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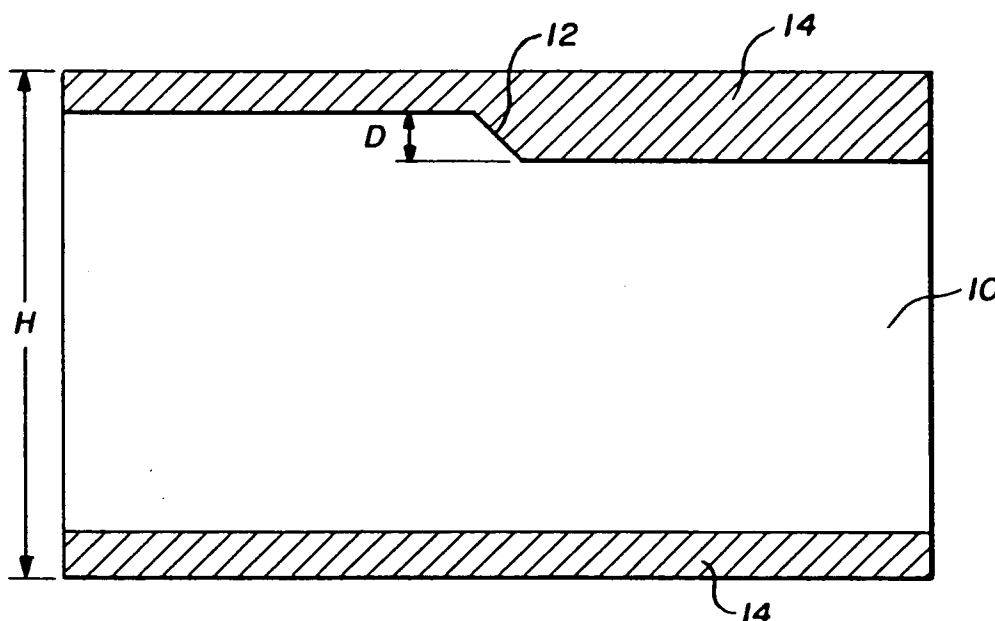
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(54) **Wood based composite.**

(57) A method of finishing a wooden surface (10). The method comprises applying to the surface a composition of a thermosetting adhesive and a mat (14). The mat comprises wood fibre, a thermosetting resin and at least one other fibre having a longer strand length than the wood fibre. Heat and pressure are applied sufficient to bond the components to each other and to the wooden surface.

Fig. 2.



FIELD OF THE INVENTION

This invention relates to a method of finishing a wooden surface.

5 DESCRIPTION OF THE PRIOR ART

In any industry that involves the reduction in size of non-uniform materials at high speed, particularly in saw milling, the cutting action of the tool results in very rough surfaces and variable dimensions of the cut pieces. A saw mill cutting lumber to a nominal thickness of one inch will obtain actual thicknesses ranging from 10 0.5 to 1.25 inches. Laminating such pieces to produce larger members for structural or decorative applications requires that the pieces be planed to uniform thickness with smooth surfaces. Failure to finish in this way will prevent the application of an adhesive or the formation of a durable bond. The cost of processing the wood to obtain the requisite surfaces and the amount of waste generated are both high. The processing of nominal one inch lumber to meet the adhesion requirements can result in losses of wood fibre in the range 25 to 40 percent 15 by weight of the original wood.

SUMMARY OF THE INVENTION

The present invention seeks to provide a method of avoiding the above processing and thus the consequent waste. 20

The invention seeks to avoid the waste involved in the above processing and is a method of finishing a wooden surface, said method comprising applying to the surface a composition comprising, (a) a thermosetting adhesive; (b) a mat comprising wood fibre, a thermosetting resin and at least one other fibre having a longer strand length than the wood fibre; and applying heat and pressure sufficient to bond the components to each 25 other and to the wooden surface.

Although the present invention is useful in finishing any wooden surface, its preferred application is in the finishing of a rough wooden surface, such as would result from a saw cut.

The thermosetting resin is preferably phenol-formaldehyde. However, other useful thermosetting adhesives include phenol-resorcinol-formaldehyde resin, resorcinol-formaldehyde resin, urea-formaldehyde resin, 30 melamine-urea-formaldehyde resin and melamine-formaldehyde resin.

The wood fibre of the mat may be either mechanically refined without delignification or chemically refined with some degree of delignification. The wood fibre may be derived from virgin or recycled, including post-consumer, wood. In carrying out the manufacture of the wood mat, the fibre is treated with the thermosetting resin and dried. The dried, resinated wood fibre is formed into a mat in an air-laid process. This mat is intimately 35 mixed with another mat composed of at least one other fibre. That fibre may be a synthetic material such as polyester or a polyolefin, or a natural material such as hemp, flex jute or kenaf. The two mats are blended together by passing them through a toothed roller. A fine synthetic scrim is fed onto the bottom of blended mat as a carrier and the entire mat-scrim assembly is needled to produce a string fibre mat with mechanically interlocked wood and synthetic fibre.

