



BOARD RACK AND MANUFACTURING METHOD THEREFOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a board rack for holding semiconductor circuit boards for environmental testing, by inserting the boards in vertically arranged slots and applying power to the boards through electrical connectors of the testing apparatus.

Description of the Related Art

Current examples of board racks include a type based on a cubic frame structure having a central opening in each of the six frame surfaces, and a series of parallel guide rails fixed on left and right walls for inserting the test boards into the rack. In this type of board rack structure, rods are used as the primary building component for the frame, and after assembling the frame by welding, the guide rails are attached on the inside of the four welded columns. Therefore, the manufacturing process is cumbersome and the rack is susceptible to misalignment during the welding process, leading to difficulty in maintaining dimensional tolerances required for reliable testing. Also, because the building components are rods, the frame tends to be fairly heavy and testing productivity are affected.

Therefore, there has been a need for a board rack of a different structure, and a new manufacturing method that enables to overcome such production problems so that a light weight board rack of high dimensional precision can be produced with a relatively simple manufacturing process that involves a minimum of welding steps.

SUMMARY OF THE INVENTION



It is an object of the present invention to provide a light weight board rack of high dimensional precision that can be produced with a relatively simple manufacturing process involving a minimum of welding steps. It is also an object of the present invention to provide a method for making such a board rack.

The object has been achieved in a board rack structure comprising: a cubical frame member, including four hollow support columns, four side openings, a top opening, and a bottom opening; a plurality of protrusions, extending towards an interior space of the cubical frame member, formed integrally on each of the four hollow support columns; and guide rail members bridging between front protrusions and back protrusions and joined to opposing pairs of front protrusions and back protrusions.

The board rack structure enables to provide a high dimensional accuracy because the frames are made by a process of punching out components from a single sheet of material, in contrast to conventional methods based on welding of components. Compared with the conventional design of racks, the present racks require lesser number of welding steps, thus enabling to reduce expensive welding labor cost. The frames are made of hollow components so that the overall weight of the frames can be reduced to facilitate production and handling. Also, the cost of manufacturing can be reduced by using a single thickness of sheet for all the components compared with the case of production involving materials of different thickness for different components.

A method for making the board rack (comprised of: a main frame component having a rectangular-shaped front section including a central opening, a rectangular-shaped bottom section including a central opening, and a rectangular-shaped back section including a central opening, laid out in continuous series on a strip pattern, and having protrusions integrally extending from left and right outer peripheral sections, or from left and right inner peripheral sections of the front section and the back section; a subframe component of a



rectangular shape, serving as a ceiling component for the main frame component; and guide rail components for attaching to the protrusions so as to extend from front to back, where, in the main frame component, a fold line section extends longitudinally on each of longitudinal peripheral sections associated with the front section, bottom section and the back section, and another fold line section extends transversely on each of two transverse peripheral sections associated with the top section and the back section while, in the subframe component, a fold line section, extends in each of four peripheral sections;) comprises the steps of: (a) forming vertical hollow support members of the main frame component by twice folding each of fold line sections of the front section and back section of the main frame component at right angles along two longitudinal parallel fold lines, forming bottom hollow support members by folding each of fold line sections of the bottom section along longitudinal parallel fold lines; and forming horizontal hollow top support members by twice folding each of the fold line sections of the front section and the back section at right angles along two transverse parallel fold lines; (b) forming horizontal hollow support members by twice folding each of the fold line sections of the subframe component at right angles along two parallel fold lines; (c) uprighting the front section and the back section at right angles with respect to the bottom section along a respective transverse fold line; (d) attaching the subframe component to horizontal top support members of the front section and the back section of the main frame component; and (e) suspending guide rail components between pairs of front protrusions and back protrusions extending inwards, and joining the guide rail components to the front protrusions and to the back protrusions so as to extend from front to back.

According to the method presented above, the rack is divided into a main frame component, a subframe component and the guide rail components so that each of the components can be produced by relatively simple forming processes. The formed components are subsequently joined together by welding only where welding is essential for strength and structural integrity. The overall process is efficient as well as economical.



