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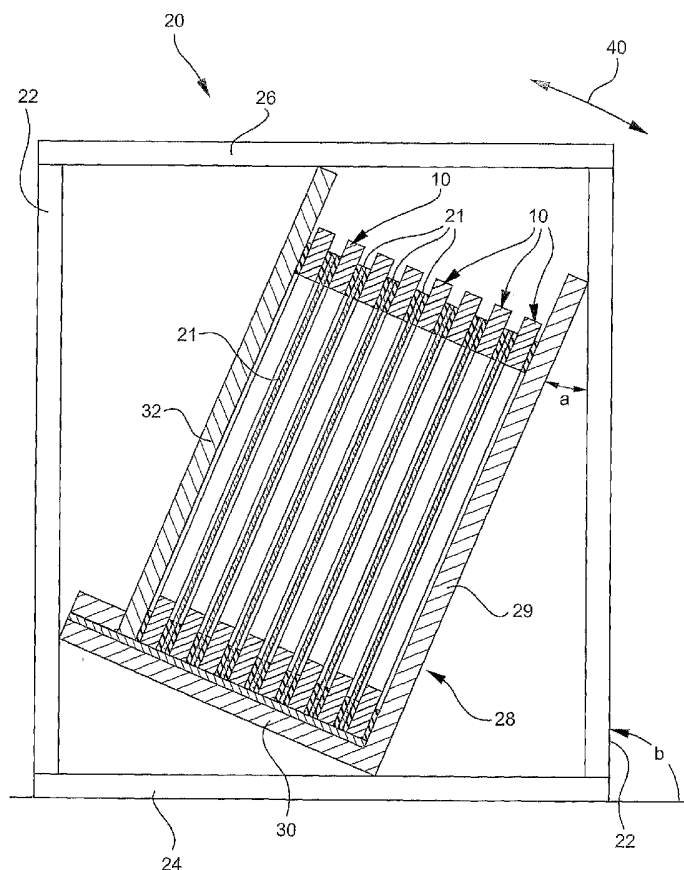
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[Continued on next page]

(54) Title: PACKING OF THIN GLASS SHEETS



(57) Abstract: Articles and methods for packing thin glass sheets are disclosed. The articles and methods include placing the glass sheets (21) in a container (20) at an angle (a) with respect to the container wall. Spacers (10) contact the glass sheets on the periphery of the sheets.



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PACKING OF THIN GLASS SHEETS

RELATED APPLICATION

[0001] This application claims the benefit of priority from U.S. Patent Application No. 10/405,667, filed, April 1, 2003, the content of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates to packing of thin glass sheets, and in particular, liquid crystal display glass substrates.

BACKGROUND OF THE INVENTION

[0003] Large, thin glass sheets, such as liquid crystal display (LCD) substrates are flexible. LCD substrates typically are one square meter in area and have a thickness of less than 0.8 mm. The drive towards larger and lighter LCD substrates has resulted in LCD substrates that exceed one square meter in area and have a thickness less than 0.7 mm, and in some cases, less than or equal to 0.5 mm. At present, LCD substrates are typically packed vertically in a box made from foamed plastic. The peripheral edges of each substrate are held in the vertical grooves on the sidewall of the box. As the length and width of thin glass sheets such as LCD sheets increase and the thickness decreases, the substrate becomes more flexible, and the glass spacing in the box must be increased to avoid glass damage and breakage by mutual contact due to excess vibration during transportation. In view of these limitations, improved methods and articles for packing

[0004] thin glass sheets for storage and shipping that provide sufficient packing density and prevent breakage are needed.

SUMMARY

Certain embodiments of the invention relate to methods and articles for packing thin glass sheets in a container having at least one wall. The glass sheets are placed in the container at an angle with respect to the wall of the container. The sheets rest against a main support member, and spacers keep the sheets in a spaced apart relationship. In certain embodiments, each spacer supports four corners of the glass sheets, and in one particular embodiment, the spacer is frame-shaped. In certain embodiments, the container is tilted during loading and unloading of the container so that the tilt angle of the glass sheets during loading and unloading is reduced. It is to be understood that both the foregoing general description and the following detailed description are exemplary and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a perspective view of a spacer used according to some embodiments of the invention;

[0006] FIG. 2 is a side view of a stack of glass sheets spaced apart by the spacers shown in Figure 1;

[0007] FIG. 3 is a side view of glass sheets packed in a container according to one embodiment; and

[0008] FIGS. 4a and 4b are side views of glass sheets packed in containers according to alternative embodiments.

