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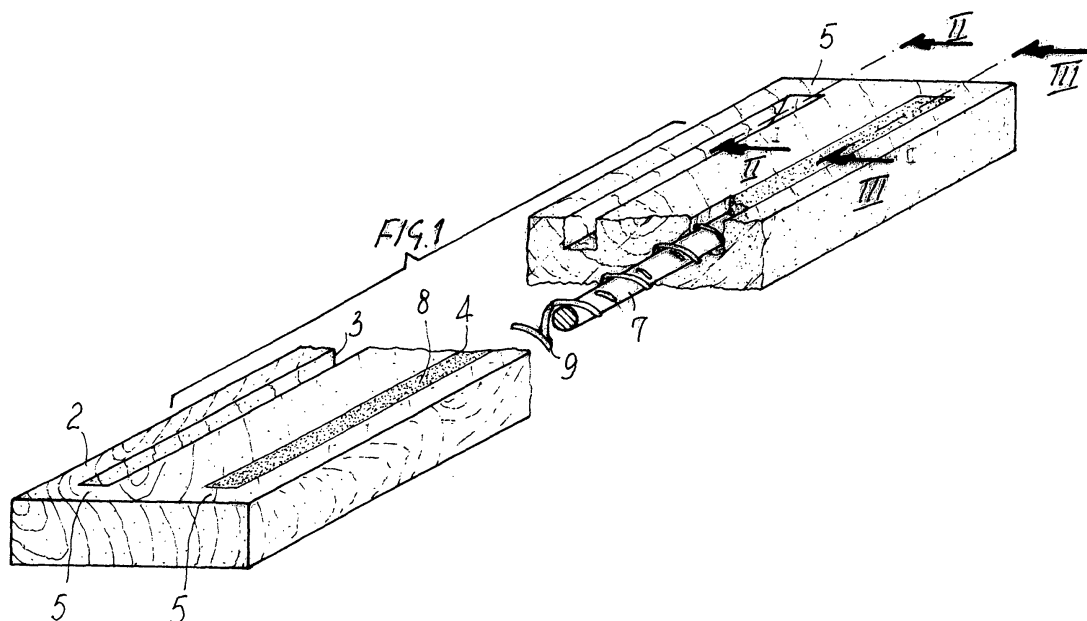
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(54) **Method of manufacturing a reinforced wooden beam and reinforced beam thus obtained**

(57) A method for the making of a reinforced wooden beam, consisting of the following stages in this sequence:

- longitudinal milling of a finished or rough beam, or at least of at least one board (1) destined to be used in the making of a lamellar beam (10), so as to obtain at least one longitudinal milled groove or slot

- (3, 4),
- the pouring of cement (8) into each milled groove or slot (3), and
- the laying of a metal bar (7), or bar of some other material, that is less in depth than the corresponding milled groove or slot (3, 4), in the or each groove, so that it is embedded in the cement (8).



Description

[0001] The present invention regards a method of manufacturing a reinforced wooden beam and reinforced wooden beam obtained by implementing such a method.

[0002] Beams reinforced with various materials such as metal sheets, fibres, steel bars, or plastics sheets and the like, have already been suggested that, although providing some improvements in the beam performance, have turned out not to be entirely satisfactory from the point of view either of their industrial manufacture or their actual performance on site.

[0003] The main object of the present invention is to provide a method of manufacturing a reinforced lamellar beam that can be manufactured on an industrial scale by standard production processes and constitutes a reinforced wooden beam of high performance as regards both its rigidity and strength.

[0004] Another object of the present invention is to provide a method of manufacturing reinforced beams either of lamellar or heartwood type.

[0005] A further object of the present invention is that the said method can also be applied to already installed heartwood beams, so that rehabilitation or renewal of old beams can be carried out in old buildings.

[0006] Not last object of the present invention is to provide a method of manufacturing reinforced wooden beams in a relatively easy and quick way whereby being also competitive from the economic view point.

[0007] These and other objects that will better appear below are attained by a method of manufacturing reinforced wooden beams, according to the present invention, comprising the following steps, in sequence:

- longitudinal milling of a finished or rough beam, or at least one board designed to be used in the manufacturing of a lamellar beam, thereby obtaining at least one longitudinal milled groove or slot,
- pouring a gluing material into each groove or slot,
- laying a bar of metal or another suitable material having a thickness smaller than the depth of its respective milled groove or slot, so as to be embedded in the gluing material.

