

Description**TECHNICAL FIELD**

The present invention relates to a method for the production of a composite structure with an intermediate three-dimensional textile, to a structure made by this method and to apparatus for carrying it out.

BACKGROUND ART

Composite structures are known for example of the type described European patent application EP-A-449.033 entitled: "Method for the Production of Sandwich Structures" filed by the same Applicants, including a so-called three-dimensional textile which is formed from two sheets of textile placed face to face and connected together by a plurality of threads extending from the adjacent surfaces of the sheets.

In order to form such structures, the three-dimensional textile, impregnated with resin, is placed in a die and an expanded resin is injected into the space between the sheets and, in expanding, forces apart the sheets which then come into contact with the surfaces of the die. In such composite structures, the expanded resin determines the mechanical characteristics and the thermally insulating properties of the structure itself.

Study has also been made of the manufacture of a composite structure of the type described above which is at least partially hollow, this being made by impregnating a three-dimensional textile with a fluid thermo-setting resin and, instead of expanded resin, blowing in compressed gas in order to force the sheets apart and form an interspace between the sheets themselves.

These methods although having the distinctiveness of generating structures with sculptured geometries, in the construction of flat structures (panels) sometimes give geometric and dimensional irregularities (for example, undulations in the surfaces and a non-constant thickness).

DISCLOSURE OF INVENTION

The object of the present invention is to form a composite structure with an intermediate three-dimensional textile in a relatively simple and repeatable manner, the structure overcoming the disadvantages mentioned above, that is, having well defined physical, mechanical and dimensional characteristics and being relatively cheap to produce.

The following object is achieved by the present invention which relates to a method for the production of composite structures with intermediate three-dimensional textiles, characterised in that it comprises:

a first phase in which a layered structure is inserted between first and second dies of a press; the layered structure including at least one three-dimensional textile constituted by two sheets of textile disposed in parallel and connected together by at least one plural-

ity of threads extending from facing surfaces of the sheets; at least one pair of layers disposed facing the said sheets on the outside of the said structure; at least the said three-dimensional textile also being impregnated with a resin; the dies being provided with means for attaching the said layers to their surfaces;

a second phase in which the dies are at least partially closed and the three-dimensional textile is pressed between the layers and the resin impregnating the said sheets distributes itself between the parts in contact, also permeating the threads uniformly;

a third phase in which the layers are attached firmly to the dies;

a fourth phase in which the dies are reopened through a certain distance within the limit of the natural elastic recovery of the three-dimensional textile due to the action of the combination of threads tending to straighten themselves ;

a fifth phase in which at least partial polymerisation of the resin present between the layers and the outermost sheets of the three-dimensional textile is obtained while the resin impregnating the threads remains substantially in a plastic state;

a sixth phase in which the dies are opened to a predetermined distance in order to move the sheets away from each other and extend the threads to form a partially hollow structure;

a seventh phase in which the structure remains clamped between the two dies until the polymerisation of the resin is complete;

an eighth phase in which the layers are released from the surfaces of the dies, the dies are opened completely and the layered structure is removed from the press.

BRIEF DESCRIPTION OF DRAWINGS

The invention will now be illustrated, by way of non-limitative example, with particular reference to the appended drawings in which:

Figure 1 is an exploded perspective view of a layered structure used for the production of the composite element according to the present invention;

Figures 2 to 7 illustrate schematically, in longitudinal section, and in successive phases, parts of the apparatus used for the production of a composite structure according to the method of the present invention;

Figure 8 is a complete longitudinal section of a press used for the production of the composite structure according to the present invention;

Figure 9 illustrates a detail of Figure 8 taken on the transverse section IX-IX; and

Figures 10, 11, 12 and 13 illustrate variants of the structure shown in Figure 1;

Figures 14 and 15 are perspective views respectively of a first and a second embodiment of a three-

dimensional textile of the type used in the layered structure illustrated in Figure 1; and

Figures 16, 17, 18 and 19 are four cross sections of three-dimensional textiles usable in the structure of Figure 1 instead of the textiles illustrated in Figures 14 and 15.

BEST MODE FOR CARRYING OUT THE INVENTION

In Figure 1, a layered structure is generally indicated 1 and includes a three-dimensional textile 3 of known type formed from a pair of woven sheets (Figure 14) or knitted sheets (Figure 15) 5 and 6 disposed face to face and connected together by a plurality of threads 10 extending between the adjacent surfaces of the sheets 5 and 6, and a pair of woven sheets 12 and 13 disposed face to face with the sheets 5 and 6.

The layered structure 1 further includes a pair of layers 16 and 17 disposed in contact with the sheets 12 and 13 respectively and conveniently made from plastics, metal or other material.

The three-dimensional textile 3 and the sheets 12 and 13 are also completely impregnated with a thermosetting plastics resin 20 (for example, a phenolic, epoxy, bismaleic, or polyester resin).

According to the method of the present invention, the layered structure 1, obtained by substantially known methods from continuous sheets which are then cut to the desired dimensions is inserted between a lower die 25 and an upper die 26 (Figure 2) of a press 28 (best seen in Figure 8) which has devices for fixing the structure 1 to the dies 25 and 26 and also has devices for heating the structure 1, enabling the resin 20 to polymerise, as will be clarified below. In particular, the dies 25 and 26 have respective flat faces 29 and 30 formed with rectangular, peripheral grooves 31 and 32 engaged by fluid-tight seals 33 and 34 with respective lips 35 and 36 which extend outwardly of the flat faces 29 and 30. The dies 25 and 26 are also provided with a plurality of vertical ducts 40 which extend within the dies perpendicular to the faces 29 and 30 and open into these faces 29 and 30, and are connected internally to crossed ducts 41 which extend parallel to the faces 29 and 30 and are connected to a respective pump 45 (illustrated schematically) to form vacuum suction means. The structure 1 also rests on the lower die 25 and the layer 17, which has greater transverse dimensions than the three-dimensional textile 3, rests on the lips 35 of the seal 33 so that the suction of air from the ducts 40 produces a low pressure between the layer 17 and the die 25 to ensure firm contact between the latter and the layer 17.

Subsequently (Figure 3) the press 28 is closed, the upper die 26 being lowered onto the structure 1; during this phase a controlled pressure is exerted on the structure 1 to enable good cohesion to be achieved between the various layers and ensure that the resin 20 is distributed uniformly between the sheets 5 and 6 of the three-dimensional textile 3 and the sheets 12 and 13 and between the latter and the layers 16 and 17.

The pressure exerted on the structure 1 also eliminates any air bubbles present between all the surfaces in contact and compresses the seals 33 and 34 against the plates 16 and 17.