DETAILED DESCRIPTION

[0009] Before describing several exemplary embodiments of the invention, it is to be understood that the invention is not limited to the details of construction or process steps set forth in the following description. The invention is capable of other embodiments and of being practiced or carried out in various ways.

[00010] One embodiment of the invention relates to a spacer for thin glass sheets, and in particular LCD glass sheets. Referring to Figures 1 and 2, a spacer 10 is shown that includes a main frame-shaped member 12 and a cushion 14 on the surfaces of the member in contact with the glass. The spacer 14 according to the present invention supports the glass sheets at four corners. Supporting the glass sheets at four corners while tilting the glass sheets induces sufficient stiffness in the glass sheets to prevent the sheets from sagging or breaking during transportation of the package. In the embodiment shown in Figure 1, the cushion 14 is a continuous piece that extends around the entire periphery of the main frame-shaped 12 member. However, according to certain embodiments, the cushion can be placed in discrete and separate sections on the periphery of the frame-shaped member. One example of a suitable frame for a sheet of glass having dimensions of 985 mm X 1300 mm X 0.7 mm is a frame-shaped member made from an acrylic material. The frame shaped member has a thickness “t” of about 4 mm and a frame width “w” of between about 10 mm and 50 mm, and more preferably between about 10 mm and 20 mm. The overall width and length dimensions of the frame-shaped member are selected to be approximately the same as the dimensions of the glass sheet. The frame width “w” is selected so that the cushion 14 contacts only a peripheral portion of the glass sheet that is intended to be discarded. In one particularly preferred embodiment, the frame shaped member 12 has at least one end 15 in which the frame has a width “w” that is less than the width of the other three ends of the frame-shaped member. For example, in one embodiment, the end 15 of frame shaped member may have a width “w” that is approximately the same as the width of the cushion material. In preferred embodiments, end 15 of the frame-shaped member 12 supports the glass sheets at the bottom of the container as shown in Figure 2. The cushion material, according to one embodiment, includes a rubber tape having a thickness of between about 0.2 mm and 2 mm, and preferably about 0.5 mm or less. Any soft material can be used for the cushion material, including, but not limited to rubber tape, plastic tape, and foamed plastic tape such as foamed polyethylene tape. In certain embodiments, a sufficiently rigid material that also provides cushioning for the glass sheets so that the frame-shaped member provides both support and cushioning for the sheets. In other words, a single frame shaped member having cushioning properties and sufficient rigidity to support the glass sheets in the container at an angle can be

used without a separate cushioning material placed on the frame-shaped member. Utilizing a frame and cushion of these dimensions, the spacing between each glass sheet is between about 2 mm and 10 mm, and preferably between about 3 mm and 4 mm. The spacer 10 should be made from a material that has sufficient stiffness and strength to support a stack of glass sheets. Suitable materials, include, but are not limited to, acrylic resin, polyvinyl chloride resin and foamed plastics. Figure 2 shows a plurality of glass sheets 16 stacked using a plurality of spacers shown in Figure 1.

[00011] A thinner spacer element is desirable to achieve a higher packing density of glass sheets, but the spacer should be thick enough so that adjacent glass sheets do not contact each other during transportation of the shipping container holding the glass sheets. Accordingly, spacer thickness will depend on the size and thickness of the glass sheet and stacking parameters discussed in more detail below. The spacer should have sufficient rigidity to maintain the shape of the spacer when the spacer is stacked vertically in a container.

[00012] Referring now to Figure 3, a container 20 for shipping thin glass sheets 21 is shown. The container 20 includes at least one substantially vertical wall 22, a floor 24 and a cover 26. The container 20 should be made from a material having enough mechanical strength to hold the packaged glass sheets. As used herein, substantially vertically means the wall 22 is generally perpendicular to the floor 24 of the container 20. A main support member 28 tilted at an angle "a" with respect one of the walls 22 is placed in the container. The main support member 28 preferably is L-shaped and includes an upper portion 29 and a lower portion 30. The upper portion 29 rests against the wall 22 of the container 20. The main support member 28 should provide sufficient mechanical strength to hold the glass sheets and spacers in place, and meet cleanliness requirements of packaged LCD glass sheets. According to one embodiment, the main support member 28 is made from acrylic plates reinforced with a steel frame. In preferred embodiments, the container 20 holds between about 20 and 100 glass sheets and the required number of spacers. An optional backing board (not shown) may be placed between the upper portion and the first sheet of glass that leans against the main support member 28.