[0008] Advantageously, after the poured gluing material has dried planning is carried out to remove any excess gluing material and the planned surface is covered with a covering board.

[0009] The invention will be described in more detail hereinbelow in connection with some embodiments thereof given merely by way of non-limiting examples, with reference to the accompanying drawings, in which:

Figure 1 shows a perspective view of two end sections of a board for a lamellar beam with milled grooves formed therein that extend throughout the intermediate length of the board but terminate just

ahead of the two ends of the board, thereby delimiting a trough, one of the slots receiving a metal bar in a spiral spacer embedded in a gluing material; Figures 2 and 3 each show a longitudinal cross-section along a respective line II-II and III-III of Figure 1 at a free and reinforced milled slot, respectively; Figure 4 is a partial perspective view of a component board of a lamellar beam on one side of which a pair of longitudinal grooves or slots have been milled, one slot being filled with gluing material and receiving a metal reinforcement bar;

Figure 5 shows a longitudinal section of the board in Figure 1 at a milled groove containing a reinforcement bar and gluing material;

Figure 6 is a longitudinal section view showing a variant of Figure 4, where the metal reinforcement bar is inserted in a number of spacer bushes;

Figure 7 shows half in a perspective view and half in cross-section a spacer bush on an enlarged scale with respect to Figure 6;

Figure 8 shows another embodiment of the invention in which the ends of the reinforcement bars project from their receiving board through threaded extension pins;

Figure 9 is a view with parts in cross-section that shows a threading coupling between a metal bar and an extension pin;

Figure 10 shows a diagrammatic perspective view of a lamellar beam with two opposite lamellar boards according to the present invention;

Figure 11 shows a curved lamellar board reinforced in accordance with the method of present invention for obtaining of non-straight beams; and

Figure 12 is a diagram comparing estimated and actual values of the coefficient of elasticity E of not reinforced lamellar beams and beams variously reinforced according to the present invention, where the effective, theoretical and actual coefficients of elasticity of lamellar wooden beams 12x23 cm non-reinforced, reinforced with round bars 1+1 Ø 14, 2+2 Ø 14, 3+3 Ø 14, 2 Ø 14 + 2 Ø 20 and round bars CFRP 2+2 Ø 7,5, respectively, are indicated in ordinates, whereas the cross-section of the various types of beams is shown at the top.

[0010] The same reference numerals have been used for the same or similar components in the various Figures of the drawings.

[0011] With reference first to Figures 1 to 7, it will be noted that a board 1 designed to be used as a component of a lamellar beam is actually longer than the final lamellar beam to be made and has a thickness ranging e.g. from 35 to 42 mm. Board 1, in general, will not be made of one piece but, as is known in this field of the art, will comprise comb joints to one or more boards.

[0012] A plane is used to plane one surface 2 of the board, planning being carried out throughout its whole length to obtain a thickness of e.g. 33 or 40 mm. Two

parallel slots or grooves 3 and 4 are then milled. To this end, the board 1 is arranged a milling machine with cylindrical cutter having a thickness equal to that of the groove to be milled, while its depth is determined by adjusting the milling machine taking as a reference the previously planed surface 2. The milling machine is of course arranged so that the axis of each milled groove is located at a given distance (e.g. 30 mm) from the edge. The width and depth of the milling are important parameters also in relation to other factors, as will be described below.

[0013] The milled grooves 3 and 4 delimit a through and affect a substantial portion of the length of the board 1, while leaving a "free" unmilled portion 5 at the ends, as illustrated in Figures 1 to 3. In that case, the milled grooves or slots 3 and 4 will be wholly hidden from view, whereas when the milled grooves 3 and 4 extend throughout the whole length of the board, as shown in Figures 4 and 5, the groove ends can be plugged by means of silicone plugs 6, as will be further described below.

[0014] The milled grooves 3 and 4 are then prepared, preferably cleaned with jets of compressed air and, if required, with silicone plugs at the ends 6, and then a bar 7, e.g. made of steel (such as Fe B 44k), aluminium or fibre such as carbon fibre, glass fibre or the like, is placed in each of the milled grooves or slots 3 and 4. Some care is required in laying the bars 7 as they must be laid straight throughout their length with no humps both side humps to avoid contact with the side walls of the milled groove and vertical humps that might cause overflows in the following gluing stage. In addition, the dimensions of the bars (size or diameter) must be smaller than the depth and width of the milled grooves or slots 3 and 4.