In this phase air is withdrawn by the vacuum pump 45 from the ducts 40 in the dies 25 and 26 so as to reduce the pressure between these latter and the layers 16 and 17 sufficiently to attach them firmly to the faces 29 and 30.

Subsequently (Figure 4) the press 28 is opened, the die 26 being raised slowly through a distance no greater than the limit of the natural elastic recovery of the three-dimensional textile 3 due to the reaction of the combination of threads 10 which tend to straighten.

This operation must not detach the layers 16 and 17 from the sheets 12 and 13 and these from the sheets 5 and 6 of the three-dimensional textile 3.

During this phase, the heat produced within the dies 25 and 26 by conventional heating means, for example electrical resistances 46, reaches the outermost layers of the structure 1, that is the textile sheets 12 and 13, via the layers 16 and 17, and subsequently reaches the sheets of the three-dimensional textile 3 on which the resin 20 partially solidifies, ensuring the mutual adhesion of all the surfaces in contact. During this phase, the solidification process in the resin 20 which impregnates the threads 10, being in the region furthest from the heat source, is delayed; this enables the threads 10 to remain flexible through the subsequent phases of the process.

Subsequently (Figure 5) the lower die 25 is released, enabling the latter to float freely in a plane parallel to the die 26.

The press 28 is opened further, the die 26 being raised through a distance such as to stretch the threads 10 of the three-dimensional textile 3. The adhesion of the sheets 5 and 6 to the sheets 12 and 13, and of these latter to the layers 16 and 17, is ensured during this traction by the vacuum effect due to the fact that air cannot penetrate the textiles impregnated with the partially solidified resin 20.

During this phase, notwithstanding the free flotation of the lower die 25, the threads 10 can not arrange themselves automatically perpendicular to the planes in which the sheets 5 and 6 lie thereby making a subsequent manual correction phase necessary.

In this case (Figure 6) the lower die 25 is moved manually by an operator to bring the threads 10 to substantially vertical positions and the die 25 is locked in this position.

Subsequently (Figure 7) the press 28 is opened again even further to distend the threads 10 completely and achieve the intended thickness of the structure 1.

The press 28 is then locked firmly in this position and the polymerisation is completed throughout the entire resin 20 which solidifies completely even in the region of the threads 10.

Subsequently, after the dies 25 and 26 have possibly been cooled with conventional means not illustrated, the vacuum pump 45 is disconnected and air is passed into

the ducts 40 so that the layers 16 and 17 become detached from the faces 29 and 30 of the dies 25 and 26 of the press 28; finally the press 28 is opened completely and the layered structure 1 is removed.

In this structure 1, the threads 10 are completely rigid and extend perpendicular to the sheets 5 and 6, establishing a rigid connection between the sheets 5 and 6 themselves and forming a partially hollow structure because of the space present between the threads 10.

This structure, moreover, may be filled with expanded resin, for example, polyurethane or phenolic foam, this being injected at the end of the phase in which the resin polymerises, illustrated in Figure 7, to improve the mechanical, thermal and acoustic insulating properties of the composite structure.

The layers 16 and 17, which in this case are conveniently releasable films, may also subsequently be detached from the structure 1 when this is removed from the press 28; in this case, they serve as release sheets and define the flat surfaces which form after the resin 20 has solidified in the textiles 12 and 13. It would not in fact be possible to insert a structure formed solely from the three-dimensional textile 3, or the textile 3 and the textile sheets 12 and 13, in the press 28 since, on compression of layered structure 1, the resin 20 would enter the ducts 40 and obstruct them.

The use of the layers 16 and 17, moreover, enables perfectly flat surfaces to be determined, differing from those obtainable by the known methods.

Moreover, in order to render the difference in polymerisation between the resin 20 impregnating the sheets 5 and 6 of the textile 3 and the impregnated threads 10 more significant it is possible, before arranging the layered structure 1 between the dies 25 and 26 to spread a catalysing substance on one side of the layer 16 and 17 in contact with the impregnated sheets 5 and 6 or directly on the sheets 5 and 6 themselves. In this way the greater reactivity of the resin 20 in the contact zones between the sheets 5 and 6 and layers 16 and 17, already increased by the greater transfer of heat, is further increased, with respect to the reactivity of the resin impregnating the threads 10, by the local presence of a greater quantity of catalyst and therefore the polymerisation time of the resin 20 is reduced, which causes a stable connection between the contacting outer surfaces of the three-dimensional textile 3, guaranteeing a secure stretching of the threads 10 in the subsequent progressive opening phases of the press 28.

Conveniently, the catalysing substance used for polyester resin can be methyl-ethyl ketone peroxide in percentages, for example, varying up to 3% for phenolic resins acid solutions can be utilized in percentages, for example, varying up to 15%, and for epoxy resins can be utilized resins based on amide in percentages, for example, varying between 30% and 50%.

Figure 8 illustrates the press 28 in greater detail, the press including a base 99 on which a body 100 supporting the lower die 25 is fixed, the die being slidable by

means of rolling ball assemblies 110 (of known type) on the body 100 itself.

These assemblies 110 enable the die 25 to move in any direction in a plane parallel to the upper die 26.

More particularly, each assembly 110 includes a plate 101 which is fixed by screws 101a to the body 100, is disposed so as to close a circular, downwardly-open recess 102 in the die 25 and has a through-hole 103 in which a shaft 104 is inserted, being fixed firmly at its lower end to the body 100 and provided at its upper end with a circular flange 105 inserted in the recess 102. The unit 110 further includes a first plurality of balls 106 disposed circumferentially in a first ring coaxial with the shaft 104 and inserted between the flange 105 and the plate 101, and a second plurality of balls 107 disposed circumferentially in second ring coaxial with the shaft 104 and inserted between the plate 101 and an annular plate 108 mounted on the body 100.

The body 100 is also provided with stop devices 120 for clamping the die 25 to the body 100 itself and each including a shaft 122 which is pneumatically actuable and movable towards the die 25 and adapted at one end 124 to press frictionally against the die 25 to prevent any movement in the plane of the die.

The die 25 also has two pairs of release devices 130 for releasing the die 25 within its own plane as well as for repositioning it, that is for returning the lower die 25 to a predefined position relative to the body 100 after the lower die has been moved in the preceding working cycle.

The devices 130 are conveniently disposed at the four opposite sides of the die 25 and each includes a respective pneumatic actuator 135 mounted so as to project outwardly and downwardly of the die 25 and provided with a respective movable rod 137 extending towards the body 100 and terminating in a spherical tip 138 facing the latter. These tips 138 of the actuators 135 are arranged to come to bear against abutment members 140 firmly fixed to the body 100.

