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(54) **Laminated timber element and a method for manufacturing the element**

(57) A glued-laminated timber element (30), in which two elongated timber pieces (38) are glued together, which pieces are straight or wedge-shaped. In at least two timber pieces the grains run in different directions. In the glued-laminated timber panel two adjacent timber pieces are joined to each other in such a way that their grains run in different directions and their

heart sides face towards each other. In the method for manufacturing the glued-laminated timber element (30) two or more elongated timber pieces are glued together in such a way that the timber pieces are placed in the glued-laminated timber element in such a way that at least one timber piece is turned around after sawing so that its grain runs in a different direction to the grain of the other timber piece.

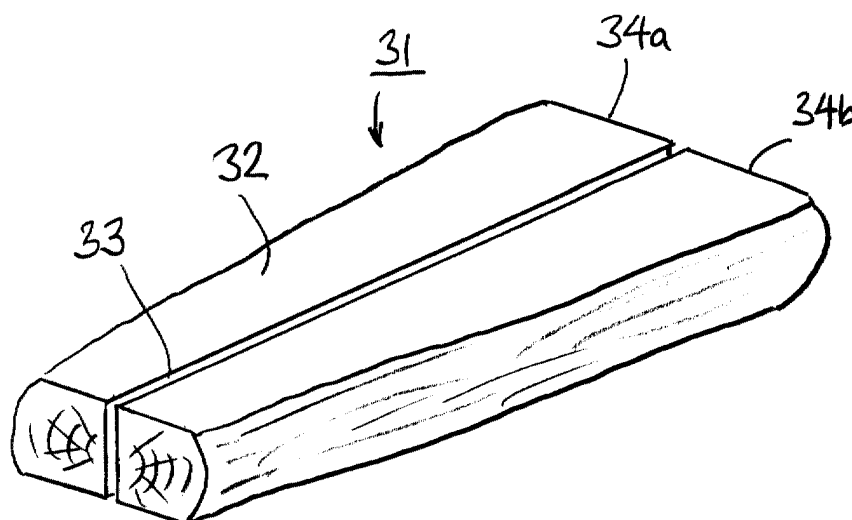
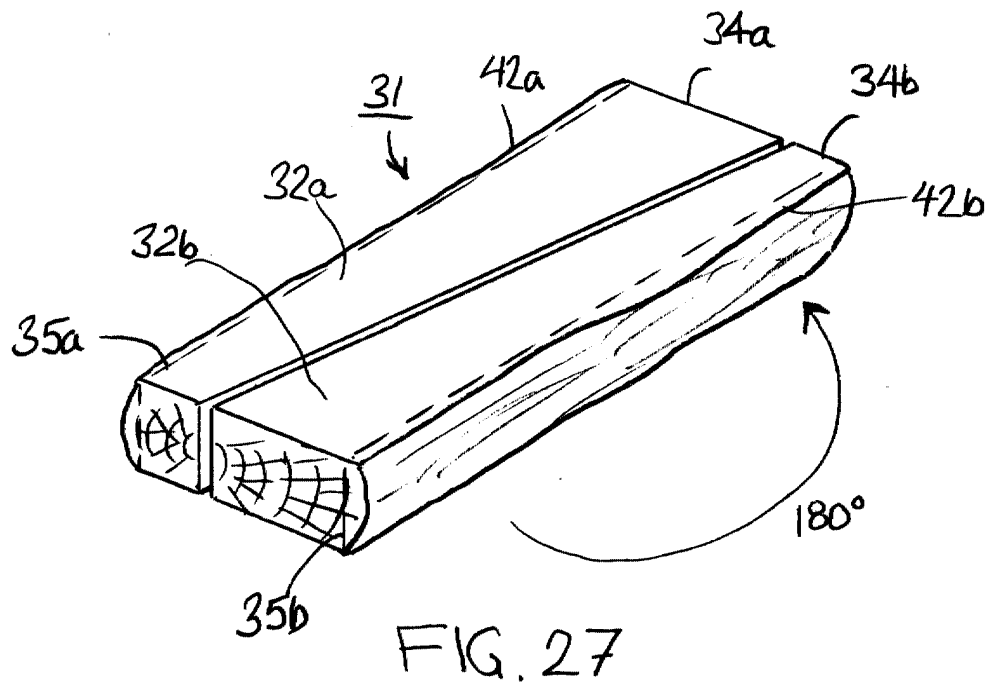


FIG. 26



Description

[0001] The object of the invention is a glued-laminated timber element comprising two or more elongated timber pieces glued together.

[0002] Known timber elements, such as glulam timber beams, usually comprise sawn timber of uniform thickness and uniform width glued together. However, since natural timber is always to some extent conical, the wood's grain structure is broken in timber sawn to uniform thickness and width. The breaking of the grain naturally reduces the strength of the sawn pieces and hence the strength of the timber elements formed by gluing them together. The breaking of the grain also reduces the capacity of a glued-laminated timber element, such as a glulam beam, to remain straight.

[0003] The above-mentioned problems are particularly pronounced in glulam panels. Present glued and laminated panels are made of regular sawn timber by dividing it into smaller pieces. The grain structure of regular sawn timber is broken in the sawing process, which reduces the strength and aesthetic appeal of the sawn timber. Another problem in this situation is that split sawn knots remain on the panel surface, in which case the knots often come loose in working the panels. Large split sawn knots reduce the aesthetic appeal of the panel and therefore its value. The raw material of the panels is also nonhomogeneous because of the colour variation of heartwood and sapwood and dry and fresh knots. The tree's heart pith also often remains visible because of the way the timber is cut. This occurs, for instance, when a sawn piece with a 50 x 100 mm cross section is cut into two 50 x 50 mm pieces. In this case, the heart pith remains on the edge of the blank and therefore visible in the glued panel.

[0004] The grain pattern also varies depending on the position of the outer and inner face of the wood. When the outer face of sawn timber is on the surface of the panel, the tree's grain may rise, forming a dangerously sharp crack.

[0005] The warping of glulam panels made of regular sawn timber is also great because of the variations in the radial and tangential contraction of the timber pieces used in their manufacture. This causes variable contraction on the various surfaces of the glulam panel, as the inner and outer sides and edges of the timber are not present to equal degrees in the various surfaces of the glulam panel. The diameter of the top end of the wood used as raw material is usually at least 15 cm, which means that knots are also relatively large. Sawlog grade timber would not have knots, but it would be uneconomical to use it for manufacturing glulam panels.

[0006] For the above-mentioned reasons, an effort has also been made to saw timber parallel to its surface, which results in wedge-shaped timber pieces instead of timber of uniform thickness and width. Since the grain structure is not broken in timber obtained in this way, the sawn pieces are markedly more durable than pieces of

uniform thickness and width. In this way it is also possible to utilise the entire tree stem substantially more efficiently. When these wedge-shaped pieces are glued together in a variety of combinations, the result is a glulam element, such as a glulam beam, which is stronger than known beams. Also the proportion of glued seams in the finished beam is smaller.

[0007] Various glulam elements made of wedge-shaped timber pieces and the methods of manufacturing them have been demonstrated in publications DK-167566, CH-645837, CH-683828, DE-4135247, DE-4212687, EP-388507, EP-518246, DE-4209407 and DE-1628884.

[0008] However, glulam elements made of wedge-shaped timber pieces have not proved to have sufficiently good properties in demanding conditions of use. The purpose of this invention is to eliminate the disadvantages of known elements and to create a novel kind of glulam element.

[0009] In the glulam element relating to the invention, the surfaces of wedge-shaped timber pieces have been sawn parallel to the grain, since in resawing, the block is sawn in two parallel to the heart and the opposite sides of the blanks are then resawn parallel to the grain at that point. In this way the grain structure of the wood remains intact, which has the effect that the wedge-shaped timber pieces and the elements made of them are stronger than known glulam elements. The glulam elements relating to the invention also have fewer seams than known glulam elements and they also keep their straightness better than known glulam beams.

[0010] According to one preferred embodiment of the glulam element relating to the invention, the outside face of a wedge-shaped timber piece is made to face towards the inside of the element, and the heartwood is on the surface of the glulam element. In this way the softer outside face which is more susceptible to splitting is protected inside the element, and the stronger and more weather-proof heartwood is on the surface. This structure reduces the occurrence of visible splits in the glulam beam.

[0011] The purpose of the invention is also to create a new glulam element, such as a glulam panel, which does not have the above-mentioned disadvantages.

[0012] The glulam panel relating to the invention has no harmful split sawn knots in sight, as the knots start from inside the panel towards the surface. This means that the knots stay in place well when the panel is worked, and the panel is homogeneous in terms of both appearance and knottiness. It is also light-coloured, and the heart pith is always concealed inside the product. The grain structure remains better intact and the panel surface obtains a scantling structure in which the grain is perpendicular to the surface. The grain pattern is even and the grain structure does not disintegrate. The contraction of both sides of the glulam panel is equal and the panel's lateral contraction is smaller than with present panels. The timber pieces used for the glulam

panel can be sawn from thin pulpwood grade timber with a diameter of 10-13 cm at the top of the stem. This saves raw material and improves the wood utilisation ratio. Using sawn timber obtained from pulpwood grade for the panels is also less expensive.

[0013] According to one preferred embodiment of the invention, the timber pieces are sawn in such a way that first of all a block is sawn in which the opposite sawn sides are parallel. Then the flat block is resawn in two through the centre at the heart and at the sides it is sawn parallel to the wood's surface and grain. In this way the block produces two wedge-shaped pieces. A timber panel is assembled in such a way that the wedge-shaped pieces are laid together so that the heart pith remains in the middle of the panel and the knots start from the inside of the panel towards the surface. This ensures that no split sawn knots remain visible on the panel surface.