[0015] The insertion of the bars into the milled grooves 3 and 4 is preferably carried out by first laying them at half the length of the milled grooves and then gradually proceeding towards the groove ends for a better distribution of the gluing material, while leaving a gap between the end of the bar and end of the board 1 whose length corresponds to that of a free area 5 or silicone plug 6 so as to leave a workable section at the ends of the board 1, i.e. of the finished beam.

[0016] Advantageously, for the bar to be better located in the wood, suitable spacers can be used, such as one or more spirals 9 (Figure 1) wound around the bar, or spacing bushes 9a (Figure 6) arranged at a distance from one another along each bar 7.

[0017] Preferably, a layer of gluing material (adhesive) is poured into the milled grooves 3 and 4 before laying the bars 7, the gluing material occupying a predetermined percentage of the volume of the grooves net of the volume of the bar. The gluing material is poured directly from its container or by injection using a suitable pistol or syringe.

[0018] The adopted gluing material is a suitable structural adhesive, e.g. such as a two-component epoxy

glue or another suitable gluing material.

[0019] Thus, a finishing operation is preferably carried out which comprises topping up the gluing material so as to obtain an uniform upper surface whereby the gluing material has an upper surface slightly lower than the outer surface of the board 1. The small difference in level between the surface of the board and that of the gluing material can be eliminated once the gluing material is set or in any case has reached such a consistency as to be machine worked. A finishing cut by a plane is then carried out to remove about 1 mm of upper surface material to obtain a flat upper surface of the board 1, while removing at the same time any dirt that almost inevitably gathers during working.

[0020] If required, a planning operation can also be carried out on the reverse surface of the board 1, before returning the (lamellar) board to the lamellar beam production process.

[0021] The board 1 should in any case be positioned in the outer portion of a lamellar beam as an end board or plank, or in any case close to an outer surface, e.g. as a second or third lamellar component. Preferably, the final lamellar beam will include two reinforced boards 1: one located at its face that, in use, is designed to act as upper surface and the other at the lower surface thereof. As far as the gluing process of the boards or laminar components is concerned one can proceed in a conventional way in relation to non-reinforced boards or laminar components with no problems.

[0022] Should plugs 6 be provided, these will be in view at the head on at both ends of the lamellar beam. This, however, is not a problem as silicone can be machined just as a piece of wood.

[0023] Figures 6 to 10 show a specific embodiment in which the bars 7 extend beyond the board 1 and thus beyond the ends of a final lamellar beam 10.

[0024] At first sight, the simplest solution would be to use bars 7 that are longer than their respective board (lamellar component) 1. Such a solution, however, cannot be adopted for a number of reasons. In the first place, the presence of the ends of the metal bars 7 would make it impossible to face the beam 10, e.g. to size it in line with the production of flat end surfaces. It should be noted, in fact, that the length of the board 1 is in practice slightly greater than its nominal length and, on the other hand, of the boards or lamellar components 1 are not perfectly equal to one another. In the second place, it would not be possible to mill with standard tools the end portion of a finished beam 10, which is required, instead, both for structural and aesthetic reasons.

[0025] Thus, it is necessary to provide a suitable clearance at each end with no bar in order to be able to economically carry out the above mentioned operations. On the other hand, the bars 7 in some cases must extend significantly beyond the length of the beam 10, i.e. beyond the end sections, to make it possible to effect a proper connection by means of bolts, counterplates or the like, to a joint designed to attain that purpose.

[0026] To this end, the present invention aims at providing the use of bars 7 having threaded sections 7a at least at their ends so as to be able to thread engaging with a respective threaded sleeve 12 which can be applied to the bar by removing the silicone plugs 6, when the lamellar beam 10 is finished.

[0027] Of course, the thickness of the threaded sleeve 12 must have a diameter not greater than the width of the milled grooves 3 or 4, unless a suitable receiving seat for the sleeve 12 is provided having a width greater than that of its respective milled groove.

[0028] A length of threaded bar or pin 7b, which projects out of the board 1 and constitutes a solid extension to the internal bar 7, can be inserted into the threaded sleeve 12. On the other hand, the fact that the threaded pins 7b are removable results in high versatility of application.

[0029] Figure 11 shows a reinforced board 15 according to the present invention having a generally curved outline.

[0030] From carried out flexion tests values of elasticity coefficient E values have been obtained that together with the estimated values of elasticity coefficient E of 11,000 N/mm² according to standard provisions are shown in Figure 12, where remarkable increases in the elasticity coefficient of a variously reinforced lamellar beam according to the present invention as compared with conventional (non-reinforced) beam are shown.