[00013] Although the upper portion 29 of the main support member 28 is shown as straight, the upper portion may be curved, as shown in Figures 4a-4b. In Figure 4a,

similar components are designated with reference numerals and a followed by ', and in Figure 4b, similar components are designated with reference numerals followed by ''.

As shown in Fig. 4a, a main support member 28' includes a curved upper portion 29' that allows a higher packing density of sheets to be packed in the container 20'. In an alternative embodiment shown in Fig. 4b, the main support member 28'' may be straight and a curved backing board 31 may be used to allow a higher packing density of sheets in the container 20''.

[00014] Referring again to Figure 3, the major surfaces of the glass sheets 21 rest upon the upper portion of the main support member 28, and the edges of the glass sheets 21 are supported by the lower portion 30 of the main support member 28. Spacers 10 maintain the glass sheets 21 in a spaced apart relation and contact the glass sheets only on the outer periphery of the sheets. The stack of glass sheets 21 may be secured by a secondary support member 32 which encloses the stack of sheets in the container 20. The main support member 28 and the secondary support member 32 when secured together form an inner package that is placed in the container 20.

[00015] According to certain embodiments of the present invention, a method is provided in which glass sheets and frame-shaped spacers are stacked alternately and leaned against a support member disposed at an angle "a" to a substantially vertical wall of the container. By packing the glass sheets in this manner, each glass sheet is supported along four edges, and the unsupported central area of the sheet sags by gravity. The amount of sag is controlled by adjusting the tilt angle. An optimal level of sag can be imparted to the glass sheets so that the sheets are strained by elastic deformation and thus stiffened. When an optimal tilt angle is selected, the glass sheets become stable against external forces such as vibration and shaking during transportation. The glass sheets are arranged in the container such that adjacent sheets are not in contact. Referring again to Figure 3, according to one preferred embodiment, during loading and unloading of the glass sheets, the container 20 is tilted at an angle "b" with respect to the surface upon which the container rests, so that the tilt angle of the glass sheets is decreased with respect to the surface upon which the container rests during the loading and unloading steps. Typically, the surface upon which the container rests is a horizontal surface, and tilting of the box in this manner facilitates loading and unloading of the sheets because the sheets can be loaded in the container in

a substantially vertical orientation with respect to the lower portion of the main support member. In preferred embodiments, during transportation and storage of the container, the angle "b" of the container with respect to the surface upon which the container rests is reduced so that the bottom surface of the box lies flat on the supporting surface.

[00016] A test was conducted to determine the optimum tilt angle and spacing of glass sheets in a container. Glass sheets having a thickness of about 0.7 mm and dimensions of about 985 mm X 1300 mm were loaded in a support member of the type shown in Figure 3 with acrylic frame shaped spacers 3 mm thick in contact with the periphery of the sheet. The spacer also included 0.5 mm of cushion (rubber tape) around the frame-shaped spacer, providing a total thickness of about 4 mm. Five glass sheets and six spacers were placed in a container, and no secondary support member was placed in the container. The amount of sag was measured at the center of the glass sheet using either calipers or a laser distance meter. The sag values at various angles are reported in Table I.

[00017] A secondary support was placed in the container as shown in Figure 3, and the secondary support member and support member were tied together firmly. The stack of glass sheets tied between the support members was shaken back and forth in the direction shown by arrow 40 in Figure 3. Glass stiffness was observed at different tilt angles, and the observations are reported in Table I. As indicated in Table I, the glass sheets become sufficiently stiff when the angle "a" between the upper portion of the main support member and the wall is about 20 degrees.