[0014] The glulam panel has a scantling structure, in which the grain runs at right angles to the panel's surface. The grain structure does not break on the panel surface, because the wedge-shaped timber pieces have been sawn parallel to the wood surface and parallel to the grain. Because the grain runs perpendicular to the surface, the grain does not disintegrate from the panel surface and the grain pattern on the surface is even. Moreover, since the grain structure is always perpendicular to the surface and in the same direction, equally strong tensions are created on both panel surfaces and their contraction is equal.

[0015] Since the radial contraction in the timber pieces is smaller than the tangential contraction, the lateral warping is less in the glulam panel than in a traditional panel. Because of the scantling structure, the warping and twisting of the glulam panel relating to the invention is less than with panels in which the angles of the grain vary in the timber pieces.

[0016] Another advantage of the glulam panel relating to the invention is the fact that it is sawn from the top portion of trees, which means that its knottiness is sound and homogeneous, and the panel is of uniform light colour. Sawing the timber into wedge-shaped pieces at the resawing stage saves timber raw material and makes panel production less expensive.

[0017] Another object of the invention is a novel method for manufacturing glued-laminated timber elements, in which method two or more elongated timber pieces are glued together.

[0018] According to one preferred embodiment of the method relating to the invention, the timber is sawn so that first normal block sawing is done, which gives the block two parallel flat surfaces. Then the block is resawn in two through the centre, and the side pieces are resawn or worked to form flat surfaces in line with the side surfaces of the stem. This way wedge-shaped timber pieces are obtained, which are blanks with sawn, hewn or planed surfaces. Then two or more blanks are joined on top of each other, side by side or end to end, with the

narrowing and widening ends of the wedges either pointing in the same direction or in opposite directions. This allows glulam beams of desired size and form to be formed.

[0019] Since it is possible, using the method relating to the invention, to utilise the entire tree length more efficiently, almost to the surface parts, the sawn timber pieces are relatively larger in relation to the thickness of the stem than when sawing timber of uniform thickness and width. Therefore fewer timber pieces are required and the number of glued seams needed decreases in the glulam elements relating to the invention.

[0020] In the following, the invention is described using examples with reference to the appended drawings, in which

Figures 1a-1c	show diagrammatically timber sawn according to the invention.
Figures 2a-2c	show a timber element relating to the invention.
Figures 3a-3c	are analogous to figure 2a-2c and show a second embodiment of the timber element.
Figures 4a-4c	are analogous to figure 2a-2c and show a third embodiment of the timber element.
Figure 5	shows a fourth embodiment of the timber element.
Figures 6-10	show various embodiments of the timber element.
Figures 11a-11b	show a tree stem from which a wedge-shaped block has first been sawn.
Figures 12a-12b	show the stage of resawing the wedge-shaped block.
Figures 13-17	show embodiments of a timber element.
Figures 18-21	show embodiments of a timber panel element.
Figures 22-23	show diagrammatically the manufacture of a timber element.
Figures 24-28	show diagrammatically the stages of manufacturing a timber element according to the invention.
Figure 29	shows diagrammatically resawing according to the invention.
Figure 30	shows diagrammatically the formation of a pair of timber pieces according to the invention.
Figure 31	shows diagrammatically the sawing of the edges of the block halves.

[0021] Figures 1a and 1b show diagrammatically a block 31, which has been sawn from a round, conical stem, in such a way that parallel sawn surfaces 32 have been formed, the distance between which surfaces is, for instance, 150 mm. Thus the width of the block is 150

mm over its whole length. Then the block 31 has been resawn in two through the centre at the heart 33 of the stem and the opposite sides of both block halves 34a and 34b have been resawn parallel to the surface of the stem along the sawing lines 35a and 35b. If, then, the thickness of the wedge-shaped block halves 34a and 34b at the narrow top 36 of the block 31 is, for instance, 50 mm, and due to the conical form of the block the thickness of the halves 34a and 34b increases towards the butt 37, for instance, by 5 mm per one metre, then the thickness of the 5-metre long halves 34a and 34b of the block 31 at the butt end 37 is 75 mm.

[0022] Figures 2a-2c show a timber element seen from three different angles, which element has been formed of the wedge-shaped timber pieces 38a and 38b sawn from the halves 34a and 34b of the block 31. One wedge-shaped timber piece 38a has been turned around 180° so that its top end 36 faces the butt end 37 of the opposite wedge-shaped timber piece 38b. The outer faces of both wedge-shaped timber pieces 38a and 38b have been laid to face each other and the inner faces 39 to face outwards. This way a 5-metre long, 125-mm wide and 150-mm thick timber element 30 is created, which element is in this example a glued-laminated timber beam.

[0023] The wedge-shaped block 31 halves 34a and 34b can be joined to one another either side by side, as in figures 2a-2c, or on top of each other, as shown in figures 3a-3c. In both cases the stem's heart side 39 has been laid to face outwards in the glulam beam 30 and the outer face, more susceptible to splitting, to face inwards. In this way any splits occurring remain concealed inside the beam.

[0024] Figures 4a-4c show a glulam beam with several wedge-shaped timber pieces 38 on top of each other. The timber pieces 38 may also be placed end to end, as shown in figure 5, or side by side, as shown in figures 6a-6c.

[0025] Figures 7a-7c show a glulam beam 30 in which the wedge-shaped timber pieces 38 are placed in the same direction. Figures 8a-8c show two beams, shown in figures 7a-7c, joined in such a way that two wedge-shaped timber pieces 38 are placed in one direction and two timber pieces in the opposite direction.

[0026] Figures 9a-9c and 10a-10c show two examples of glulam beams 30, which comprise several wedge-shaped timber pieces 38 placed in different directions. Both beams 30 have two pairs of timber pieces 38 placed in such a way that in both pairs two timber pieces 38 together form a rectangular prism, which can be joined to a similar rectangular prism formed by the timber pieces in the other pair. In the glulam beams 30, the heart sides of the stem face outwards and the outer faces inwards towards the inside of the beam, or vice versa.

[0027] Figures 11a and 11b show a conical tree stem 40, from which a wedge-shaped block 31 has been sawn in such a way that it is wider at the butt end 37 of

the stem 40 than at the top end 36. In connection with sawing the block 31, schaalboards 41 have also been sawn at both sides, parallel to the grain of the stem 40.

[0028] Figures 12a and 12b show the sawing of a wedge-shaped block 31, outlined by flat surfaces 32a and 32b, at the resawing stage into timber pieces 38 of uniform thickness. This results in similar wedge-shaped timber pieces as above, where the sawing was done so that the block sawing was uniform-thickness and the resawing wedge-like.

[0029] Figures 13a-13c show a glulam beam 31, in which two timber pieces 38, sawn to be wedge-shaped at the block sawing stage, have been joined one on top of the other. Figures 14a-15c show glulam beams 31, in which wedge-shaped timber pieces 38 have been placed both one on top of the other and side by side.

[0030] Figures 16a and 16b show a sawing method in which only side pieces 42 are sawn from the block 31 parallel to the grain and sides of the stem. After this the block 31 can be utilised as raw material for a glulam beam.

[0031] Figures 17a-17d show various glulam beams 31, in which the heart face 39 of the timber pieces has been placed so as to face towards the inside of the beam 31, unlike in the previous examples.

[0032] Figure 18 shows a timber element 30 relating to the invention, which in this case is a timber panel. It has been glued together from wedge-shaped timber pieces 38 in such a way that every two adjacent timber pieces 38 are placed to face in opposite directions and their heart sides are facing each other. In this way the stems' heart piths remain concealed inside the glulam panel 30. The panel has a scantling structure, in which the grain structure is mainly perpendicular to the surface. In this particular case this means that in the timber piece 38, the annual rings are almost at right angles to the surface of the glulam panel 30. Figure 18 shows the angle α between the tangent of the annual rings and the normal of the surface of the glulam panel 30, which angle is most advantageously as small as possible. The angle α should at least be less than 45°. The wedge-shaped timber pieces 38 have been sawn in the direction of the grain of the stem, as shown in figure 20. In this way the timber's grain structure is intact on the surface of the glulam panel 30.

[0033] Figure 19 shows diagrammatically how the knots 43 in the timber pieces 38 of the glulam panel 30 start from the inside of the panel 30 towards the surface. In this way the knots 43 cause the least possible harm to the surface of the glulam panel 30. Due to the symmetrical structure of the glulam panel 30 it also follows that the radial contraction of the panel is equal on both its surfaces. The scantling structure also makes it possible to achieve reduced lateral warping and contraction of the panel compared to a structure where the grain of the timber is at some other angle.

[0034] In the timber piece 38 joined to the glulam element 30 according to the invention, the grain remains

as intact as possible and runs mainly parallel to the surfaces of the piece, as is clearly shown in figure 20.

[0035] The structure of the panel can be changed by gluing timber pieces 38 together with their heart sides facing each other or the outer sides facing each other. The sides can also be in a random order depending on the end use, as in the embodiment of the timber panel 30 shown in figure 21.

[0036] Figure 22 shows the resawing of a block 31 sawn from a conical stem, in which process the block 31 is sawn in two along the sawing line 33, which is as close as possible to the heart pith of the tree.

[0037] Figure 23 shows the next stage of the manufacture of the glulam panel relating to the invention, at which stage one half 34b of the block 31 has been turned around 180° and placed back to face the other half 34a of the block 31. Thus the heartwoods of both halves 34a and 34b of the block 31 are still facing each other, but the top end of one block half 34a faces the butt end of the other block half 34a.

[0038] Figure 24 shows a conical tree stem 40 used as starting material for the glulam element. It is sawn according to prior art, first to form the block 31 shown in figure 25 using two usually vertical saw blades, which are not shown in the figure. The saw blades saw the tree stem 40 so that two opposite, parallel flat surfaces 32 are formed on the block 31. The distance of the saw blades from each other determines the width b of the block 31. In figure 25 the block 31 has been turned 90° onto its face.

[0039] Figure 26 shows block 31, which has been sawn in two in the centre at right angles to the surface 32 along the sawing line 33, which most advantageously follows as closely as possible the heart pith at the centre of the sawn stem.

