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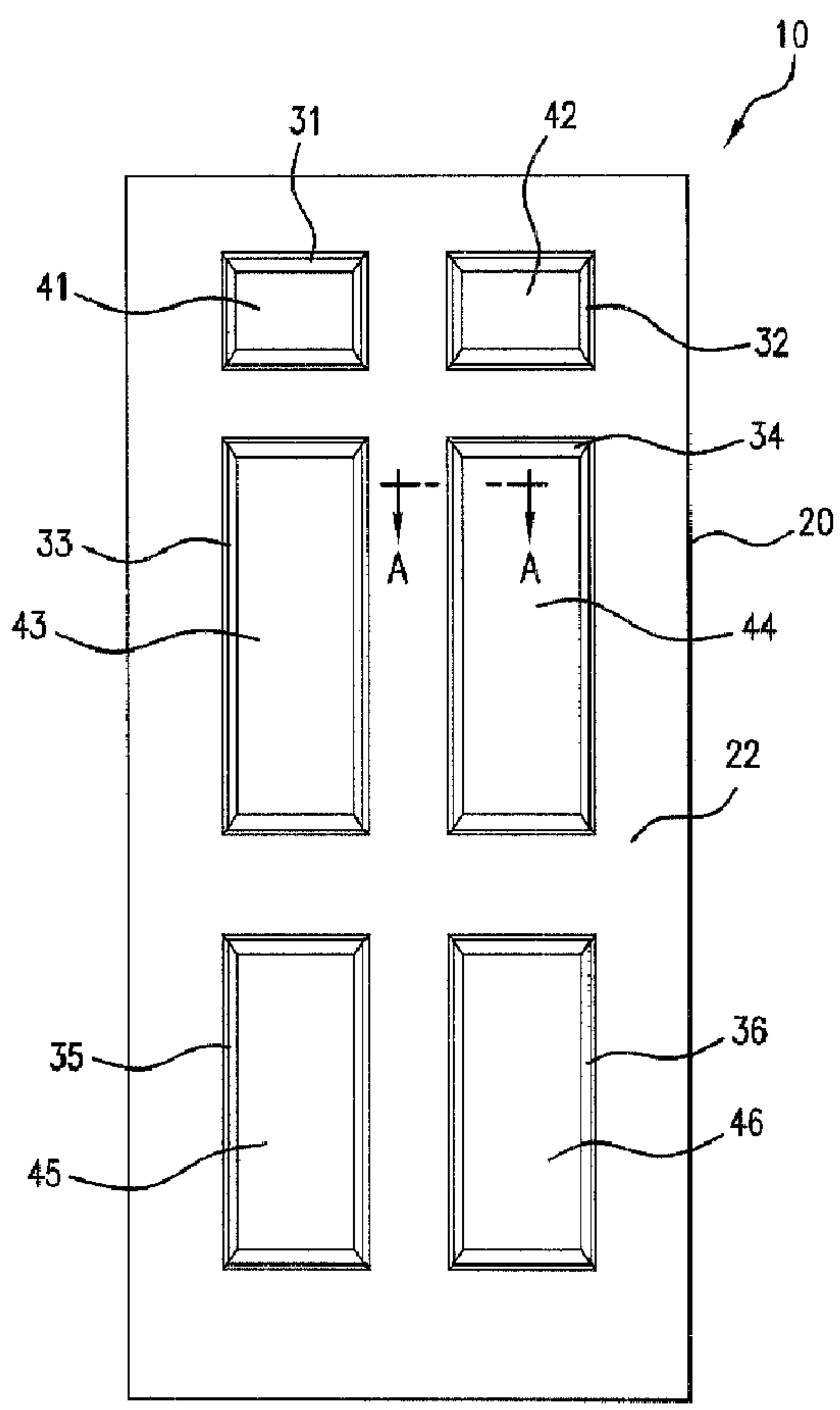


(57) Abrégé/Abstract:
Molded skins and methods of making molded skins are disclosed. An embodiment of a skin includes a sheet having first and second surfaces, a first arcuate portion integral with the sheet, and a second arcuate portion integral with the sheet and adjacent to

(57) Abrégé(suite)/Abstract(continued):

the first arcuate portion. The sheet includes a cellulosic material. The first arcuate portion includes a first surface and a second surface, each having an arc. The second arcuate portion includes a first surface and a second surface, each having an arc. An angle forming the arc of the first surface of the first arcuate portion is greater than 110 degrees and an angle forming the arc of the first surface of the second arcuate portion is less than 102 degrees.

ABSTRACT

Molded skins and methods of making molded skins are disclosed. An embodiment of a skin includes a sheet having first and second surfaces, a first arcuate portion integral with the sheet, and a second arcuate portion integral with the sheet and adjacent to the first arcuate portion. The sheet includes a cellulosic material. The first arcuate portion includes a first surface and a second surface, each having an arc. The second arcuate portion includes a first surface and a second surface, each having an arc. An angle forming the arc of the first surface of the first arcuate portion is greater than 110 degrees and an angle forming the arc of the first surface of the second arcuate portion is less than 102 degrees.

MOLDED SKIN WITH CURVATURE

FIELD OF THE INVENTION

The invention generally relates to skins, and more particularly, to molded skins.

BACKGROUND

For aesthetic reasons, it may be desirable for a door skin to have two adjacent half-round curvatures, *i.e.*, curvatures of greater than 90 degrees. Metal doors are known to have such configurations. Metal doors, however, can be damaged somewhat easily, for example, by denting. Additionally, metal doors can be heavy to ship, cumbersome to install, and costly.

Fiberglass doors are also known to have adjacent, sharp curved portions. While fiberglass is not damaged easily and is light-weight compared to metal, it is one of the more costly materials to use for doors. Furthermore, over time, ultraviolet light degrades the coating of the fiberglass door, and ultimately, destroys the face of the door.

Fiberboard door skins have the advantages of being economical, not easily damaged, and durable over time. However, when forming fiberboard door skins with curvatures greater than 90 degrees, proper surface consistency and density have been extremely difficult to achieve. When a fiberboard mat is molded, *i.e.,* stretched, to include two adjacent bends of at least 90 degrees, the added contours increase the amount of surface distance of the mat compared to a substantially flat mat. Stretching the fiberboard mat farther than desirable, *i.e.*, over-stretching, results in surface discontinuities and flaws such that paint, stains, and other finishes do not properly adhere to the surface of the mat.

Prior attempts at forming fiberboards having two adjacent half-round curvatures as described below have resulted in door skins being either too porous or too dense. In regions where the skin is too porous, *i.e.*, the density is too low, paint, stains, and other finishes do not adhere to the surface but rather, are absorbed by the wood. Such surfaces appear rough or uncovered.

In regions where such a skin has an unusually high density, the surface blisters and cracks. Paint, stains, and other finishes cannot adhere to such surfaces, and generally appear darker when compared to other regions where the density is within acceptable ranges. A door surface having such an uneven appearance is generally considered to be aesthetically unpleasing. Additionally, there are discontinuities and flaws in the surfaces of such door skins in such situations.

Attempts have been made to compensate or correct for such density extremes. One such attempt includes increasing the density of regions where low densities are expected when molding the door skin. This approach, while successful in gradual curvatures of the surface, such as, for example, quarter curves, has not been successful for the curvatures described above. Blistering and cracking of the surface still occurs in this approach.

Other approaches have been attempted, and have been unsuccessful as well. Once a fiberboard door skin has been formed with a density that is either too low or too high, there are no known solutions to remedy or correct problems with the surface appearance and consistency of door skins. Thus, such door skins must be discarded, which ultimately increases the costs of door production.