40 In practising the invention the combined fibre mat is placed on top of lumber, for example nominal one inch thick pieces of spruce - pine - fir (SPF) as commonly produced in Western Canada. A layer of the thermosetting adhesive is applied between the two layers. The mat is transferred to a heated platen press which bonds the materials of the mat and bonds the mat to the lumber substrate. In general the pressing conditions are chosen such that compression of the lumber substrate is minimized while the fibre layer is compressed to a density 45 of up to 1.2 g/cm².

DESCRIPTION OF THE DRAWINGS

The following examples illustrate the invention. In the drawings referred to in these examples: 50
Figure 1 relates thickness of the composition to the position on the wooden surface;
Figure 2 illustrates the mouldability of the composition of the present invention;
Figure 3 shows density profiles achieved on an X-ray density analyzer; and
Figure 4 relates the screw withdrawal resistance of the composition of the present invention and other, comparative materials. 55

DESCRIPTION OF THE PREFERRED EMBODIMENTS

General Procedure

5 Rough, kiln-dried lumber with a moisture content in the range 8 - 16%, based on the weight of dry wood, and with nominal thickness and width of 25-50 mm and 75-300 mm respectively is planed to a thickness between 14 and 38 mm. A thermosetting adhesive layer, containing phenol-formaldehyde, phenol-resorcinol-formaldehyde, resorcinol-formaldehyde, urea-formaldehyde, melamine-urea-formaldehyde or melamine-formaldehyde resin but preferably comprising a) a commercially available phenol-formaldehyde resole resin, b) wood
10 flour, c) wheat flour, d) soda ash and e) water, is applied at a rate of about 0.244-0.489 kg/m² to both faces of the lumber. On top of the adhesive is placed a pre-formed mat consisting of a) refined wood fibre (80-90%); b) phenol-formaldehyde or urea-formaldehyde thermosetting resin (4-9%); and c) polyester, thermoplastic or natural fibre (4-12%). The combined five element construction, comprising from top to bottom, fibre mat, adhesive, lumber, adhesive, fibre mat is consolidated and cured in a flat platen hot press. The platens are heated
15 to a temperature in the range 150-250°C. The platens are closed at a rate of 20-40 mm/sec to a separation of 140-240% of the final thickness of the product and at a rate of 1-10 mm/sec until the maximum pressure is obtained. The final position is chosen so as to allow fibre layer thicknesses of 2-6 mm. The maximum pressure exerted on the board is in the range 20-30 kg/cm². The total press time, daylight to daylight, ranges from 2-3.5 minutes and includes from 0-4 breathing cycles of 5 to 15 seconds, which prevents steam pressure from
20 causing inter- or intra-laminar rupturing of the elements and are achieved by opening and re-closing the press. At the end of the pressing cycle, the platens are separated to allow the finished boards to be removed from the press. The boards are subsequently stacked together so as to cool slowly to room temperature and allow complete curing of the adhesive.

The following examples illustrate the invention more specifically.

Example 1

New Composite Products

30 Four 16 inch lengths of clear kiln-dried SPF lumber with a moisture content in the range 8-16% and with nominal thickness and width of 1 inch and 4 inches respectively were planed to a thickness of 14 mm. A layer of thermosetting adhesive as described in Table 1 was applied at a rate of 0.244 kg/m² to both faces of each piece of lumber at room temperature. On top of each glued face was placed a similarly sized section of pre-formed fibre mat from Canadian Forest Products Ltd.'s Panel and Fibre Division. The basis weight of the fibre
35 mat was 2.4 kg/m² and the thickness was 25.4 mm. The four sets of combined elements were placed in a hot press with 16 x 18" platens heated to 205°C. The platens were closed at a rate of 27 mm/sec to a separation of 45 mm and then at a rate of 3 mm/sec to a pressure of 24 kg/cm². The minimum separation of the platens was governed by a pair of aluminum bars of 19.0 mm thickness on the sides of the bottom platen. Once the pressure reached the maximum value, a timer was started. The pressure was maintained to an elapsed time of 60 seconds before the platen separation was increased to allow venting of the steam pressure. This opening and the subsequent closing was completed at an elapsed time of 65 seconds. The pressure was maintained again at 24 kg/cm² until an elapsed time of 90 seconds when the pressure was again removed and reapplied. This was completed at an elapsed time of 95 seconds. The maximum pressure was then maintained until an elapsed time of 120 seconds when the platen separation was increased and returned to 19.0 mm by an elapsed
40 time of 125 seconds. At an elapsed time of 150 seconds, the platens were separated to allow removal of the pressed boards. The boards were stacked on top on one another to retain heat and complete the cure of the adhesive.

The difference between the lumber thickness and the thickness of the product is accounted for by the pressed fibre, neglecting any compression of the lumber substrate. In this example the target thickness of the fibre layer in the finished product was 2.5 mm. This corresponds to a density of that layer of ca. 1.0 g/cm³.

This example demonstrates the feasibility of using fibre mats for overlaying solid wood substrates.

