

METHOD OF MANUFACTURING ELEVATED FLOOR PANEL

This invention relates generally to elevated floor panels adapted to be supported at their corners, and more particularly to a novel and improved method for producing such elevated floor panels.

5 Various elevated floor panels are formed by combining a substantially planar sheet metal cover member with a lower or base sheet metal member which has been subjected to die drawing operations to provide an array of projections which extend from the lower surface of the
10 panel to the upper cover member. Such panels provide a beamlike structure in which the cover and base are interconnected at relatively closely spaced intervals to provide a strong, substantially rigid structure. Examples of such floor panels are illustrated in United
15 States Letters Patents Nos. 3,011,602; 3,876,492; and 4,411,121.

 It is also known to provide panels with a face or lower sheet metal member which is die drawn to provide
25 projections each having a shape which is substantially a square, truncated pyramid. Such pyramids are welded along their upper surfaces to the upper or cover sheet. Such panels are often filled with cementitious material or the like, and in other instances, such panels are hollow. Such prior art panels, which have been marketed
25 by us, are die-formed so that the height of the truncated pyramids is greater along the periphery but is less along the central portions of the panels. This arrangement, in which the truncated pyramid projections have less depth along the central portions of the panel, is
30 provided to eliminate problems encountered when attempting to make draws of greater height. Because the depth of the truncated pyramids is reduced along the

central portion of the panel, some reduction of strength and rigidity results.

The present invention is concerned to provide an improved method for producing elevated floor panels.

5 Thus, in accordance with the method of this invention, a lower or base sheet metal member is die-drawn in two operations to provide an array of projections extending the full distance between the plane of the lower panel face and the plane of the upper panel
10 face. During the first drawing operation, projections of intermediate height are formed in such a manner that a relatively large, central portion of the metal forming each of the intermediate projections is substantially unworked.

15 More particularly, the present invention provides a method of producing a sheet metal elevated floor panel having an upper sheet and a lower sheet wherein the lower sheet provides an array of projections extending to the upper sheet, comprising in a first
20 operation drawing in said lower sheet preliminary projections to an intermediate depth by stretching a first portion of said sheet metal while leaving a second portion substantially adjacent to said first portion substantially unworked, and subsequently drawing said
25 second portion to increase the depth of said projections.

 Thereafter, in a second drawing operation, such unworked central portions are drawn to form projections extending beyond the intermediate height to provide the required full projection height. Because the two
30 separate drawing operations are each performed on metal, which prior to the drawing operations is substantially unworked, and because each draw is to a height less than

the required total height, satisfactory drawing operations can be reliably performed and projections of greater height are possible.

Further, because the total thickness of the resultant panel can be uniformly maintained, a stronger, more rigid panel can be produced from a given thickness of material.

In the illustrated embodiment of this invention, described in detail hereafter, a base sheet of metal is die-drawn to form an array of projections of intermediate height having a shape of a square, truncated pyramid. The upper surface of each pyramid provides a substantially square central portion which is substantially unworked. Such unworked metal is subsequently drawn to form four symmetrically arranged, generally semispherical projections having a flattened upper surface.

A cover member or a sheet is then welded to the flattened upper surfaces of the semispherical projections. In some instances, the panels are filled with lightweight concrete material or like settable material. However, such panels can also be used without such filling material.

In the illustrated embodiment, the first drawing operation produces 25 truncated pyramids arranged in rows of five having a height of about 0.75 inch (1.9 cm). The second drawing operation produces 100 semispherical projections about 0.5 inch (1.27 cm) high. Consequently, the total height of the projections is about 1.25 inch (3.2 cm). Because the individual drawing operations are of lesser depth, they can be produced reliably with less difficulty. Further, each

of the projections is connected to the cover sheet by a spot weld so that the cover sheet and the base sheet are interconnected at relatively closely spaced intervals to provide good stress transfer between the two metal parts
5 and good support for the cover sheet.

Further, the combined structural shapes of the projections efficiently function to provide effective stress transfer. The upper spherical projections cooperate to form an upper beam system which is rigid
10 and provides substantial strength. Such upper beam system efficiently transfers stresses from the cover to the upper portions of the truncated pyramids. Such stresses are then supported by the lower beam system provided by the truncated pyramid array. These two beam
15 systems combine to provide a very rigid and strong panel which maximizes the efficient use of the material forming the panel.

