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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B27D 1/08, B32B 1/00, 21/14

A1

(11) International Publication Number: **WO 98/24602**

(43) International Publication Date: 11 June 1998 (11.06.98)

(21) International Application Number: PCT/NO97/00324

(22) International Filing Date: 4 December 1997 (04.12.97)

(30) Priority Data:
965205 5 December 1996 (05.12.96) NO

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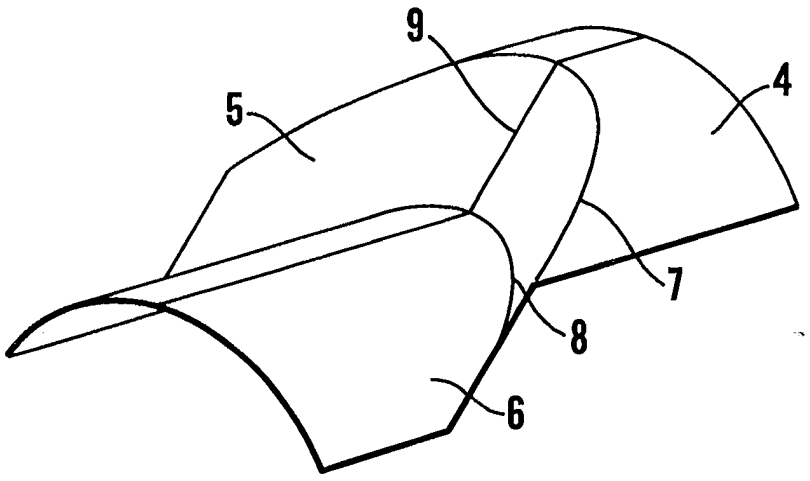
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: LAMINATED OBJECT AND MOULD

(57) Abstract

The invention concerns a laminated object comprising successive laminate plate portions (4, 5, 6) which are curved in a direction perpendicular to a longitudinal extension (9) through the object. Adjacently located laminate plate portions (4, 5) are continuously connected through a turning line (7) which defines an intersection between the adjacently located plate portions (4, 5). The laminate plate portions (4, 5) on opposite sides of the turning line (7) have equal, but oppositely directed curvature. The invention also concerns a mould for moulding the laminated object.



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Laminated object and mould

The invention concerns a laminated object comprising successive laminate plate portions which are curved in a direction perpendicular to a longitudinal extension through the object.

The invention also concerns a mould for moulding a laminated object, comprising two mould halves which can be pressed together, the mould halves comprising corresponding successive shaping surfaces which are curved in a direction perpendicular to a longitudinal extension through the mould.

Laminated objects, consisting of layers of material, often in the form of plywood, are used for furniture, especially chairs.

The most rational method of manufacturing laminated objects is by stacking the different layers on top of one another with intermediate layers of glue. The stack is placed in a mould in a press, whereupon under the influence of pressure and possibly heat the layers of material are bent and pressed together to form the finished laminated object. This bending process will cause the outermost layers of material in a bend to be stretched, while the innermost layers of material in the bend are compressed, with the result that delamination and cracks may occur.

For this reason there are obvious limitations to the shape of the laminated object. The usual shape is a single-curved surface, such as a chair back, which may be produced with some degree of sliding between the layers during the pressing. With the above-mentioned method, however, it is not possible to achieve a sharply bended continuous transition between two single-curved surfaces, for example between a chair back and a chair seat, which sets an obvious limit to the shape of laminated objects.

Finnish patent 34 604 describes a laminated body of a chair consisting of a substantially single-curved back and a substantially single-curved seat. The back and the seat are connected in a transition section which is provided with wedge-shaped slits which taper off in towards the central part of the transition section. When the laminate is pressed the chair is bent in the transition section, thus closing the slits and the back and the seat become connected along the entire width of the chair. A continuous transition is

thereby produced between two single-curved surfaces, but there is no continuity in the layers of material, with the result that the transition section is weaker than the back and the seat.

Danish patent 147 173 mentions hot pressing of a polygonal plywood object with a strongly profiled transitional zone between a generally flat edge zone and a flat or weakly profiled central section. In order to counteract cracking in the transitional zone during pressing it is provided with wedge-shaped slits. During pressing of the plywood object the slits are closed, thus forming a continuous object, but in this case too there is no continuity in the layers of material, with the result that the transitional zone is weaker than the rest of the object.

