Aug. 30, 1932. C. F. WILLIAMS 1,875,188

UNIT FORMED OF SHEET MATERIAL

Filed Jan. 27, 1932 3 Sheets-Sheet 1

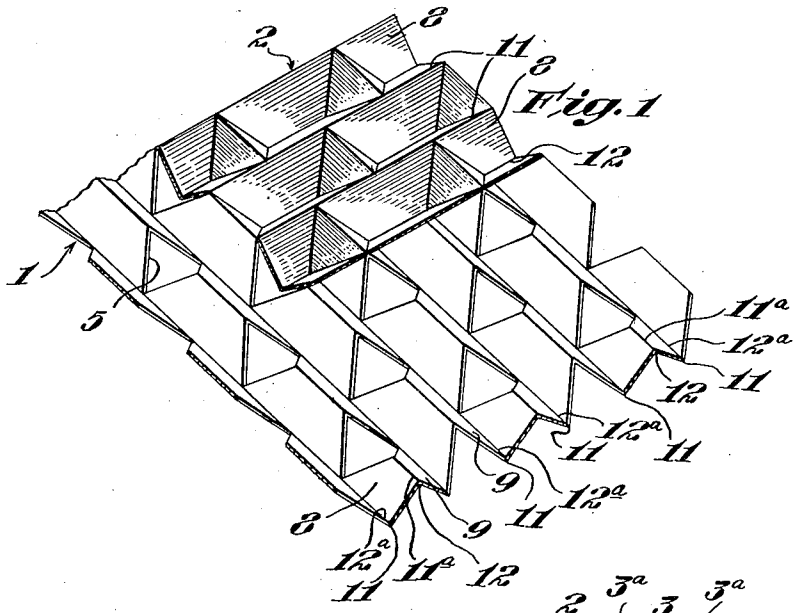

Fig. 1

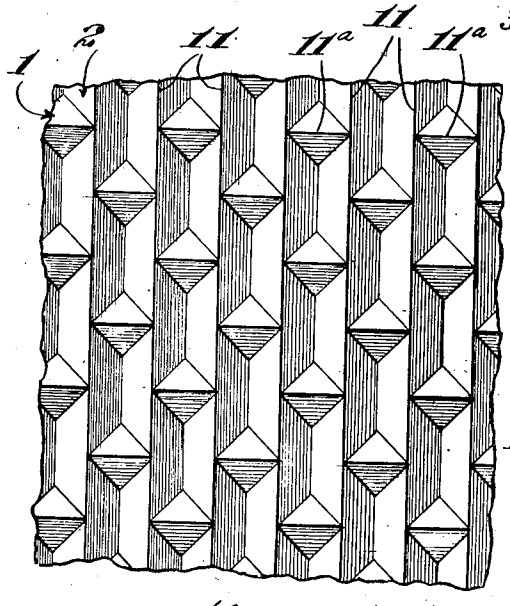

Fig. 2

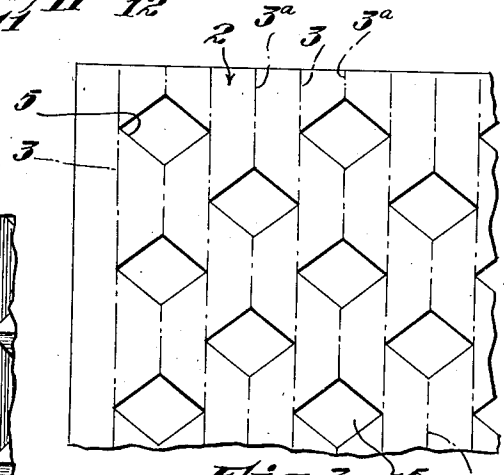

Fig. 3

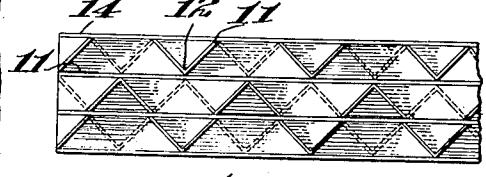

Fig. 4

Inventor
Charles F. Williams,
by Pollock, Ashman & Woodling
Attys.