More particularly, as illustrated in Figure 9, each of the abutment members 40 has a wide V-shaped groove 142 which receives the tip 138 of the respective rod 137 in the repositioning phase. Thus, when the tip 138 of each rod 137 contacts the faces of the groove 142, the lower die 25 is returned to a defined position relative to the body 100.

From what has been explained above, it will be clear that the method of the present invention solves the problems of the known processes; indeed this process forms to advantage, in a simple and economic manner, a layered structure which is partially hollow and which has constant geometric and mechanical characteristics (for example, uniform thickness) and a specific shape.

It is clear finally that modifications and variations may be made to the present method without thereby departing from the protective scope of the method itself.

The thermo-setting resin 20, for example could be replaced by a thermoplastics resin (for example, a polyamide, a polyetherimide, a polyester ketone, a polyamide)

impregnating the three-dimensional textile 3 and made fluid and subsequently cooled within the press 28.

The structure 1, as illustrated in Figure 10 may be without the sheets 12 and 13, including solely the three-dimensional textile 3 and the plates 16 and 17 forming part of the structure itself.

The removable plates 16 and 17 (Figure 11) may also be covered with a gel-coat resin 160 or other surface finish deposited between the three-dimensional textile 3 and the plates 16 and 17. Thus, after the removal of the plates 16 and 17, the outer surfaces of the structure 1 are perfectly smooth and of agreeable appearance, giving the composite structure a valued aesthetic appearance.

Figure 12 illustrates a structure in which the upper sheet 16 is formed from a metal or plastics laminate and is kept firmly fixed to the composite structure while the lower plate 17 acts as a release sheet and is removed. This lower sheet 17 may also be covered with a gel-coat 160.

Figure 13 illustrates a structure almost entirely the same as that shown in Figure 11 but which differs from this solely in that it includes a textile sheet 13 between the three-dimensional textile 3 and the lower release plate 17.

The threads 10, moreover, may be arranged to lie differently from those illustrated in Figures 1, 2-7, 14 and 15. More particularly (Figure 16) the threads 10 may be inclined to the textile sheets 5 and 6 and may cross each other to form an X structure (or a V structure). Such a structure (Figure 17), in addition to the threads 10 which form X-structures with each other, may include threads 10A disposed perpendicular to the textile sheets 5 and 6. Finally the threads 10 (Figure 18) may be curved relative to the sheets 5 and 6.

The sheets 5 and 6, moreover may be connected together (Figure 19) by a textile piece 200 which extends substantially perpendicular to and between the facing surfaces of the sheets 5 and 6 and is firmly connected to these latter; the threads 10 are also present in such textile pieces 200 in addition to threads which lie parallel to the sheets 5 and 6.

The structure 1 could, moreover, be constituted by a plurality of superimposed layers of three-dimensional textile 3; conveniently a catalysing substance could be preliminarily spread between the facing surfaces of these layers, for example between the sheets 5 and 6, in order locally to accelerate the polymerisation process of the resin to cause a stable connection between the facing surfaces of the various layers so as to guarantee the stretching of the threads 10 of the various internal layers during progressive opening of the press.

The phase of alignment of the two dies 25 and 26 could be eliminated when unnecessary and both the dies could be movable in parallel planes.

Finally the press 28 could be provided with devices other than those shown for the floating of the lower die 25 relative to the upper die 26. For example, it could be

formed with commercially available ball-bearing or pneumatic support slides (air cushions).

Likewise, the electric heating means 46 for the dies 25 and 26 could be replaced by other means for accelerating the resin polymerisation process.

Claims

1. A method for the production of composite structures with intermediate three-dimensional textiles, characterized in that it comprises:

a first phase in which a layered structure (1) is inserted between first and second dies (25,26) of a press (28); the layered structured (1) including at least one three-dimensional textile (3) constituted by two sheets (5,6) of textile disposed in parallel and connected together by at least one plurality of threads (10) extending from facing surfaces of the sheets (5,6); at least one pair of layers (16,17) disposed facing the said sheets (5,6) on the outside of the said structure (1); at least the said three-dimensional textile (3) also being impregnated with a resin (20); the dies (25,26) being provided with means (40,45) for attaching the said layers (16,17) to their surfaces;

a second phase in which the dies (25,26) are at least partially closed and the three-dimensional textile (3) is pressed between the layers (16,17) and the resin (20) impregnating the said sheets distributes itself between the parts in contact, also permeating the threads (10) uniformly;

a third phase in which the layers (16,17) are attached firmly to the dies (25,26);

a fourth phase in which the dies (25,26) are reopened through a certain distance within the limit of the natural elastic recovery of the three-dimensional textile (3) due to the action of the combination of threads (10) tending to straighten themselves;

a fifth phase in which at least a partial polymerisation of the resin (20) between the layers (16,17) and the outermost sheets (5,6) of the three-dimensional textile (3) is achieved while the resin (20) impregnating the threads (10) remains substantially in a plastic state;

a sixth phase in which the dies (25,26) are opened to a predetermined distance in order to move the sheets (5,6) away from each other and extend the threads (10) to form a partially hollow structure;

a seventh phase in which the structure (1) remains clamped between the two dies (25,26) until the polymerisation of the resin (20) is complete;

an eighth phase in which the plates (16,17) are released from the surfaces of the dies (25,26), the dies (25,26) are opened completely and the layered structure (1) is removed from the press (28).

2. A method according to Claim 1, characterised in that, in the sixth phase, at least one of the dies

impregnating the three-dimensional textile 3 and made fluid and subsequently cooled within the press 28.

The structure 1, as illustrated in Figure 10 may be without the sheets 12 and 13, including solely the three-dimensional textile 3 and the plates 16 and 17 forming part of the structure itself.

The removable plates 16 and 17 (Figure 11) may also be covered with a gel-coat resin 160 or other surface finish deposited between the three-dimensional textile 3 and the plates 16 and 17. Thus, after the removal of the plates 16 and 17, the outer surfaces of the structure 1 are perfectly smooth and of agreeable appearance, giving the composite structure a valued aesthetic appearance.

Figure 12 illustrates a structure in which the upper sheet 16 is formed from a metal or plastics laminate and is kept firmly fixed to the composite structure while the lower plate 17 acts as a release sheet and is removed. This lower sheet 17 may also be covered with a gel-coat 160.

Figure 13 illustrates a structure almost entirely the same as that shown in Figure 11 but which differs from this solely in that it includes a textile sheet 13 between the three-dimensional textile 3 and the lower release plate 17.

The threads 10, moreover, may be arranged to lie differently from those illustrated in Figures 1, 2-7, 14 and 15. More particularly (Figure 16) the threads 10 may be inclined to the textile sheets 5 and 6 and may cross each other to form an X structure (or a V structure). Such a structure (Figure 17), in addition to the threads 10 which form X-structures with each other, may include threads 10A disposed perpendicular to the textile sheets 5 and 6. Finally the threads 10 (Figure 18) may be curved relative to the sheets 5 and 6.