The object of the invention is to provide a laminated object comprising curved, mutually connected laminate plate portions, wherein the layers of material should be continuous in transitional areas between the laminate plate portions, and wherein it should not be easy for fractures or delamination to occur in the transitional areas.

The object is further to provide a mould for moulding a laminated object comprising curved, mutually connected laminate plate portions, wherein the layers of material should be continuous in transitional areas between the laminate plate portions.

The objects are achieved according to the invention with a laminated object and a mould of the type mentioned in the introduction, characterized by the features which are stated in the claims.

The claims uses "longitudinal extension" to describe a longitudinal direction extending through successive plate portions forming the object. "Turning line" is used to describe an intersecting line between two adjacently located curved plate portions or curved surfaces where the longitudinal extension undergoes a bending.

The claims specify the invention by the definition of a laminated object with a previously unknown shape, and where the layers of material are continuous, maintaining the strength of the laminate throughout the entire object. The invention discloses a construction principle for a laminated object, which principle may form the basis for various products.

Is should however be understood that the practical design of the object or product may also include an adaption of the shape according to known principles within the field. The final shape of the object may thus deviate somewhat from the definition in the claims.

Thus "curved plate portions" and "curved surfaces" should in a practical design be understood as "substantially curved plate portions/surfaces", also including angular plate portions/surfaces of a substantially curved nature. Similarly "equal curvature" should be understood as "substantially equal curvature".

The invention will now be explained in more detail in connection with a description of a specific embodiment, and with reference to the drawing, in which:

Fig. 1 is a side view of a laminate plate which is bent according to prior art.

Figs. 2, 3 and 4 illustrate the principle of the inventive concept, applied on an object consisting of three curved laminate plate portions.

Fig. 5 illustrates a blank for a laminated object according to the invention.

Fig. 6 illustrates a mould for moulding a laminated object according to the invention.

Fig. 7 illustrates a ready-moulded object according to the invention.

Fig. 8 illustrates an object according to the invention, in the form of a chair.

Fig. 1 is a side view of a single-curved laminate, bent according to prior art by placing a stack of layers of material on top of each other with intermediate layers of glue, and pressing the stack to the finished laminate. The laminate consists of three layers of material, an outer layer 1, a central layer 2 and an inner layer 3. When the laminate is bent the outer layer 1 will be stretched and the inner layer 3 compressed, with the result that cracks 14 may occur in the outer layer of material. Delamination may also occur between the layers of material as a result of stresses in the laminate. Minimum bending radii R for the laminate have therefore been laid down in the field, depending on material type, layer thickness and number of layers, in order to avoid delamination and cracking. In addition the bending of each layer of material

must of course also be performed with a certain minimum radius, in order to avoid fractures in the layer of material.

Fig. 2 is a schematic side view of a laminated object according to the invention, consisting of three successive, mutually connected curved laminate plate portions 4, 5, 6. The laminate plate portions are shown here only as surfaces without any thickness. Each plate portion thus defines a curved plane. The first plate portion or plane 4 intersects and is continuously connected with the second plate portion or plane 5 along an intersecting line 7, which in the invention is designated turning line 7, and the second plate portion or plane 5 intersects and is continuously connected with the third plate portion or plane 6 along an intersecting line 8, designated turning line 8.

Fig. 3 shows the curved planes in fig. 2 in perspective. The turning lines are not shown here. The curved planes 4, 5 and 6 illustrated in the figures are single-curved. The form of the plate portions may however deviate from the single-curved shape, as will be discussed later.

Fig. 4 shows the same plate portions or planes, where the parts of the plate portions which do not form a part of the object are omitted. The planes 4, 5, 6 forms a continuous object, and thus fig. 4 in principle illustrates the finished laminated object. It is also illustrated here how the plate portions or planes 4, 5, 6 are curved in a direction perpendicular to a longitudinal extension 9 through the object. The longitudinal extension 9 through the object is formed by lines of longitudinal extension in each plate portion or plane 4, 5, 6, which are mutually connected in the turning lines 7, 8. In the illustrated design each planes' curvature is symmetrical about the line of longitudinal extension in each plane, and the longitudinal extension 9 through the object is thus located in a symmetry plane through the three planes 4, 5, 6.