Aug. 30, 1932. C. F. WILLIAMS 1,875,188

UNIT FORMED OF SHEET MATERIAL

Filed Jan. 27, 1932 3 Sheets-Sheet 2

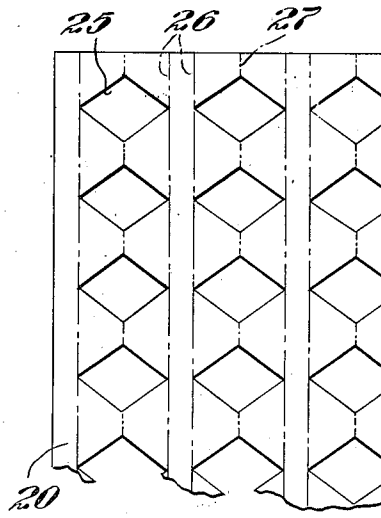

Fig. 5

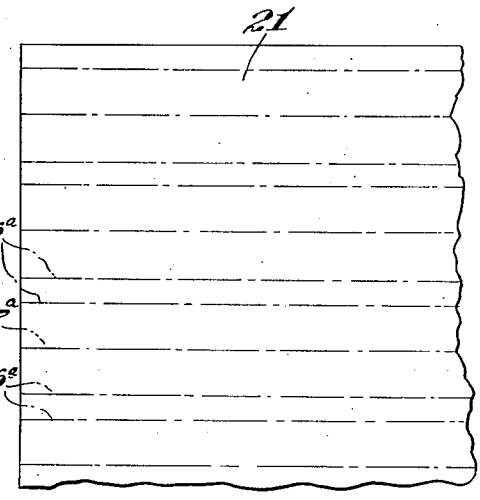

Fig. 6

Fig. 7

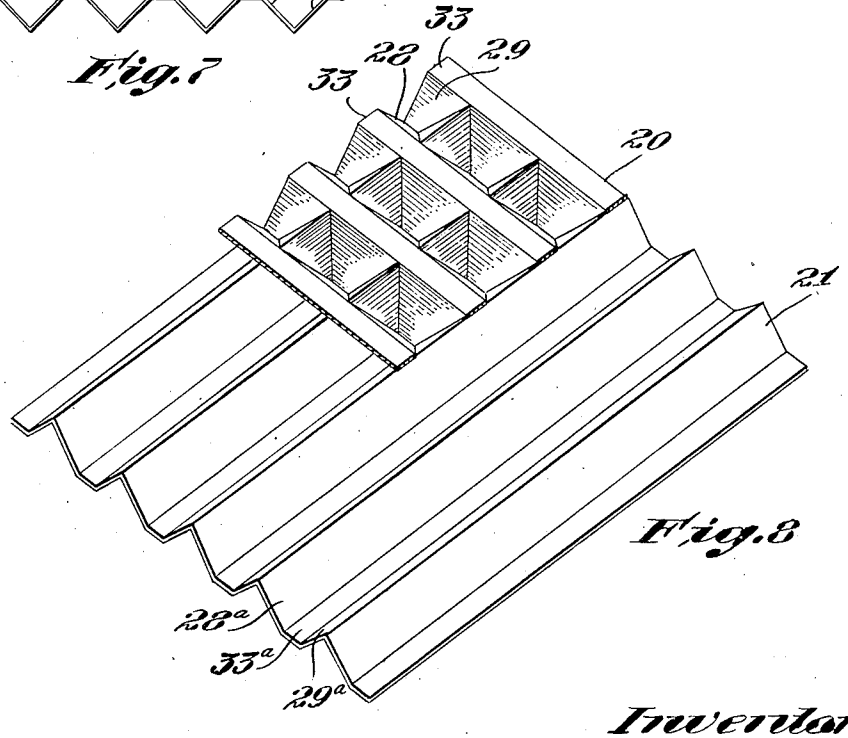

Fig. 8

Inventor
Charles F. Williams,
by Roberts, Cushman & Woodberry.
Atty's.