[0040] In figure 27 one half 34b of the block 31 has been turned around 180° so that its top end faces the butt end of the opposite half 34a of the block 31. At the same time, the half 34b of the block 31 has also had to be turned upside down so that in the half 34b the bottom surface 32b of the block 31 now faces upwards. The opposite half 34a of the block 31 is still in its original position, with the surface 32a facing upwards. After this, the edges 42a and 42b of the block 31 are sawn off along the sawing lines 35a and 35b, after which the shape of the pair of elements, formed by the main part of the timber element 30, i.e. the two wedge-shaped timber pieces 38a and 38b, is complete. It is shown in figure 28.

[0041] Figure 29 shows the resawing relating to the invention, in which the block 31 is sawn in two by a saw 44. Figure 29 shows that the stem from which the block 31 has been sawn has been crooked. This means that the block 31 is equally crooked. Since according to the invention the block 31 is sawn as closely as possible following the core centre line of the stem, the guide rollers 45a and 45b keep the saw blade 44 in the centre of the block 31 throughout the sawing process, in which case the distance (a) of the saw blade 44 from both

guide rollers 45a and 45b is equal. This means that the crookedness of the block 31 also causes the sawing line 33, following the core of the stem, to be crooked. The purpose of this arrangement is to utilise the greatest possible portion of the sawn timber. It is clear that if the resawing line of a crooked stem were straight, the sawn halves would turn out indefinitely shaped and wood would be wasted.

[0042] Figure 30 shows the process of joining the halves 34a and 34b of the block 31 in figure 29, after one half of the block 31 has been turned around 180°. The figure shows that the crooked sawing lines 33a and 33b of the two halves 34a and 34b do not match each other as such. Therefore pressure rollers 46a and 46b have been arranged in the sawing equipment, which rollers press the halves 34a and 34b of the block 31 against each other with sufficiently strong pressure. In this way a compact, elongated beam is obtained, from which the edges can be sawn off.

[0043] Figure 31 shows the sawing of the edges of the pair of timber pieces 38s and 38b. Pressure rollers 46a and 46b press the halves 34a and 34b of the block 31 against each other, and photocells 47a and 47b or other similar members measure the form of the outer sides of the pair of timber pieces 38s and 38b. When the narrowest point 48 of the pair of timber pieces 38s and 38b has been found, the edge saw blades 49a and 49b are placed at the appropriate point and the edge parts 42a and 42b are sawn off.

[0044] According to the invention the surfaces to be joined can be sawn, honed or planed. The timber pieces can be wedge-shaped or straight. Most advantageously the element is made of pairs of timber pieces, in which one piece has been turned around 180° in respect to the opposite timber piece. In joining the timber pieces together into an element, it is possible to use, for instance, certain fastening members instead of gluing. Panels according to the invention can be used in furniture, floorboards, floor panels, door frames, doors or other timber products. The panels are easy to work, since they are symmetrical in structure. In the timber element the surface side of the timber pieces faces outwards and the heart face inwards or vice versa, depending on the end use of the element.

Claims

1. A glued-laminated timber element (30) in which two or more elongated timber pieces (38) are glued together, **characterised** in that the glued-laminated timber element (30) comprises straight or wedge-shaped timber pieces (38) joined together in such a way that the grains of at least two timber pieces run in different directions.
2. A glued-laminated timber element (30) according to claim 2, **characterised** in that the glued-laminated

timber element (30) is a glued-laminated timber panel, in which two adjacent timber pieces (38) are joined to each other in such a way that their grains run in different directions and their heart sides face towards each other.

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3. A method for manufacturing a glued-laminated timber element (30) in which two or more elongated timber pieces (38) are glued together, **characterised** in that the timber pieces (38) are placed in the glued-laminated timber element (30) in such a way that at least one timber piece is turned around after sawing so that its grain runs in a different direction to the grain of the other timber piece.