SUMMARY OF THE INVENTION

Embodiments of the present invention include skins and methods of making molded skins that include door skins having two adjacent half-round curvatures in the profile. Embodiments of the present invention may take a wide variety of forms. In one exemplary embodiment, a skin includes a sheet having first and second surfaces, a first arcuate portion integral with the sheet, and a second arcuate portion integral with the sheet and adjacent with the first arcuate portion. The sheet includes a cellulosic material. The first arcuate portion includes a first surface and a second surface, each having an arc. The second arcuate portion also includes a first surface and a second surface, each having an arc. An angle forming the arc of the first surface of the first arcuate portion is greater than 110 degrees and an angle forming the arc of the first surface of the second arcuate portion is less than 102 degrees.

In another exemplary embodiment, a method includes a method of making a skin. The method includes providing a sheet having cellulosic material, molding a first arcuate portion integral with the sheet, and molding a second arcuate portion integral with the sheet and adjacent to the first arcuate portion. The first and second arcuate portions each include first and second surfaces having an arc. An angle forming the arc of the first surface of the first arcuate portion is greater than 110 degrees and an angle forming the arc of the first surface of the second arcuate portion is less than 102 degrees.

One advantage of the present invention can be to provide a molded skin with two adjacent half-round curvatures.

Another advantage of the present invention can be to provide a molded fiberboard skin with a proper density for surface finishing.

Yet another advantage of the present invention can be to provide a molded skin that exhibits a substantially uniform surface appearance.

A further advantage of the present invention can be to provide a molded fiberboard skin with a profile that is similar to profiles of metal and fiberglass skins.

Yet a further advantage of the present invention can be to provide a molded skin with a profile having a surface distance greater than a linear distance.

These exemplary embodiments are mentioned not to summarize the invention, but to provide an example of an embodiment of the invention to aid understanding. Exemplary embodiments are discussed in the Detailed Description, and further description of the invention is provided there. Advantages offered by the various embodiments of the present invention may be understood by examining this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which constitute part of this specification, help to illustrate embodiments of the invention. In the drawings, like numerals are used to indicate like elements throughout.

Figure 1 is a perspective view of a skin according to an embodiment of the present invention.

Figure 2 is a view of the skin of Figure 1 taken along line A-A.

Figure 3 is a view of a prior art skin.

Figure 4 is a block diagram of a method according to an embodiment of the invention.

DETAILED DESCRIPTION

Embodiments of the invention include products and processes for molding a skin. A sheet typically comprises a cellulosic material, such as for example, a fiberboard mat. Preferably, the embodiments shown comprise a nominal caliper ranging between 0.100 inches (0.254 centimeters) and 0.130 inches (0.330 centimeters) molded product made using a dry process fiberboard mat, comprising approximately 1% to approximately 15% urea formaldehyde resin and approximately 0% to approximately 4% wax, initially approximately two inches thick, and molded under a temperature of approximately 250 degrees F (121 degrees C) to approximately 550 degrees F (288 degrees C) and a pressure of approximately 400 pounds per square inch (psi) 2758 (kilograms pascal) to approximately 1000 psi (6897 kilograms pascal). Most preferably, the temperature is 300 degrees F (149 degrees C). Alternatively, a phenol formaldehyde resin is used for the fiberboard mat, which is molded under a temperature of approximately 350 degrees F (177 degrees C) to 400 degrees F (204 degrees C).

In the exemplary embodiments shown in the figures, two sheets forming the exterior surfaces of a door are molded in separate molds and then laminated or adhered to a core, frame, or other support to simulate a solid, natural wood door. Alternatively, the two sheets can be molded from the same mold. The principles of the present invention can be applied to molded articles in addition to those shown here, such as for example, cabinet doors, wall paneling, siding, and the like.

Referring now to Figure 1, a perspective view of a skin 10 according to the principles of the present invention is shown. The skin 10 includes a sheet 20 having a first surface 22 and a second surface 24 (see Figure 2). Planar surfaces of the first and second surfaces 22, 24 are generally parallel to one another. Generally, a perpendicular distance D_1 between the planar surfaces of the first surface 22 and the second surface 24 typically is between approximately 0.100 inches (0.254 centimeters) and 0.130 inches (0.330 centimeters). In one embodiment, the distance D_1 is between 0.110 inches (0.279 centimeters) and 0.120 inches (0.305 centimeters). Typically, the sheet 20 comprises a cellulosic material. In one embodiment, the sheet 20 is a fiberboard mat having a density in a range between approximately 50 (801) and approximately 70 pounds per cubic foot (pcf) (1,121 kilograms per cubic meter). Alternatively, other suitable materials and densities can be used.

In one embodiment, the sheet 20 includes six molded depressions, 31, 32, 33, 34, 35, and 36, which surround six panels 41, 42, 43, 44, 45, and 46. Alternatively, other suitable number of depressions and panels can be used. Each depression 31, 32, 33, 34, 35, and 36 is completely surrounded by the first surface 22 of the sheet 20. In one embodiment, the depressions 31, 32, 33, 34, 35, and 36 are substantially rectangular in shape and surround the panels 41, 42, 43, 44, 45, and 46. Alternatively, other suitable configurations can be used.

Referring now to Figure 2, a view of the molded depression 34 of the sheet 20 of Figure 1 taken along line A-A is shown. The molded depression 34 typically includes an upper contour 34a and a lower contour 34b. The upper contour 34a includes an upper inclined wall 70 and a lower inclined wall 80. The lower contour 34b includes a lower contour wall 90. Disposed between the upper inclined wall 70 and the lower inclined wall 80 are a first arcuate portion 50 and a second arcuate portion 60. The upper and lower inclined walls 70, 80 and first and second arcuate portions 50, 60 are integral with the sheet 20.

Typically, the upper inclined wall 70 includes a first end 72 and a second end 74, and the lower inclined wall 80 includes a first end 82 and a second end 84. The lower contour wall 90 includes a first end 92 and a second end 94. In one embodiment, the first end 72 of the upper inclined wall 70 is adjacent to the first surface 22 of the sheet 20, and the second end 74 is adjacent to the first arcuate portion 50. Generally, the first end 82 of the lower inclined wall 80 is adjacent to the second arcuate portion 60, and the second end 84 is adjacent to the first end 92 of the lower contour wall 90. In one embodiment, the second end 84 of the lower inclined wall 80 adjoins the first end 92 of the lower contour wall 90. Generally, the second end 94 of the lower contour wall 90 is adjacent to the panel 44.

A length L_{34} of the molded depression 34 measured from the first end 72 of the upper inclined wall 70 to the second end 94 of the lower contour wall 90 generally is greater than 1.979 inches (5.027 centimeters). The length L_{34} is measured substantially parallel to the planar surface of the first surface 22. In one embodiment, the length L_{34} of the molded depression 34 is approximately 2.012 inches (5.11 centimeters). Alternatively, other suitable lengths for the molded depression 34 can be used.

Generally, a ratio of a surface distance from the first end 72 of the upper inclined wall 70 to the second end 94 of the lower contour wall to the length L_{34} is less than 1.159. In one embodiment, the ratio of the surface distance from the first end 72 of the upper inclined wall 70 to the second end 94 of the lower contour wall to the length L_{34} is in a range between greater than 1.135 and less than 1.159. In another embodiment, the ratio of the surface distance from the first end 72 of the upper inclined wall 70 to the second end 94 of the lower contour wall to the length L_{34} is approximately 1.147. Surface distance is a measurement along an entire length of a line or contour, rather than a linear distance, between a beginning point and an end point of the line or contour. Thus, a surface distance of a line that includes arcs or contours typically is greater than a corresponding linear, distance.

A distance D_2 measured from the first end 72 of the upper inclined wall 70 to the second end 84 of the lower inclined wall 80 is less than 0.862 inches (2.189 centimeters). In one embodiment, the distance D_2 is approximately 0.853 inches (2.167 centimeters). Alternatively, other suitable distances can be used. In one embodiment, a ratio of a surface distance from the first end 72 of the inclined wall 70 to the second end 84 of the lower inclined wall 80 to the distance D_2 is less than 1.256. In one embodiment, the ratio of the surface distance from the first end 72 of the inclined wall 70 to the second end 84 of the lower inclined wall 80 to the distance D_2 is approximately 1.236.