Table 1

Phenol-Formaldehyde Thermosetting Adhesive		
Liquid Resole Resin		43.70
Water		14.31
Wood Flour		7.31
Wheat Flour		5.91
Soda Ash		1.97
	Mix for 20 minutes	
Liquid Resole Resin		19.81
Water		6.99
	Mix for 5 minutes	
Total		100.00

Example 2

SPF Lumber with Various Thickness Profiles

Example 1 described the preparation of the new composite using smooth, planed lumber as the substrate. One of the main advantages of this invention is the ability of the fibre mat to mould to the shape of the lumber substrate and effectively mask any thickness variations or extreme roughness. It is a desirable feature of the invention that large variations in the thickness of the substrate can be tolerated without impairing the bonding at the solid wood/fibre interface.

To illustrate this point, some samples of the composite were prepared from lumber that had been analyzed with a custom built laser-based thickness scanner. The system consisted of a conveyor, laser heads and sensors mounted above and below the conveyor, data acquisition card, encoder and personal computer. The lumber thicknesses were determined by subtracting the sum of the distance from the bottom laser head to the bottom of the board and the distance from the top laser head to the top of the board from the total distance between the laser heads. This technique allowed non-contact measurement unaffected by any vertical board movement. In this manner, the data depicted in Figure 1 were collected from 4 pieces of lumber. Board 1 was a sample of rough, unplanned 1x4 SPF with an average thickness of approximately 28.5 mm from a Canadian Forest Products sawmill in northern British Columbia. Board 2,3,4, were from the same source but had been planed in the laboratory to average thickness of ca. 27.4, 25.1, 22.1 mm respectively.

These boards were overlaid with wood/polyester fibre mat using the conditions described in Example 1. Inter-laminar adhesion of the pressed composite were evaluated using a modification of ASTM D 2338-82, Standard Test Method for Strength Properties of Adhesives in Two-Ply Wood Construction in Shear by Tension Testing in which the samples were sliced so that the lumber remaining was the same thickness as the pressed fibre layer. In this way, each glue-line could be evaluated as two-ply construction. The results of the shear testing are shown in Table 2 and reveal that the strength of the inter-laminar bond does not depend on the average thickness or the thickness profile. At the end of the test, the broken samples were inspected and the reason for the breakage was determined by visual inspection and ascribed to solid wood failure, fibre mat failure, glue-line failure or a combination thereof. The amount of glue-line failure during the test is very small in all cases.

This example demonstrates that lumber thickness and surface roughness are not key determinants of the integrity of the present invention and that smooth lumber surfaces, usually of vital importance to the bond quality of laminated wood composites, is not required in the invention.

Table 2

Specimen Number	Condition	Lumber Thickness (mm)	Fibre Thickness (mm)	Composite Thickness (mm)	Shear Avg (psi)	Standard Deviation (psi)	Glueline Failure (%)
0	Rough	28.45	5.08	33.53	246	29	0
1	Planed	27.35	5.08	32.43	240	36	1
5	Planed	25.08	5.08	30.16	228	33	5
6	Planed	22.10	5.08	27.18	251	22	9

1. Determined by visual inspection of the tested samples. Breakage was described as occurring in the fibre layer, in the wood layer or at the glueline.

Example 3Density Profile Measurements

Lumber thickness variations such as those described in Example 2 are compensated for in this invention by the mouldability of the fibre mat which allows the fibre to fill depressions and voids in the lumber surface. As a result, the density of the fibre layer is lower in density in such areas.

To demonstrate this property, some composite samples, as shown in Figure 1, were prepared from lumber 10, machined to create some exaggerated thickness changes as shown at 12, and mat 14. In the samples prepared distance D was 1.5, 3.0, 4.5 or 6mm. Finished height H was 36mm. These samples were analyzed on a Recon Model 8900/DA X-Ray Density Analyzer and the resultant density profiles are shown in Figure 2. The sample with the shallowest depression (40X) clearly shows 3 distinct density ranges. In the middle, the density is constant at approximately 0.40 g/cm³ which corresponds to the density of the lumber substrate. On each face, there is a high density region resulting from the pressed fibre mat. In each of these fibre areas there is also some density variation as the density in the middle of the region is lower than the density either at the lumber interface or the surface that would have been next to the platen during pressing. The density profile of the fibre layers changes as the depth of the depressions becomes greater (Samples 50x, 60x and 70x). In these cases, the average density of the fibre regions lowers considerably on the side containing the depression. In fact in the extreme cases, the density of the fibre layer is lower than that of the lumber. However, there are also some noticeable changes in the fibre layer on the side opposite to the depression. In this case there is also a lowering in average density and the density profile across the fibre layer becomes more pronounced. Therefore, the conclusion is that both fibre layers assist in masking a defect on one of the faces.

Another advantage of this invention is that the average density is considerably lower than other wood-based composites such as particleboard or medium density fibreboard. This is advantageous from the point in view of the user (e.g. better machinability and lower shipping costs) and the producer (e.g. increased fibre utilization). However, the composite does have a high surface density of up to 1.0 g/cm³. In fact, it is possible, by changing the fibre layer thickness, to alter the surface density to produce a desired surface property. This is important since the surface qualities (e.g. bending strength - see Table 4 - abrasion resistance and paintability) depend on surface density.