TABLE I

Angle "a"	Sag (mm)	Stiffness Observation Upon Shaking
0	0	Flexible, rattled easily.
5	2.0	Flexible, rattled easily.
10	2.5	Increase in stiffness and decrease in rattle.
15	3.0	Increase in stiffness and decrease in rattle.
20	3.5	Nearly stiff; no rattle
25	4.0	Sufficiently stiff; no rattle.
30	4.5	Sufficiently stiff; no rattle.

[00018] The packaging method described above has also been successfully applied to LCD substrates having dimensions of about 1500 mm X 1800 mm X 0.7 mm. Twenty glass sheets and twenty-one spacers were alternately placed in a boxed tilted 5 degrees. The box was made of acrylic plates reinforced with a steel frame. The spacers were made from an acrylic material having a thickness of about 3 mm and a cushion made from foamed polyethylene tape having a thickness of about 0.5 mm or less. The stacked glass sheets and spacers were tied together firmly, and then lifted at an angle of between about 5 degrees and 30 degrees. As the tilt angle increased, the glass deformed more by gravity sag, and was more stabilized against mechanical vibration. The optimum tilt angle will be determined by further experiments measuring the expected external vibration during package transportation.

[00019] The various embodiments of the invention are particularly useful for storing and shipping LCD glass substrates having an area greater than one square meter. As discussed above, these glass sheets typically have a thickness less than about 0.8 mm, and some sheets have a thickness less than or equal to about 0.5 mm. The present invention has been successfully demonstrated on LCD substrates having dimensions of about 1500 mm X 1800 mm X 0.7 mm. The front and back major surfaces of the glass sheet are not contacted by the spacers, except for a peripheral portion of the sheet which typically discarded by the end user. No films or surface coatings are required on the glass sheets to prevent scratching, reducing the cost of processing of the glass sheets. Handling of the glass sheets is simplified and loading and unloading of the shipping container is simple and requires no special equipment. According to certain embodiments of the present invention the glass sheets packed in containers are stiffened by the gravitational force induced when the sheets are packed at an angle in a package. The stiffening reduces the glass flexibility and reduces the chance of glass breakage due to external vibration during transportation.

[00020] It will be apparent to those skilled in the art that various modifications and variations can be made to the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A package for thin glass sheets comprising:
at least one substantially vertical wall and a substantially horizontal floor;
a main support member tilted at an angle with respect to the wall; and
a plurality of spacers adapted to separate the glass sheets by contacting the sheets on the peripheral edges of the sheets, each spacer supporting at least one glass sheet at four corners of the sheet.
2. The package of claim 1, wherein the glass sheets are liquid crystal display substrates.
3. The package of claim 2, wherein the glass sheets have a thickness less than about 0.8 mm.
4. The package of claim 3, wherein the glass sheets have a thickness less than equal to about 0.5 mm.
5. The package of claim 1, wherein the angle between the wall and a portion of the main support member is greater than about 5 degrees.
6. The package of claim 1, wherein the angle between the wall and a portion of the main support member is greater than or equal to about 20 degrees.
7. The package of claim 1, wherein the angle between the wall and a portion of the main support member is between about 15 degrees and 30 degrees.
8. The package of claim 1, wherein spacer has a thickness less than about 5 mm.

9. The package of claim 8, wherein the spacer is in the shape of a flexible frame that contacts the glass sheets only on the peripheral edges of the sheets.

10. The package of claim 9, wherein the spacer includes a main frame made from acrylic material and an auxiliary cushion material associated with the main frame.

11. The package of claim 1, wherein the main support member is L-shaped including an upper portion for supporting a major surface of the glass sheets and a lower portion for supporting the edges of the glass sheets.

12. The package of claim 12, wherein the upper portion of the main support member is curved.

13. A method of packaging thin glass sheets comprising:
providing a container having a substantially vertical wall and a substantially horizontal floor;
disposing a portion of the main support member in the container at an angle with respect to the wall;
separating the glass sheets with a frame-shaped spacer; and
placing the glass sheets in the container so that the glass sheets rest on the main support member in a spaced apart relation and each spacer supports at least one glass sheet at four corners of the sheet.

14. The method of claim 13, further comprising placing spacers between the glass sheets, wherein the spacers contact only the periphery of the glass sheets.

15. The method of claim 13, wherein the glass sheets have a thickness of less than about 0.8 mm.

16. The method of claim 15, wherein the angle between a portion of the main support member and the wall is less than about 30 degrees and greater than about 5 degrees.