[0031] The above described beam reinforcement method can also be carried out on a beam that is already in site in a building, e.g. for restoration works, by milling one or more longitudinal grooves 3, 4 along the beam and inserting reinforcing bars 7 that are embedded in a gluing material and, if desired, by providing covering with wooden strip or masking board.

[0032] The above described invention is susceptible to numerous modifications and variations within the scope as defined by the claims.

[0033] The disclosure in Italian patent application no. VR2001A00034 from which priority is claimed is incorporated herein by reference.

Claims

1. A method of manufacturing a reinforced wooden beam, comprising the following steps in sequence:

- longitudinal milling of a finished or rough beam, or of at least one board (1) designed to form a component of a lamellar beam (10), thereby obtaining at least one milled longitudinal groove or slot (3, 4),
- pouring a gluing material (8) into each milled groove or slot (3, 4), and
- laying a metal bar (7) or a bar of another suitable material, having a size smaller than the depth of its respective slot or groove (3, 4) so

as to be embedded in the said gluing material (8).

2. A method according to claim 1, **characterised in that** after the pouring in and drying of the gluing material, the milled surface or face of the beam or board (1) is planed or levelled.
3. A method according to claim 1 or 2, **characterised in that** the said milled surface or face is covered by a covering board.
4. A method according to any preceding claim, **characterised in that** said milled groove or grooves (3, 4) extend at least along a substantial part of the length of the beam or board (1), thereby providing a not-milled end portion (5).
5. A method according to any claim 1 to 3, **characterised in that** the said milled groove or grooves (3, 4) extend throughout whole length of the beam or board (1) and the end portions of each milled groove (7) are filled in with a suitable plugging material (6).
6. A method according to any previous claim, **characterised in that** before pouring said gluing material the or each of the milled grooves (3, 4) is cleaned with a jet of compressed air.
7. A method according to any previous claim 4 to 6, **characterised in that** said laying of each bar (7) in a respective milled groove (3, 4) is carried out using bars (7) that are shorter in length than the beam or board (1), thereby leaving a free area between the end of the bar (7) and the end of the board 1 that substantially corresponds to the length of said free areas (5) or said plugs (6).
8. A method according to any preceding claim, **characterised in that** spacers are positioned between the bar (7) and the wood.
9. A method according to claim 8, **characterised in that** said spacers comprise at least one spiral (9) wound around each bar (7).
10. A method according to claim 8, **characterised in that** said spacers comprise a number of spacer bushes (9a) arranged spaced from one another along the length of each bar (7).
11. A method according to any preceding claim, **characterised in that** said gluing material (8) comprises a suitable structural adhesive, such as a two-component epoxy glue.
12. A method according to any preceding claim, **characterised in that** it comprises a planing operation

after said gluing material has set, thereby eliminating any differences in level between the board (1) or beam and the upper surface of said gluing material (8).

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13. A method according to any preceding claim, **characterised in that** the or each bar (7) is provided with an extension (7b) projecting outside the beam or board (1).

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14. A method according to any preceding claim, **characterised in that** once said board (1) has been reinforced it is put in a production process for manufacturing a lamellar beam.

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15. A reinforced beam or board (1) when produced according to the method as claimed in any preceding claim.

16. A lamellar beam including at least one reinforced board according to claim 13, **characterised in that** the or each reinforced board has an extension (7b) comprising at least one threaded end (7a) for each bar (7), an internally threaded sleeve (12) screwable onto the said threaded portion of a respective bar (7), and a pin (7b) screwable onto the said threaded sleeve and projecting from the said beam or board (1).

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17. A lamellar beam according to claim 15 or 16, **characterised in that** it comprises curved boards or strips (1).