Aug. 30, 1932. C. F. WILLIAMS 1,875,188

UNIT FORMED OF SHEET MATERIAL

Filed Jan. 27, 1932 3 Sheets-Sheet 3

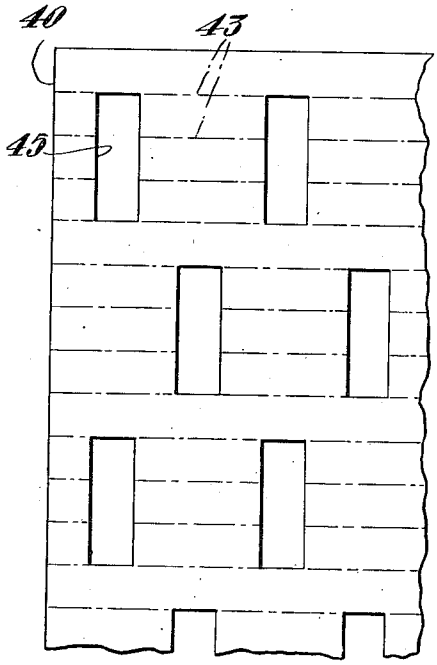

Fig. 9

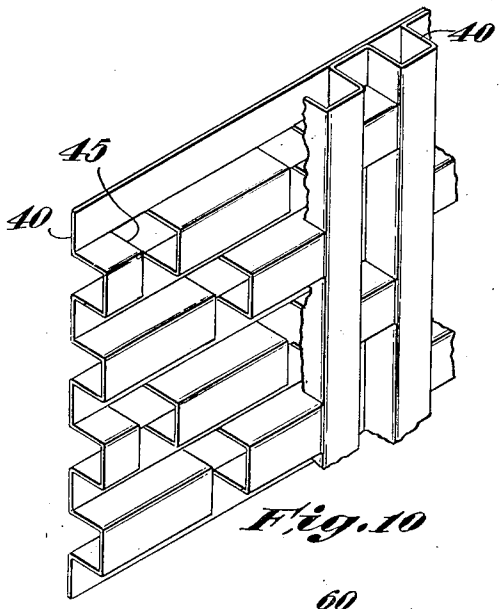

Fig. 10

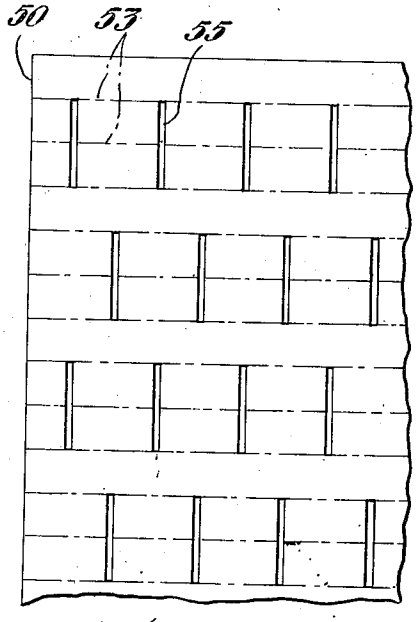

Fig. 11

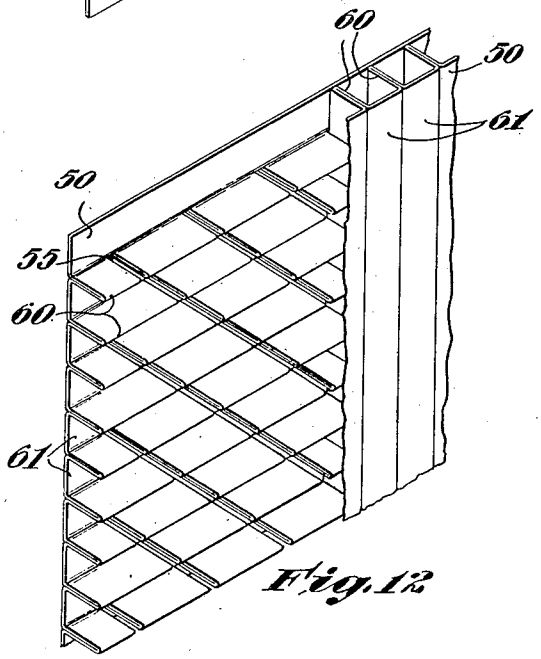

Fig. 12

Inventor
Charles F. Williams
by Roberts, Cushman & Woodbury
Attys.

Patented Aug. 30, 1932

1,875,188

UNITED STATES PATENT OFFICE

CHARLES F. WILLIAMS, OF BELMONT, MASSACHUSETTS, ASSIGNOR TO SHERMAN PRODUCTS CORPORATION, OF SOUTH BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

UNIT FORMED OF SHEET MATERIAL

Application filed January 27, 1932. Serial No. 589,234.

This invention relates to units formed of sheet material, such for example as paper, and preferably arranged with interlocked ribs to provide a plurality of closed air cells.

In accordance with this invention, a sheet element may have a plurality of folded or bent-out ribs or ridges, these ribs being notched for interlocking engagement with similar ribs upon a second sheet element, the elements cooperating to provide numerous enclosed cells or chambers, which may be substantially hermetically sealed. In certain embodiments of the invention a plane sheet may be secured to the back of the unit to cooperate with the recesses provided by ribs in order to afford additional cells. In some cases the plane sheet may be formed of material having high ability to reflect radiant heat, aluminum foil being preferred for this purpose.

The sheet elements may be secured together in any desired manner; for example, a suitable agglutinant such as an ordinary animal glue may be employed at the contacting portions of the sheets, or the sheet elements may be dipped in a suitable adhesive and/or protective coating such as melted paraffine and then pressed into adhesive engagement. The specific form of the sheet elements and bent-out ridges may vary considerably. For example, I may employ sheet elements which are provided with portions bent at an angle to each other, alternate portions being in substantial parallelism so that a plurality of parallel ridges and elongate recesses are provided. Before or after the sheet element is thus bent, a plurality of openings, for example of substantially diamond shape, may be suitably formed in the element or