17. The method of claim 15, wherein the angle between a portion of the main support member and the wall is less than about 20 degrees and greater than about 5 degrees.

18. The method of claim 15, wherein the angle between a portion of the main support member and the wall is between about 15 degrees and 30 degrees.

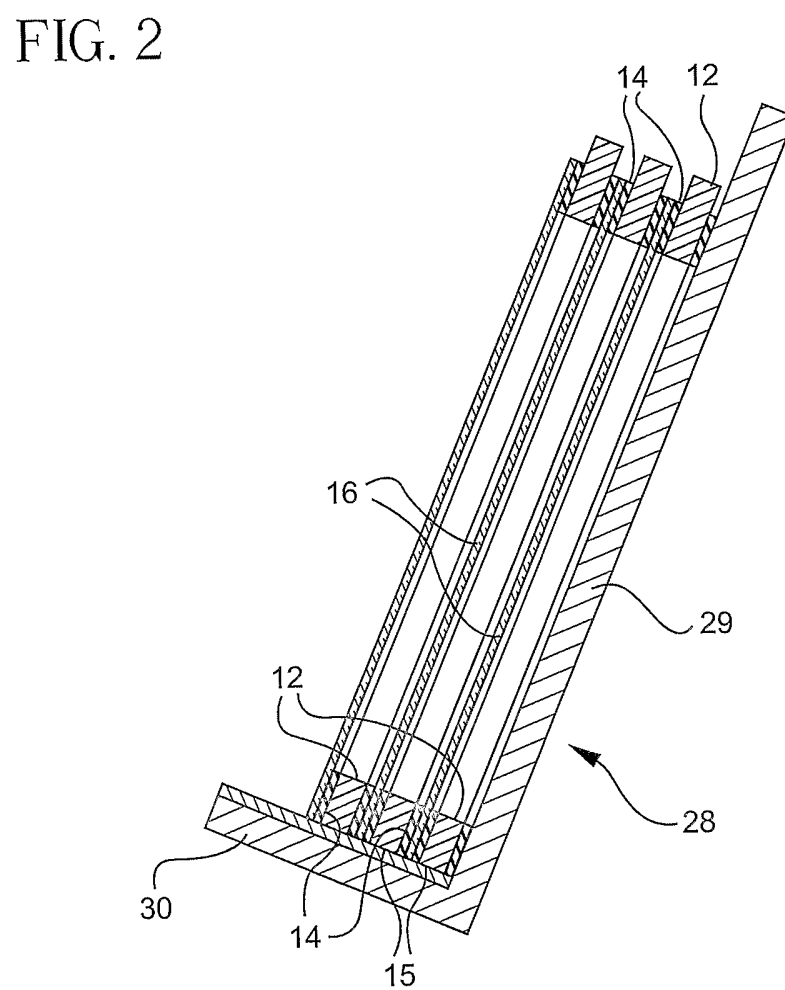
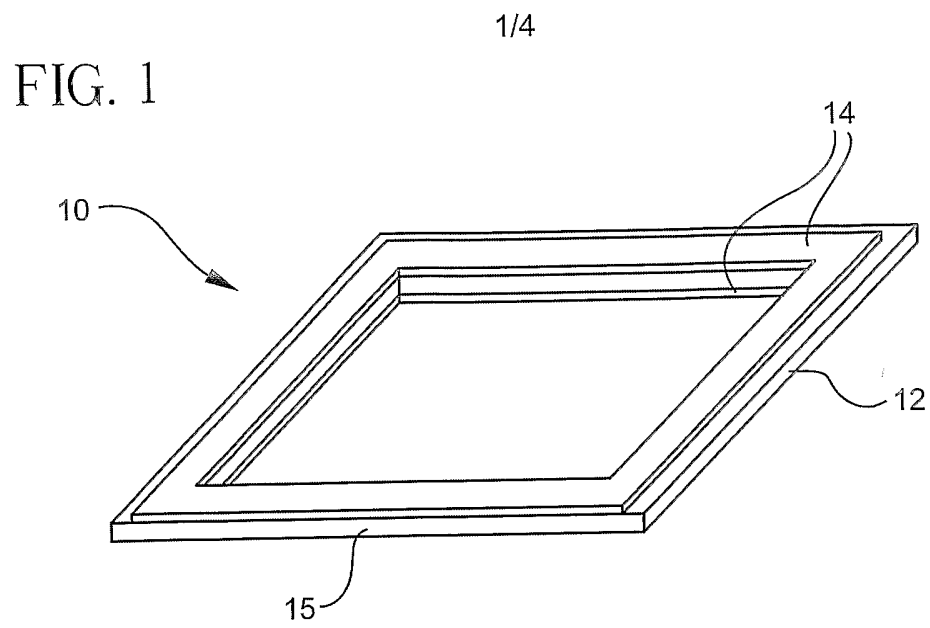
19. The method of claim 14, wherein the spacer includes a flexible acrylic frame and a cushioning element associated with the frame.