The sheets 5 and 6, moreover may be connected together (Figure 19) by a textile piece 200 which extends substantially perpendicular to and between the facing surfaces of the sheets 5 and 6 and is firmly connected to these latter; the threads 10 are also present in such textile pieces 200 in addition to threads which lie parallel to the sheets 5 and 6.

The structure 1 could, moreover, be constituted by a plurality of superimposed layers of three-dimensional textile 3; conveniently a catalysing substance could be preliminary spread between the facing surfaces of these layers, for example between the sheets 5 and 6, in order locally to accelerate the polymerisation process of the resin to cause a stable connection between the facing surfaces of the various layers so as to guarantee the stretching of the threads 10 of the various internal layers during progressive opening of the press.

The phase of alignment of the two dies 25 and 26 could be eliminated when unnecessary and both the dies could be movable in parallel planes.

Finally the press 28 could be provided with devices other than those shown for the floating of the lower die 25 relative to the upper die 26. For example, it could be

formed with commercially available ball-bearing or pneumatic support slides (air cushions).

Likewise, the electric heating means 46 for the dies 25 and 26 could be replaced by other means for accelerating the resin polymerisation process.

Claims

1. A method for the production of composite structures with intermediate three-dimensional textiles, characterized in that it comprises:

a first phase in which a layered structure (1) is inserted between first and second dies (25,26) of a press (28); the layered structured (1) including at least one three-dimensional textile (3) constituted by two sheets (5,6) of textile disposed in parallel and connected together by at least one plurality of threads (10) extending from facing surfaces of the sheets (5,6); at least one pair of layers (16,17) disposed facing the said sheets (5,6) on the outside of the said structure (1); at least the said three-dimensional textile (3) also being impregnated with a resin (20); the dies (25,26) being provided with means (40,45) for attaching the said layers (16,17) to their surfaces;

a second phase in which the dies (25,26) are at least partially closed and the three-dimensional textile (3) is pressed between the layers (16,17) and the resin (20) impregnating the said sheets distributes itself between the parts in contact, also permeating the threads (10) uniformly;

a third phase in which the layers (16,17) are attached firmly to the dies (25,26);

a fourth phase in which the dies (25,26) are reopened through a certain distance within the limit of the natural elastic recovery of the three-dimensional textile (3) due to the action of the combination of threads (10) tending to straighten themselves;

a fifth phase in which at least a partial polymerisation of the resin (20) between the layers (16,17) and the outermost sheets (5,6) of the three-dimensional textile (3) is achieved while the resin (20) impregnating the threads (10) remains substantially in a plastic state;

a sixth phase in which the dies (25,26) are opened to a predetermined distance in order to move the sheets (5,6) away from each other and extend the threads (10) to form a partially hollow structure;

a seventh phase in which the structure (1) remains clamped between the two dies (25,26) until the polymerisation of the resin (20) is complete;

an eighth phase in which the plates (16,17) are released from the surfaces of the dies (25,26), the dies (25,26) are opened completely and the layered structure (1) is removed from the press (28).

2. A method according to Claim 1, characterised in that, in the sixth phase, at least one of the dies



- (25,26) is rendered movable relative to the other in the plane perpendicular to the spacing between the dies (25,26,) then the dies (25,26) are moved apart again through a first distance to extend the said threads (10) at least partially, the movable die (25) possibly being floated in the sixth phase so as to dispose the threads (10) in a direction substantially perpendicular to the planes of the sheets (5,6) of the three-dimensional textile; the dies (25,26) then being locked in position in their planes and dies (25,26) then being moved further apart through a second predetermined distance to extend the threads (10) completely in order to achieve an overall desired thickness of the structure (1).
3. A method according to Claim 1 or Claim 2, characterised in that the said dies (25,26) are heated to accelerate the process of polymerisation of the said resin (20); in the said fifth phase the said dies (25,26), by heating substantially only the outer most parts of the said structure, cause substantially only the said partial polymerisation of the resin (20) on the outer sheets (5,6) of the said three-dimensional textile (3).
 4. A process according to any preceding Claim, characterised in that the said resin (20) is a thermosetting resin.
 5. A process according to Claim 4, characterised in that, before the said first phase, a catalysing substance is applied between the said layers (16,17) and the said sheets (5,6) of the said three-dimensional textile in order locally to accelerate the process of polymerisation of the said resin (20).
 6. A method according to any of Claims from 1 to 3, characterised by the fact that the said resin (20) is a thermoplastic resin.
 7. A method according to any preceding Claim, characterised in that the resin (20), by at least partially polymerising in the said second phase, firmly fixes the sheets (5,6) to the plates (16,17).
 8. A method according to any of Claims from 1 to 6, characterised in that it includes a ninth phase in which the plates (16,17) are detached mechanically and removed from the layered structure (1).
 9. A method according to any one of the preceding claims, characterised in that the plates (16,17) have a greater extent than that of the layered structure (1), in order to separate the latter from the surfaces of the dies (25,26).
 10. A method according to any one of the preceding claims, characterised in that it includes a further phase, after the seventh phase, in which the three-dimensional textile (3) in the layered structure (1) is filled with an expanded resin.
 11. A method according to any preceding claim, characterised in that the said layered structure includes at least one plurality of superimposed layers of the said three-dimensional textile (3).
 12. A method according to claim 11, characterised in that before the said first phase a catalysing substance is applied between the facing surfaces of the said layers whereby locally to accelerate the polymerisation process of the said resin (20).
 13.
 - A composite structure characterised by comprising:
 - at least one three-dimensional textile (3) constituted by two sheets (5,6) of textile disposed in parallel and connected together by at least one plurality of threads (10) extending from facing surfaces of the sheets (5,6);
said three-dimensional textile (3) being impregnated with a hardened resin and the threads being rigid and extending between the sheets (5,6) establishing a rigid connection between the sheets themselves (5,6) and forming a partial hollow structure because of the space present between the threads (10);
said two sheets (5,6) being hardened by solidified resin and forming flat surfaces; and
 - a couple of external detachable plates (16,17) each of which is facing and connected with a respective sheets (5,6).
 14. A structure according to Claim 13, characterised in that the layered structure (1) includes at least one textile sheet (12,13) disposed between one of the plates (16,17) and the three dimensional textile (3).
 15. A structure according to Claims 13 or 14, characterised in that the layered structure (1) includes at least one layer of gel-coat resin (160) interposed between the three-dimensional textile (3) and one of the plates (16,17).
 16. A structure according to any one of claims 13 to 15, characterised in that the plates (16,17) are made from plastics material.
 17. A structure according to any one of Claims 13 to 15, characterised in that the plates (16,17) are of metal.
 18.
 - Apparatus for the manufacture of composite structures with intermediate three-dimensional textiles, characterised by comprising:
 - a press (28) provided with a first die (25) and a second die (26);



said press (28) for accommodating a layered structure disposed between said first die and said second die;

the layered structure including at least one three-dimensional textile (3) constituted by two sheets of textile (5,6) disposed in parallel and connected together by at least one plurality of threads (10) extending from facing surfaces of the sheets (5,6); at least one pair of plates (16,17) disposed facing said sheets (5,6) on the outside of the said structure; at least the said three-dimensional textile (3) also being impregnated with a resin;

- said first and second die (25,26) being provided with attaching means (33,34,40,41,45) for attaching the said plates (16,17) to their surfaces;
- said first and second die (25,26) being provided with polymerising means (46) for obtaining at least a partial polymerisation of the resin between the plates (16,17).