blank for interengagement with ridge portions of the other cooperating sheet element, which may have the same general form. The sheet elements are then disposed with their ridged portions or ribs extending transversely of each other and in interfitting engagement so that small closed chambers or air cells are provided between the cooperating bent-out portions of the sheets. The elongate channels or recesses of one unit are interrupted by the ribs of the other unit, so that there need be no continuous channel to permit convection currents of air.

Units of this type particularly having plane sheets of heat reflective material secured thereto may be advantageously employed for heat insulating purposes. When the units are exposed to considerable moisture, they are preferably treated by a coating of paraffine or the like to render the individual sheet elements substantially water resistant. While these units have particular utility for heat insulating purposes, the arrangement of the crossed ribs in interfitting engagement permits the employment of relatively thin and light sheet stock to afford a sheet unit which is relatively strong and stiff, and yet which is very light in weight, and accordingly which may have utility for a wide variety of purposes.

In the accompanying drawings:

Fig. 1 is a broken isometric view of a portion of a sheet unit constructed in accordance with this invention;

Fig. 2 is a top plan view of a portion of the unit shown in Fig. 1;

Fig. 3 is a top plan view of a portion of a blank from which the unit of Fig. 1 is formed, the fold lines being indicated in dot and dash lines;

Fig. 4 is an end elevation showing the arrangement of a plurality of the units in an insulatng assembly, such as may be employed in a hollow insulating wall;

Figs. 5 and 6 are plan views of blanks employed in forming an optional sheet unit;

Fig. 7 is an elevation of the edge of the blank shown in Fig. 5;

Fig. 8 is a broken isometric view of a unit constructed of the blanks shown in Figs. 5 and 6;

Fig. 9 is a top plan view of another type of blank;

Fig. 10 is a broken isometric view of a sheet unit constructed of blanks such as shown in Fig. 9;

Fig. 11 is a plan view of another type of blank; and

Fig. 12 is a broken isometric view showing a unit formed of blanks such as that illustrated in Fig. 11.