A variation in the basic method for making the board rack (comprised of: a main frame component having a rectangular-shaped front section including a central opening, a rectangular-shaped bottom section including a central opening, and a rectangular-shaped back section including a central opening, laid out in continuous series on a strip pattern, and having protrusions integrally extending from left and right outer peripheral sections, or from left and right inner peripheral sections of the front section and the back section; two angle pipe components, serving as a top support component for the main frame component; and guide rail components for attaching to the protrusions so as to extend from front to back, where, in the main frame component, a fold line section extends longitudinally on each of longitudinal peripheral sections associated with the front section, bottom section and the back section, and another fold line section extends transversely on each of two transverse peripheral sections associated with the top section and the back section while, in the subframe component, a fold line section, extends in each of four peripheral sections;) comprises the steps of: (a) forming vertical hollow support members of the main frame component by twice folding each of fold line sections of the front section and back section of the main frame component at right angles along two longitudinal parallel fold lines, forming bottom hollow support members by folding each of fold line sections of the bottom section along longitudinal parallel fold lines; and forming horizontal hollow top support members by twice folding each of the fold line sections of the front section and the back section at right angles along two transverse parallel fold lines; (b) uprighting the front section and the back section at right angles with respect to the bottom section along a respective transverse fold line; (c) attaching the two angle pipes between top horizontal support members of the front section and the back section of the main frame component; and (d) suspending the guide rail components between pairs of front protrusion and back protrusion extending inwards, and joining the guide rail components to the front protrusions and to the back protrusions so as to extend from front to back.



According to a variation of the basic method, the same advantages for the basic method are accrued as well as an added advantage of process simplicity derived from using ready made angle pipes for part of the components while retaining the same degree of structural strength of the overall rack, and minimum number of welded joints.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an unfolded view of a main frame pattern in a first embodiment.

Figure 2 is an unfolded view of a subframe pattern in a second embodiment.

Figure 3 is a perspective view of an assembled board rack.

Figure 4 is a cross sectional view seen through a plane A-A in Figure 3.

Figure 5 is a cross sectional view seen through a plane B-B in Figure 3.

Figure 6 is an unfolded view of a main frame pattern in a second embodiment.

Figure 7A and 7B are examples of a guide rail shape.

Figure 8 is a perspective view of an assembled board rack based on another embodiment of the subframe.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments will be presented with reference to Figures 1 to 8.

A first embodiment is shown in Figure 1. A unit pattern for frame 1 is made by a suitable process such as press punching, and comprises a front section 2, a bottom section 3 and a back section 4, all of which sections are joined together in a single pattern, but is marked by fold lines 5, 6 extending transversely on both longitudinal ends of the bottom section 3. In the center region of the front, back and bottom sections 2, 3 and 4, there is a respective open section 7, 8 or 9, respectively.



On left and right longitudinal peripheral sections of the bottom section 3, two fold lines 10, 11 are provided to extend in the longitudinal direction so that bottom section support members can be produced by folding at right angles twice along each of the fold lines 10, 11. To assure that, when the bottom section support members are folded into position, the end portions of the fold lines 10, 11 will meet with the other support members without interfering with each other, the end sections of the fold line 10 are inclined at 45 degrees towards the end sections of the fold line 11.

Similar to the case of the bottom section 3, transverse fold lines 12, 13 are provided at both peripheral sections of the front and back sections 2, 4, so that horizontal support members can be produced by folding twice at right angles along each of the fold lines 12, 13. To assure that, when the horizontal support members are folded into position, the end portions of the fold lines 12, 13 will meet with the other support members without interfering with each other, the end sections of the fold line 12 are inclined inwards at 45 degrees.

In the center region of the transverse peripheral sections, two holes 14, 15 are fabricated. These holes 14, 15 are for positioning the board rack in the environmental test tank, but they can also be utilized for locating the main frame with respect to the subframe for welding.