19. Apparatus according to Claim 18, characterised in that the means for attaching the plates (16,17) to the dies (25,26) include pneumatic fixing means.

20. Apparatus according to Claim 19, characterised in that the pneumatic fixing means comprise a plurality of ducts (40) which extend within the dies (25,26) and open into the surfaces of the dies themselves, and which are arranged to be connected to a vacuum pump (45), and at least one peripheral seal (33,34) extending around each of the dies (25,26) and adapted to cooperate with the plates (16,17) to achieve a fluid-tight connection.

21. Apparatus according to any one of Claims 18 to 20 characterised in that at least one (25) of the dies has means for enabling it to move at least along two perpendicular axes parallel to the plane of the other of the dies (25,26).

22. Apparatus according to Claim 21, characterised in that the means include at least one rolling ball assembly (110).

23. Apparatus according to Claim 21, characterised in that the means include pneumatic support slides.

24. Apparatus according to any one of Claims 18 to 23, characterised in that it includes means (122) for fixing the relative positions of the dies (25,26).

25. Apparatus according to Claim 24, characterised in that the fixing means (122) include frictional clamping means.

26. Apparatus according to any one of Claims 18 to 25, characterised in that it includes means (130) for releasing at least one of the dies (25,26).

27. Apparatus according to any one of Claims 18 to 26, characterised in that it includes means (130) for centring the relative positions of the dies (25,26).

28. Apparatus according to Claim 27 as dependent on Claim 26, characterised in that the release means (130) when operated in reverse constitute the centring means (130).

29. Apparatus according to any one of Claims 18 to 28 characterised in that it includes means (46) for heating the dies (25,26) to accelerate the polymerisation of the resin (20).

30. Apparatus according to Claim 29 characterised in that the heating means comprise electrical resistances (46).

Patentansprüche

1. Verfahren zum Herstellen von Verbundstrukturen mit zwischenliegenden, dreidimensionalen Geweben, dadurch gekennzeichnet, daß es die folgenden Schritte umfaßt:
- eine erste Phase, in der eine geschichtete Struktur (1) zwischen eine erste und eine zweite Form (25, 26) einer Presse (28) eingesetzt wird; wobei die geschichtete Struktur (1) zumindest ein dreidimensionales Gewebe (3) aufweist, das aus zwei Gewebelagen (5, 6) zusammengesetzt ist, die parallel angeordnet und mit mindestens einer Vielzahl von Fäden (10) miteinander verbunden sind, die sich von gegenüberliegenden Oberflächen der Lagen (5, 6) erstrecken; wobei mindestens ein Paar von Schichten (16, 17) derart angeordnet ist, daß es den Lagen (5, 6) an der Außenseite der Struktur (1) gegenüberliegt; wobei zumindest das dreidimensionale Gewebe (3) auch mit einem Harz (20) getränkt wird; wobei die Formel (25, 26) mit einer Einrichtung (40, 45) versehen sind, um die Schichten (16, 17) an deren Oberflächen zu befestigen;
- eine zweite Phase, in der die Formen (25, 26) zumindest teilweise geschlossen werden und das dreidimensionale Gewebe (3) zwischen den Schichten (16, 17) gepreßt wird und das Harz (20), das die Lagen durchtränkt, sich selbst zwischen den in Berührung bestehenden Teilen verteilt und auch die Fäden (10) gleichmäßig durchdringt;
- eine dritte Phase, in der die Schichten (16, 17) fest an den Formen (25, 26) befestigt werden;
- eine vierte Phase, in der die Formen (25, 26) um einen bestimmten Abstand innerhalb der Grenze der natürlichen elastischen Rückbildung des dreidimensionalen Gewebes (3) aufgrund der Wirkung



der Kombination der Fäden (10) wieder geöffnet werden, die dazu neigen, sich selbst gerade zu richten;

eine fünfte Phase, in der zumindest eine teilweise Polymerisation des Harzes (20) zwischen den Schichten (16, 17) und den äußersten Lagen (5, 6) des dreidimensionalen Gewebes (3) erzielt wird, während das Harz (20), das die Fäden (10) durchtränkt, im wesentlichen in einem plastischen Zustand verbleibt;

eine sechste Phase, in der die Formen (25, 26) bis zu einem vorbestimmten Abstand wieder geöffnet werden, um die Lagen (5, 6) voneinander weg zu bewegen und die Fäden (10) zu strecken, um eine teilweise hohle Struktur zu bilden;

eine siebte Phase, in der die Struktur (1) zwischen den beiden Formen (25, 26) geklemmt verbleibt, bis die Polymerisation des Harzes (20) abgeschlossen ist;

eine achte Phase, in der die Platten (16, 17) von den Oberflächen der Formen (25, 26) gelöst werden, die Formen (25, 26) vollständig geöffnet werden und die geschichtete Struktur (1) aus der Presse (28) entfernt wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß in der sechsten Phase mindestens eine der Formen (25, 26) relativ zu der anderen in der senkrecht zu dem Abstand zwischen den Formen (25, 26) verlaufenden Ebene bewegbar gemacht wird, daß dann die Formen (25, 26) wieder um einen ersten Abstand auseinander bewegt werden, um die Fäden (10) zumindest teilweise zu strecken, wobei die bewegbare Form (25) möglicherweise in der sechsten Phase zum Schwimmen gebracht wird, so daß die Fäden (10) in einer Richtung im wesentlichen senkrecht zu der Ebene der Lagen (5, 6) des dreidimensionalen Gewebes angeordnet werden; wobei die Formen (25, 26) dann in ihren Ebenen in ihrer Position verriegelt werden und die Formen (25, 26) dann um einen zweiten vorbestimmten Abstand weiter auseinander bewegt werden, um die Fäden (10) vollständig auseinander zu ziehen, um eine gewünschte Gesamtdicke der Struktur (1) zu erzielen.
3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Formen (25, 26) erwärmt werden, um den Vorgang der Polymerisation des Harzes (20) zu beschleunigen; wobei in der fünften Phase die Formen (25, 26) durch Erwärmen von im wesentlichen lediglich der äußersten Teile der Struktur im wesentlichen lediglich bewirken, daß die teilweise Polymerisation des Harzes (20) an den äußeren Lagen (5, 6) des dreidimensionalen Gewebes (3) erfolgt.