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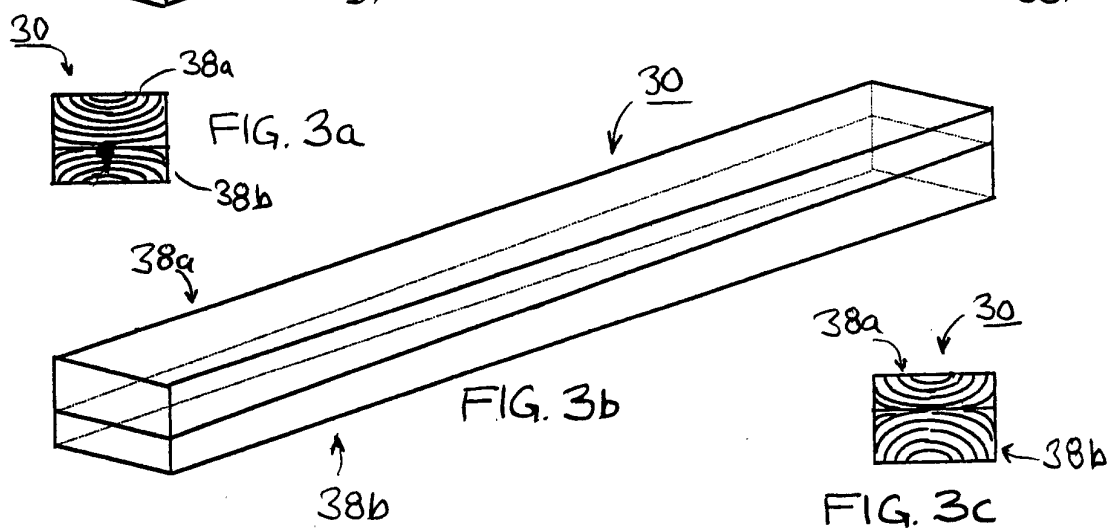
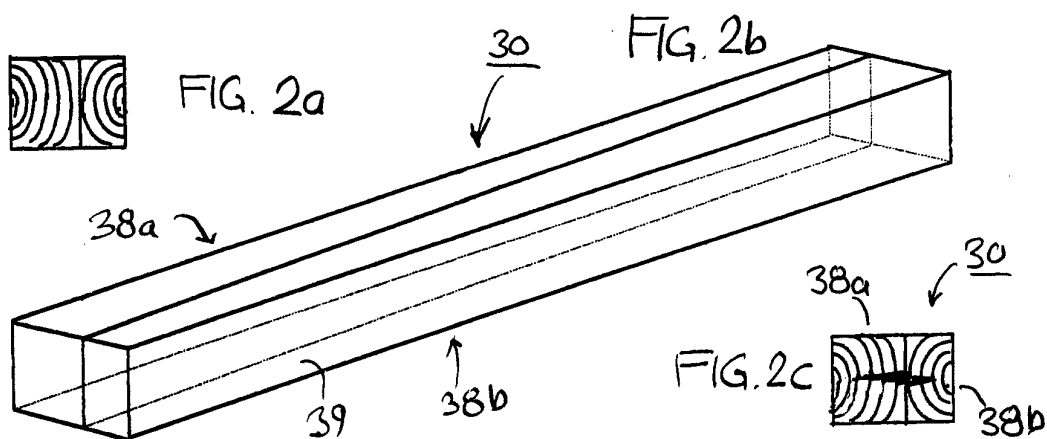
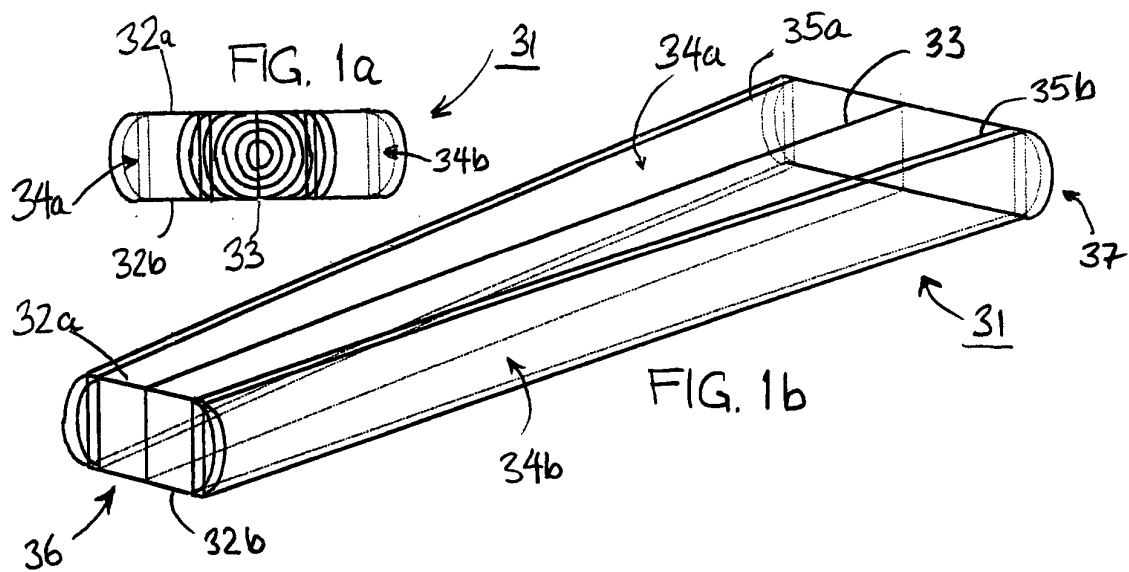
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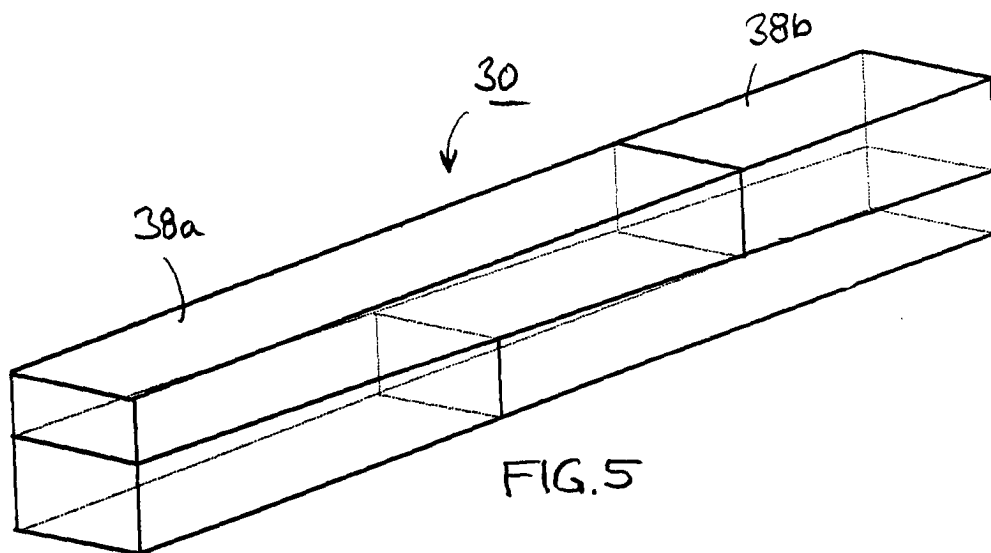
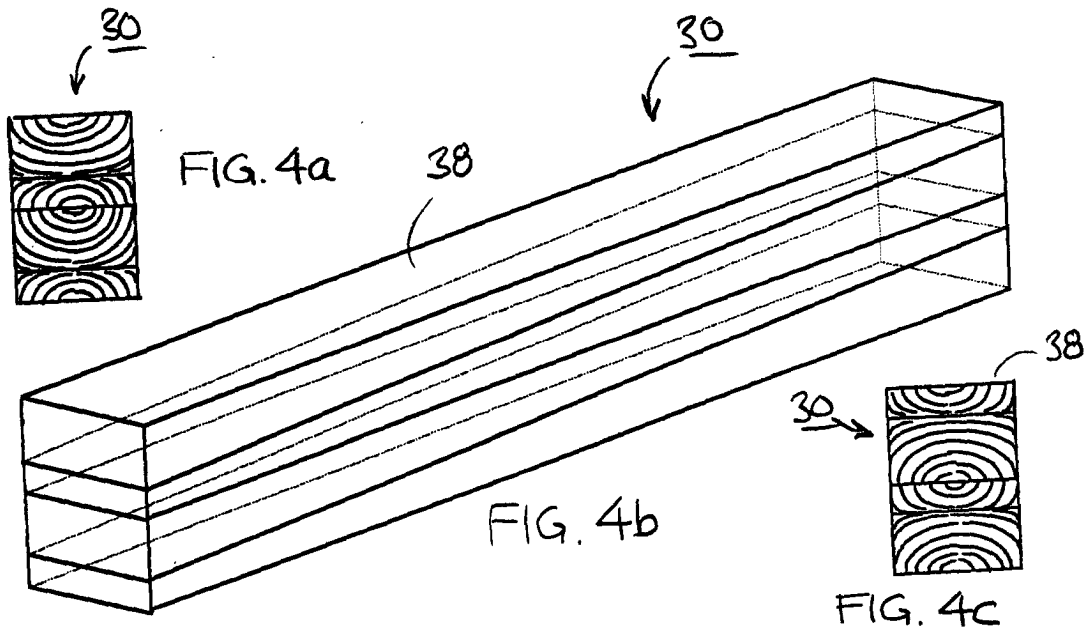
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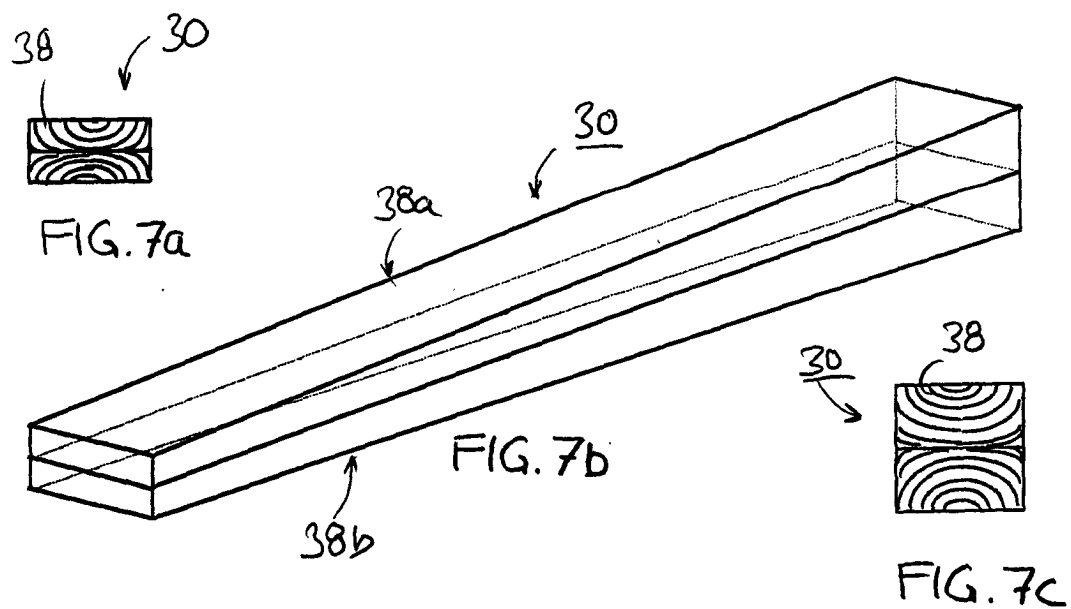