The first arcuate portion 50 includes a first surface 51 and a second surface 52. The first surface 51 of the first arcuate portion 50 includes an arc 51a. The second surface 52 of the first arcuate portion 50 includes an arc 52a. Alternatively, rather than a substantially continuous arc, multiple lines, arcs, and/or contours can be joined together to form arcs 51a and 52a. In one embodiment, the arc 51a includes a concave shape. In another embodiment, the arc 51a includes a convex shape. An angle Θ_{51a} forming the arc 51a of the first surface 51 of the first arcuate portion 50 is greater than 110 degrees. In one embodiment, the angle Θ_{51a} is approximately 118 degrees.

The second arcuate portion 60 is adjacent to the first arcuate portion 50. In one embodiment, the first and second arcuate portions 50, 60 are adjoining. The second arcuate portion 60 includes a first surface 61 and a second surface 62. The first surface 61 of the second arcuate portion 60 includes an arc 61a. The second surface 62 of the second arcuate portion 60 includes an arc 62a. Alternatively, rather than a substantially continuous arc, multiple lines, arcs, and/or contours can be joined together to form arcs 61a and 62a. In one embodiment, the arc 62a includes a concave shape. In another embodiment, the arc 62a includes a convex shape.

An angle Θ_{61a} forming the arc 61a of the first surface 61 of the second arcuate portion 60 is less than 102 degrees. In one embodiment, the angle Θ_{61a} is approximately 93 degrees. A ratio of the angle Θ_{61a} to the angle Θ_{51a} is less than 0.927. In one embodiment, the ratio of the angle Θ_{61a} to the angle Θ_{51a} (*i.e.*, $\Theta_{61a}/\Theta_{51a}$) is approximately 0.788.

A radius R_{51a} of the arc 51a of the first surface 51 of the first arcuate portion 50 is greater than 0.068 inches (0.173 centimeters) and a radius R_{61a} of the arc 61a of the first surface 61 of the second arcuate portion 60 is greater than 0.350 inches (0.889 centimeters). In one embodiment, the radius R_{51a} is approximately 0.074 inches (0.188 centimeters) and the radius R_{61a} is approximately 0.376 inches (0.955 centimeters). Typically, a ratio of the radius R_{61a} to the radius R_{51a} (*i.e.,* R_{61a}/R_{51a}) is less than 5.147. In one embodiment, the ratio of R_{61a}/R_{51a} is approximately 5.081. Typically, a linear distance D_R between the radius R_{51a} and the radius R_{61a} is less than 0.278 inches (0.706 centimeters). In one embodiment, the distance D_R is approximately 0.270 inches (0.686 centimeters). Linear distances are generally measured substantially parallel to the planar surface of the first surface 22 or the second surface 24.

A ratio of a length of the arc 51a to a length of a chord C_{51a} of the arc 51a is less than 1.18. In one embodiment, the ratio of the length of the arc 51a to the length of the chord C_{51a} of the arc 51a is approximately 1.118. Generally, the length of the arc 51a is greater than 0.131 inches (0.333 centimeters) and the length of the chord C_{51a} is greater than 0.111 inches (0.282 centimeters). In one embodiment, the length of the arc 51a is approximately 0.142 inches (0.361 centimeters) and the length of the chord C_{51a} is approximately 0.127 inches (0.323 centimeters).

A ratio of a length of the arc 61a to a length of a chord C_{61a} of the arc 61a is less than 1.15. In one embodiment, the ratio of the length of the arc 61a to the length of the chord C_{61a} of the arc 61a is in a range between 1.045 and less than 1.150. In another embodiment, the ratio of the length of the arc 61a to the length of the chord C_{61a} of the arc 61a is approximately 1.122. Generally, the length of the arc 61a is less than 0.628 inches (1.60 centimeters) and the length of the chord C_{61a} is greater than 0.546 inches (1.387 centimeters). In one embodiment, the length of the arc 61a is approximately 0.614 inches (1.56 centimeters) and the length of the chord C_{61a} is approximately 0.547 inches (1.389 centimeters).

In one embodiment, a maximum perpendicular distance D_3 between the first surface 22 of the sheet 20 and the first surface 51 of the first arcuate portion 50 is less than the distance between the first and second surfaces 22, 24 of the sheet 20, *i.e.,* D_1. As described above, D_1 typically is between approximately 0.110 inches (0.279 centimeters) and 0.120 inches (0.305 centimeters). Generally, the distance D_3 is in a range between approximately 0.033 inches (0.084 centimeters) and less than 0.133 inches (0.338 centimeters). In one embodiment, the distance D_3 is approximately 0.118 inches (0.30 centimeters).

A minimum perpendicular distance D_4 between the first surface 22 of the sheet 20 and the first surface 61 of the second arcuate portion 60 typically is less than the distance D_3. In one embodiment the distance D_4 is approximately 0.027 inches (0.069 centimeters). A ratio of the distance D_3 to the distance D_4 generally is less than 4.926. In one embodiment, the ratio of the distance D_3/D_4 is approximately 4.370.

In one embodiment, a perpendicular distance D_5 between the first and second surfaces 51, 52 of the first arcuate portion 50 is in a range between approximately 0.095 inches (0.241 centimeters) and approximately 0.107 inches (0.272 centimeters). In another embodiment, the distance D_5 is in a range between approximately 0.097 inches (0.246 centimeters) and 0.100 inches (0.254 centimeters). Typically, a ratio of the distance D_5 to the distance D_1 is in a range between approximately 0.760 and approximately 0.860. Alternatively other suitable distances can be used.

In one embodiment, a perpendicular distance D_6 between the first and second surfaces 61, 62 of the second arcuate portion 60 typically is in a range between approximately 0.095 inches (0.241 centimeters) and approximately 0.107 inches (0.272 centimeters). In another embodiment, the distance D_6 is in a range between approximately 0.099 inches (0.251 centimeters) and approximately 0.105 inches (0.267 centimeters). Typically, a ratio of the distance D_6 to the distance D_1 is in a range between approximately 0.760 and approximately 0.860. Alternatively other suitable distances can be used.

One formula that is used to describe several of the relationships described above is that the ratio of the length of the arc 61a to the length of the chord C_{61a} of the arc 61a is less than 1.150.

The profile of a prior art molded depression 134 in a prior art sheet 120, shown in Figure 3 does not achieve the curvature that the profile of the molded depression 34 according to the present invention achieves while maintaining the proper density of the mat. When a fiberboard mat is molded, *i.e.*, stretched, to include two adjacent bends of at least 90 degrees, the added contours increase the amount of surface distance of the mat compared to a substantially flat mat. The prior art, which is described below and shown in Figure 3, stretches the fiberboard mat farther than desirable. In the prior art, this over-stretching results in surface discontinuities and flaws. Additionally, the density of the fiberboard mat of the prior art is such that paint, stains, and other finishes do not properly adhere to the surface of the mat. The present invention identifies an optimum limit for molding a fiberboard mat that includes two adjacent curvatures while maintaining a desirable surface appearance.

The length of the molded depression 134 is 1.979 inches (5.027 centimeters). The surface distance of the molded depression 134 measured from the first end 172 of the upper inclined wall 170 to the second end 194 of the lower contour wall 190 is 2.294 inches (5.827 centimeters). Thus, the ratio of the surface distance of the molded depression 134 to the length of the molded depression 134 is 1.159.

The linear distance measured from the first end 172 of the upper inclined wall 170 to the second end 184 of the lower inclined wall 180 is 0.862 inches (2.189 centimeters), and the surface distance is 1.083 inches (2.751 centimeters). This linear distance is measured substantially parallel to the planar surface of the first surface 122. Thus, the ratio of the surface distance of 1.083 inches (2.751 centimeters) to the linear distance of 0.862 inches (2.189 centimeters) (*i.e.*, 1.083/0.862) is 1.256.