It is further illustrated how plane 4 and 6 are curved in the same direction, while plane 5 is curved in the opposite direction. This is best illustrated in fig. 3. Thus it is shown how adjacently located planes or plate portions on opposite sides of the turning line have equal, but oppositely directed curvature.

The curvature of the planes or the plate portions may have different shapes, such as circular, elliptical or parabolic. The curvature may be constant or continuously increasing or decreasing in the direction of the object's longitudinal extension. Even if the curvature is continuously increasing or decreasing in the direction of the object's longitudinal extension, it will still be equal, but oppositely directed, on opposite sides of a turning line, due to the continuity of the plate portions through the turning line.

Fig. 5 illustrates a blank 10 for a laminated object according to the invention. The blank is of a known type, consisting of a stack of material layers with intermediate layers of glue. The layers of material are typically composed of plywood with the fibres running in different directions.

Fig. 6 illustrates a mould according to the invention for use in a press for manufacturing a laminate. The mould comprises two mould halves, an upper part 11 and a lower part 12.

The mould's upper part 11 has three successive, curved, shaping surfaces 24, 25, 26, turning lines 27 and 28 and a longitudinal extension 29, corresponding to the plate portions 4, 5, 6, the turning lines 7 and 8 and the longitudinal extension 9.

The mould's lower part 12 similarly has three successive, curved, shaping surfaces 34, 35, 36, turning lines 37 and 38 and a longitudinal extension 39.

The surfaces 24, 25, 26, 34, 35, 36 are curved in a direction perpendicular to the longitudinal extension 29, 39 through the mould. Adjacently located surfaces of each mould half, e.g. surfaces 24, 25, are continuous through a turning line 27 which defines an intersection between the adjacently located mould surfaces 24, 25. Further the surfaces 24, 25 on opposite sides of the turning line 27 have equal, but oppositely directed curvature.

The surfaces' curvature may be single-curved to correspond to a single-curved curvature of the laminate plate portions.

The surfaces of the mould further corresponds to the planes 4, 5 and 6, and this discussion will consequently not be repeated.

The actual manufacture of the laminate, where the blank is placed in the mould and exposed to pressure and possibly heat, whereupon after a time the

blank assumes the shape of the ready-laminated object, is prior art and will not be described further.

Fig. 7 illustrates a ready-moulded laminated object according to the invention, moulded by the blank in fig. 5 with the mould in fig. 6. The ready-moulded object consists of three sections or plate portions 44, 45, 46, turning lines 47 and 48 and a longitudinal extension 49, corresponding to the planes 4, 5, 6, the turning lines 7 and 8 and the longitudinal extension 9.

As the laminated object in fig. 7 consist of several layers of material which all have minimum requirements to bending radius, the actual bending of each layer will take place in a bending or turning area on both sides of the turning lines.

Fig. 8 illustrates a chair which comprises a laminated object according to the invention, where the laminated object is composed of a chair back 54, an intermediate section 55 and a seat 56, connected by turning lines 57 and 58, fundamentally corresponding to the planes 4, 5, 6 and the turning lines 7, 8. As the longitudinal extension is not physical line, it is not illustrated in fig. 8.

According to the invention the turning line is an intersecting line between the two curved planes which are located on each side of the turning line, and the turning line therefore becomes a curved line. This is in sharp contrast with turning or bending lines in known manufacture of laminated objects, which are straight or almost straight.

Both in the invention and according to the prior art the bending of the laminates is performed perpendicularly to the turning line. In the prior art, where the turning line is straight, the laminate is bent only in a plane perpendicular to the turning line, while in the invention, where the turning line is curved, the bending also takes place in a direction along the bending line, thus making the bending three-dimensional.

In the physical embodiment of the invention, represented by the object in fig. 7 and the chair in fig. 8, where the laminate has a thickness, the bending of each layer of material in the laminate follows its own turning line. Moreover, the bending of each of the layers of material in the laminate is performed with a minimum radius in order to avoid cracking of the material layer

concerned, since the requirement for a minimum radius when bending each material layer is naturally not changed by the invention. The total bending of the layers of material in the laminate therefore extends over a bending or turning area about a common theoretical turning line.