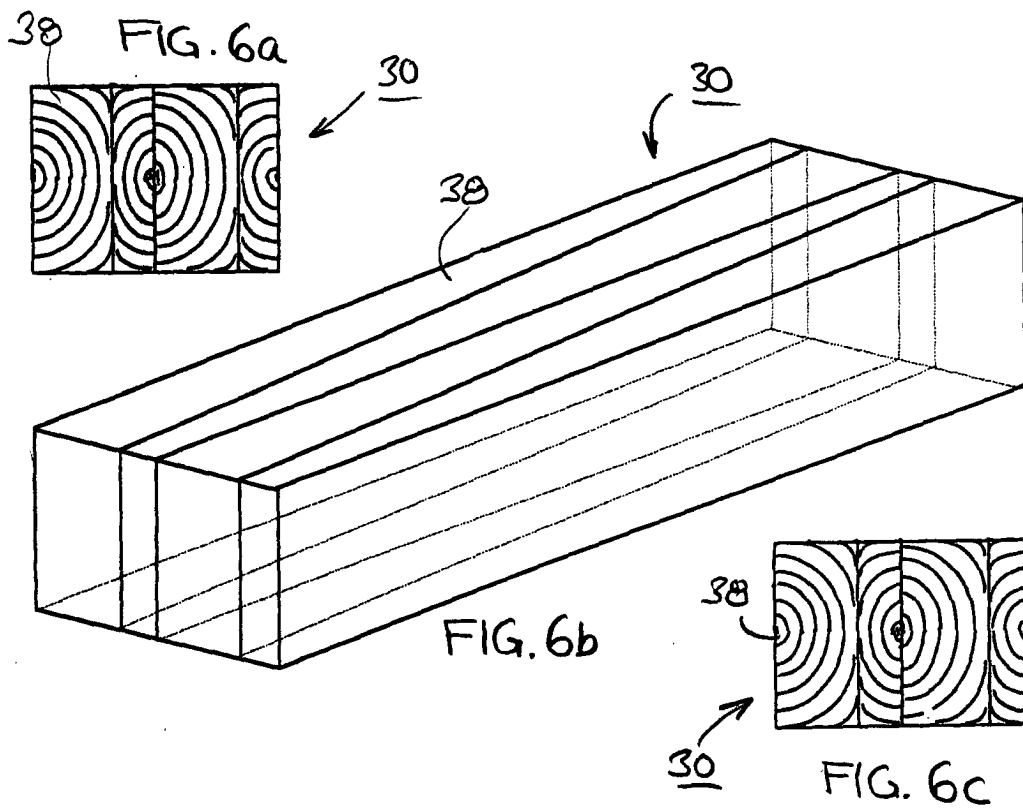
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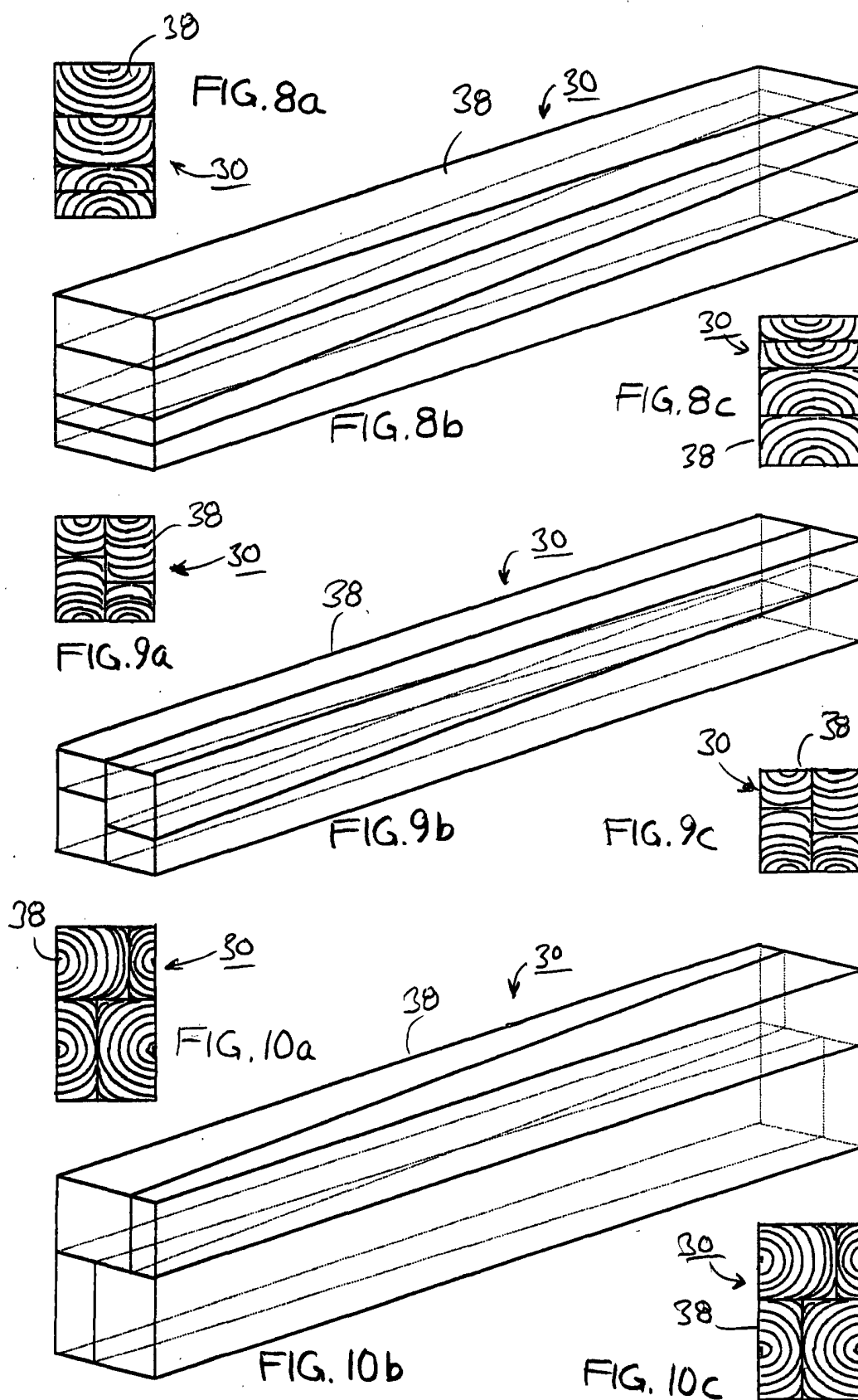
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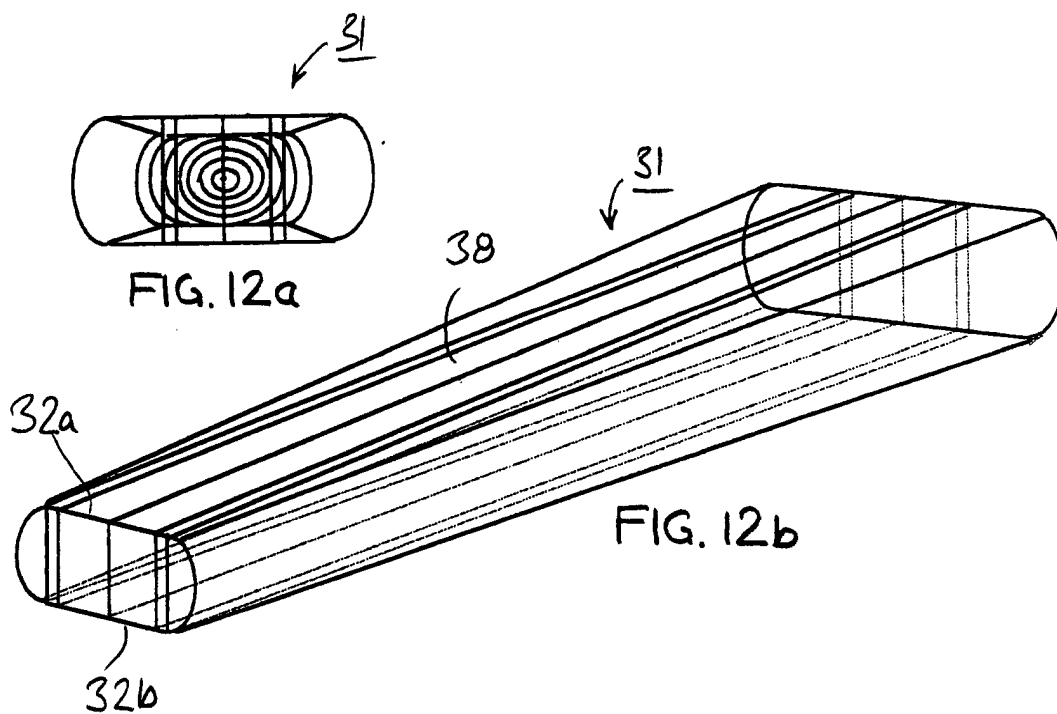
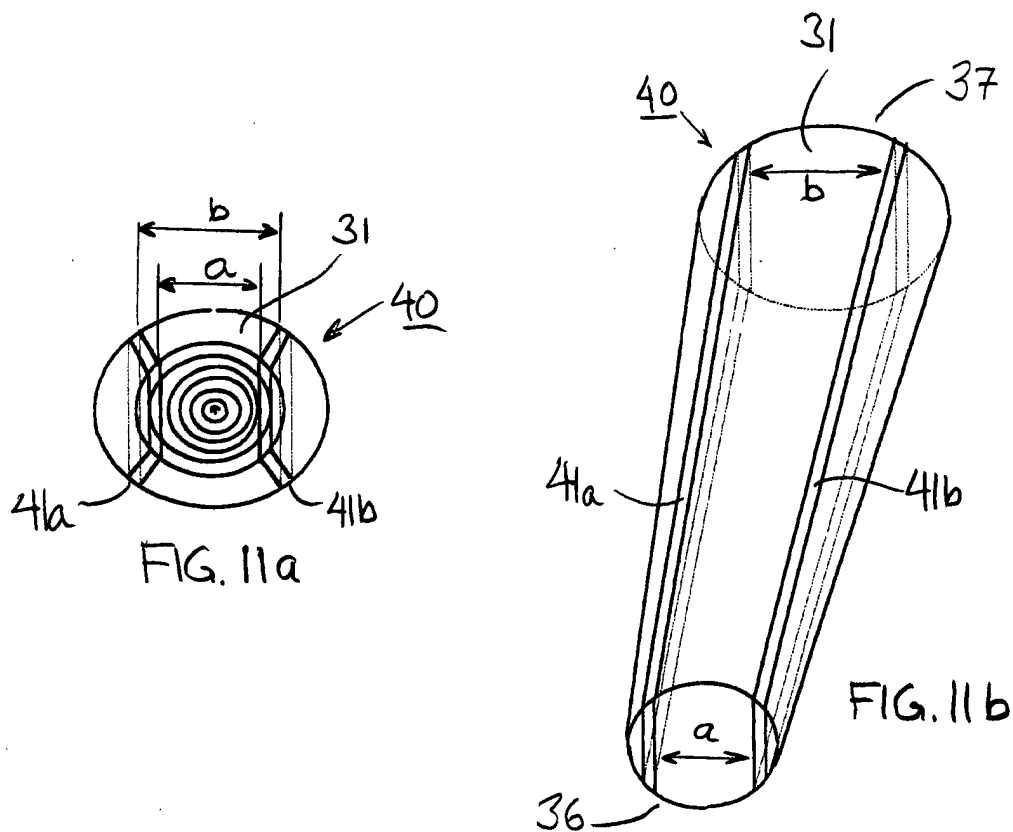
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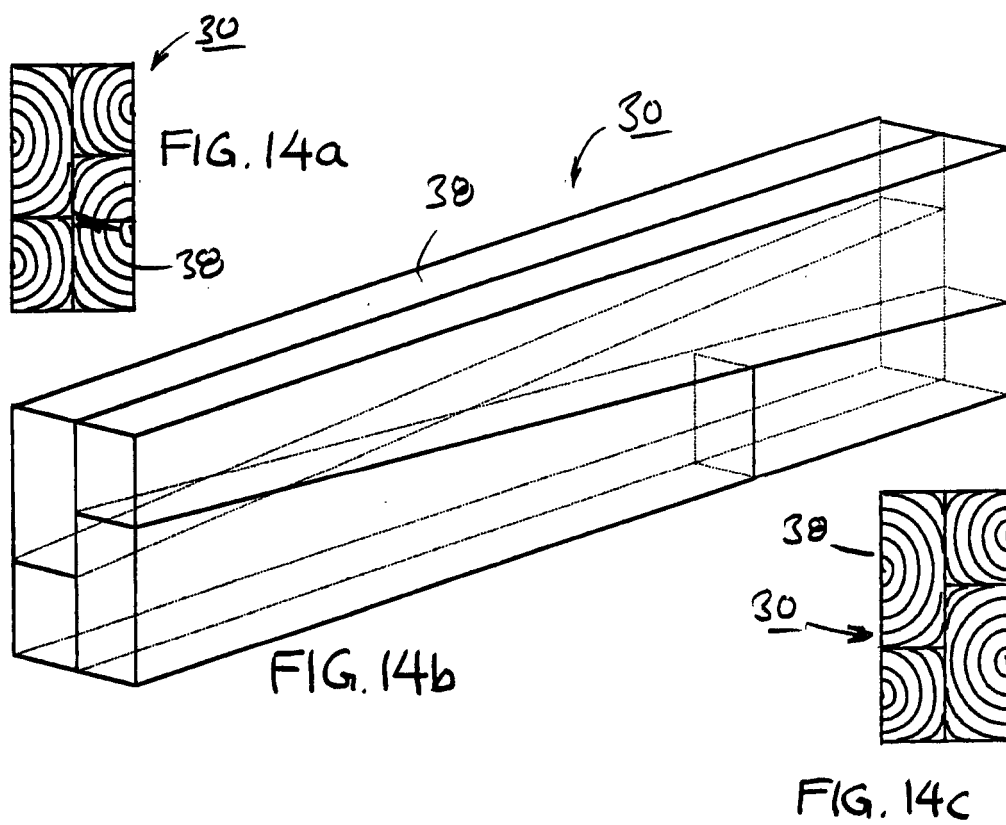
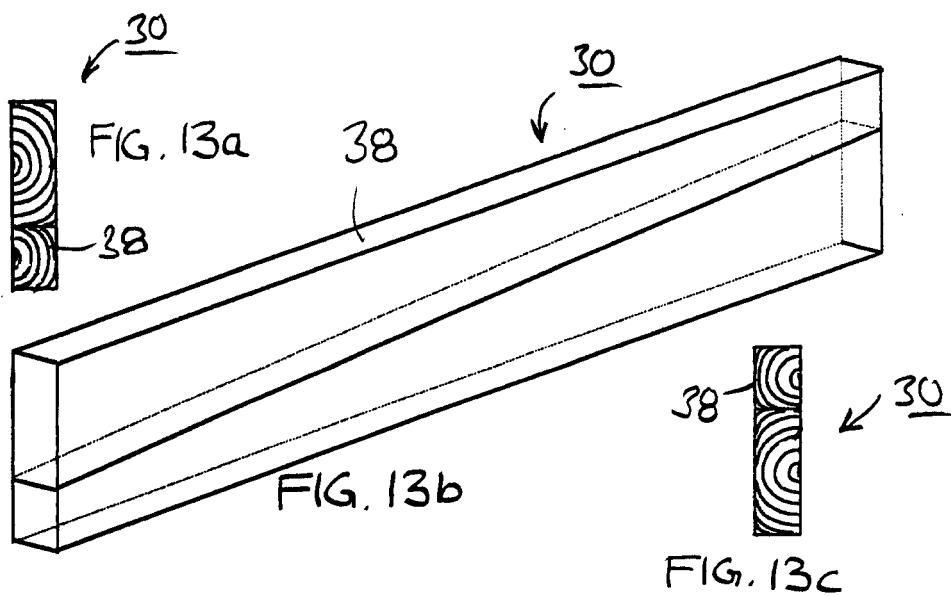