The above example demonstrates why the strength to weight ratios of the present invention are superior to other wood based composites such as particleboard or medium density fibreboard. In simple terms, the product can be described as being "strong and light".

Example 4Other Processing Parameters

The procedure of Example 1 was repeated several times with the following changes being made: 1) the total time in the hot press was varied from 1.75 to 2.75 minutes and 2) the open assembly time (i.e. the amount of time from the application of the adhesive to the lumber substrate and the mating of the fibre mat to that layer) was varied from 0 to 20 minutes. The pressed samples were tested for inter-laminar adhesion using ASTM D 2339-82, Standard Test Method for Strength Properties of Adhesives in Two-Ply Wood Construction in Shear by Tension Testing. The samples were tested for shear values and position of failure (either glueline, wood or fibre). The results, as shown in Table 3, show that 2.50 minutes press time appears to be the optimum condition for this combination of materials as the shear values are near the maximum and the glueline failure is near the minimum for all assembly times. However, the product will tolerate other processing parameters required by available species, materials, equipment or ambient conditions.

Table 3

Inter-Laminar Adhesion of Fibre Mat Overlaid SPF					
	Sample	Open Time (min)	Press Time (min)	Stress Average (psi)	Glueline Failure (%)
5	A	0	1.75	136	94
		5		198	48
10		10		171	50
		15		197	50
		20		189	25
15	B	0	2.00	148	75
		5		92	68
20		10		238	06
		15		202	06
		20		223	12
25	C	0	2.25	164	50
		5		89	63
30		10		217	00
		15		237	00
		20		220	00
35	D	0	2.50	237	01
		5		233	00
40		10		229	00
		15		214	00
		20		225	00
45	E	0	2.75	239	00
		5		207	00
50		10		245	00
		15		236	00
		20		216	01

Example 555 Incorporation of Other Natural Fibres

The above examples describe the use of fibre mats composed of a mixture of natural wood and synthetic (polyester) fibres. However, it is possible to replace the synthetic fibre with other, natural materials such as

flax. In a typical experiment, resinated hemlock fibre used in production of Woodmat at Canadian Forest Products Ltd.'s Panel and Fibre Division (90%) was combined with flax fibre (10%) cut to approximately 7.5 cm in length. The flax (237.84g, 11.9% moisture) and hemlock (2156.88g, 11.9% moisture) fibre were blended in a static Littleford mixer for 10 minutes. A portion (89.23g) of the blended fibre was formed into a mat on each side of a 16" section of SPF 1x4 that had previously been coated with the adhesive described in Example 1. The resulting billet was pressed under the same conditions as those used for the polyester containing mats. The flexural (Modulus of Rupture = 9400 psi, Modulus of Elasticity = 1066000 psi) and lap shear properties (Stress = 200 psi) were in the same range as those obtained for polyester-containing samples.

The above example demonstrates that fibres, other than polyester, that possess a length to width ratio and good tensile strength can be used to prepare the composite.

Example 6

Strength Properties

Test methods were taken from ASTM D1037-87, Standard Methods of Evaluating the Properties of Wood-Base Fibre and Particle Panel Materials and ASTM D143-83, Standard Methods of Testing Small Clear Specimens of Timber. The Screw Withdrawal test was adapted for use with 19 mm material by prorating the lead hole and screw insertion depths to 12.75 mm. The material prepared as described in Example 1 was compared with other wood composite materials such as a) hardwood plywood b) a composite comprised of a softwood veneer crossband laminate over a particleboard core c) particleboard, and d) medium density fibreboard. These samples were obtained from commercial supplies and are believed to be representative of products generally used in the marketplace. The results are shown in Table 4 and demonstrate the superiority of the present invention over currently available wood base composites as it is up to 2-3 times stronger than some other composites.

Table 4
Physical Properties of Wood Based Composites

Type	Density (g/cm ³)	Modulus of Rupture (psi)	Modulus of Elasticity (psi)	Edge Screw Retention (lb)
Hardwood Plywood	0.523	6430	580800	140
Particleboard/Veneer Composite	0.585	4160	306300	90
Particleboard	0.720	1700	327800	80
Medium Density Fibreboard	0.746	4990	455600	130
Oriented Strandboard	0.649	2420	325600	150
Present Invention	0.538	7690	685300	200

Example 7

Retention of Screw Withdrawal Resistance

As an extension of the Screw Withdrawal results described in Example 2, the ability of the materials to retain withdrawal resistance after multiple failures was investigated. The test consisted of applying load to the

screw until failure, reinserting the screw to the initial depth and retesting the sample. This was repeated up to 5 reinsertions. The results are graphically displayed in Figure 4 and show that even after 5 reinsertions this invention offers withdrawal resistance superior to the initial resistance of any of the other composites. Since fastener retention is an important property of materials used in the manufacture of furniture, casegoods and cabinets, this invention should find applications in those areas.

Although the forgoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it will be readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of the appended claims.