Since the laminate plate portions on opposite sides of a turning line have equal, but oppositely directed curvature, and due to the above-mentioned three-dimensional bending, a bending area is obtained where all the layers of material through the bending area have the same or approximately the same area or length. There will practically be no stretching of the outer layer or compression of the inner layer, as for prior art. Fibres running in every direction in all the layers of material are thus not exposed to any appreciable length alteration during the bending process, and the above-mentioned problem of cracking and delamination in the bending area is thereby eliminated.

The advantages achieved are confirmed by theoretical considerations, where by means of computer assisted design of a laminate consisting of several planes measurements were performed of the length of different lines in various laminate planes through a turning area at a turning line. These theoretical measurements showed that the lines which passed through the turning area were of equal length, regardless of the laminate plane in which they were located, and regardless of the direction of the line.

Production tests have also been carried out, which have demonstrated that the principles of the invention enables production of laminated objects which is bent to a much higher degree than laminated objects which is produced according to prior art.

Thus the invention provides a laminated object and a mould for moulding a laminated object which fulfil the object of the invention, viz. that in the transitional areas between curved, connected laminate plate portions the laminate should have continuous layers of material in which it is not easy for fractures or delamination to occur.

The inventive concept may be employed together with known principles for manufacturing laminated objects, where rounding, adaptations and curved sections can be given a certain extension depending on the laminate material, the number of layers of material and the thickness of the layers, thereby

making it easy for a person skilled in the art to manufacture an object which will deviate from the exact shape as described above. An example of such an adaptation may be to give a turning area in connection with the turning line 57 in fig. 8, a certain extension in the direction of the objects longitudinal extension, thus giving the back 54 a comfortable rounding in its lower section. Such an adapted object will naturally still be within the scope of the invention as it is defined in the claims.

PATENT CLAIMS

1. A laminated object comprising successive laminate plate portions (4, 5, 6; 44, 45, 46; 54, 55, 56) which are curved in a direction perpendicular to a longitudinal extension (9; 49) through the object,
characterized in that adjacently located laminate plate portions (4, 5) are continuously connected through a turning line (7) which defines an intersection between the adjacently located plate portions (4, 5), and that the laminate plate portions (4, 5) on opposite sides of the turning line (7) have equal, but oppositely directed curvature.

2. A laminated object according to claim 1,
characterized in that the plate portions' curvature is symmetrical about the object's longitudinal extension (9).

3. A laminated object according to claim 1 or 2,
characterized in that the plate portions' curvature is single-curved.

4. A laminated object according to one of the preceding claims,
characterized in that the plate portions' curvature is circular.

5. A laminated object according to one of the preceding claims,
characterized in that the plate portions' curvature is constant in the direction of the object's longitudinal extension.

6. A laminated object according to one of the claims 1-4,
characterized in that the plate portions' curvature is continuously increasing or decreasing in the direction of the object's longitudinal extension.

7. A mould for moulding a laminated object, comprising two mould halves (11;12) which can be pressed together, the mould halves comprising corresponding successive shaping surfaces (24, 25, 26; 34, 35, 36) which are curved in a direction perpendicular to a longitudinal extension (29; 39) through the mould,
characterized in that adjacently located surfaces (24, 25) of each mould half are continuous through a turning line (27) which defines an intersection between the adjacently located mould surfaces (24, 25), and that the surfaces (24, 25) on opposite sides of the turning line (27) have equal, but oppositely directed curvature.