Referring to the accompanying drawings, and first more particularly to Figs. 1, 2, 3 and 4, it is evident that a sheet unit may be formed of similar sheet elements or suitably shaped blanks 1 and 2. As shown in Fig. 3, the blank 2 may be provided with a plurality of parallel fold lines 3 and 3*a*, diamond-shaped openings 5 being disposed with their longer diagonals transversely to the fold lines and extending between alternate pairs of lines 3, so that a plurality of rows of openings are provided, each opening being spaced transversely of the fold lines from the next opening at a distance corresponding to two spaces between fold lines, and each opening having its shorter diagonal in alignment with one of the fold lines 3*a*. Openings in rows extending transversely of the blank are spaced vertically of the sheet (as viewed in Fig. 3), so that fold lines 3 may be juxtaposed to the corners of alternate openings extending in opposite directions from that line, and so that the fold lines 3*a* are interrupted by the central portions of these openings.

Both the blanks 1 and 2 may be formed in the same general manner with openings 5 and may be folded along lines 3 and 3*a* to provide oppositely inclined sections 8 and 9 in respective parallelism, these adjoining sections being substantially at right angles to each other. The blanks are thus provided with sections 8 and 9, which are parallel to each other, each section 9 being substantially at right angles to the adjoining sections 8. Thus the sections 8 and 9 meet to provide ribs 11 and grooves 12 upon one side of the element and respectively corresponding grooves 12*a* and ribs 11*a* upon the opposite side of the sheet. The ribs 11 of each element are formed by folding along the lines 3, and the intermediate recesses 12 are provided by folding along lines 3*a*; while, as viewed from the opposite face of the blank, the recesses 12*a* opposite ribs 11 are afforded by folding along lines 3, and ribs 11*a* opposite recesses 12 are afforded by folding along lines 3*a*. Thus, as viewed from one side, a blank has ribs 11 at the ends of openings 5 and grooves 12 interrupted by said openings, while, as viewed from the other side, the blank has ribs 11*a* interrupted by the openings and recesses 12*a* uninterrupted by said openings.

The blanks are assembled with their ribs in transverse relation to each other, the openings 5 of each blank being in interfitting engagement with the ribs 11*a* of the other blank. The sheets may then be secured to each other in any suitable way as, for example, by an adhesive applied around the edges of the openings 5 or preferably the sheet elements may be coated or impregnated with a protective adhesive, such as melted paraffin, just before they are arranged in interfitting engagement.

Fig. 2 shows a portion of a unit thus formed with transverse rib portions 11*a* and elongate ribs 11, so that each exposed face of the blank comprises a series of elongate ribs 11 with rib portions 11*a* extending therebetween. Intermediate the elements are closed chambers or dead air cells, which are enclosed by the opposite sides of parallel ribs 11 and 11*a*. Each of these air cells may be considered to be of pyramidal form, having an inclined base corresponding to the face 9 of one of the ridges, and three inclined sides, two of which are provided by the mutually inclined sections 8 and 9 of the ridge element extending transversely of the ridge which provides the base surface, and the third of which is provided by the face 8 of an adjoining ridge extending in the same direction as the first-named ridge.