4. Prozeß nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß das Harz (20) ein in Wärme aushärtendes Harz ist.

5. Prozeß nach Anspruch 4, dadurch gekennzeichnet, daß vor der ersten Phase eine katalysierende Substanz zwischen den Schichten (16, 17) und den Lagen (5, 6) des dreidimensionalen Gewebes aufgebracht wird, um lokal den Polymerisationsprozeß des Harzes (20) zu beschleunigen.

6. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß das Harz (20) ein thermoplastisches Harz ist.

7. Verfahren nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß das Harz (20) durch zumindest teilweises Polymerisieren in der zweiten Phase die Lagen (5, 6) fest an den Platten (16, 17) befestigt.

8. Verfahren nach einem der vorstehenden Ansprüche 1 bis 6, dadurch gekennzeichnet, daß dieses eine neunte Phase aufweist, in der die Platten (16, 17) mechanisch abgenommen und von der geschichteten Struktur (1) entfernt werden.

9. Verfahren nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß die Platten (16, 17) eine größere Abmessung besitzen als die geschichtete Struktur (1), um letztere von den Oberflächen der Formen (25, 26) zu entfernen.

10. Verfahren nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß dieses eine weitere Phase nach der siebten Phase aufweist, in der das dreidimensionale Gewebe (3) in der geschichteten Struktur (1) mit einem geschäumten Harz gefüllt wird.

11. Verfahren nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß die geschichtete Struktur zumindest eine Vielzahl von übereinander angeordneten Schichten des dreidimensionalen Gewebes (3) aufweist.

12. Verfahren nach Anspruch 11, dadurch gekennzeichnet, daß vor der ersten Phase eine katalysierende Substanz zwischen die gegenüberliegenden Oberflächen der Schichten aufgebracht wird, wodurch der Polymeri-



sationsprozeß des Harzes (20) lokal beschleunigt wird.

13. Verbundstruktur

dadurch gekennzeichnet, daß sie folgendes umfaßt:

- zumindest ein dreidimensionales Gewebe (3), das aus zwei Gewebelagen (5, 6) zusammengesetzt ist, die parallel angeordnet und miteinander durch zumindest eine Vielzahl von Fäden (10) verbunden sind, die sich von den gegenüberliegenden Oberflächen der Lagen (5, 6) erstrecken;

wobei das dreidimensionale Gewebe (3) mit einem gehärteten Harz durchtränkt ist und die Fäden steif sind und sich zwischen den Lagen (5, 6) erstrecken und eine steife Verbindung zwischen den Lagen selbst (5, 6) herstellen und eine teilweise hohle Struktur aufgrund des vorhandenen Zwischenraumes zwischen den Fäden (10) bilden; wobei die beiden Lagen (5, 6) durch verfestigtes Harz gehärtet sind und flache Oberflächen bilden; und

- ein Paar äußerer abnehmbarer Platten (16, 17), von denen jede einer entsprechenden Lage (5, 6) gegenüberliegt und mit dieser verbunden ist.

14. Struktur nach Anspruch 13, dadurch gekennzeichnet, daß

die geschichtete Struktur (1) mindestens eine Gewebelage (12, 13) aufweist, die zwischen einer der Platten (16, 17) und dem dreidimensionalen Gewebe (3) angeordnet ist.

15. Struktur nach Anspruch 13 oder 14, dadurch gekennzeichnet, daß

die geschichtete Struktur (1) mindestens eine Schicht aus Gel-Schicht-Harz (160) aufweist, die zwischen dem dreidimensionalen Gewebe (3) und einer der Platten (16, 17) angeordnet ist.

16. Struktur nach einem der Ansprüche 13 bis 15, dadurch gekennzeichnet, daß

die Platten (16, 17) aus Kunststoffmaterial hergestellt sind.

17. Struktur nach einem der Ansprüche 13 bis 15, dadurch gekennzeichnet, daß

die Platten (16, 17) aus Metall bestehen.

18. Vorrichtung zur Herstellung von Verbundstrukturen mit dazwischenliegenden, dreidimensionalen Geweben, gekennzeichnet durch:

- eine Presse (28), die mit einer ersten Form (25) und einer zweiten Form (26) versehen ist;

wobei die Presse (28) zum Unterbringen einer geschichteten Struktur dient, die zwischen der ersten Form und der zweiten Form angeordnet ist; wobei die geschichtete Struktur mindestens ein dreidimensionales Gewebe (3) aufweist, das durch zwei Gewebelagen (5, 6) gebildet ist, die parallel angeordnet und miteinander durch mindestens eine Vielzahl von Fäden (10) verbunden sind, die sich von gegenüberliegenden Oberflächen der Lagen (5, 6) erstrecken; wobei mindestens ein Plattenpaar (16, 17) den Lagen (5, 6) gegenüberliegend an der Außenseite der Struktur angeordnet ist; wobei zumindest das dreidimensionale Gewebe (3) auch mit einem Harz getränkt ist;

- wobei die erste und die zweite Form (25, 26) mit einer Befestigungseinrichtung (33, 34, 40, 41, 45) versehen sind, um die Platten (16, 17) an deren Oberflächen zu befestigen;

- wobei die erste und die zweite Form (25, 26) mit einer Polymerisierungseinrichtung (46) versehen sind, um zumindest eine teilweise Polymerisation des Harzes zwischen den Platten (16, 17) zu erzielen.

19. Vorrichtung nach Anspruch 18, dadurch gekennzeichnet, daß die Einrichtungen zum Befestigen der Platten (16, 17) an den Formen (25, 26) eine pneumatische Befestigungseinrichtung umfassen.

20. Vorrichtung nach Anspruch 19, dadurch gekennzeichnet, daß die pneumatische Befestigungseinrichtung eine Vielzahl von Kanälen (40) umfaßt, die sich innerhalb der Formen (25, 26) erstrecken und in die Oberflächen der Formen selbst öffnen und die derart angeordnet sind, daß sie mit einer Vakuumpumpe (45) verbunden werden können, und daß sich zumindest eine Umfangsdichtung (33, 34) um jede Form (25, 26) erstreckt und derart ausgebildet ist, daß diese mit den Platten (16, 17) zusammenwirkt, um eine fluiddichte Verbindung zu erzielen.