The angle forming the arc of the first surface 151 of the first arcuate portion 150 is 110 degrees. The angle forming the arc of the first surface 161 of the second arcuate portion 160 is 102 degrees. Thus, the ratio of the angle forming the arc of the first surface 161 of the second arcuate portion to the angle forming the arc of the first surface 151 of the first arcuate portion 150 (*i.e.*, 102/110) is 0.927.

The radius of the arc of the first surface 151 of the first arcuate portion 150 is 0.068 inches (0.173 centimeters) and the radius of the arc of the first surface 161 of the second arcuate portion 160 is 0.350 inches (0.889 centimeters). The ratio of the radius of the arc of the first surface 161 of the second arcuate portion 160 to the radius of the arc of the first surface 151 of the first arcuate portion 150 (*i.e.*, 0.350/0.068) is 5.147. The distance between these two radii is 0.278 inches (0.706 centimeters).

The ratio of the length of the arc 161a to the length of the chord C_{161a} of the arc 61a is 1.150. The maximum perpendicular distance between the first surface 122 of the sheet 120 and the first surface 151 of the first arcuate portion 150 is 0.133 inches (0.338

centimeters), which is greater than the perpendicular distance between the first and second surfaces 122, 124 of the sheet 120, *i.e.*, 0.125 inches (0.318 centimeters).

The minimum perpendicular distance between the first surface 122 of the sheet 120 and the first surface 161 of the second arcuate portion 160 is 0.027 inches (0.069 centimeters). A ratio of the maximum perpendicular distance between the first surface 122 of the sheet 120 and the first surface 151 of the first arcuate portion 150 and the minimum perpendicular distance between the first surface 122 of the sheet 120 and the first surface 161 of the second arcuate portion 160 (*i.e.*, 0.133/0.027) is 4.926.

The perpendicular distance between the first and second surfaces 151, 152 of the first arcuate portion 150 is in a range between 0.091 inches (0.231 centimeters) and 0.097 inches (0.246 centimeters). The distance between the first and second surfaces 161, 162 of the second arcuate portion 160 is in a range between 0.090 inches (0.229 centimeters) and 0.100 inches (0.254 centimeters).

The prior art skin, shown in Figure 3, does not achieve the adjacent half-round curvatures that the profile of the molded depression 34 according to the present invention achieves. For example, in one embodiment of the present invention, the angle Θ_{51a} forming the arc 51a of the first surface 51 of the first arcuate portion 50 is approximately 118 degrees, whereas the angle forming the arc 151a of the prior art door skin is 110 degrees. The angle Θ_{61a} forming the arc 61a of the first surface of the second arcuate portion 60 is, in one embodiment, approximately 93 degrees, whereas the angle forming the arc 161a of the prior art door skin is 102 degrees.

As discussed above, one formula that is used to describe several of the relationships of the embodiment according to the present invention is that the ratio of the length of the arc 61a to the length of the chord C_{61a} of the arc 61a is less than 1.150. In the prior art skin, such a ratio, *i.e.*, the length of the arc 161a to the length of the chord C_{161a} of the arc 161a, is 1.150.

Referring now to Figure 4, a method 200 according to an embodiment of the present invention is shown. Figure 4 shows an embodiment of a method 200 of making a skin that provides a molded depression comprising two adjacent “half-round” arcuate portions. The method 200 may be employed to make the sheet 20 for use in the skin 10 described above. Items shown in Figures 1 and 2 are referred to in describing Figure 4 to aid understanding of the embodiment of the method 200 shown. However, embodiments of methods according to the present invention may be employed to make a wide variety of other products, including, without limitation, cabinet doors, wall paneling, siding, and the like.

As indicated by block 210, a sheet comprising cellulosic material is provided. The sheet comprises a first surface and a second surface. In one embodiment, the sheet comprises a fiberboard having a density in a range between approximately 50 pcf (801 kilograms per cubic meter) and approximately 70 pcf (1,121 kilograms per cubic meter).

As indicated by block 220, a first arcuate portion integral with the sheet is molded. The first arcuate portion comprises a first surface and a second surface, each comprising an arc. Alternatively, rather than a substantially continuous arc, multiple lines, arcs, and/or contours can be joined together to form the arc. In one embodiment, the first arcuate portion comprises a concave shape. In another embodiment, the first arcuate portion comprises a convex shape.

Typically, an angle forming the arc of the first surface of the first arcuate portion is greater than 110 degrees. In one embodiment, the angle forming the arc of the first surface of the first arcuate portion is approximately 118 degrees. Alternatively, other suitable angles can be used. A radius of the arc of the first surface of the first arcuate portion is greater than 0.068 inches (0.173 centimeters). In one embodiment, the radius, of the arc of the first surface of the first arcuate portion is approximately 0.074 inches (0.188 centimeters).

Typically, a length of a chord of the arc of the first surface of the first arcuate portion generally is greater than 0.111 inches (0.282 centimeters). In one embodiment, a ratio of the length of the arc of the first surface of the first arcuate portion to the length of the chord of the arc of the first surface of the first arcuate portion is less than 1.180. In another embodiment, the ratio of the length of the arc of the first surface of the first arcuate portion to the length of the chord of the arc of the first surface of the first arcuate portion is approximately 1.118.

As indicated by block 230, a second arcuate portion integral with the sheet and adjacent to the first arcuate portion is molded. In one embodiment, the first and second arcuate portions are adjoining. The second arcuate portion comprises a first surface and a second surface, each comprising an arc. Alternatively, rather than a substantially continuous arc, multiple lines, arcs, and/or contours can be joined together to form the arc. In one embodiment, the second arcuate portion comprises a convex shape. In another embodiment, the second arcuate portion comprises a concave shape.

An angle forming the arc of the first surface of the second arcuate portion is less than 102 degrees. In one embodiment, the angle forming the arc of the first surface of the second arcuate portion is approximately 93 degrees. A ratio of the angle forming the arc of the first surface of the second arcuate portion to the angle forming the arc of the first surface of the first arcuate portion generally is less than 0.927. In one embodiment, the ratio of the angle forming the arc of the first surface of the second arcuate portion to the angle forming the arc of the first surface of the first arcuate portion is approximately 0.788.

Typically, a radius of the arc of the first surface of the second arcuate portion is greater than 0.350 inches (0.889 centimeters). In one embodiment, the radius of the arc of the first surface of the second arcuate portion is approximately 0.376 inches (0.955 centimeters). Generally, a distance between a center of the radius of the arc of the first surface of the first arcuate portion and a center of the radius of the arc of the first surface of the second arcuate portion is less than 0.278 inches (0.706 centimeters).

In one embodiment, the distance between a center of the radius of the arc of the first surface of the first arcuate portion and a center of the radius of the arc of the first surface of the second arcuate portion is approximately 0.270 inches (0.686 centimeters). Typically, a ratio of the radius of the arc of the first surface of the first arcuate portion to the radius of the arc of the first surface of the second arcuate portion is greater than approximately 0.194.

Typically, a length of a chord of the arc of the first surface of the second arcuate portion is greater than 0.546 inches (1.387 centimeters). A ratio of a length of the arc of the first surface of the second arcuate portion to the length of the chord of the arc of the first surface of the second arcuate portion generally is less than 1.150. In one embodiment, the ratio of the length of the arc of the first surface of the second arcuate portion to the length of the chord of the arc of the first surface of the second arcuate portion comprises a range between 1.045 and less than 1.150.

The relationships described above are used in the method 200 to make the skin according to the present invention. These relationships are defined in one formula, which requires that the ratio of a length of the arc of the first surface of the second arcuate portion to the length of the chord of the arc of the first surface of the second arcuate portion is less than 1.150.