As shown in Figure 1, on the left and right longitudinal peripheral sections of the front section 2 and back section 4, a series of equidistantly spaced protrusions 16, extending in the transverse direction of the rack pattern, are formed by press punching and other such process, symmetrically about a longitudinal center line of the rack pattern. The left and right peripheral sections, two parallel fold lines 17, 18 are provided so that support members (hollow columns) can be formed by folding twice at right angles along each of the fold lines 17, 18. Therefore, those sections which lie outside of the reference line 19, provided



between the protrusions 16 and fold line 18, will be protruding inwardly in an assembled board rack.

To assure that, when the support columns are folded into position, the ends of the fold lines 17, 18 will meet with the support members formed on the bottom section 3 without interfering with each other, the end sections of the fold line 17 are inclined at 45 degrees towards the end sections of the fold line 18. Similarly, to assure that, when the support columns are folded into position, the end portions of the fold line 18, and the reference line 19 will meet with the support members formed by the fold lines 12, 13 without interfering with each other, the end sections of the fold line 18 not adjacent to the bottom section 3 are inclined at 45 degrees towards the end sections of the reference line 19. The protrusions 16 may also be placed directly on the reference line 19.

Figure 2 shows a pattern for the subframe 20 to serve as a ceiling section of the board rack. The subframe 20 is provided with an opening section 22 in the central region, and has a unit frame construction with support members produced by fold sections formed at its four peripheries. Each of the fold sections has two parallel fold lines 21, 23 so that, horizontal support members can be produced by folding twice at right angles along each of the fold lines 21, 23. To assure that, the end portions of the fold line 23 will meet without interfering when the support members are folded in position, the end sections of the fold line 23 are inclined inward at 45 degrees. The subframe 20 is also provided with a positioning hole 25 for locating it to be joined to the main frame 1.

Assembling steps for the board rack will be explained next. The pattern for the frame 1, shown in Figures 1, is folded twice at right angles along the longitudinal fold lines 10, 11, 17, and 18 to produce hollow column members, and along the transverse fold lines 12, 13 to produce horizontal hollow support members. The pattern for the frame 2 shown in



Figure 2 is folded twice at right angles along the fold lines 21 and 23 to produce hollow horizontal support members. Next, with reference to the fold lines 5, 6, the front section 2 and the back section 4 are uprighted, and the contact sections of the horizontal support members of the bottom section 3 to the front section 2 and the back section 4 are joined together by welding.

Next, a subframe 20 is formed into a profile of the horizontal support member shown in Figure 4, and is joined to the main frame 1. In joining the subframe 20 to the main frame 1, they are held in an arrangement shown in Figure 5 to aligning the holes 14, 15 and 25, and are fixed in place by welding.

In an assembled rack, the protrusions 16 protrude inward, and are located behind the front outer surface of the board rack at a distance equal to the dimension of the vertical support column. A guide rail 24, having an L-shaped profile shown in Figure 2, is then inserted into the interior space of the rack so that it is supported on a pair of front and back protrusions 16, and is then fixed to the protrusions 16 by welding. This process is repeated for as many other guide rails 24 as necessary for the board rack to complete the assembling process.

In the above embodiment, an L-shaped guide rail was used, but it is clear that other shapes are equally effective as guide rails. For example, a combination of an asymmetrical U-channel piece with a shorter top piece shown in Figure 7A or, a symmetrical U-channel guide rail, shown in Figure 7B may also be considered.

Figure 6 shows an unfolded pattern of a second embodiment of the board rack. The only difference in the board rack patterns of the first and the second embodiments is that the protrusions 16' in the second design are provided on the peripheral protrusion sections



so as to face the openings 7, 9 of the front section 2 and the back section 4. It should be noted that the length of the guide rail 24, in the second embodiment, must be increased slightly to accommodate an increase in separation distance, because the protrusions 16' are located in the same plane as the outermost surfaces of the board rack.

Also, in the first embodiment, the subframe 20 was made by folding a sheet material, but it is clear that a reduction in weight can also be achieved by using two angle pipes 26 shown in Figure 8 while retaining the same strength of the board rack.