In instances in which the panel is filled with a cementitious material or the like settable material,
20 such material extends between the spherical projections and provides a support intermediate the weld which reduces any tendency for dimpling to occur when concentrated loads are applied to the cover sheet. Further, such structure provides improved sound deadening
25 characteristics.

With the present invention, it is possible to produce an improved, elevated floor panel which is stronger and more rigid for a given amount of material required for the production of the panels and to achieve
30 the die drawing operations in a reliable manner without difficulty.

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a panel
5 produced according to this invention;

FIG. 2 is a plan view of the base member of the panel, illustrating the arrangement of the projections formed therein;

FIG. 3 is an enlarged, fragmentary section of a
10 concrete-filled panel taken along line 3-3 of FIG. 1, and illustrating the shape of the projections;

FIG. 4 is an enlarged, fragmentary section, similar to FIG. 3 illustrating a panel that does not include a cementitious filler; and

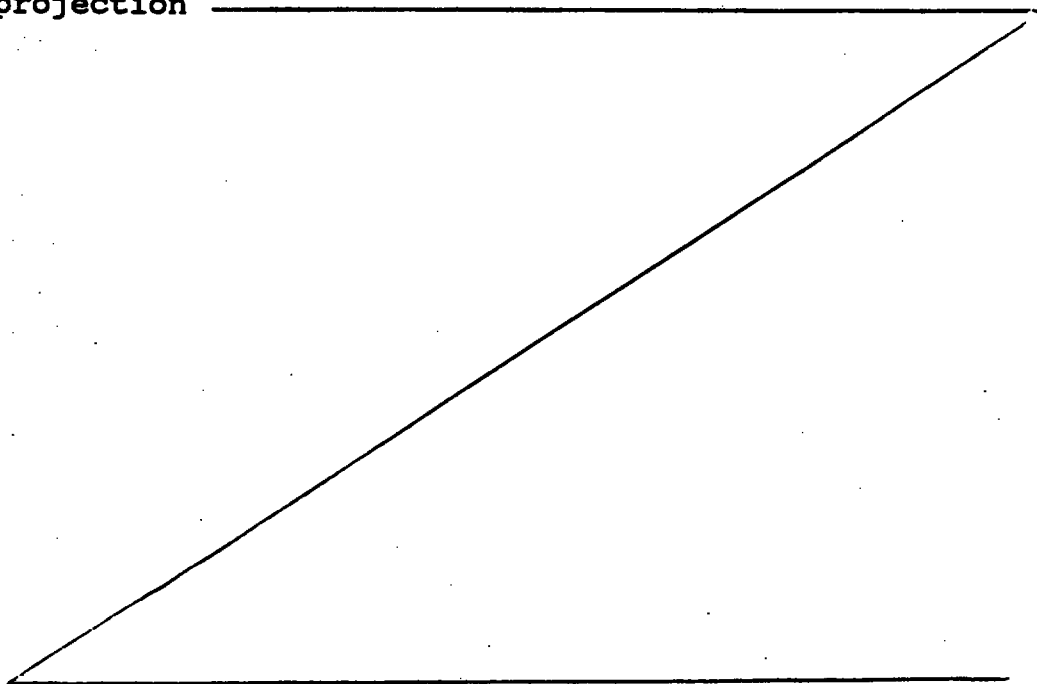
15 FIG. 5 is a fragmentary section illustrating the base sheet member at the completion of the first drawing operation before the spherical projections are produced by a second drawing operation.

FIG. 1 illustrates a typical elevated floor
20 panel 10 produced according to the present invention. Such panel is adapted to be supported at its corners on pedestals (not illustrated) and assembled in an array to provide a floor system spaced from the base floor system of a building. The illustrated panel 10 includes an
25 upper cover sheet 11 and a base sheet 12 which are welded along the periphery of the panel at 13 to provide a unitary structure. In some embodiments of this invention, the panel is filled with a lightweight cementitious material 14 illustrated in FIG. 3.
30 However, it is also within the scope of this invention to

form a panel which is hollow and consists only of the upper and lower sheets 11 and 12.