In the method 200, a maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion generally is less than a perpendicular distance between the first and second surfaces of the sheet. Typically, the perpendicular distance between the first and second surfaces of the sheet is approximately 0.125 inches (0.318 centimeters). In one embodiment, the maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion is in a range between approximately 0.090 inches (0.229 centimeters) and less than 0.133 inches (0.338 centimeters). In another embodiment, the perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion is approximately 0.118 inches (0.30 centimeters).

Generally, a ratio of the maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion to a minimum perpendicular distance between the first surface of the sheet and the first surface of the second arcuate portion is less than 4.926.

In one embodiment, the method 200 further comprises providing an upper inclined wall, providing a lower inclined wall, and providing a lower contour wall. The upper inclined wall comprises a first end and a second end. The lower inclined wall comprises a first end and a second end. The first and second arcuate portions are disposed between the second end of the upper inclined wall and the first end of the lower inclined wall. The lower contour wall comprises a first end and a second end. The first end of the lower contour wall is adjacent to the second end of the lower inclined wall.

Generally, a linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is less than 0.862 inches (2.189 centimeters). Generally, linear distances are measured substantially parallel to the planar surface of the first surface of the sheet. In one embodiment, the linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is approximately 0.853 inches (2.167 centimeters). A ratio of a surface distance from the first end of the upper inclined wall to the second end of the lower inclined wall and the linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is less than 1.256. In another embodiment, the ratio of a surface distance from the first end of the upper inclined wall to the second end of the lower inclined wall and the linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is approximately 1.236.

Generally, a linear distance between the first end of the upper inclined wall and the second end of the lower contour wall is greater than 1.979 inches (5.027 inches). A ratio of a surface distance from the first end of the upper inclined wall to the second end of the lower contour wall to the linear distance between the first end of the upper inclined wall and the second end of the lower contour wall is less than 1.159.

Typically, a perpendicular distance between the first and second surfaces of the first arcuate portion is in a range between approximately 0.095 inches (0.241 centimeters) and approximately 0.107 inches (0.272 centimeters). In one embodiment, the perpendicular distance between the first and second surfaces of the first arcuate portion is in a range between approximately 0.097 inches (0.246 centimeters) and approximately 0.100 inches (0.254 centimeters). Generally, a ratio of the perpendicular distance between the first and second surfaces of the first arcuate portion to the perpendicular distance between the first and second surfaces of the sheet is in a range between approximately 0.760 and approximately 0.860.

Also typically, a perpendicular distance between the first and second surfaces of the second arcuate portion is in a range between approximately 0.095 inches (0.241 centimeters) and approximately 0.107 inches (0.272 centimeters). In one embodiment, the perpendicular distance between the first and second surfaces of the second arcuate portion is in a range between approximately 0.099 inches (0.252 centimeters) and approximately 0.105 inches (0.267 centimeters). Generally, a ratio of the perpendicular distance between the first and second surfaces of the second arcuate portion to the perpendicular distance between the first and second surfaces of the sheet is in a range between approximately 0.760 and approximately 0.860.

While the present invention has been disclosed with reference to certain embodiments, numerous modifications, alterations, and changes to the described embodiments are possible without departing from the sphere and scope of the present invention, as defined by the appended claims. Accordingly, it is intended that the present invention not be limited to the described embodiments, but that it has the full scope defined by the language of the following claims, and equivalents thereof.

What Is Claimed Is:

1. A skin comprising:

a sheet comprising a cellulosic material, the sheet further comprising a first surface and a second surface;

a first arcuate portion integral with the sheet, the first arcuate portion comprising a first surface and a second surface, the first and second surfaces of the first arcuate portion each comprising an arc; and

a second arcuate portion integral with the sheet and adjacent to the first arcuate portion, the second arcuate portion comprising a first surface and a second surface, the first and second surfaces of the second arcuate portion each comprising an arc, wherein an angle forming the arc of the first surface of the first arcuate portion is greater than 110 degrees and an angle forming the arc of the first surface of the second arcuate portion is less than 102 degrees.

2. The skin of claim 1, wherein the sheet comprises a fiberboard having a density in a range between approximately 50 pounds per cubic foot (801 kilograms per cubic meter) and approximately 70 pounds per cubic foot (1,121 kilograms per cubic meter).

3. The skin of claim 1, wherein the first and second arcuate portions are adjoining.

4. The skin of claim 1, wherein the first arcuate portion comprises a concave shape and the second arcuate portion comprises a convex shape.

5. The skin of claim 1, wherein the first arcuate portion comprises a convex shape and the second arcuate portion comprises a concave shape.

6. The skin of claim 1, wherein a radius of the arc of the first surface of the first arcuate portion is greater than 0.068 inches (0.173 centimeters) and a radius of the arc of the first surface of the second arcuate portion is greater than 0.350 inches (0.889 centimeters).

7. The skin of claim 6, wherein a ratio of the radius of the arc of the first surface of the second arcuate portion to the radius of the arc of the first surface of the first arcuate portion is less than 5.147.

8. The skin of claim 6, wherein a distance between a center of the radius of the arc of the first surface of the first arcuate portion and a center of the radius of the arc of the first surface of the second arcuate portion is less than 0.278 inches (0.706 centimeters).

9. The skin of claim 6, wherein a ratio of a length of the arc of the first surface of the second arcuate portion to a length of a chord of the arc of the first surface of the second arcuate portion comprises less than 1.150.

10. The skin of claim 9, wherein the length of the chord of the arc of the first surface of the second arcuate portion is greater than 0.546 inches (1.387 centimeters).

11. The skin of claim 1, wherein a ratio of the angle forming the arc of the first surface of the second arcuate portion to the angle forming the arc of the first surface of the first arcuate portion is less than 0.927.

12. The skin of claim 1, wherein a ratio of a length of the arc of the first surface of the first arcuate portion to a length of a chord of the arc of the first surface of the first arcuate portion is less than 1.180.

13. The skin of claim 12, wherein the length of the chord of the arc of the first surface of the first arcuate portion is greater than 0.111 inches (0.282 centimeters).

14. The skin of claim 1, further comprising:

an upper inclined wall comprising a first end and a second end;

a lower inclined wall comprising a first end and a second end, the first and second arcuate portions being disposed between the second end of the upper inclined wall and the first end of the lower inclined wall; and

a lower contour wall comprising a first end and a second end, the first end of the lower contour wall adjacent to the second end of the lower inclined wall.

15. The skin of claim 14, wherein a linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is less than 0.862 inches (2.189 centimeters).

16. The skin of claim 15, wherein a ratio of a surface distance from the first end of the upper inclined wall to the second end of the lower inclined wall to the linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is less than 1.256.

17. The skin of claim 14, wherein a linear distance between the first end of the upper inclined wall and the second end of the lower contour wall is greater than 1.979 inches (5.027 centimeters).

18. The skin of claim 17, wherein a ratio of a surface distance from the first end of the upper inclined wall to the second end of the lower contour wall to the linear distance between the first end of the upper inclined wall and the second end of the lower contour wall is less than 1.159.

19. The skin of claim 1, wherein a maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion is in a range between approximately 0.033 inches (0.084 centimeters) and less than 0.133 inches (0.338 centimeters) and wherein a minimum perpendicular distance between the first surface of the sheet and the first surface of the second arcuate portion is less than the maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion.

20. The skin of claim 19, wherein a ratio of the maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion to the minimum perpendicular distance between the first surface of the sheet and the first surface of the second arcuate portion is less than 4.926.