21. Vorrichtung nach einem der Ansprüche 18 bis 20, dadurch gekennzeichnet, daß zumindest eine (25) der Formen eine Einrichtung besitzt, die ermöglicht, daß sich diese zumindest entlang zweier zueinander senkrechter Achsen parallel zu der Ebene der anderen Form (25, 26) bewegt.

22. Vorrichtung nach Anspruch 21, dadurch gekennzeichnet, daß



die Einrichtung mindestens eine Rollkugelanordnung (110) aufweist.

23. Vorrichtung nach Anspruch 21, dadurch gekennzeichnet, daß die Einrichtung pneumatische Lagerschlitten aufweist. 5
24. Vorrichtung nach einem der Ansprüche 18 bis 23, dadurch gekennzeichnet, daß diese eine Einrichtung (122) zum Fixieren der Relativpositionen der Formen (25, 26) aufweist. 10
25. Vorrichtung nach Anspruch 24, dadurch gekennzeichnet, daß die Fixiereinrichtung (122) eine Reibungsklemmeinrichtung aufweist. 15
26. Vorrichtung nach einem der Ansprüche 18 bis 25, dadurch gekennzeichnet, daß diese eine Einrichtung (130) zum Freigeben mindestens einer der Formen (25, 26) aufweist. 20
27. Vorrichtung nach einem der Ansprüche 18 bis 26, dadurch gekennzeichnet, daß diese eine Einrichtung (130) zum Zentrieren der Relativpositionen der Formen (25, 26) aufweist. 25
28. Vorrichtung nach Anspruch 27, sofern abhängig von Anspruch 26, dadurch gekennzeichnet, daß die Freigabeeinrichtung (130) die Zentriereinrichtung (130) bildet, wenn diese umgekehrt bedient wird. 30
29. Vorrichtung nach einem der Ansprüche 18 bis 28, dadurch gekennzeichnet, daß diese eine Einrichtung (46) zum Erwärmen der Formen (25, 26) aufweist, um die Polymerisation des Harzes (20) zu beschleunigen. 35
30. Vorrichtung nach Anspruch 29, dadurch gekennzeichnet, daß die Heizeinrichtung elektrische Widerstände (46) aufweist. 40
- 45

Revendications

1. Procédé de production de structures composites avec des tissus tridimensionnels intermédiaires, caractérisé en ce qu'il comprend : 50
- une première phase dans laquelle une structure en couches (1) est insérée entre une première et une deuxième matrice (25, 26) d'une presse (28), la structure en couches (1) comprenant au moins un tissu tridimensionnel (3) constitué par deux nappes (5, 6) de tissu disposées en parallèle et reliées entre elles par au moins une pluralité de fils (10) s'étendant depuis des faces en vis-à-vis des nappes (5, 6); 55

au moins une paire de couches (16, 17) placées en vis-à-vis desdites nappes (5, 6) à l'extérieur de ladite structure (1); au moins ledit tissu tridimensionnel (3) étant également imprégné avec une résine (20); les matrices (25, 26) étant munies de moyens (40, 45) pour fixer lesdites couches (16, 17) à leurs surfaces ;

une deuxième phase dans laquelle les matrices (25, 26) sont au moins partiellement fermées et le tissu tridimensionnel (3) est pressé entre les couches (16, 17), et la résine (20) imprégnant lesdites nappes se répartissant entre les pièces en contact, pénétrant également les fils (10) uniformément ;

une troisième phase dans laquelle les couches (16, 17) sont fixées solidement aux matrices (25, 26) ;

une quatrième phase dans laquelle les matrices (25, 26) sont rouvertes d'une certaine distance dans la limite du retour élastique naturel du tissu tridimensionnel (3) par suite de l'action de la combinaison de fils (10) tendant à se tendre ;

une cinquième phase dans laquelle au moins une polymérisation partielle de la résine (20) entre les couches (16, 17) et les couches les plus extérieures (5, 6) du tissu tridimensionnel (3) est obtenue alors que la résine (20) imprégnant les fils (10) reste sensiblement dans un état plastique ;

une sixième phase dans laquelle les matrices (25, 26) sont ouvertes d'une distance prédéterminée afin d'écarter les nappes (5, 6) les unes des autres et d'étendre les fils (10) pour former une structure partiellement creuse ;

une septième phase dans laquelle la structure (1) reste serrée entre les deux matrices (25, 26) jusqu'à ce que la polymérisation de la résine (20) soit complète ;

une huitième phase dans laquelle les plaques (16, 17) sont dégagées des surfaces des matrices (25, 26), les matrices (25, 26) sont ouvertes complètement et la structure en couches (1) est retirée de la presse (28).

2. Procédé selon la Revendication 1, caractérisé en ce que, dans la sixième phase, au moins l'une des matrices (25, 26) est rendue mobile par rapport à l'autre dans le plan perpendiculaire à l'espace entre les matrices (25, 26), les matrices (25, 26) sont alors écartées de nouveau d'une première distance pour étendre lesdits fils (10) au moins partiellement, la matrice mobile (25) étant éventuellement mise en flottement pendant la sixième phase de manière à placer les fils (10) dans une direction sensiblement perpendiculaire aux plans des nappes (5, 6) du tissu tridimensionnel ; les matrices (25, 26) étant alors bloquées en position dans leurs plans et les matrices (25, 26) étant alors écartées de nouveau d'une deuxième distance prédéterminée afin d'étendre les fils (10) complètement pour obtenir une épaisseur d'ensemble désirée de la structure (1).