FIG. 15a

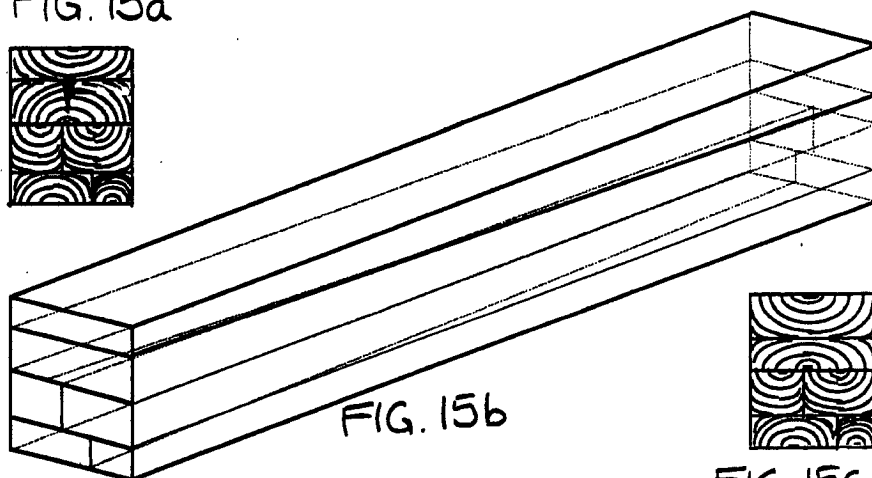
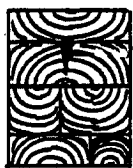