Claims

1. A method of finishing a wooden surface, said method comprising applying to the surface a composition comprising:
 - (a) a thermosetting adhesive;
 - (b) a mat comprising wood fibre, a thermosetting resin and at least one other fibre having a longer strand length than the wood fibre; and
 applying heat and pressure sufficient to bond the components to each other and to the wooden surface.
2. A method as claimed in claim 1 in which the wooden surface is a rough wooden surface.
3. A method as claimed in claim 1 in which the thermosetting adhesive is a phenol-formaldehyde resin.
4. A method as claimed in claim 1 in which the thermosetting adhesive is selected from the group consisting of phenol-resorcinol-formaldehyde resin; resorcinol-formaldehyde resin; urea-formaldehyde resin; melamine-urea-formaldehyde resin and melamine-formaldehyde resin.
5. A method as claimed in claim 1 in which the thermosetting adhesive comprises a phenol-formaldehyde resin, wood flour, wheat flour, soda ash and water.
6. A method as claimed in claim 1 in which the thermosetting adhesive is applied to the wooden surface at a rate of about 0.244 to 0.489 kg/m².
7. A method as claimed in claim 1 in which the wood fibre of the mat is refined wood fibre.
8. A method as claimed in claim 1 in which the thermosetting resin of the mat is phenol-formaldehyde or urea-formaldehyde resin.
9. A method as claimed in claim 1 in which said at least one other fibre has a length in the range 50 - 100 mms.
10. A method as claimed in claim 9 in which said at least one other fibre is a synthetic fibre selected from polyester and polyolefin fibres.
11. A method as claimed in claim 9 in which said at least one other fibre is hemp or flax.
12. A method as claimed in claim 1 in which the wood fibre and said at least one other fibre are intimately mixed.
13. A method as claimed in claim 12 in which the intimate mixing is carried out by needling.
14. A method as claimed in claim 1 in which the mat comprises about 80-90% of the wood fibre; about 4-9% of the thermosetting resin and about 4-12% of the at least one other fibre.
15. A method as claimed in claim 1 in which the heat and pressure are applied by the use of heated platens.

16. A method as claimed in claim 15 in which the platens are heated to a temperature in the range 150° to 250°C.

17. A method as claimed in claim 1 in which the maximum pressure exerted is in the range 20 - 30 kg/cm².

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18. A method as claimed in claim 1 in which the heat and pressure are applied for a time in the range 2 - 3.5 minutes including breathing cycles to release steam pressure.