20. The method of claim 19, wherein the frame has a width of between about 10 mm and 20 mm.

21. The method of claim 14, wherein the main support member is L-shaped having an upper portion for supporting the major surface of the sheets and a lower portion for supporting the edges of the sheets.

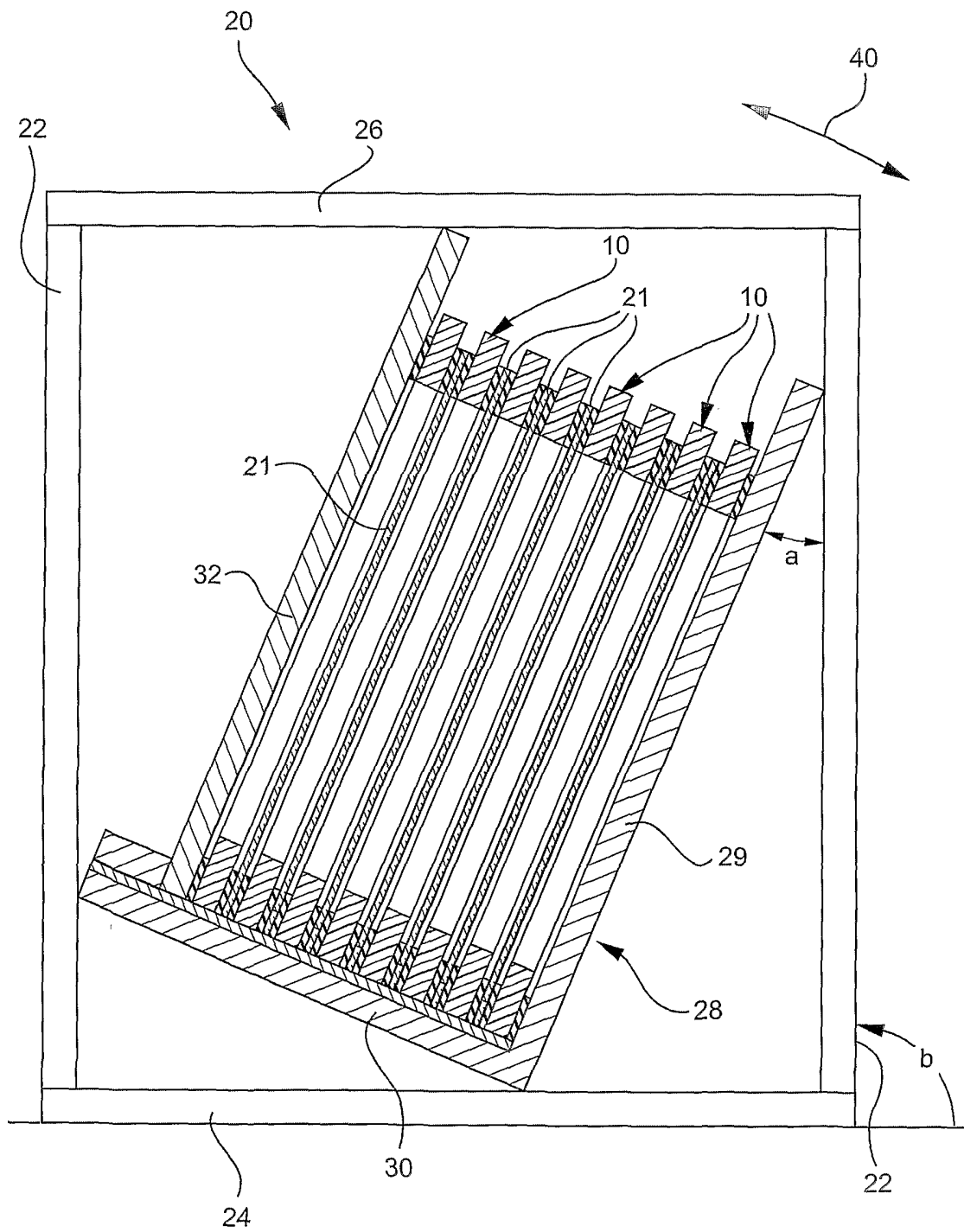
22. The method of claim 13, wherein during the step of placing the sheets in the container the container is placed on a horizontal surface and the container is tilted such that the angle of the sheets with respect to the horizontal surface is decreased.