Referring to FIGS. 2 through 5, the base sheet 12 is formed with a plurality of compound projections 16. In the illustrated embodiment, the panel 10 is square and provided with 25 compound projections 16 arranged in an array of perpendicularly extending rows, with each row containing 5 compound projections. It should be understood that the number of rows and the number of projections in each row is not critical to the present invention.

Each of the compound projections 16 includes a lower truncated pyramid portion 17 which extend from a plane 18 extending along the lower side of the panel to an intermediate plane 19. Extending from the intermediate plane 19, each compound projection provides four symmetrically arranged, generally semispherical projection portions 21. Each of these semispherical projection



portions 21 provides a flattened upper extremity 22 which is coplanar with the flattened surfaces of the other semispherical projection portions. The cover sheet 11, which is a planar member, is welded to each of the flattened extremities 22 by welds 23 so as to produce a unitary structure.

The rows of projections are spaced inwardly from the side edges of the panel to provide a peripheral wall 24 joining the outermost compound projections 16 to an upstanding side wall 26. Such peripheral wall extends along the plane 18 and is spaced from the upper cover sheet 11 by the full depth of the panel. The upper extremity of the side wall 26 is bent at right angles to provide a peripheral flange 27 engaging the lower side of the cover sheet 11 and welded thereto by the weld 13.

In the embodiment of FIG. 3, the cavity defined by the cover sheet 11 and the base sheet 12 is filled with lightweight cementitious material 14. Such material provides the panel with additional rigidity and supports the cover sheet, resisting the tendency for the cover sheet to dent when relatively concentrated loads are applied thereto. Further, the lightweight cementitious material provides a substantial amount of sound deadening along substantially the entire surface of the panel, and thereby reduces the tendency for the panel to emit noise characteristic of metal panels if objects are dropped on the panel. Since the cementitious material 14 provides support for the cover sheet 11, it can be formed of relatively thin material without becoming susceptible to denting and the like. Further, even in the zones where cementitious material does not exist to support the cover sheet, sufficient strength is provided because a

double layer of metal is provided by the flattened extremity 22 in combination with the cover sheet 11.

FIG. 4 illustrates a second embodiment in which the panel is unfilled and remains hollow. In such embodiment, the base sheet is formed in the identical manner as the base sheet of the first embodiment. However, in this embodiment, the cover sheet 12a is of thicker gauge so as to provide the necessary resistance to denting under concentrated loads. In both embodiments, however, the cover sheet and the base sheet are interconnected at relatively closely spaced intervals so that good support is provided for the cover sheet along its entire surface and a cooperative beam system is established to provide a high degree of rigidity. Because the welds 23 are located at closely spaced intervals along the entire panel, at 100 locations in the illustrated embodiment, sufficient interconnection is provided to produce good stress transfer between the cover sheet and the base sheet for high strength and rigidity.

Further, because the compound projections are formed with curved surfaces, the tendency for the metal to buckle or bend in localized areas is greatly diminished. It should be noted that in FIG. 2, which illustrates the arrangement of the array of projections, even the corners 31 of the truncated pyramid portions are rounded to minimize sharp corners which could produce problems in the forming of the projections, and which could create localized stress conditions which could result in buckling and the like.

The compound projections 16 in the base sheet are formed in sequential drawing operations. At the

completion of the first drawing operation, the base sheet is provided with 25 projections arranged in rows of 5, in which each projection is in the shape of a square, truncated pyramid 17. The upper surface 33 of such pyramids 32 is flat and substantially unworked during the first drawing operation. During the forming operation in which the truncated pyramids 17 are produced, the metal of the side wall 34 is stretched beyond its elastic limit and is thinned to some extent. Further, such metal tends to be work-hardened. Preferably, the angle of the side walls 34 is selected so that such side walls are sloped to a substantial extent. This ensures that a substantial amount of metal is available for the drawing operation in which the side walls 34 are formed. The lower ends of the side walls 34 are formed with ample radius so that a smooth transition is provided between the material at the base 36 of the side walls 26 and also to retain a substantial amount of metal between the projections at the lower plane 18. In the illustrated embodiment, the total depth of the panel is about 1-1/4 inches, and the height of the truncated pyramids is about 3/4 inch. Therefore, the upper surface 33 of each pyramid extends along the intermediate plane 19 spaced from the plane 18 by about 3/4 inch. Those skilled in the art will recognize that the drawing of the metal to produce the truncated pyramids can be performed reliably without great difficulty because such draw is relatively shallow.