21. The skin of claim 1, wherein the sheet is coupled to an inner structure, thereby forming a door.

22. A method of making a skin, the method comprising:

providing a sheet comprising a cellulosic material, the sheet further comprising a first surface and a second surface;

molding a first arcuate portion integral with the sheet, the first arcuate portion comprising a first surface and a second surface, the first and second surfaces of the first arcuate portion each comprising an arc; and

molding a second arcuate portion integral with the sheet and adjacent to the first arcuate portion, the second arcuate portion comprising a first surface and a second surface, the first and second surfaces of the second arcuate portion each comprising an arc, wherein an angle forming the arc of the first surface of the first arcuate portion is greater than 110 degrees and an angle forming the arc of the first surface of the second arcuate portion is less than 102 degrees.

23. The method of claim 22, wherein the sheet comprises a fiberboard having a density in a range between approximately 50 (801 kilograms per cubic meter) and approximately 70 pounds per cubic foot (1,121 kilograms per cubic meter).

24. The method of claim 22, wherein the first and second arcuate portions are adjoining.

25. The method of claim 22, wherein the first arcuate portion comprises a concave shape and the second arcuate portion comprises a convex shape.

26. The method of claim 22, wherein the first arcuate portion comprises a convex shape and the second arcuate portion comprises a concave shape.

27. The method of claim 22, wherein a radius of the arc of the first surface of the first arcuate portion is greater than 0.068 inches (0.173 centimeters) and a radius of the arc of the first surface of the second arcuate portion is greater than 0.350 inches (0.889 centimeters).

28. The method of claim 27, wherein a ratio of the radius of the arc of the first surface of the first arcuate portion to the radius of the arc of the first surface of the second arcuate portion is less than 5.147.

29. The method of claim 27, wherein a distance between a center of the radius of the arc of the first surface of the first arcuate portion and a center of the radius of the arc of the first surface of the second arcuate portion is less than 0.278 inches (0.706 centimeters).

30. The method of claim 27, wherein a length of a chord of the arc of the first surface of the second arcuate portion is greater than 0.546 inches (1.387 centimeters).

31. The method of claim 30, wherein a ratio of a length of the arc of the first surface of the second arcuate portion to the length of the chord of the arc of the first surface of the second arcuate portion comprises less than 1.150.

32. The method of claim 22, wherein a ratio of the angle forming the arc of the first surface of the second arcuate portion to the angle forming the arc of the first surface of the first arcuate portion is less than 0.927.

33. The method of claim 22, wherein a length of a chord of the arc of the first surface of the first arcuate portion is greater than 0.111 inches (0.282 centimeters).

34. The method of claim 33, wherein a ratio of a length of the arc of the first surface of the first arcuate portion to the length of the chord of the arc of the first surface of the first arcuate portion is less than 1.180.

35. The method of claim 22, further comprising:

providing an upper inclined wall comprising a first end and a second end;

providing a lower inclined wall comprising a first end and a second end, the first and second arcuate portions being disposed between the second end of the upper inclined wall and the first end of the lower inclined wall; and

providing a lower contour wall comprising a first end and a second end, the first end of the lower contour wall adjacent to the second end of the lower inclined wall.

36. The method of claim 35, wherein a linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is less than 0.862 inches (2.189 centimeters).

37. The skin of claim 36, wherein a ratio of a surface distance from the first end of the upper inclined wall to the second end of the lower inclined wall to the linear distance between the first end of the upper inclined wall and the second end of the lower inclined wall is less than 1.256.

38. The skin of claim 35, wherein a linear distance between the first end of the upper inclined wall and the second end of the lower contour wall is greater than 1.979 inches (5.027 centimeters).

39. The skin of claim 38, wherein a ratio of a surface distance from the first end of the upper inclined wall to the second end of the lower contour wall to the linear distance between the first end of the upper inclined wall and the second end of the lower contour wall is less than 1.159.

40. The method of claim 22, wherein a maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion is in a range between approximately 0.033 inches (0.084 centimeters) and less than 0.133 inches (0.338 centimeters) and wherein a minimum perpendicular distance between the first surface of the sheet and the first surface of the second arcuate portion is less than the maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion.

41. The method of claim 40, wherein a ratio of the maximum perpendicular distance between the first surface of the sheet and the first surface of the first arcuate portion to the minimum perpendicular distance between the first surface of the sheet and the first surface of the second arcuate portion is less than 4.926.