23. The method of claim 22, further including securing the glass sheets between a secondary support member and the main support member so that the glass sheets are sandwiched between both support members and securing a lid on the container.



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FIG. 3



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FIG. 4A

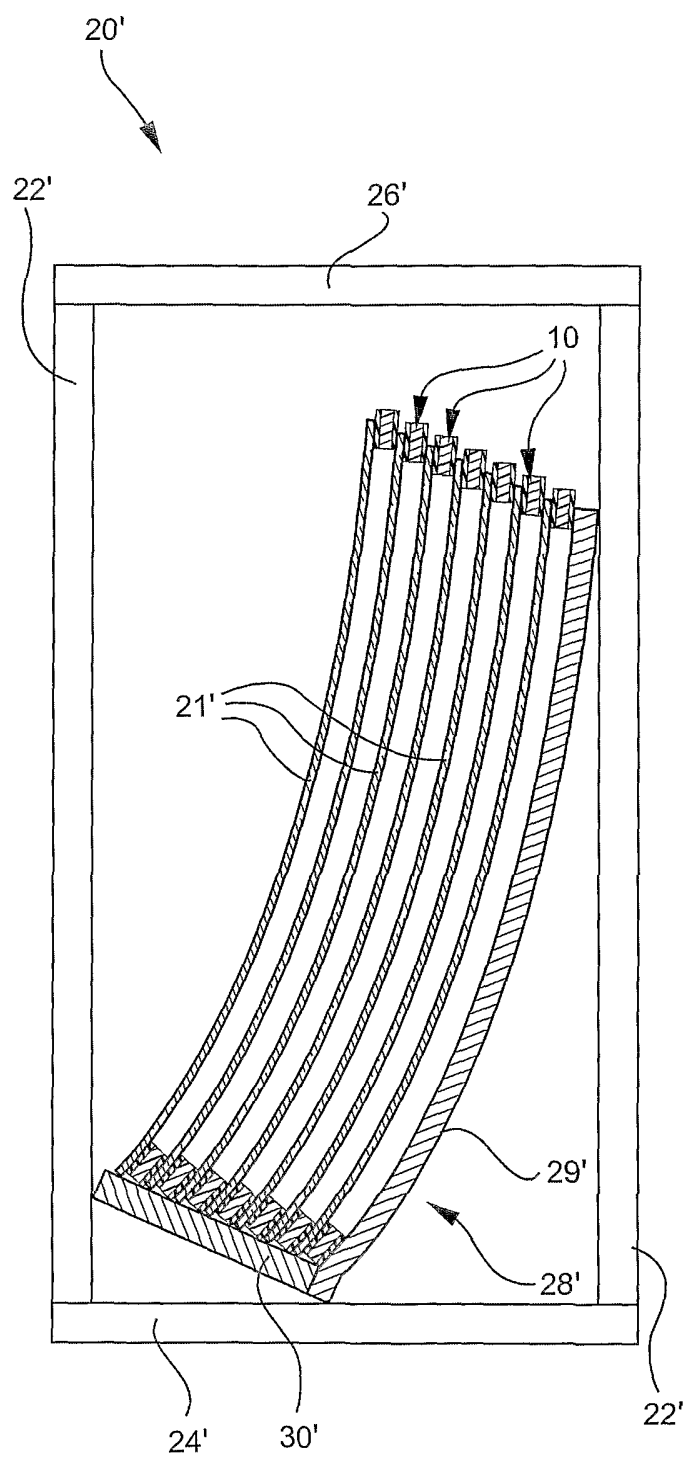