During a second drawing operation, the material of the upper surface 33 of each truncated pyramid which is substantially unworked during the first drawing operation is subsequently drawn in dies to form the substantially semispherical projecting portions 21 in this illustrated embodiment. Here again, the depth of the

second drawing operation used to form the generally spherical projections 21 is relatively small. In this illustrated embodiment, the spherical projections have a total height of only 1/2 inch. However, the total height of the compound projections 16 is 1-1/4 inches. Therefore, relatively high projections are produced without subjecting the material of the base sheet to deep drawing operations. Because the metal which is drawn during the second operation is substantially unworked during the first drawing operation, the second drawing operation is performed on substantially virgin material which has not been previously work-hardened.

Further, with the two drawing operations, better control of the stretching of the metal is provided because a large area of metal is not being drawn during a given drawing operation.

Because each of the compound projections extends the full distance between the lower plane 18 and the plane of the upper sheet 11, the panel has a good moment of inertia and the ability to support substantial loads on the upper surface of the panel with a minimum amount of deflection. Because the outermost rows of the compound projections are spaced from the side walls 26, a substantial amount of metal is provided at the upper and lower surfaces of the panel to support edge loading of the panel where the greatest stresses occur for a given load on the panel. In the illustrated embodiment, the semispherical projections are shaped so that the lower extremities of the adjacent portions of their side walls 37 are in substantial alignment with the side walls 34 of the truncated pyramid portion of the compound projection. Therefore, the curved portions 31 at the corners of the truncated pyramids blend into the associated portions of the side walls 37 of the spherical projections.

Because the compound projections provide compound curves, as mentioned above, there is very little tendency for the material forming the compound projections to buckle under loading conditions.

Further, the semispherical projections 21 cooperate with the cover sheet 12 or 12a to provide an upper beam system shaped to provide for the effective support of the cover 12 or 12a and to transfer stress to the upper extremity of the truncated pyramids. Such upper beam system includes compound curved surfaces provided by the semispherical projections themselves and the portion 41 of the surface 33 which remains in the plane 19 after the second drawing operation. Such portion 41 is spaced from and is substantially parallel to the cover 12 and cooperates therewith to provide an upper beam system at the upper extremity of each compound projection 16 which is strong and rigid. Therefore, the upper beam system efficiently transfers stress to the upper extremities of the truncated pyramids 17.

The truncated pyramids cooperate to provide a lower beam system which combines with the upper beam system to provide a combined beam system of substantial depth for supporting the loads applied to the covers 12 or 12a. Because these beam systems cooperate to provide a combined beam system of full panel depth over the entire panel, higher loads can be satisfactorily supported for a given amount of material forming the panel.

With the present invention, it is possible to reliably produce an improved panel having a high degree of rigidity with metal of minimum thickness so that the material cost of producing the panel is minimized.

CLAIMS:

1. A method of producing a sheet metal elevated floor panel having an upper sheet and a lower sheet wherein the lower sheet provides an array of projections extending to the upper sheet, comprising in a first operation drawing in said lower sheet preliminary projections to an intermediate depth by stretching a first portion of said sheet metal while leaving a second portion substantially adjacent to said first portion substantially unworked, and subsequently drawing said second portion to increase the depth of said projections.

2. A method as set forth in Claim 1, wherein the depth of said projections is increased by a substantial extent by said subsequent drawing operation.

3. A method as set forth in Claim 2, wherein said intermediate depth is about 0.75 inch (1.9 cm) and the final depth of said projections after said subsequent drawing operation is about 1.25 inch (3.2 cm).

4. A method as set forth in any preceding claim, wherein said first portion is substantially unworked during said subsequent drawing operation.

5. A method as set forth in any preceding claim, wherein said first operation is performed so that said first portion of said lower sheet is substantially annular and said second portion is located within said first portion at the extremity of said preliminary projections.

6. A method as set forth in any preceding claim, wherein said subsequent drawing produces a plurality of separate secondary projections extending beyond each said preliminary projection.