42. The method of claim 22, further comprising coupling a sheet to an inner structure, thereby forming a door.

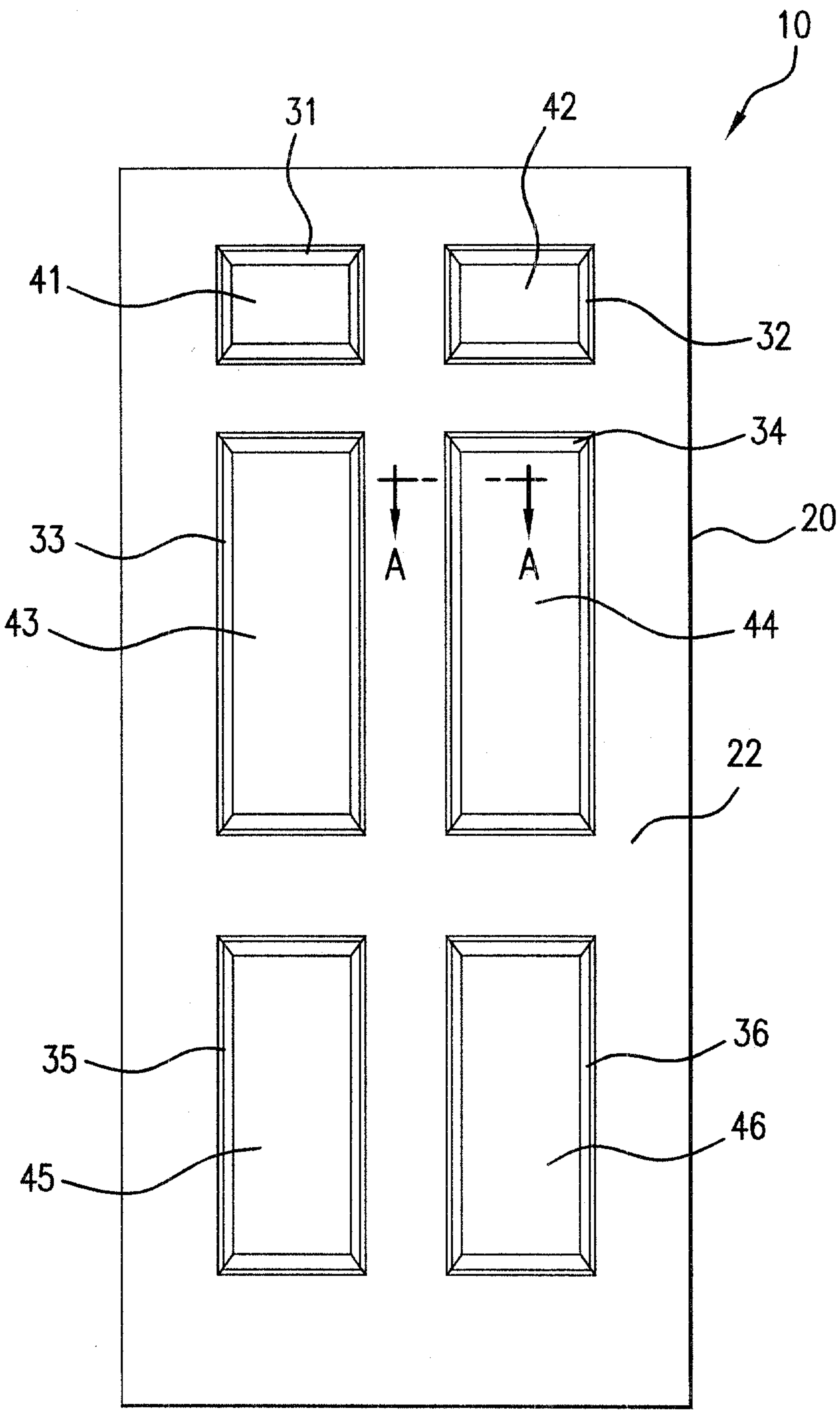
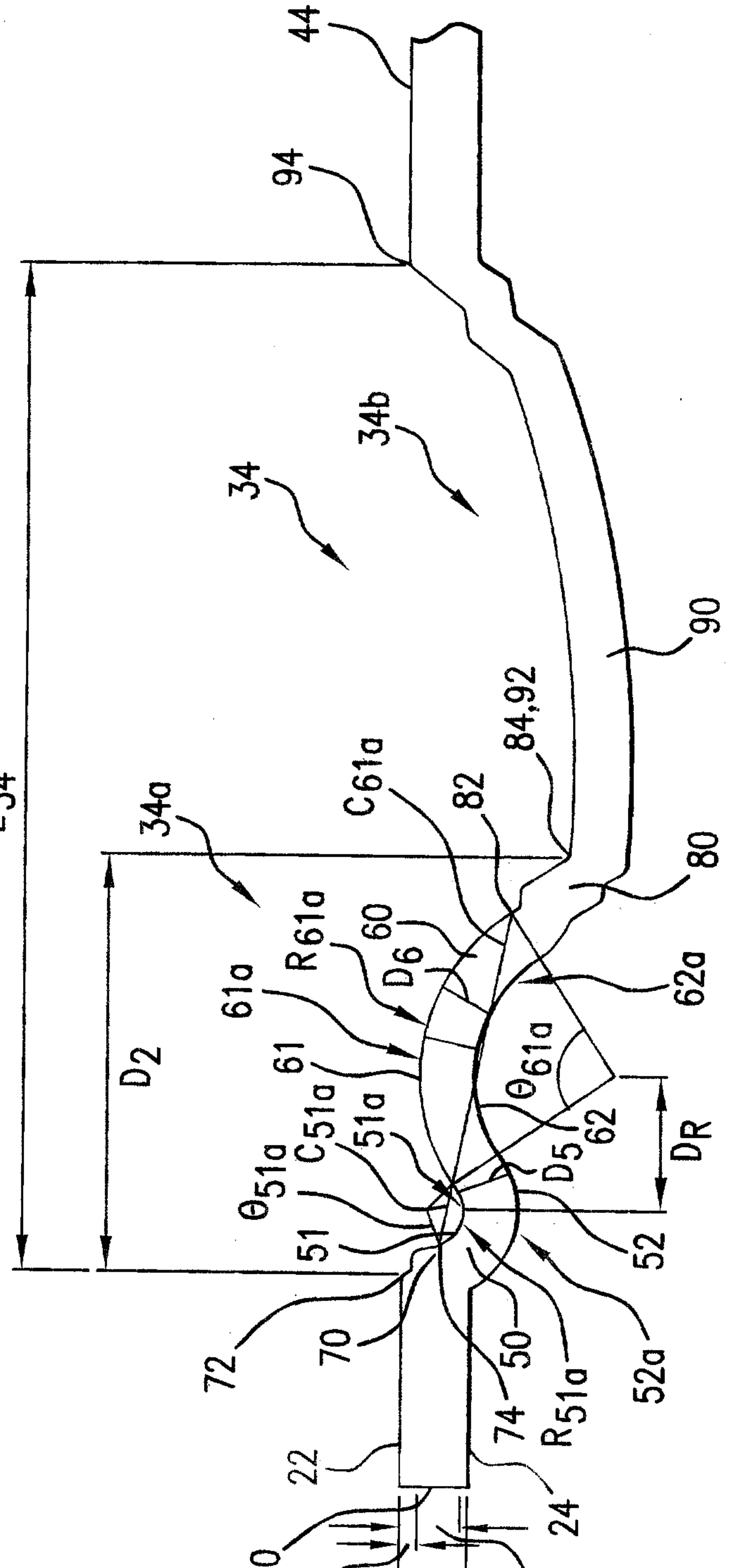


FIG.1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D_2
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D_1
D_3