8. A mould according to claim 7 or 8,
characterized in that the surfaces' curvature is single-curved.

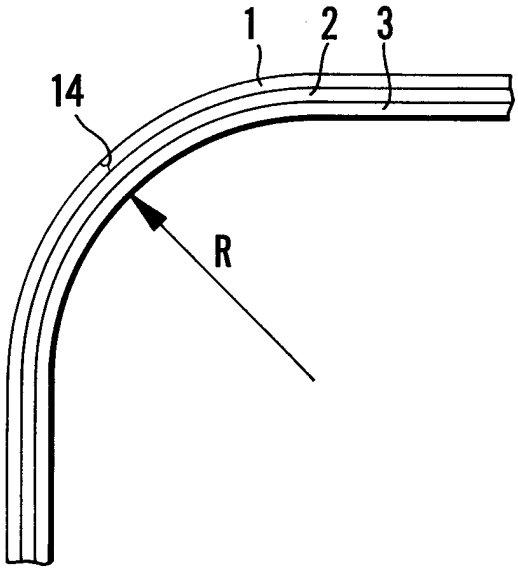

Fig. 1

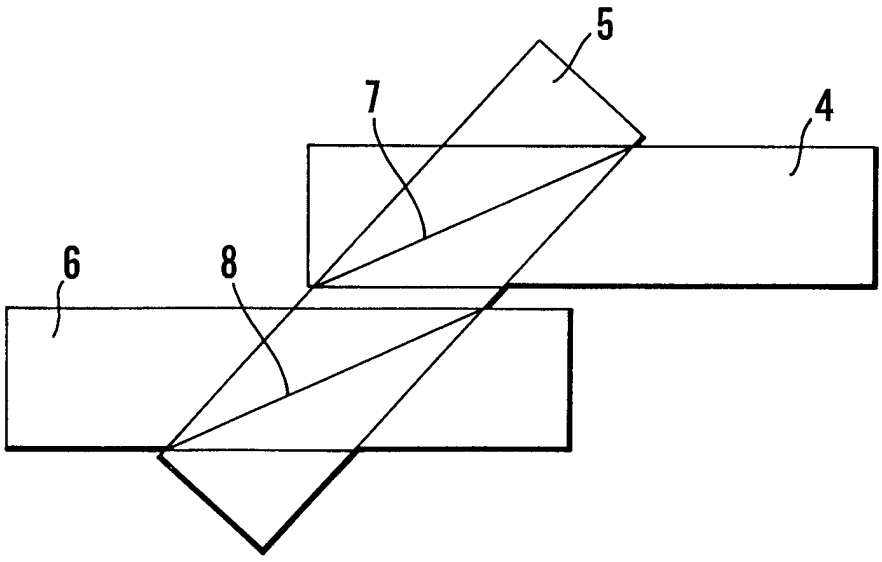

Fig. 2

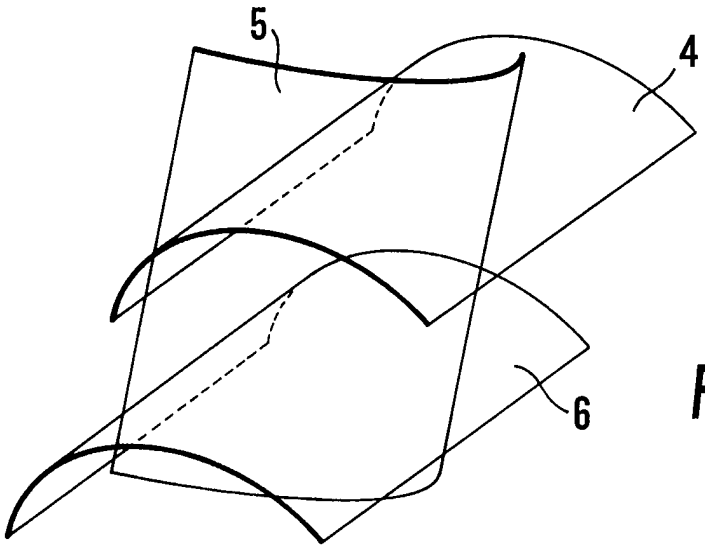

Fig.3

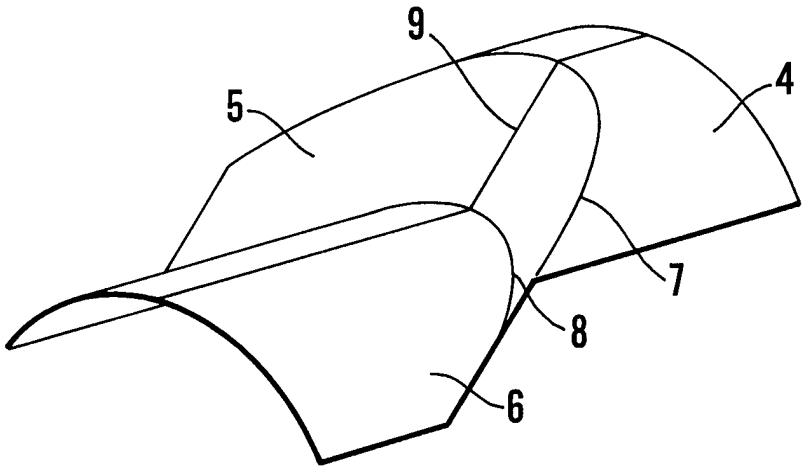

Fig.4

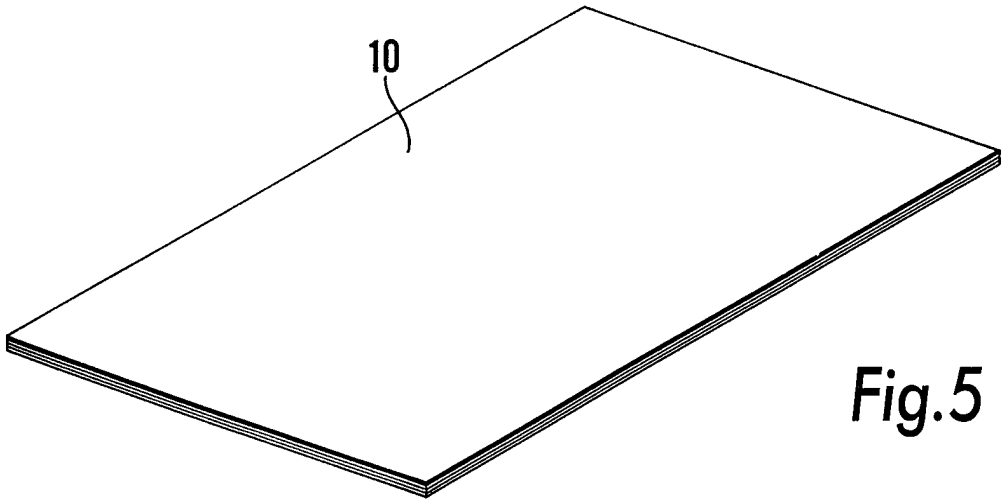

Fig.5

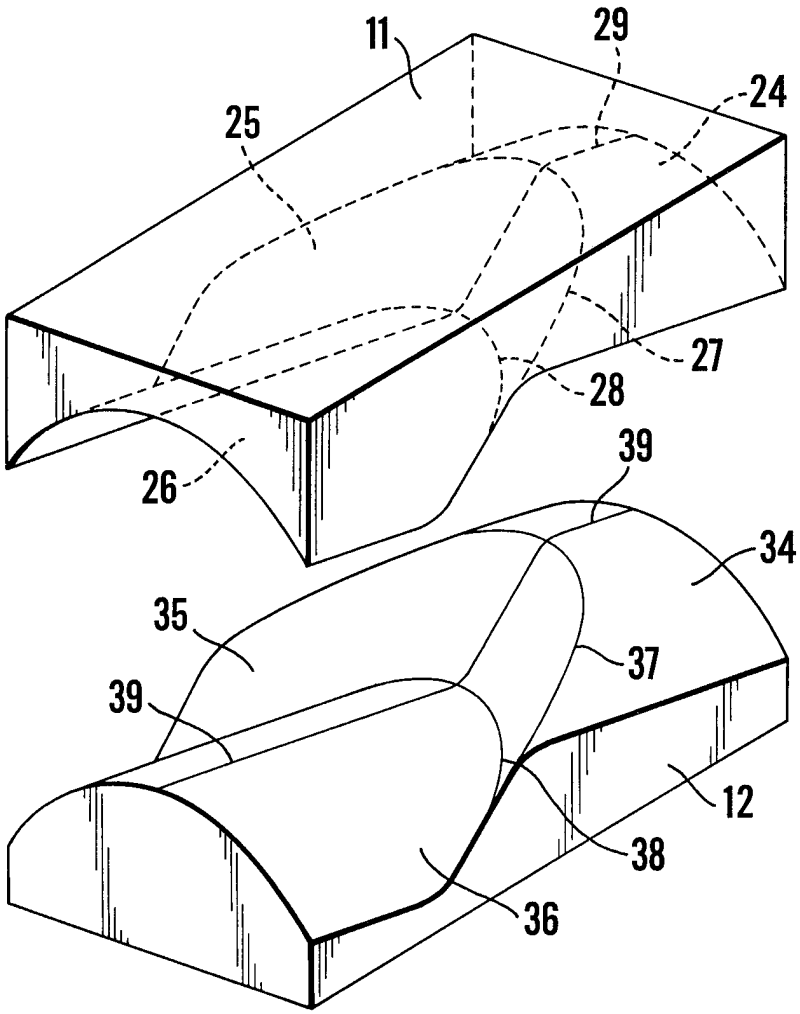

Fig.6