19. A method as claimed in claim 1 used to treat at least two surfaces of a piece of lumber.

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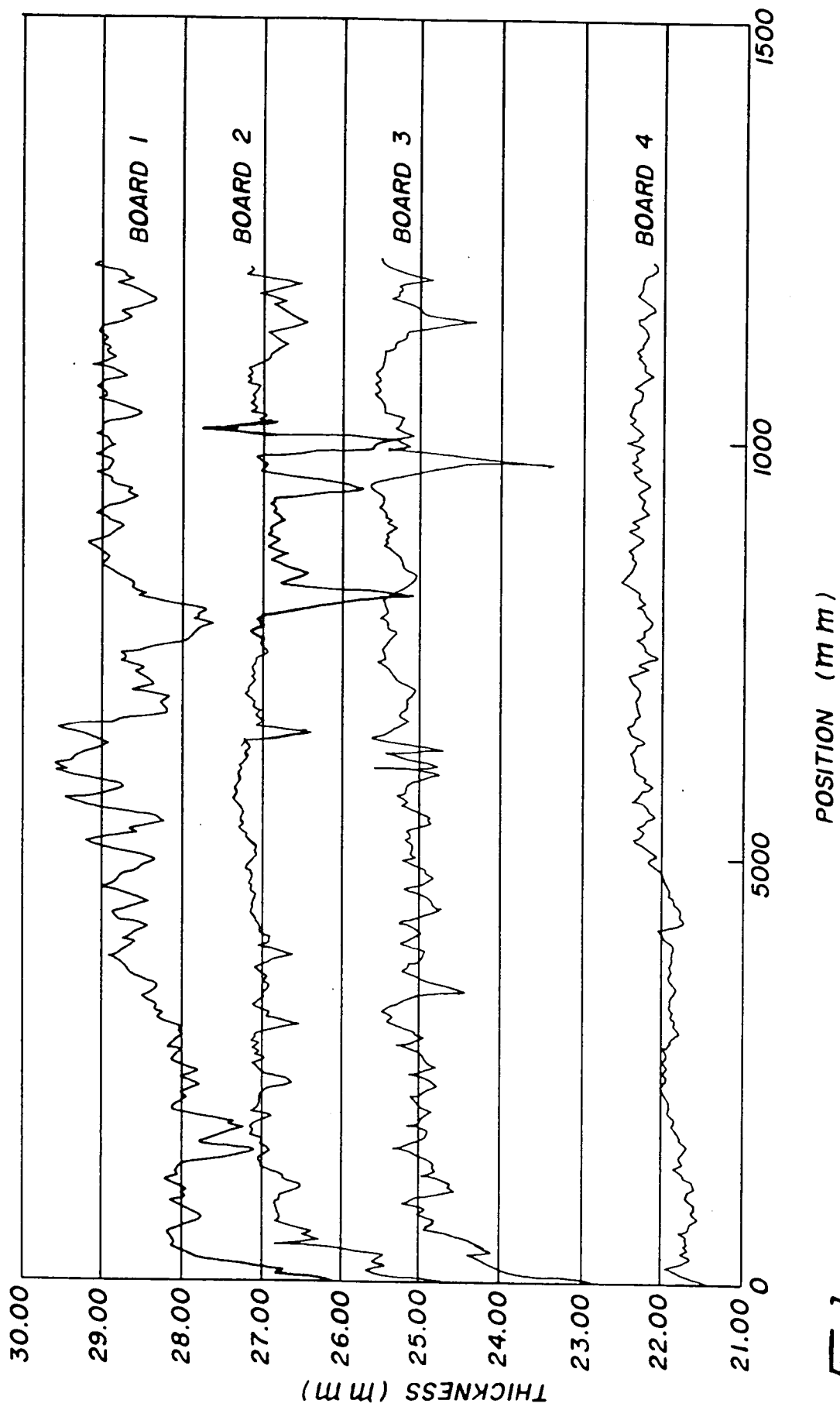
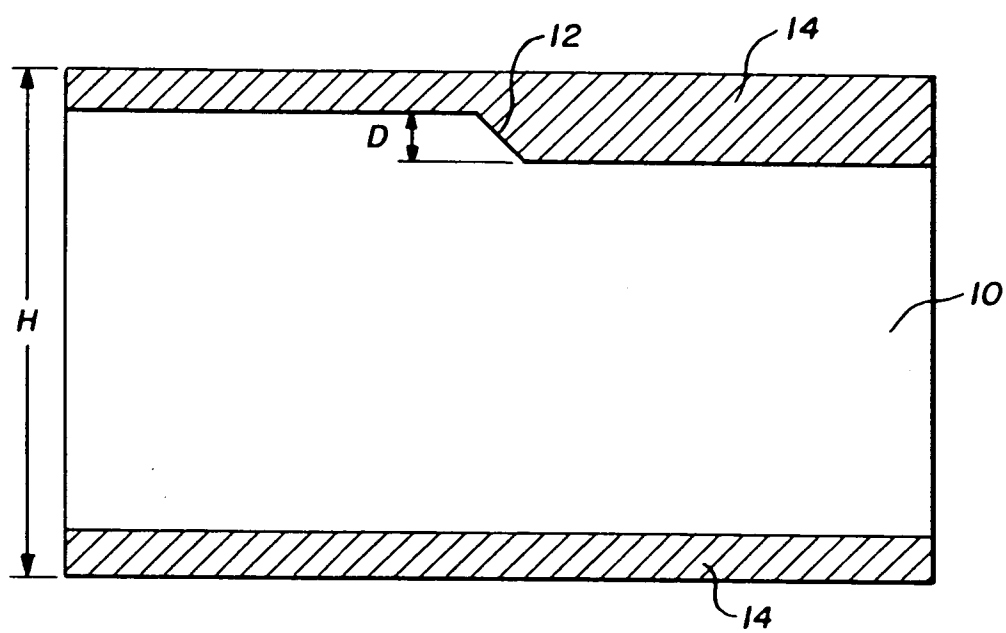


Fig. 1.

Fig. 2.