FIG. 2

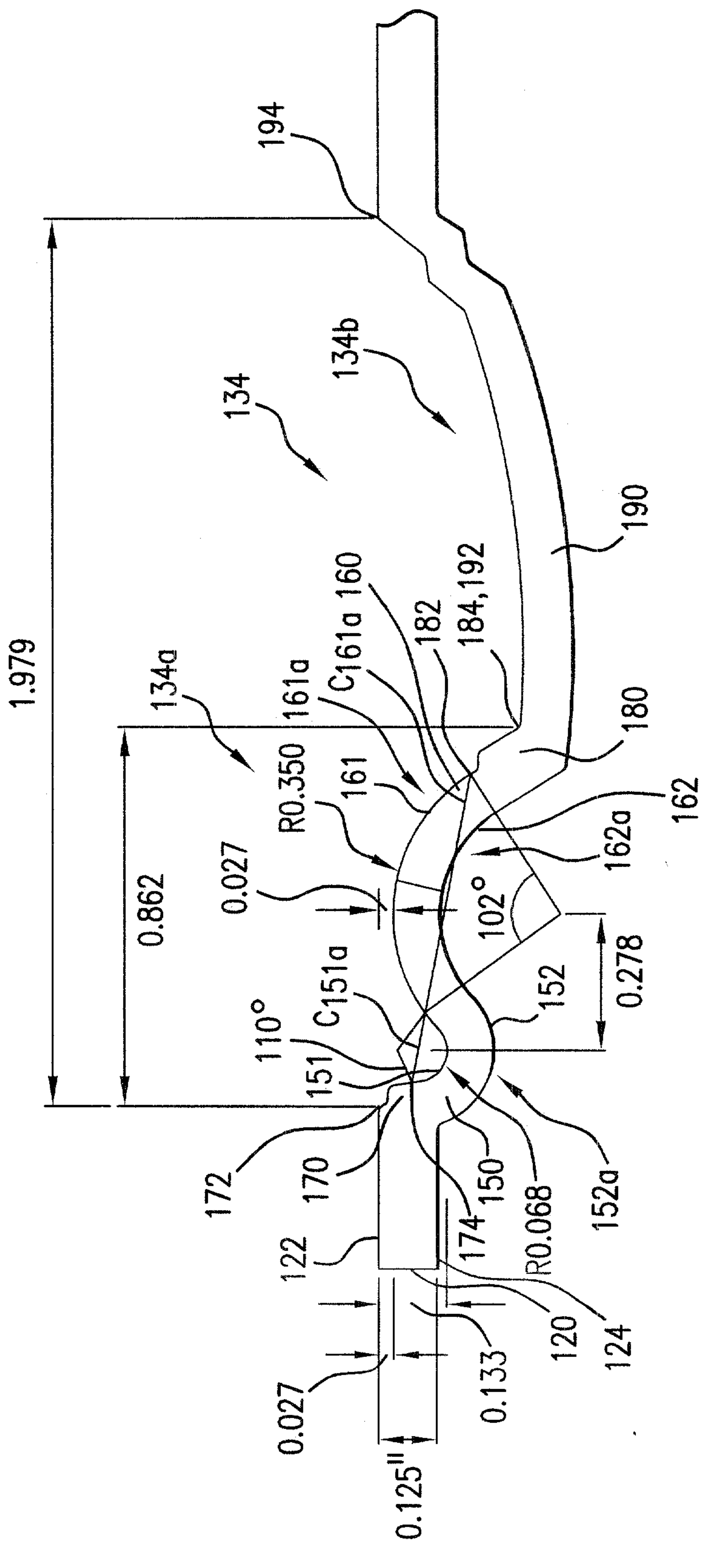


FIG.3
PRIOR ART

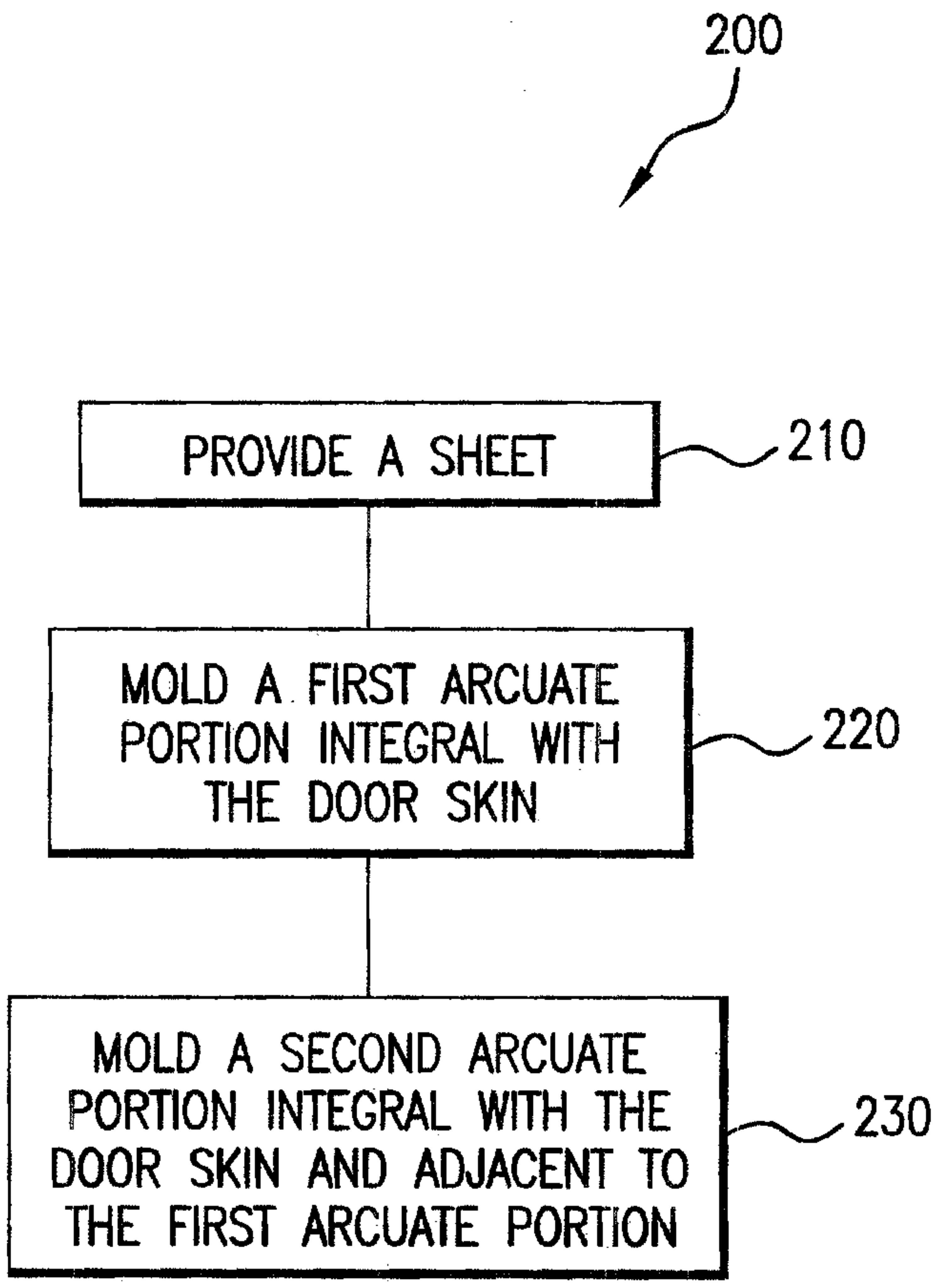
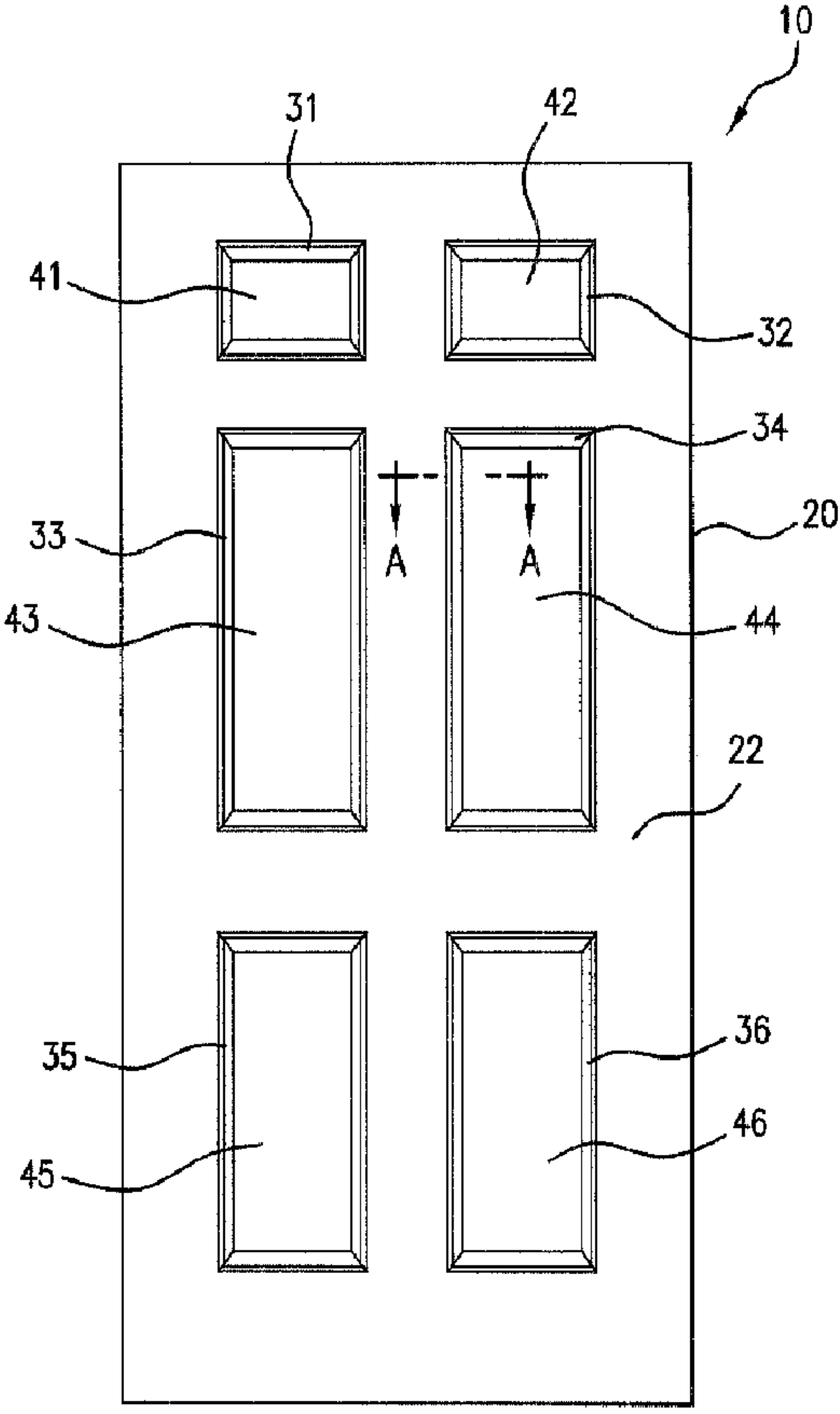

200
PROVIDE A SHEET
210
MOLD A FIRST ARCUATE PORTION INTEGRAL WITH THE DOOR SKIN
220
MOLD A SECOND ARCUATE PORTION INTEGRAL WITH THE DOOR SKIN AND ADJACENT TO THE FIRST ARCUATE PORTION
230

FIG.4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