As shown in Fig. 4, a sheet unit as thus provided may have a plane sheet 14 secured to one of its faces so that the mutual ridge portions cooperate with the plane sheet in defining additional air cells, the sides and ends of which are provided by adjoining surfaces of parallel pairs of ribs, and the remaining sides of which are provided by the plane sheet. Such a plane sheet 14 preferably may be formed of material having high ability to reflect radiant heat as, for example, aluminum foil. Obviously several of the units when assembled with face sheets, as shown in Fig. 4, and employed to fill a space as, for example, the hollow walls of a refrigerator, may be effective in defining numerous small chambers containing air. If desired, when a plurality of the units are assembled in contacting relation, as shown in Fig. 4, the sheets 14 may be disposed between the units without adhesive connection thereto.

It is evident that units of the type shown in Fig. 4 provide numerous small air cells which may be entirely closed so that circulation of air by convection is materially impeded and relatively effective insulation is attained in so far as heat conduction is concerned. If heat reflective sheets 14 are also employed, the amount of heat transferred, due to radiant action, may be very low so that a wall employing units arranged in the manner shown in Fig. 4 may have high heat insulating efficiency. Quite aside from the heat insulating effectiveness of units of this type, a unit such as shown in Fig. 2 may be relatively strong, although formed of light material, and if a plane sheet 14 is adhesively secured to the ridges provided by the ribs of the unit, the stiffness of the same is materially increased, providing a surprisingly rigid and sturdy unit, even if relatively light sheet material is employed.

Figs. 5 to 8 illustrate an optional embodiment of the invention. As shown in Fig. 5, a blank 20 may be provided with rows of openings 25, which are aligned both vertically

and transversely of the sheet, with their longer and shorter diagonals mutually aligned and with their corners in spaced relation. Preferably the corners at the ends of the longer diagonals are juxtaposed to fold lines 26, two of which may be provided between each row of openings 25. Intermediate each pair of fold lines 26 there may be a single fold line 27 corresponding to the shorter diagonals of the openings 25.

Fig. 6 illustrates the second blank 21 which may be employed to cooperate with the blank 20 of Fig. 5. This blank 21 may have the same shape as the blank 20 of Fig. 5, with pairs of adjoining fold lines 26*a*, with fold lines 27*a* between each pair of lines 26*a*. The blank 20 may be folded, as shown in Fig. 7, to provide planar portions 33 between adjoining fold lines 26 and to provide mutually inclined sections 28 and 29 between each planar portion 33. The blank 21 may be folded in a similar manner to have planar portions 33*a* providing the aligned outer surfaces of parallel ribs with respectively parallel inclined sections 28*a* and 29*a* meeting substantially at right angles therebetween. The blanks 20 and 21 are then secured together with their ribs extending transversely of each other, as shown in Fig. 8, the planar portions 33 of the blank 20 contacting with the ridges between adjoining sections 28*a* and 29*a* of blank 21, the openings 25 permitting these ridges to extend continuously along the unit, as shown in Fig. 8, while the short fold portions provided along the fold lines 27 of element 20 extend transversely of and engage the planar sections 33*a*.

It is evident that the blanks 20 and 21, when thus secured together, enclose numerous air cells or chambers therebetween, which are defined by the opposite faces 28 and 29 of the ribs of the blank 21 and by the adjoining inclined sides 28*a* and 29*a* of the corresponding ribs of blank 20, as well as the connecting planar portions 33 and 33*a*. Furthermore, the side of the unit shown in Fig. 8 provides numerous recesses which may be closed by the application of a plane sheet element to the surfaces 33. The unit shown in Fig. 8 is capable of ready bending in the direction of extent of surfaces 33, while affording relatively high resistance to bending in a transverse direction.

Fig. 9 illustrates a blank which may be employed in another type of sheet unit, this blank 40 being provided with parallel equally spaced fold lines 43 and rows of elongate rectangular openings 45 being disposed between the fold lines in the general manner shown. The blank is then folded along the lines 43, so that adjoining sections are at right angles to each other, thus providing alternate ribs defined by three planar portions, the intermediate portion of each rib being at right angles to the side portions which are parallel to each other and normal to the general plane of the sheet. Two of the units 40, as thus formed, may be assembled, as shown in Fig. 10, with their rib portions crossing each other, and rib portions of each element interfitting with the openings provided in the rib portions of the other unit. Thus an element is provided in which the rib portions enclose substantially cubical chambers and provide rectilinear or prismatic recesses upon each side, which may be closed with a face sheet of aluminum foil or any desired material.