As described above, the board rack of the present invention is advantageous because it is produced as a uniframe structure from a single sheet pattern by such processes as press punching to provide a dimensionally accurate pattern that requires relatively few weld joining. Accordingly, the present method, requiring lower welding labor, is superior to those existing methods for making welded racks. Another advantage of the present board rack is that the support members are hollow so that the rack weight is reduced, facilitating transporting of the rack. Furthermore, because nearly all the components are made from sheet material of one thickness, manufacturing steps are simple and efficient, compared with those processes of forming and cutting involving more than one thickness of sheet material.



What is claimed is:

1. A board rack structure comprising: a cubical frame member, including four hollow support columns, four side openings, a top opening, and a bottom opening; a plurality of protrusions, extending towards an interior space of the cubical frame member, formed integrally on each of said four hollow support columns; and guide rail members bridging between front protrusions and back protrusions and joined to opposing pairs of front protrusions and back protrusions.
2. A method for making a board rack comprised of: a main frame component having a rectangular-shaped front section including a central opening, a rectangular-shaped bottom section including a central opening, and a rectangular-shaped back section including a central opening, laid out in continuous series on a strip pattern, and having protrusions integrally extending from left and right outer peripheral sections, or from left and right inner peripheral sections of said front section and said back section; a subframe component of a rectangular shape, serving as a ceiling component for said main frame component; and guide rail components for attaching to said protrusions so as to extend from front to back, where, in said main frame component, a fold line section extends longitudinally on each of longitudinal peripheral sections associated with said front section, bottom section and said back section, and another fold line section extends transversely on each of two transverse peripheral sections associated with said top section and said back section while, in said subframe component, a fold line section, extends in each of four peripheral sections; said method comprising the steps of:
 - (a) forming vertical hollow support members of said main frame component by twice folding each of fold line sections of said front section and back section of said main frame component at right angles along two longitudinal parallel fold lines, forming bottom hollow support members by folding each of fold line sections of said bottom section along





longitudinal parallel fold lines; and forming horizontal hollow top support members by twice folding each of said fold line sections of said front section and said back section at right angles along two transverse parallel fold lines;

(b) forming horizontal hollow support members by twice folding each of said fold line sections of said subframe component at right angles along two parallel fold lines;

(c) uprighting said front section and said back section at right angles with respect to said bottom section along a respective transverse fold line;

(d) attaching said subframe component to horizontal top support members of said front section and said back section of said main frame component; and

(e) suspending guide rail components between pairs of front protrusions and back protrusions extending inwards, and joining said guide rail components to said front protrusions and to said back protrusions so as to extend from front to back.

3. A method for making a board rack comprised of: a main frame component having a rectangular-shaped front section including a central opening, a rectangular-shaped bottom section including a central opening, and a rectangular-shaped back section including a central opening, laid out in continuous series on a strip pattern, and having protrusions integrally extending from left and right outer peripheral sections, or from left and right inner peripheral sections of said front section and said back section; two angle pipe components, serving as a top support component for said main frame component; and guide rail components for attaching to said protrusions so as to extend from front to back, where, in said main frame component, a fold line section extends longitudinally on each of longitudinal peripheral sections associated with said front section, bottom section and said back section, and another fold line section extends transversely on each of two transverse peripheral sections associated with said top section and said back section while, in said subframe component, a fold line section, extends in each of four peripheral sections; said method comprising the steps of:





(a) forming vertical hollow support members of said main frame component by twice folding each of fold line sections of said front section and back section of said main frame component at right angles along two longitudinal parallel fold lines, forming bottom hollow support members by folding each of fold line sections of said bottom section along longitudinal parallel fold lines; and forming horizontal hollow top support members by twice folding each of said fold line sections of said front section and said back section at right angles along two transverse parallel fold lines;

(b) uprighting said front section and said back section at right angles with respect to said bottom section along a respective transverse fold line;

(c) attaching said two angle pipes between top horizontal support members of said front section and said back section of said main frame component; and

(d) suspending said guide rail components between pairs of front protrusion and back protrusion extending inwards, and joining said guide rail components to said front protrusions and to said back protrusions so as to extend from front to back.

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