FIG. 15b

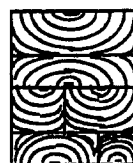


FIG. 15c

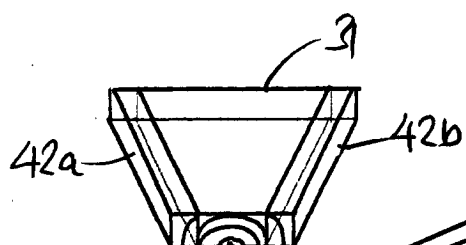


FIG. 16a

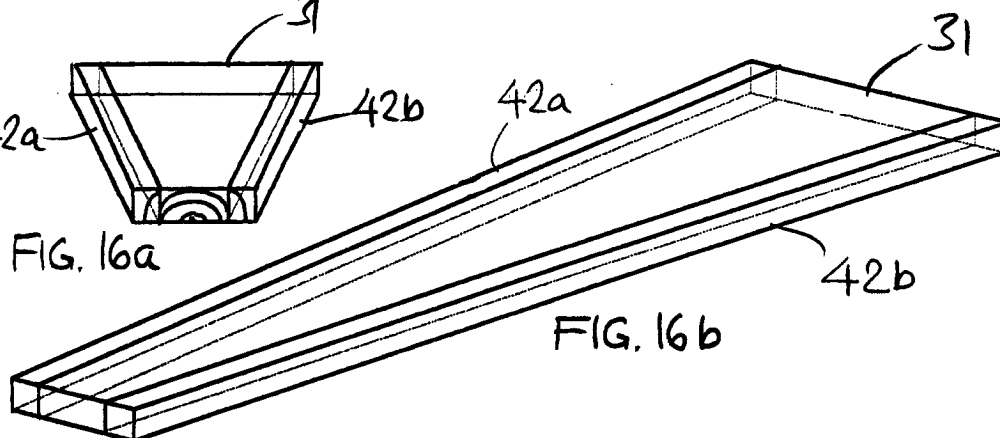


FIG. 16b

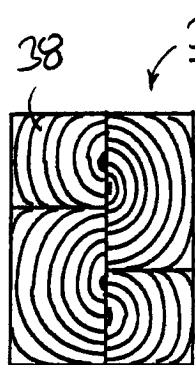


FIG. 17a

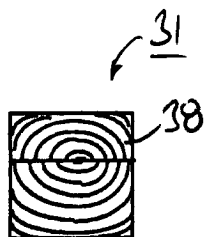


FIG. 17b

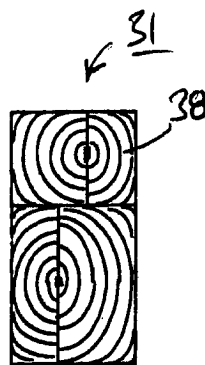


FIG. 17c

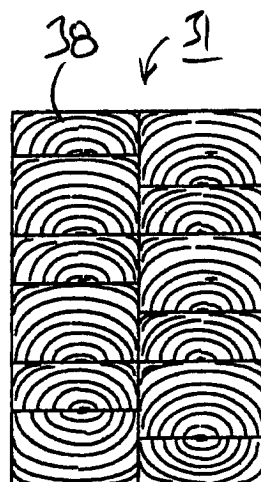


FIG. 17d

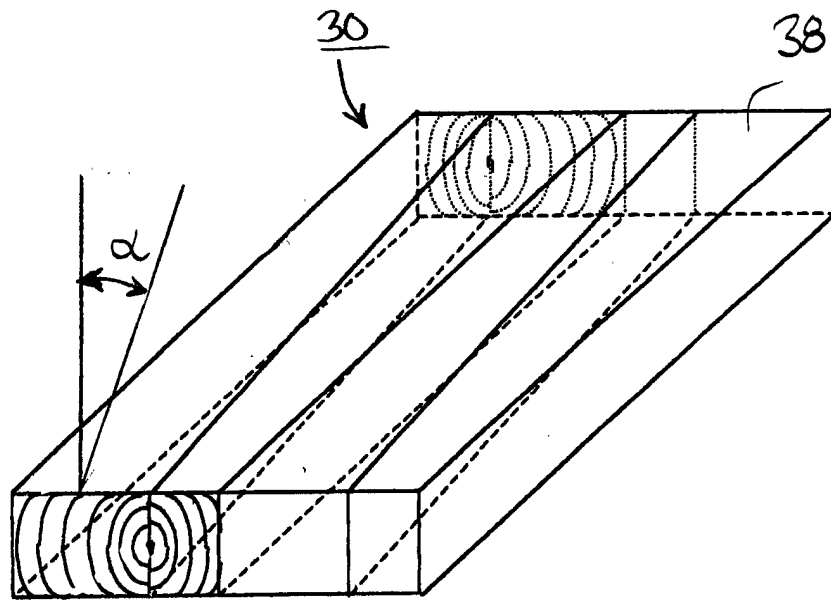


FIG. 18

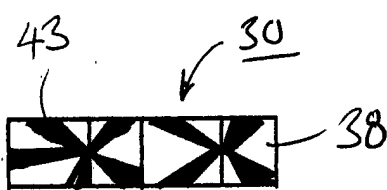


FIG. 19

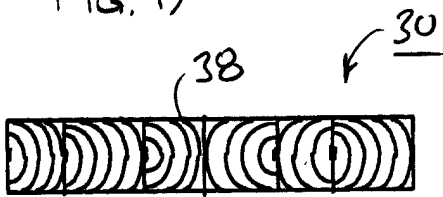


FIG. 21

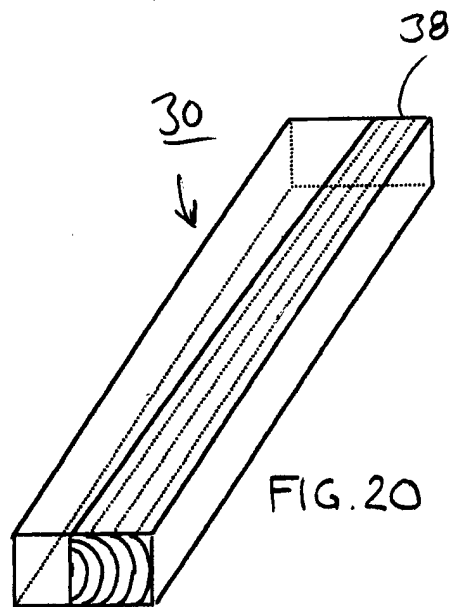
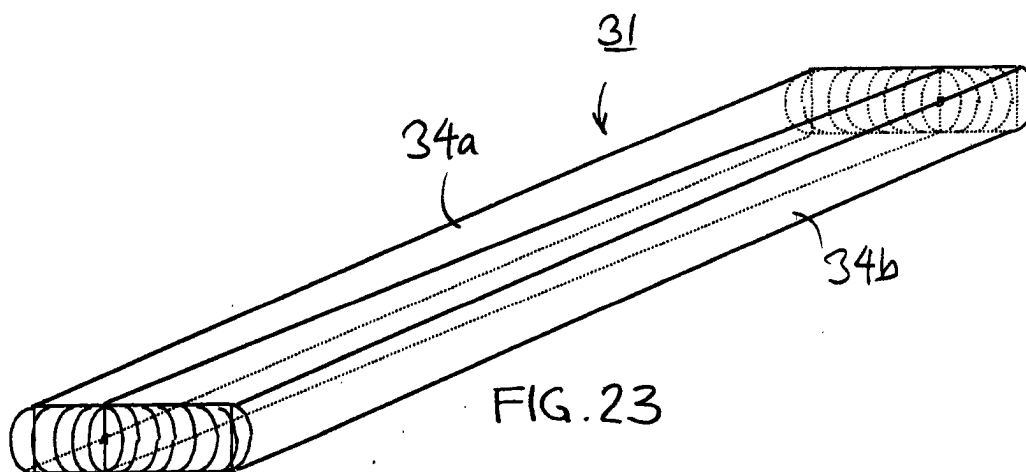
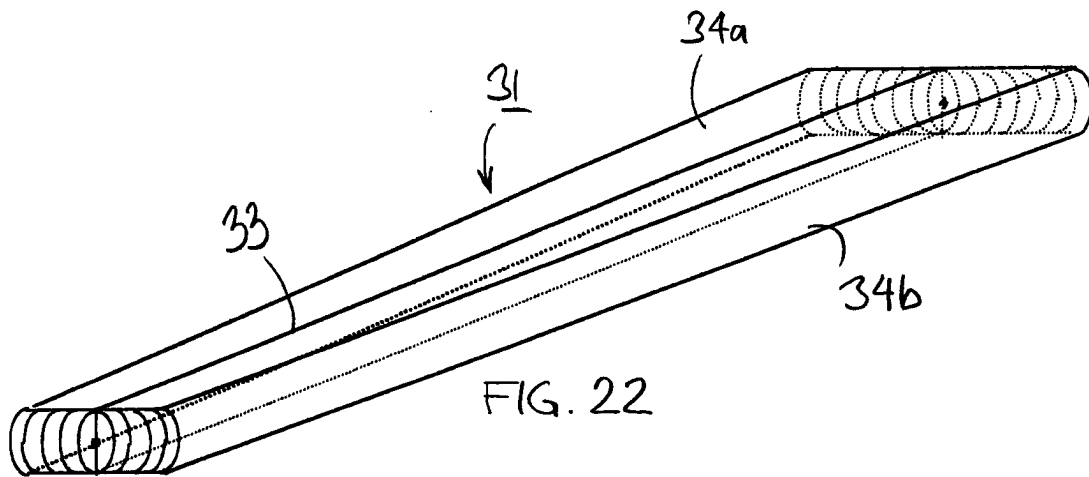