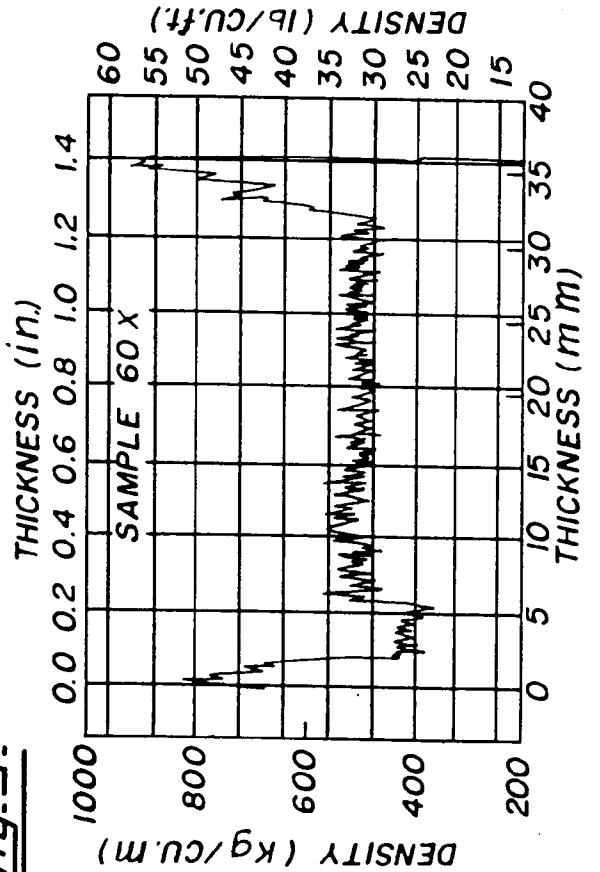
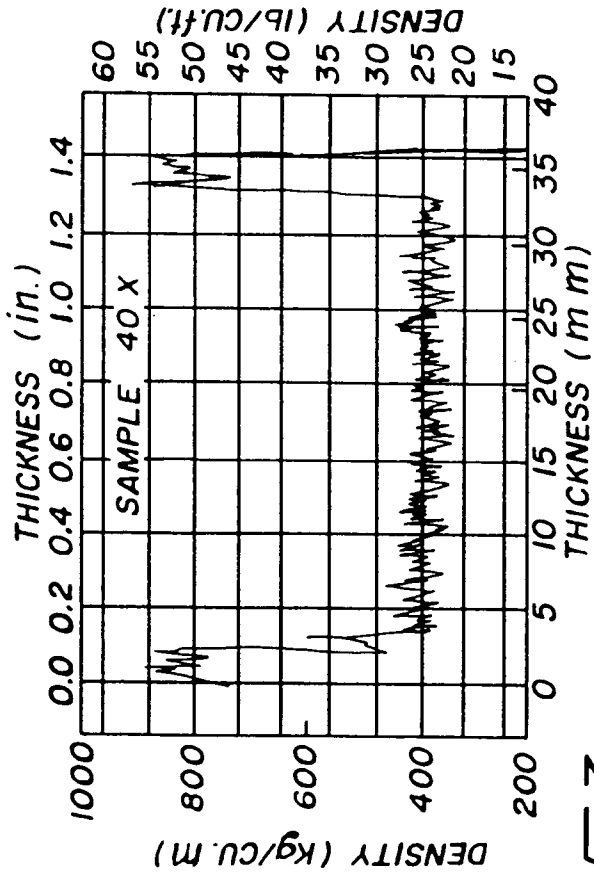
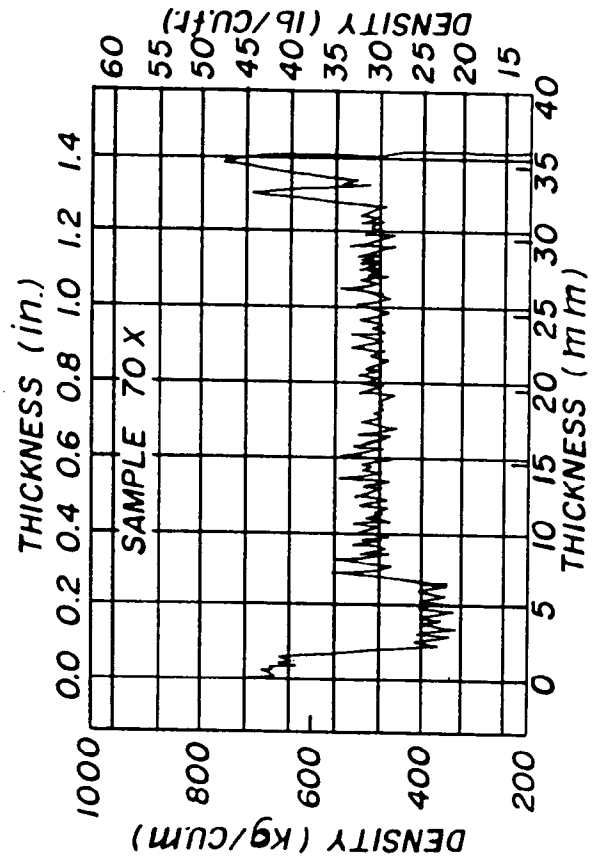
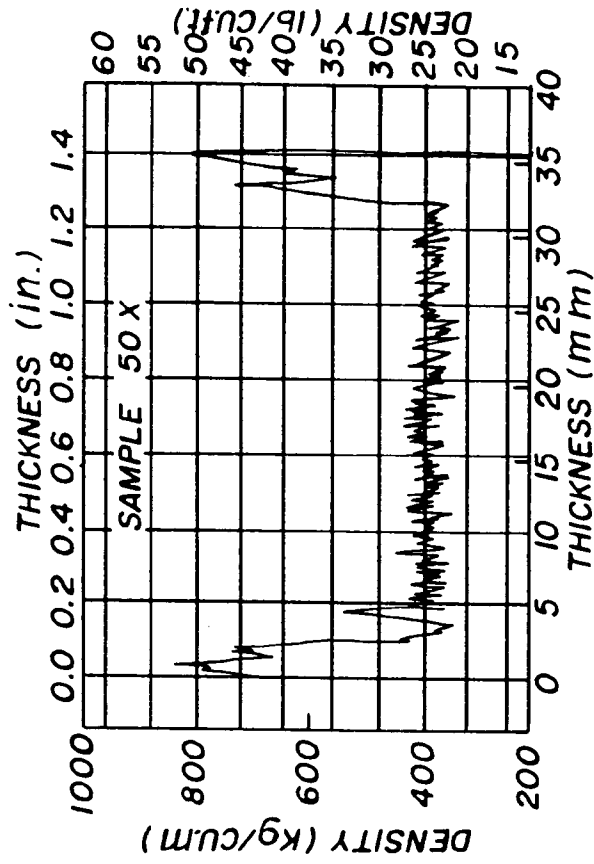
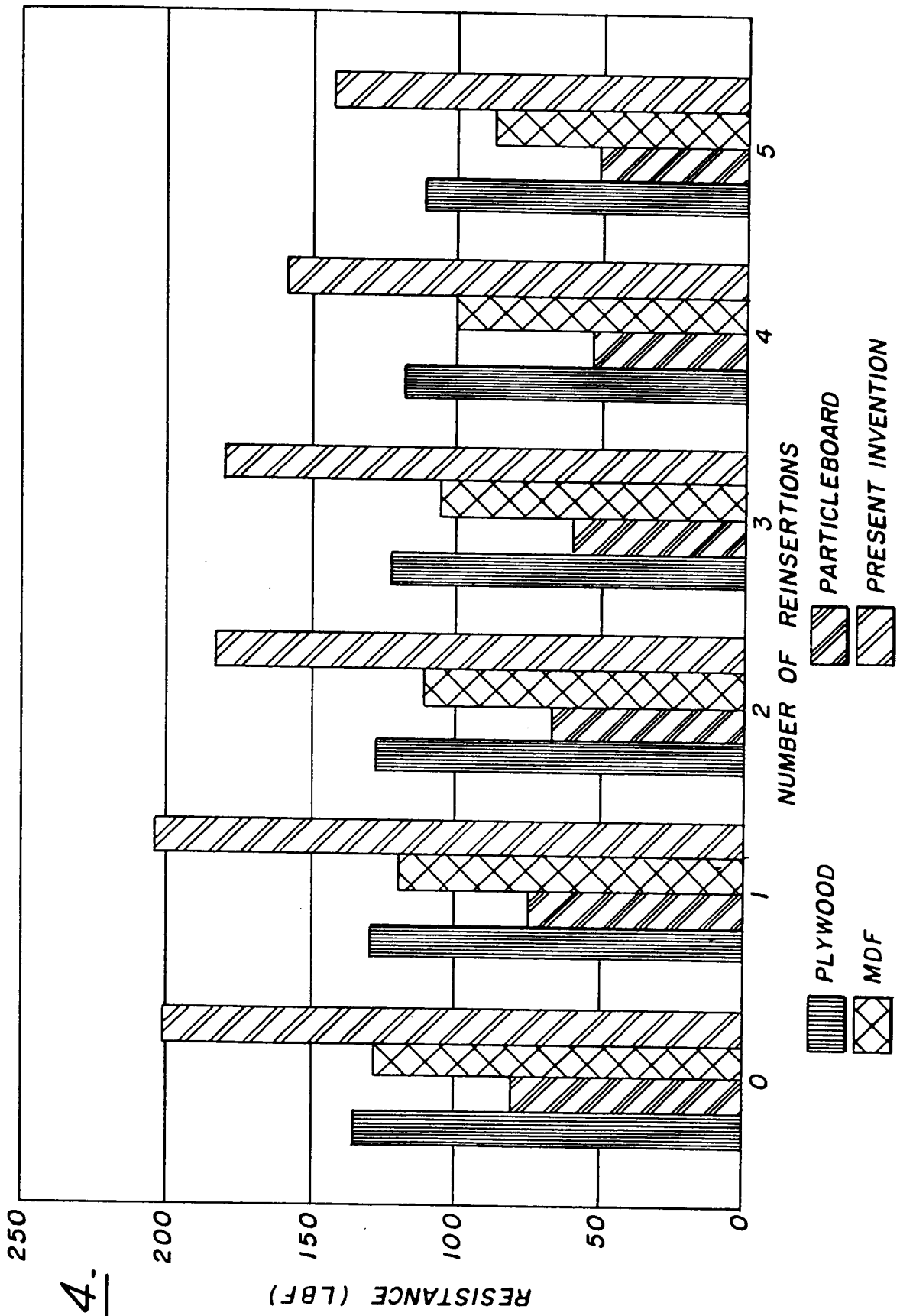


Fig. 3.





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 81 0403

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	FR-A-2 667 264 (MASCHINENFABRIK J. DIEFFENBACHER GMBH & CO.) 3 April 1992 * page 3, line 1 - line 9 * * page 6, line 26 - line 31; claims; figures 2-4 *	1-19	B27N7/00
Y	US-A-4 612 224 (DAVIS) 16 September 1986 * abstract; claims; examples *	1-19	
A	FR-A-2 568 510 (GARCIA JEAN) 7 February 1986		
A	DE-A-24 39 016 (THERMOPAL-WERK INGEBORG KRAGES) 26 February 1976		
A	DATABASE WPI Derwent Publications Ltd., London, GB; AN 92-136605 & JP-A-4 077 241 (TAKEHIRO KK) 11 March 1992 * abstract *		
A	DATABASE WPI Derwent Publications Ltd., London, GB; AN 89-066698 & JP-A-1 020 399 (NICHIIHA KK) 24 January 1989 * abstract *		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B27N E04C
Place of search		Date of completion of the search	Examiner
THE HAGUE		10 March 1995	Soederberg, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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