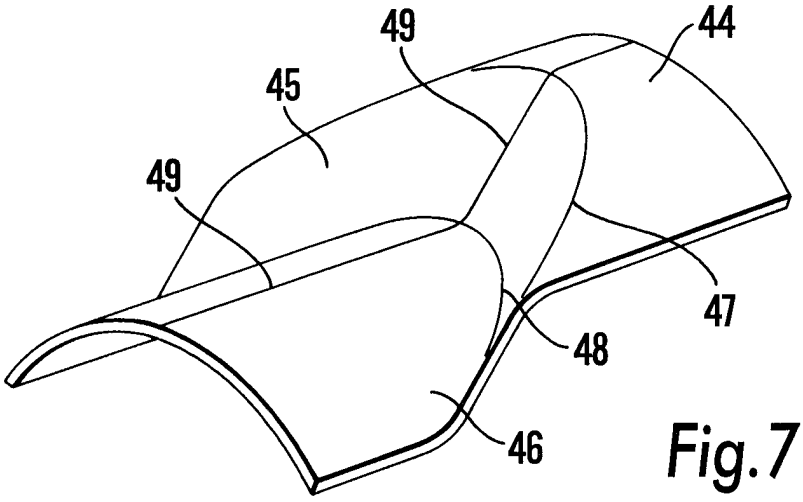

Fig.7

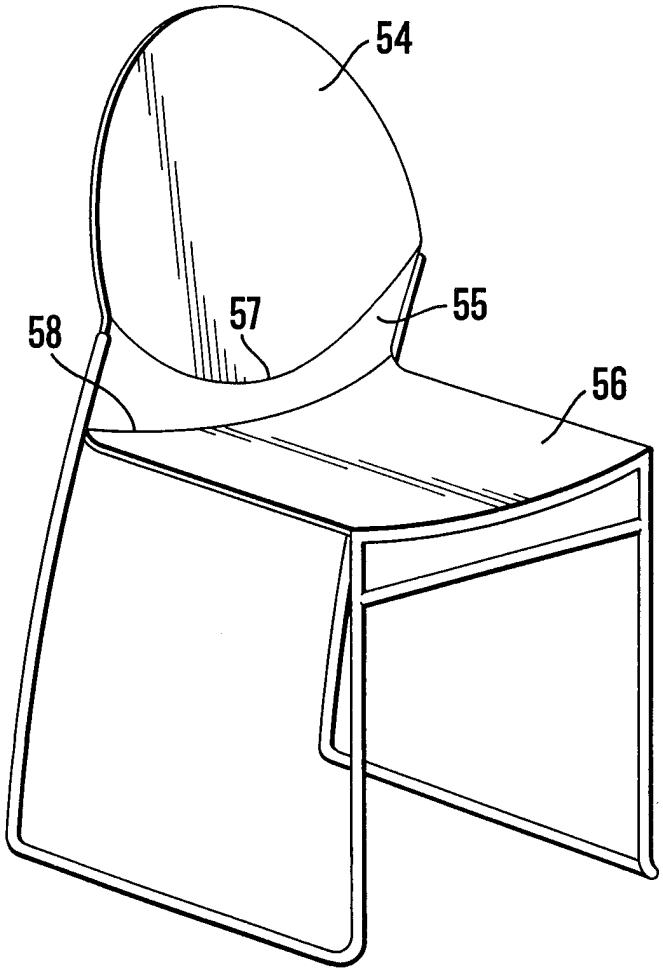

Fig.8

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B27D 1/08, B32B 1/00, B32B 21/14
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)

IPC6: B27D, B32B

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

SE,DK,FI,NO classes as above

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0106427 A1 (OGG, RICHARD), 25 April 1984 (25.04.84) --	1-8
A	US 3878015 A (ERVIN R. JOHNSTON), 15 April 1975 (15.04.75) --	1-8
A	WO 8102541 A1 (SMEDEGÅRD, TOMMY, LYKKE, CHRISTENSEN), 17 Sept 1981 (17.09.81) --	1-8

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16 March 1998	17 -03- 1998
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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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