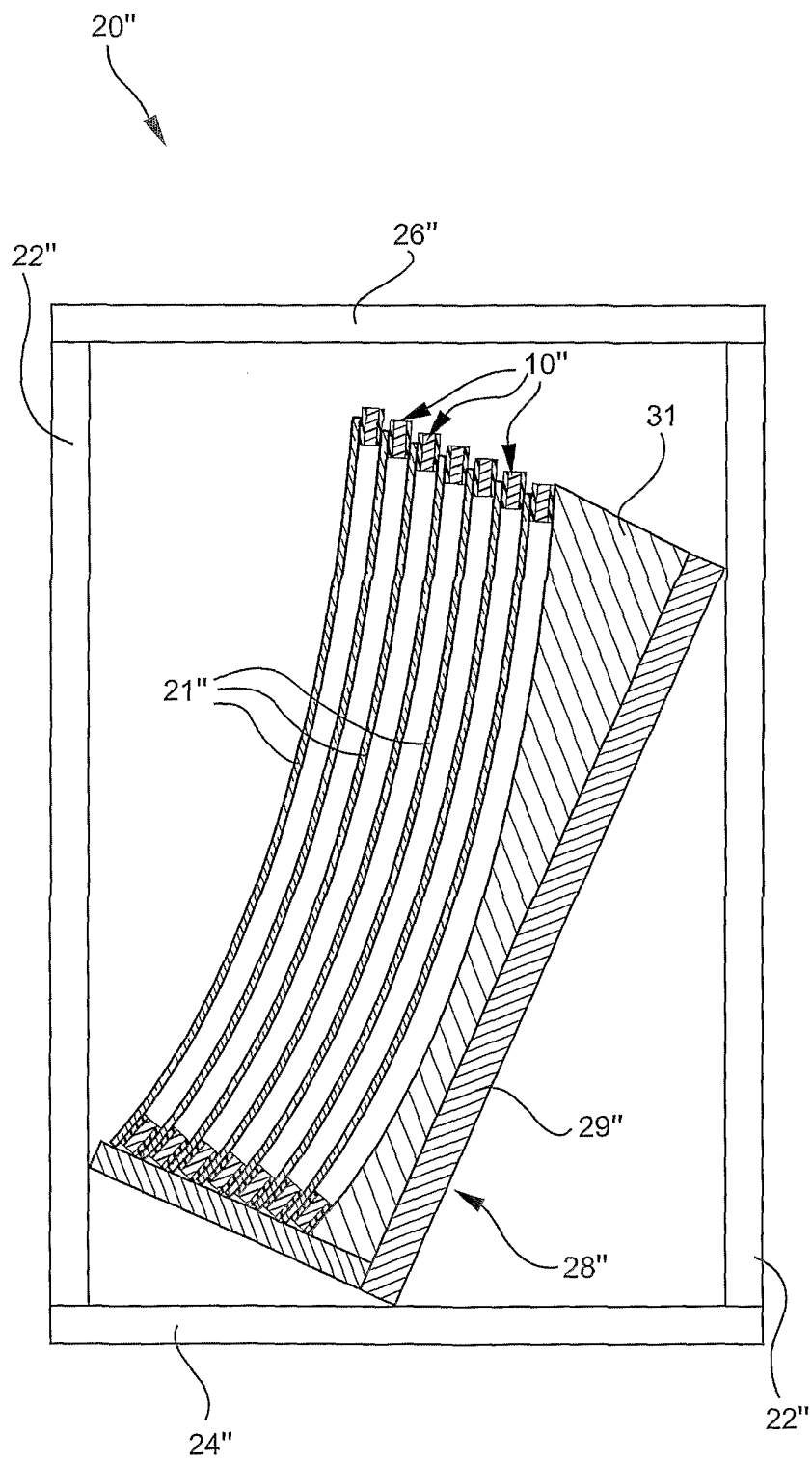


FIG. 4B



INTERNATIONAL SEARCH REPORT

International Application No

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B65D85/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B65D B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	column 2, line 6 - line 42; claim 1; figures 1,2	13
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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