7. A method as set forth in any preceding claim, wherein said preliminary projections are formed as truncated pyramids.

8. A method as set forth in any preceding claim, wherein said secondary projections are symmetrically arranged along the top of said preliminary projections.

9. A method as set forth in any preceding claim, wherein said secondary projections are substantially semispherical.

10. A method of producing an elevated floor panel with a sheet metal upper sheet and a sheet metal lower sheet connected to said upper sheet by an array of projections, comprising die drawing said lower sheet to produce an array of preliminary projections of intermediate height by stretching a portion of the metal of said lower sheet to provide inclined side walls of said preliminary projections and leaving a second portion of said lower sheet adjacent said first portion substantially unworked, and thereafter die forming said lower sheet to increase the depth of said projections by stretching said second portions without substantially reworking said first portions, and thereafter connecting the extremities of said projections to said upper sheet.

11. A method as set forth in Claim 10, including welding said projections to said upper sheet to provide said connection.

12. A method as set forth in Claim 10 or Claim 11, wherein the depth of said projections is increased by a substantial extent by said stretching of said second portions.



13. A method as set forth in any one of Claims 10-12, wherein said preliminary projections are formed as square truncated pyramids arranged in an array of rows extending perpendicular to each other and said second portions are located at the extremity of said preliminary projections.

14. A method as set forth in any one of Claims 10-13, wherein said stretching of said second portions produces a plurality of separate secondary projections extending beyond each said preliminary projection.

15. A method as set forth in Claim 14, including deforming a plurality of substantially semispherical projections in said second portions.

16. A method as set forth in Claim 15, including forming said substantially semispherical projections with flattened portions at the extremities thereof.

17. A method as set forth in any one of Claims 10-16, including connecting said upper and lower sheets to define a cavity therebetween, and filling the cavity between said upper and lower sheets with a settable material.

18. A method as set forth in Claim 17, wherein said settable material is a cementitious material.

19. A rectangular sheet metal elevated floor panel having upper and lower spaced apart surfaces, comprising a base sheet and a cover sheet, said base sheet providing an array of lower projections of a predetermined size, said base sheet also providing an array of upper projections extending from the extremities



of said lower projections having a size less than said predetermined size, the upper extremities of said upper projections being connected to said cover sheet, said upper projections in combination with said cover sheet forming a beam system operable to transfer stress from said cover sheet to said lower projections and distribute said stress over said lower projections, and said upper and lower projections cooperating with said cover sheet to provide a composite beam system of substantial depth operable to support loads applied to said cover sheet; said floor panel having been produced by a method as set forth in Claim 1 or Claim 10.

20. A floor panel as set forth in Claim 19, wherein said lower projections are truncated and provide inclined walls of substantially uniform thickness, and a plurality of upper projections on each of said lower projections extending from the upper extremity thereof, said upper projections also being provided with inclined walls of substantially uniform thickness.

21. A floor panel as set forth in Claim 20, wherein said lower projections are substantially square truncated pyramids.

22. A floor panel as set forth in Claim 21, wherein said upper projections are generally semispherical in shape and are provided with flattened extremities engaging said cover sheet and welded thereto.

23. A floor panel as set forth in Claim 22, wherein said base sheet and cover sheet cooperate to define a cavity therebetween, and said cavity is filled at least in part with a sound deadening material.



* C L M S *

24. A floor panel as set forth in Claim 23, wherein said cavity is filled with a cementitious material.

25. A rectangular sheet metal floor panel having upper and lower surfaces extending along upper and lower spaced-apart planes and being adapted to be supported at its corners, comprising a base sheet and a cover sheet, said base sheet providing an array of truncated pyramids extending from said lower plane to an intermediate plane and a plurality of generally semispherical projections extending from each truncated pyramid at said intermediate plane to an upper extremity in said upper plane, said cover sheet being welded to the upper extremities of said projections, and said base and cover sheets cooperating to provide a beam system operable to support loads applied to the surface of said cover sheet; said floor panel having been produced by a method as set forth in Claim 1 or Claim 10.

26. A method of producing a sheet metal elevated floor panel, substantially as hereinbefore described with reference to Figs. 1, 2, 4 and 5 or to Figs. 1-3 and 5 of the accompanying drawings.