3. Procédé selon la Revendication 1 ou 2, *caractérisé en ce que* lesdites matrices (25, 26) sont chauffées pour accélérer le processus de polymérisation de ladite résine (20), dans la cinquième phase, lesdites matrices (25, 26), en ne chauffant sensiblement que les parties les plus extérieures de ladite structure, ne provoquent sensiblement que la polymérisation partielle de la résine (20) sur les nappes extérieures (5, 6) dudit tissu tridimensionnel (3).
4. Procédé selon l'une quelconque des Revendications précédentes, *caractérisé en ce que* ladite résine (20) est une résine thermodurcissable.
5. Procédé selon la Revendication 4, *caractérisé en ce que*, avant ladite première phase, une substance de catalyse est appliquée entre lesdites couches (16, 17) et lesdites nappes (5, 6) dudit tissu tridimensionnel afin d'accélérer localement le processus de polymérisation de ladite résine (20).
6. Procédé selon l'une quelconque des Revendications 1 à 3, *caractérisé en ce que* ladite résine (20) est une résine thermoplastique.
7. Procédé selon l'une quelconque des Revendications précédentes, *caractérisé en ce que* la résine (20), en polymérisant au moins partiellement lors de ladite deuxième phase, fixe fermement les nappes (5, 6) aux plaques (16, 17).
8. Procédé selon l'une quelconque des Revendications 1 à 6, *caractérisé en ce qu'il* comprend une neuvième phase dans laquelle les plaques (16, 17) sont détachées mécaniquement et retirées de la structure en couches (1).
9. Procédé selon l'une quelconque des Revendications précédentes, *caractérisé en ce que* les plaques (16, 17) ont une plus grande étendue que celle de la structure en couches (1), afin de séparer cette dernière des surfaces des matrices (25, 26).
10. Procédé selon l'une quelconque des Revendications précédentes, *caractérisé en ce qu'il* comprend une autre phase, après la septième phase, dans laquelle le tissu tridimensionnel (3) dans la structure en couches (1) est rempli avec une résine expansée.
11. Procédé selon l'une quelconque des Revendications précédentes, *caractérisé en ce que* ladite structure en couches comprend au moins une pluralité de couches superposées dudit tissu tridimensionnel (3).
12. Procédé selon la Revendication 11, *caractérisé en ce que*, avant ladite première phase, une substance de catalyse est appliquée entre les faces en vis-à-

vis desdites couches afin d'accélérer localement le processus de polymérisation de ladite résine (20).

13. Structure composite, caractérisée en ce qu'elle comprend :

- au moins un tissu tridimensionnel (3) constitué de deux nappes (5, 6) de tissu disposées en parallèle et reliées entre elles par au moins une pluralité de fils (10) s'étendant depuis des faces en vis-à-vis des nappes (5, 6);
ledit tissu tridimensionnel (3) étant imprégné avec une résine durcie et les fils étant rigides et s'étendant entre les nappes (5, 6), établissant ainsi une liaison rigide entre les nappes (5, 6) elles-mêmes et formant une structure partiellement creuse par suite de l'espace présent entre les fils (10);
lesdites deux nappes (5, 6) étant durcies par de la résine solidifiée et formant des surfaces plates; et
- un couple de plaques externes détachables (16, 17), chacune faisant face et étant reliée à l'une respective des nappes (5, 6).

14. Structure selon la Revendication 13, *caractérisée en ce que* la structure en couches (1) comprend au moins une nappe de tissu (12, 13) placée entre l'une des plaques (16, 17) et le tissu tridimensionnel (3).

15. Structure selon la Revendication 13 ou 14, *caractérisée en ce que* la structure en couches (1) comprend au moins une couche de résine Gel-coat (160) intercalée entre le tissu tridimensionnel (3) et l'une des plaques (16, 17).

16. Structure selon l'une quelconque des Revendications 13 à 15, *caractérisée en ce que* les plaques (16, 17) sont fabriquées dans une matière plastique.

17. Structure selon l'une quelconque des Revendications 13 à 15, *caractérisée en ce que* les plaques (16, 17) sont fabriquées en métal.

18. Dispositif pour la fabrication de structures composites avec des tissus tridimensionnels intermédiaires, *caractérisé en ce qu'il* comprend :

- une presse (28) munie d'une première matrice (25) et d'une deuxième matrice (26);
ladite presse (28) étant destinée à recevoir une structure en couches placée entre lesdites première et deuxième matrices;
la structure en couches comprenant au moins un tissu tridimensionnel (3) constitué de deux nappes (5, 6) de tissu disposées en parallèle et reliées entre elles par au moins une pluralité de fils (10) s'étendant depuis des faces en vis-à-vis des nappes (5, 6); au moins une paire



- de plaques (16, 17) placées en vis-à-vis desdites nappes (5, 6) à l'extérieur de ladite structure ; au moins ledit tissu tridimensionnel (3) étant également imprégné avec une résine ;
- lesdites première et deuxième matrices (25, 26) 5 étant munies de moyens de fixation (33, 34, 40, 41, 45) pour fixer lesdites plaques (16, 17) à leurs surfaces ;
 - lesdites première et deuxième matrices (25, 26) 10 étant munies de moyens de polymérisation (46) pour obtenir au moins une polymérisation partielle de la résine entre les plaques (16, 17).
19. Dispositif selon la Revendication 18, *caractérisé en ce que* les moyens de fixation des plaques (16, 17) 15 aux matrices (25, 26) comprennent des moyens de fixation pneumatiques.
20. Dispositif selon la Revendication 19, *caractérisé en ce que* les moyens de fixation pneumatiques comprennent une pluralité de conduits (40) qui 20 s'étendent à l'intérieur des matrices (25, 26) et débouchent dans les surfaces des matrices elles-mêmes, et qui sont agencés pour être reliés à une pompe à vide (45), et au moins un joint périphérique 25 (33, 34) s'étendant autour de chacune des matrices (25, 26) et adapté pour coopérer avec les plaques (16, 17) afin d'obtenir une liaison étanche aux fluides.
21. Dispositif selon l'une quelconque des Revendications 18 à 20, *caractérisé en ce qu'*au moins l'une des matrices a des moyens pour lui permettre de se déplacer au moins le long de deux axes perpendiculaires parallèlement au plan de l'autre des matrices 30 (25, 26).
22. Dispositif selon la Revendication 21, *caractérisé en ce que* les moyens comprennent au moins un ensemble à roulement à bille (110). 35 40
23. Dispositif selon la Revendication 21, *caractérisé en ce que* les moyens comprennent des coulisses de soutien pneumatiques. 45
24. Dispositif selon l'une quelconque des Revendications 18 à 23, *caractérisé en ce qu'il* comprend des moyens (122) pour fixer les positions relatives des matrices (25, 26). 50
25. Dispositif selon la Revendication 24, *caractérisé en ce que* les moyens de fixation (122) comprennent des moyens de serrage à frottement.
26. Dispositif selon l'une quelconque des Revendications 18 à 25, *caractérisé en ce qu'il* comprend des moyens (130) pour dégager au moins l'une des matrices (25, 26). 55
27. Dispositif selon l'une quelconque des Revendications 18 à 26, *caractérisé en ce qu'il* comprend des moyens (130) pour centrer les positions relatives des matrices (25, 26).
28. Dispositif selon la Revendication 27 prise en dépendance à la Revendication 26, *caractérisé en ce que* les moyens de dégagement (130), lorsqu'on les actionne à l'envers, constituent les moyens de centrage (130).
29. Dispositif selon l'une quelconque des Revendications 18 à 28, *caractérisé en ce qu'il* comprend des moyens (46) pour chauffer les matrices (25, 26) afin d'accélérer la polymérisation de la résine (20).
30. Dispositif selon la Revendication 29, *caractérisé en ce que* les moyens chauffants comprennent des résistances électriques (46).