Fig. 11 illustrates a further type of blank 50, which, in the position shown, has parallel fold lines 53 disposed horizontally of the sheet in equally spaced relation to each other. Slots 55 are provided extending between fold lines as shown, these slots being arranged in rows vertically and transversely of the sheet. The sheet element is folded so that the intermediate parts of the slots are disposed at portions of ribs which are provided by bending sheet sections substantially in parallelism upon themselves, as indicated by numeral 60 in Fig. 12. Between these ribs are continuous planar sections 61, so that the unit may be provided with a series of outstanding substantially flat ribs or flanges 61 separated by planar sections 61 in alignment with each other and disposed in the general plane of the sheet. Two similar elements 50 may be employed with their ribs 61 extending transversely of each other, the slotted portions of the ribs of each element or section being in interfitting engagement with the rib portions of the other section.

With this embodiment of the invention a plurality of substantially cubular or prismatic cells are defined and enclosed by the ridge sections and the planar sections 62, so that an entirely enclosed system of cells is provided without necessity for the employment of an additional face sheet. In this form of the invention one of the elements 50 may be formed of heat reflective material or may have a layer of this material secured thereto.

From the foregoing, it is evident that this invention permits the employment of sheet elements formed of flat sheet blanks and folded to provide suitable ribs and recesses, openings being provided in one or both of the blanks, so that the blanks may fit together to enclose certain air cells and to provide recesses, if desired, which may be closed by a face sheet applied to one face of the unit. A unit of this type is relatively stiff and has a wide range of utility, but is particularly suitable for heat insulating purposes, especially when a face sheet of heat reflective material is employed between adjoining units.

I claim:

1. Unit formed of sheet material, comprising a pair of sheet elements, each of said ele-

ments having ribs formed side by side with recesses therebetween, openings in certain of said ribs, the ribs of one of said elements being received in the openings and having their tops engaging recesses of the other element, the elements cooperating to provide closed air chambers.

2. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having substantially parallel folds to provide ribs and recesses upon one side of the element and corresponding recesses and ribs upon the opposite side of the element, certain of the ribs of one element having openings therein, the ribs of the other element extending transversely of the ribs of the first element and through said openings whereby the elements are in interfitting relation.

3. Article of the class described, comprising two sheet elements, each element being provided with a plurality of folded portions affording parallel ribs and grooves therebetween, the ribs of each element extending transversely to the ribs of the other element, notches being formed in certain of the ribs of one element to receive the ribs of the other element, whereby a plurality of air cells are defined by the ribs and grooves.

4. Article of the class described comprising a pair of sheet elements, each having parallel ridges and grooves formed therein, the ridges of one element extending transversely of the ridges of the other element, said ridges being notched and the tops of the ridges of one element being juxtaposed to the grooves of the other element, whereby a plurality of substantially enclosed air cells are provided.

5. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having ribs formed side by side with grooves therebetween, openings in certain of said ribs, the ribs of one of said elements being received in the openings and having their tops engaging the grooves of the other element, the elements cooperating to provide closed air chambers and outer recesses, and a face sheet secured to one side of one element, the elements and sheet being adhesively connected.

6. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having parallel folds to provide ribs and grooves upon one side of the element and corresponding grooves and ribs upon the opposite side of the element, certain of the ribs upon one element having openings therein, the ribs upon the other element extending transversely of the ribs of the first element and through said openings, whereby the elements are in interfitting relation, the ribs cooperating to provide recesses, and a face sheet of high ability to reflect radiant heat, secured over the recesses to afford substantially closed chambers.

7. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having parallel folds to provide ribs and grooves upon one side of the element and corresponding grooves and ribs upon the opposite side of the element, certain of the ribs upon one element having openings therein, the ribs upon the other element extending transversely of the ribs of the first element and through said openings whereby the elements are in interfitting relation, the elements cooperating to provide closed chambers therebetween and outer recesses between pairs of opposite ribs, and a face sheet disposed over the ribs to close said recesses.

8. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having ribs formed side by side with grooves therebetween, openings in certain of said ribs, the ribs of one of said elements being received in the openings and having their tops engaging the grooves of the other element, the elements cooperating to provide closed air chambers and outer recesses, and a face sheet of aluminum foil mounted over the recesses at one side of the unit to provide closed chambers.

9. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having ribs formed side by side with grooves therebetween, openings in certain of said ribs, the ribs of one of said elements being received in the openings and having their tops engaging the grooves of the other element, the elements cooperating to provide closed air chambers, said elements being formed of fibrous material and treated with a protective agent which adhesively holds them together.

10. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having ribs substantially parallel to each other with oppositely inclined surfaces, alternate surfaces being substantially parallel, said elements having openings disposed in rows along certain ribs, the ribs of one element extending transversely of the ribs of the other element and being received in said openings, the elements cooperating to enclose air chambers of substantially pyramidal shape therebetween and providing recesses on each side between oppositely inclined surfaces of pairs of parallel ridges.

11. Unit formed of sheet material comprising a pair of sheet elements, each of said elements being bent in opposite directions along parallel fold lines to provide sets of alternate substantially parallel sections, adjoining sections being at an angle to each other, substantially diamond-shaped openings with one pair of corners juxtaposed to the alternate parallel fold lines, said openings interrupting intermediate fold lines, said fold lines affording substantially continuous ridges on one side of a sheet element and interrupted rib portions upon its oppo-

site side, the first-named ridges of one element extending through the openings between rib portions of the other element.

12. Unit formed of sheet elements comprising a pair of sheet elements, each of said elements being folded to afford substantially parallel ribs and recesses upon one side and comprising corresponding recesses and ribs respectively upon its other side, the ribs upon one side of each element being characterized by planar outer portions with opposite inclined side sections, the ribs upon the other side being formed by the meeting of said inclined sections to provide ridges, one of said elements having a row of openings between said planar portions thus interrupting its ridges to provide separate ridge portions, the ridges of the other element extending transversely through said openings and engaging planar portions of the element having the openings, said last-named element having its ridge portions engaging planar portions of the other element.

13. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements being folded to provide alternate sections in parallelism to each other and disposed in two parallel planes, alternate sections being connected by sections at right angles thereto, each side of the element thus being provided with parallel ribs with planar outer faces and parallel planar sides, the ribs upon one side of each element having openings therein, the elements being secured together with their ribs in interfitting engagement so that the ribs of one element are received in the openings of the other element, the elements cooperating in enclosing air chambers therebetween and in providing prismatic recesses upon each side of the unit.

14. Unit formed of sheet material, comprising a pair of sheet elements each of said elements having aligned planar sections with parallel ribs substantially at right angles thereto afforded by folding the material back upon itself between said aligned sections, the ribs having slots therein, the elements being secured in interfitting relation with the ribs of one element extending through the openings in ribs of the element and juxtaposed to the planar sections of said element, whereby a plurality of air chambers are provided between the elements.

15. Unit formed of sheet material, comprising a pair of sheet elements, each of said elements having ribs substantially parallel to each other with oppositely inclined surfaces, alternate surfaces being substantially parallel, said elements having openings disposed in rows along certain ribs, the ribs of one element extending transversely of the ribs of the other element and being received in said openings, the elements cooperating to enclose air chambers of substantially pyramidal shape therebetween and providing recesses on each side between oppositely inclined surfaces of pairs of parallel ridges, and a face sheet secured over the recesses at one side of the unit.

Signed by me at Boston, Massachusetts, this 26th day of January, 1932.

CHARLES F. WILLIAMS.