of the compression flanges *a*, *b* there is a multiplicity of the rectangular offset segments 20 which are also illustrated in FIGS. 2 and 3. Each of the offset portions 20 is defined by a pair of parallel slits 22. The offset segments 20 have sloping end portions 24 which merge into the sheet metal *a*. Preferably the offset segments 20 are formed by slitting and drawing operations.

The staggered pattern of the offset segments shown in FIG. 2 provides an offset segment 20 in registry with a space 20*a* in the adjacent row.

In a typical element 10 having a base width of 600 millimeters, the crests *a*, *b* may be about 90 millimeters in width. The crests *a*, *b* may be offset from the valleys 11 by about 5 millimeters. Accordingly the offset segments 20 may be upset by a distance of about 2 millimeters.

The introduction of the multiplicity of offset segments 20 minimizes the oil-canning and pillowing of the sheet metal. By providing the offset segments 20 in the elevated position shown in FIG. 1, they serve as spacer elements for sound insulation material which is subsequently laid within the tray 10.

The presentation of the offset segments 20 in the manner shown in FIG. 1 tends to minimize the tendency for the slit openings of the unit to become blinded by subsequent painting of the undersurface of the tray elements 10.

The offset segments in FIGS. 16 and 17 are all shown to be disposed on the same side of the surface of the medial strip. It is possible within the scope of the invention to provide some offset segments drawn on one side and other segments drawn on the other side of the medial strip.

The horizontal liner trays as shown in FIG. 1 have a length up to about 13 meters, preferably about 10 meters, to admit single-span assembly in use. The width is about 15 to 90 centimeters, preferably about 45 to 75 centimeters. The depth of the units, i.e., the dimension of the side walls 12, 13 is 2 to 20 centimeters, preferably 3 to 12 centimeters. The tray units are fabricated from steel sheets having a thickness from 16 to 26 gauge, preferably from 18 to 22 gauge.

Acoustical roof decking as shown in FIG. 17 has a

length up to about 13 meters, preferably up to about 10 meters. For roof decking, double spanning or even triple spanning is preferred. The unit width should be as wide as available steel sheet will permit, preferable from 60 to 120 centimeters. The units have a depth from about 3 to 20 centimeters, preferably from 5 to 10 centimeters. The units are fabricated from steel sheet having a thickness of 16 to 26 gauge, preferably from 18 to 24 gauge.

I claim:

1. An acoustically absorbent sheet metal building unit adapted particularly to use as a horizontal liner tray, said unit having a base and a pair of perpendicular side walls, each having a parallel flange extending at right angles, one of which passes over the said base and the other of which passes away from the said base, said base including at least one medial strip which is offset from said base in the direction of said side walls, and plural offset segments provided solely in said medial strip and presented in the direction away from the said base and toward the said flanges.

2. The acoustically absorbent sheet metal building unit of claim 1 wherein the offset segments have a length which is greater than the segment-to-segment spacing.

3. An acoustically absorbent sheet metal building unit according to claim 1 wherein the offset segments are arranged so that a transverse line cutting across the compression flange perpendicularly to the length of the flange will intercept at least one offset segment.

4. An acoustically absorbent sheet metal building unit according to claim 1 wherein the said offset segments are drawn apart from the surface of the medial strip by a distance which is one to three metal thicknesses.

5. An acoustical absorbent sheet metal building unit according to claim 1 wherein the cumulative area of the apertures provided in the compression flange equals 10 to 15 percent of the total covering area of the building unit.

6. An acoustically absorbent sheet metal building unit according to claim 1 wherein the said medial strip is comprised of sheet metal which is not effective metal as defined in the A.I.S.I. code.

7. An acoustically absorbent sheet metal building unit having at least one compression flange including coplanar edge ribbons and at least one medial strip which is offset from the plane of the edge ribbons, a plurality of offset segments arranged in plural parallel ribbons and provided solely within the said medial strip, each offset segment consisting of that portion of sheet metal disposed between a pair of lengthwise slits, each offset segment having its sides spaced apart from the surface of the said medial strip, said offset segments having an arcuate configuration which is convex toward the surface of the said medial strip.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,861,493

DATED : January 21, 1975

INVENTOR(S) : Harold James William Payne

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Cover page, item [30]: Change "010532/72"
to --- 010523/72 ---.

Signed and Sealed this
thirtieth **Day of** *March* 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT AND TRADEMARK OFFICE
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