FIG. 20



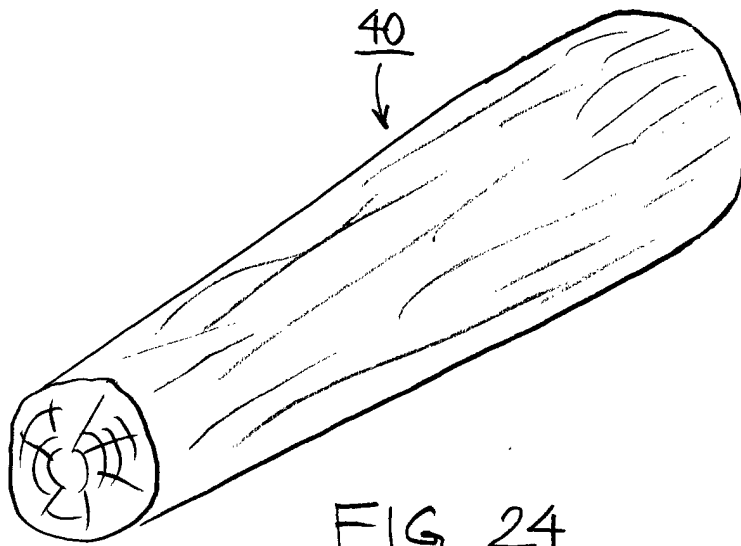


FIG. 24

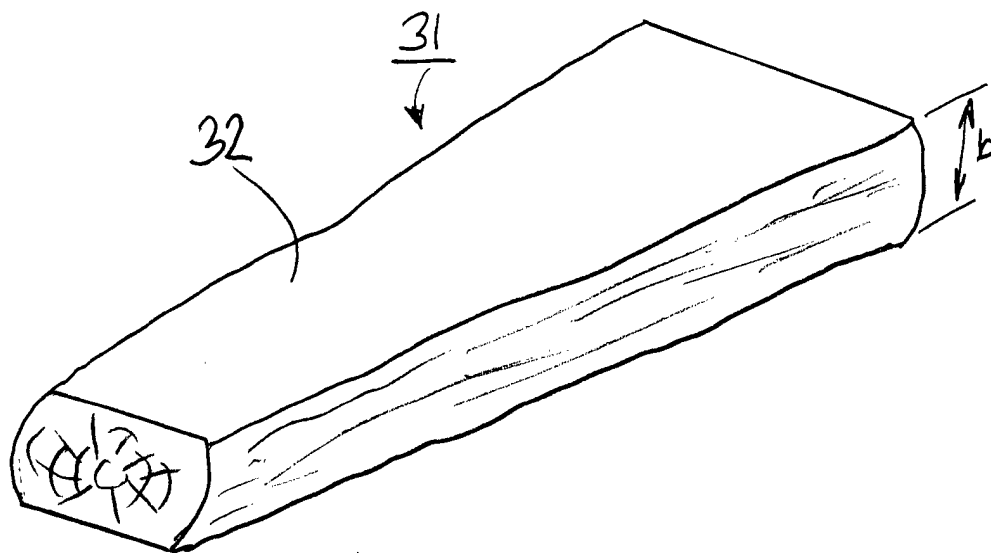


FIG. 25

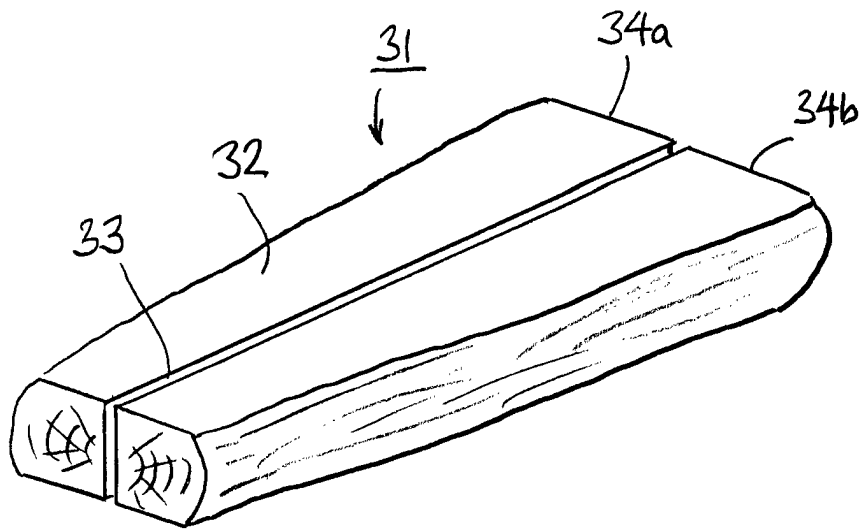


FIG. 26

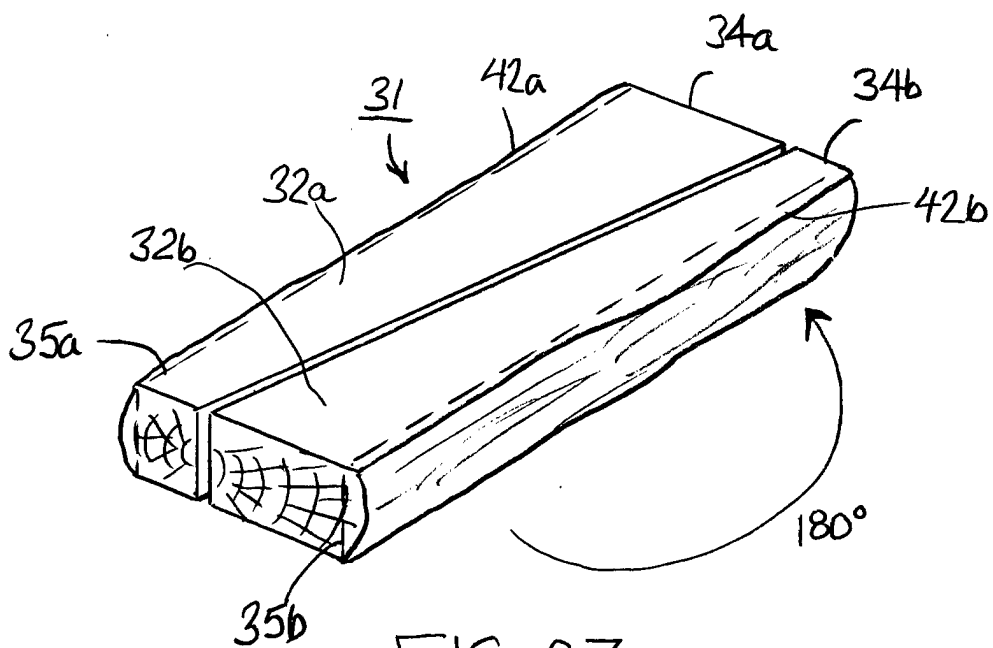
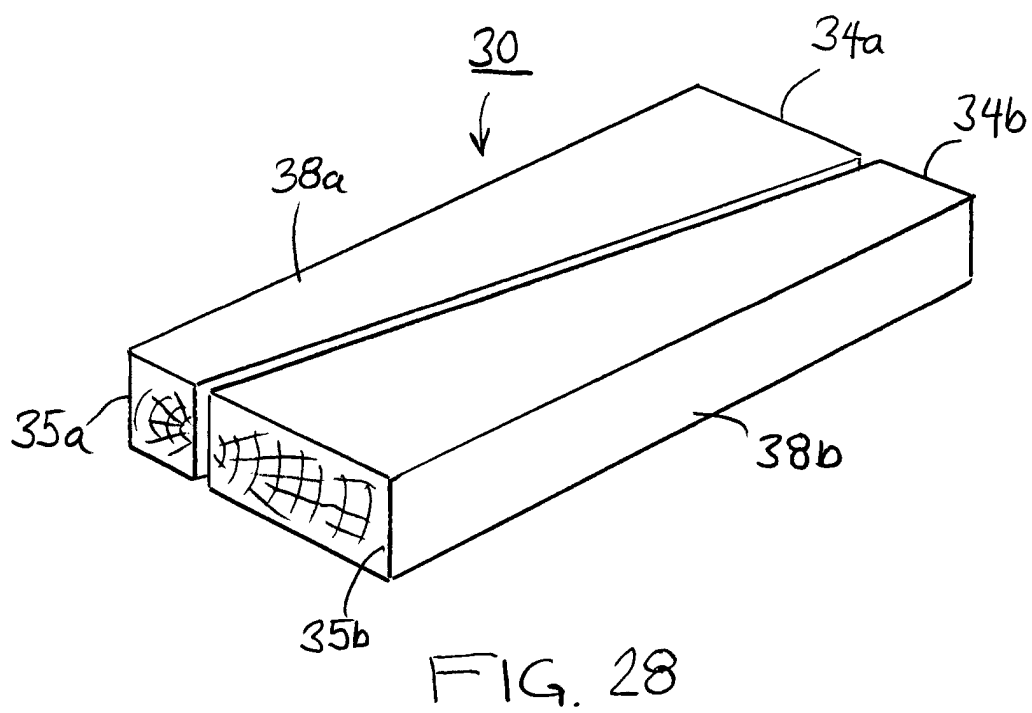
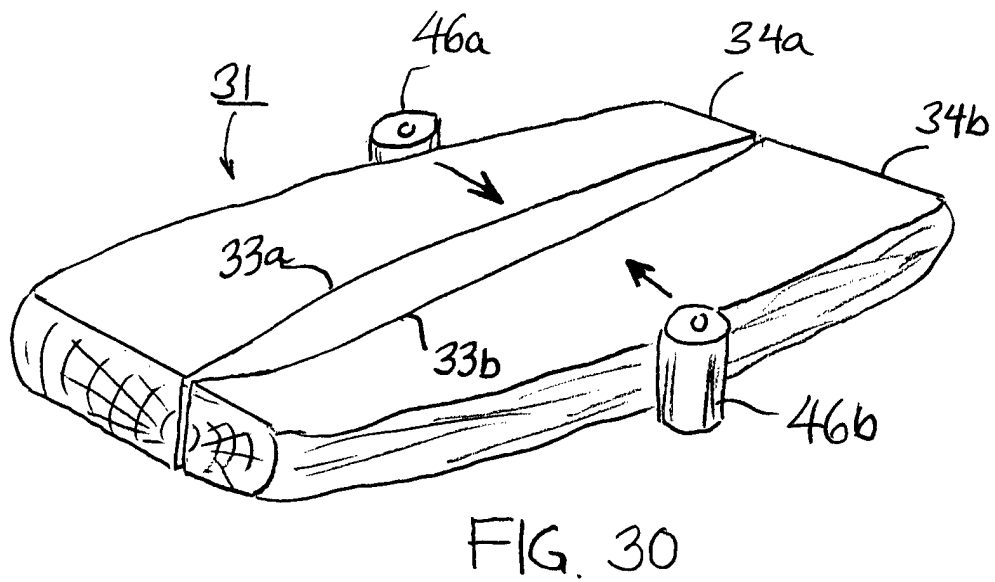
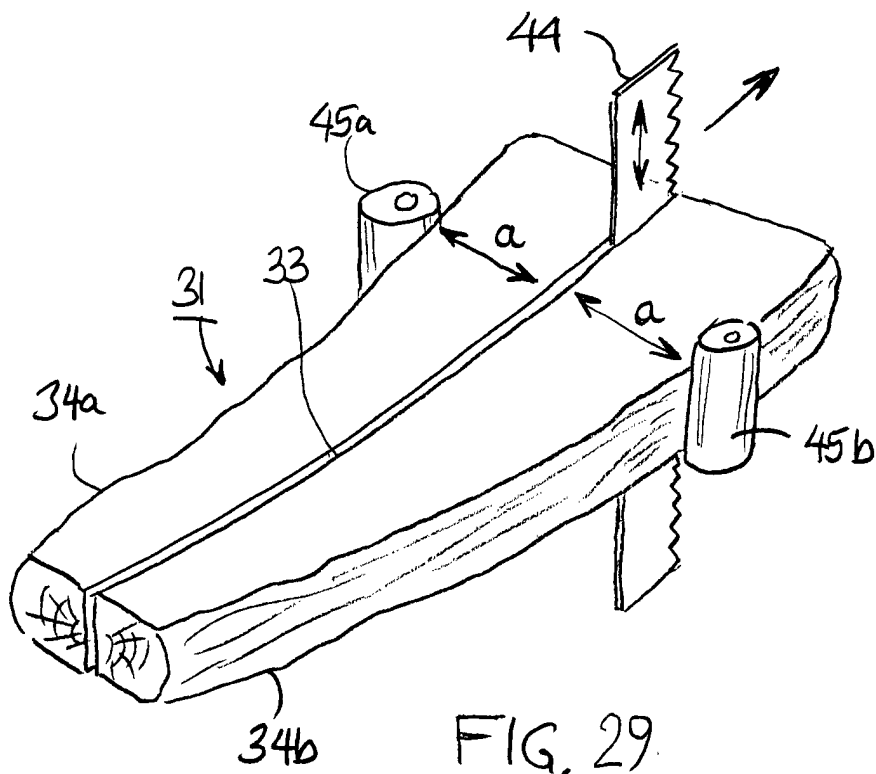


FIG. 27





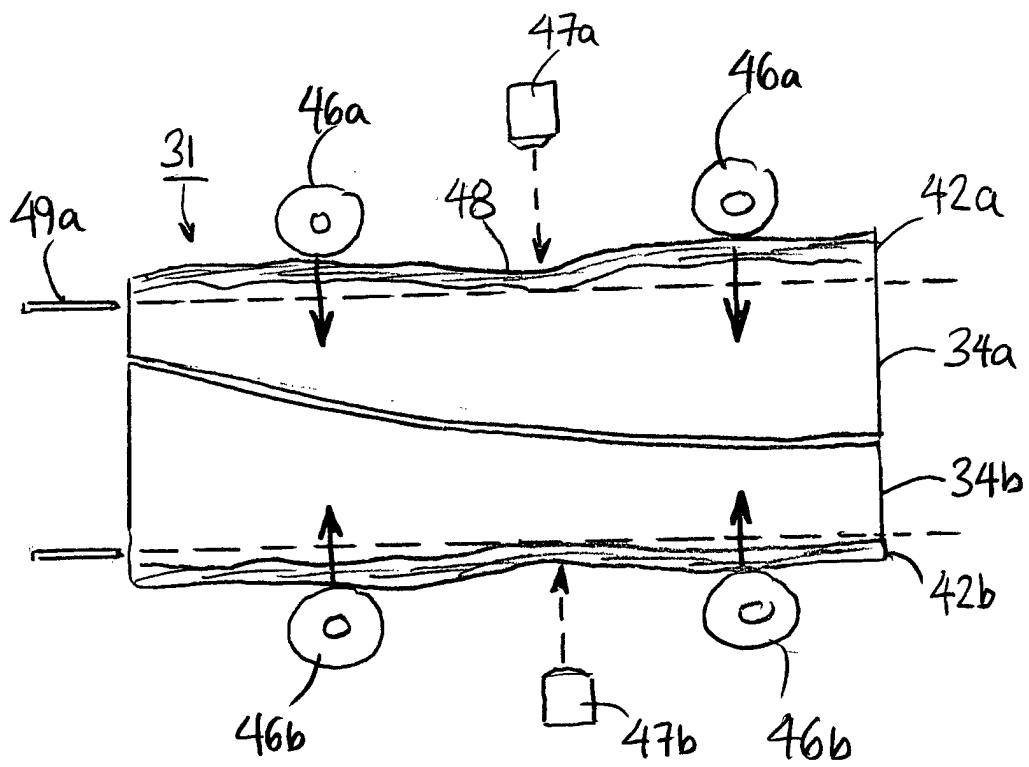


FIG. 31



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 66 0025

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DE 40 16 628 A (ESTERER AG MASCHF) 28 November 1991 (1991-11-28) * column 2, line 9 - line 11 * * column 3, line 20 - line 25; figure 4 * ----	1-3	B27M3/00 B27B1/00 E04C3/14
X	GB 119 525 A (WALKER) * page 2, line 41 - line 44; figures 1,2 * ----	1-3	
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			B27M B27B E04C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 21 June 2000	Examiner Huggins, J
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EPO FORM 1503 03.82 (P04C01)

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The members are as contained in the European Patent Office EDP file on
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21-06-2000

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