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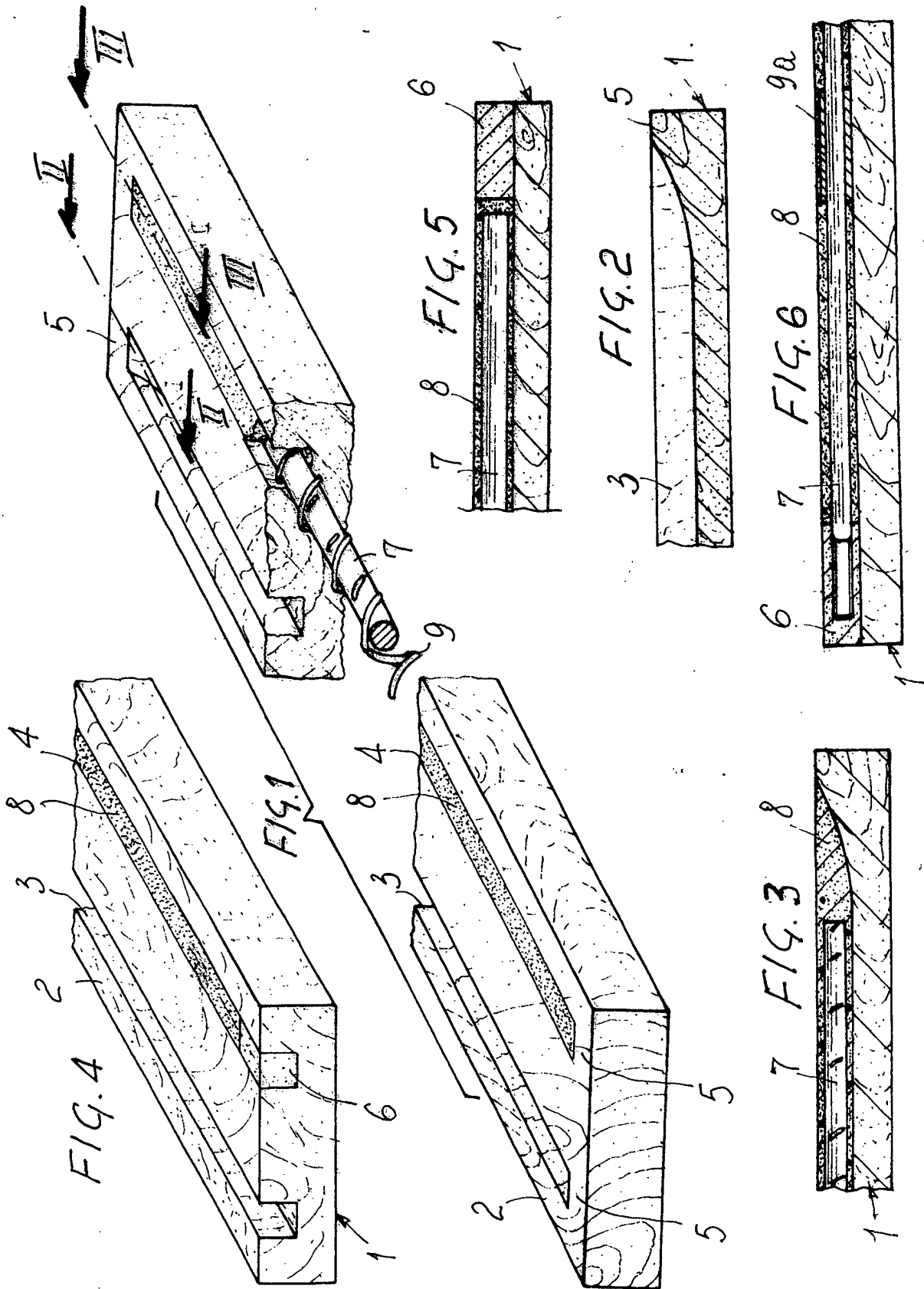
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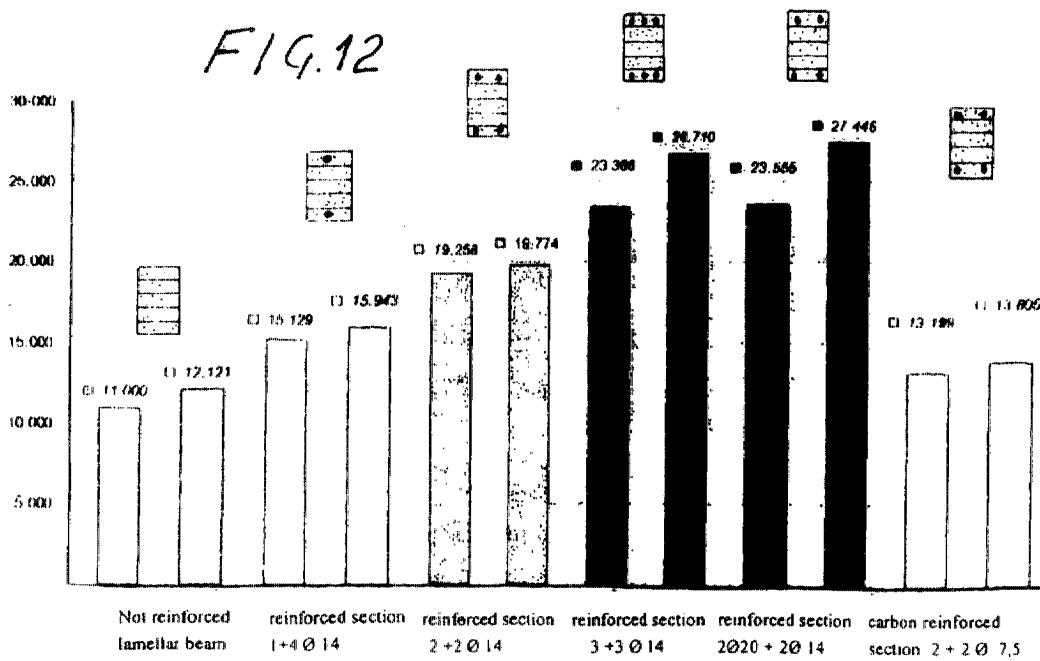
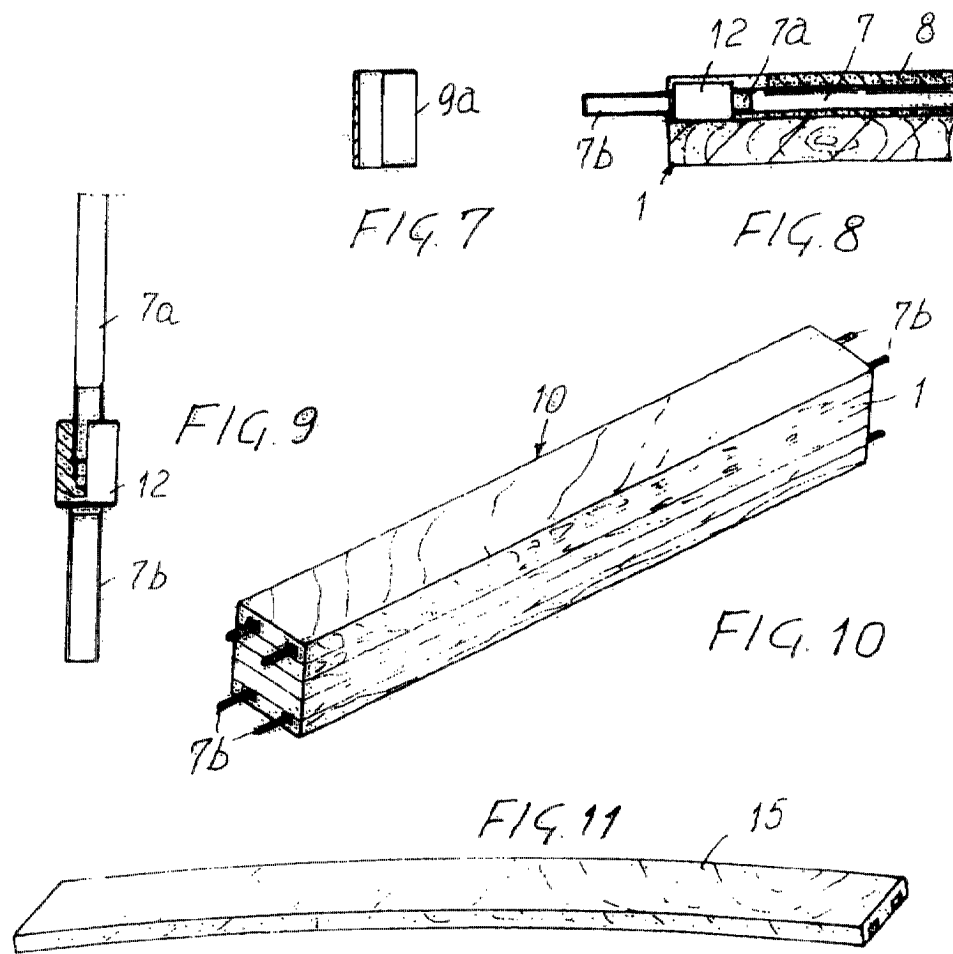
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EUROPEAN SEARCH REPORT

Application Number
EP 02 00 5324

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Place of search THE HAGUE		Date of completion of the search 14 June 2002	Examiner Demeester, J
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EPO FORM 1503 03 82 (P04C01)



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EUROPEAN SEARCH REPORT

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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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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