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CITTERIO(10) **Pub. No.: US 2010/0307629 A1**(43) **Pub. Date: Dec. 9, 2010**(54) **METHOD AND APPARATUS FOR
CONTINUOUS PRODUCTION OF A TEXTILE
STRUCTURE RESISTANT TO PERFORATION
AND PENETRATION AND TEXTILE
STRUCTURE THUS OBTAINED**(75) Inventor: **Giorgio Celeste CITTERIO,**
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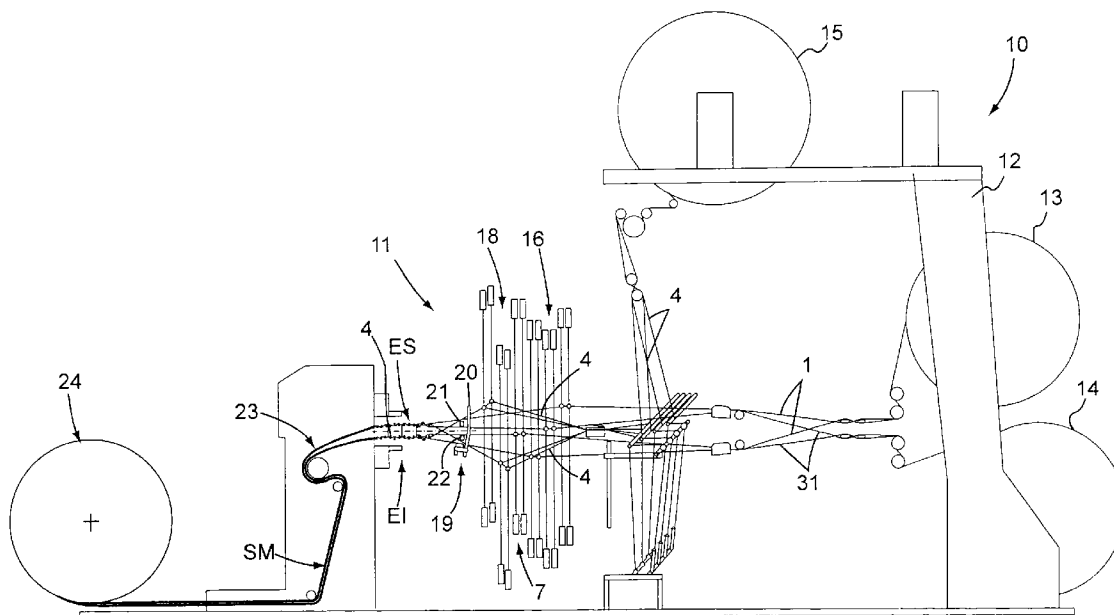
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D03D 49/50 (2006.01)(52) **U.S. Cl.** **139/116.1**(57) **ABSTRACT**

The present invention refers to a method for continuous production of a textile structure resistant to perforation and penetration, comprising the steps consisting in:

a) simultaneously weaving two fabric elements (ES, EI) overlapped and spaced from each other, wherein each of the two fabric elements comprises a bundle of warp threads (1) which are at least partially made of ballistic threads and which are arranged parallel to each other on a first plane, a bundle of weft threads (2) which are at least partially made of ballistic threads and which are arranged parallel to each other on a second plane overlapped to the first and oriented at 90° with respect to said warp threads (1) and a stabilization weave (3) interwoven between the warp (1) and weft (2) threads of said two overlapped planes and made of first binding threads (30, 31);

b) joining, during said step of weaving said two fabric elements (ES, EI) overlapped and spaced from each other, the upper fabric element (ES) and the lower fabric element (EI) to form a multilayer textile structure (SM) with second binding threads (4) alternatingly interwoven therein.



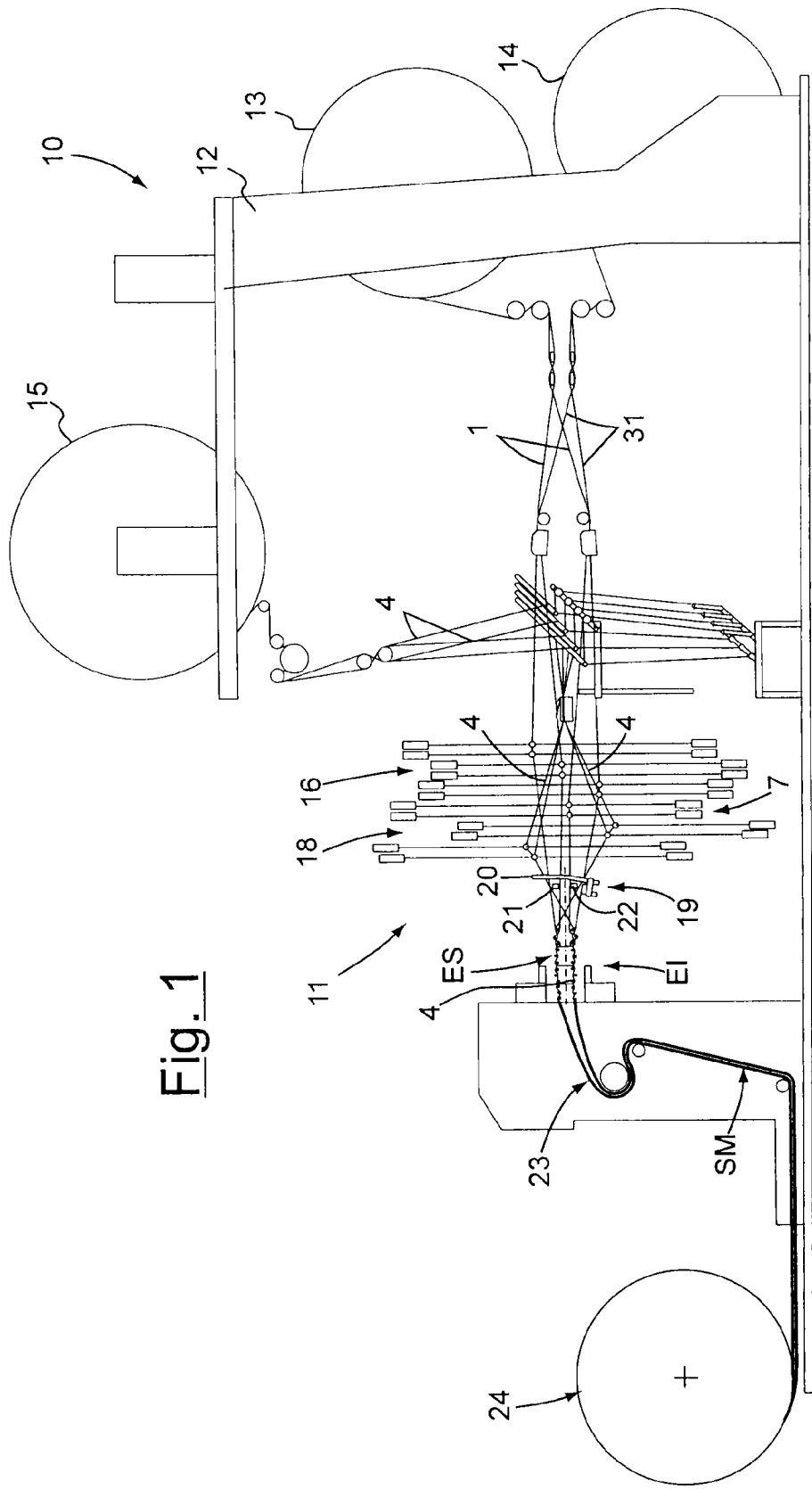


Fig. 1

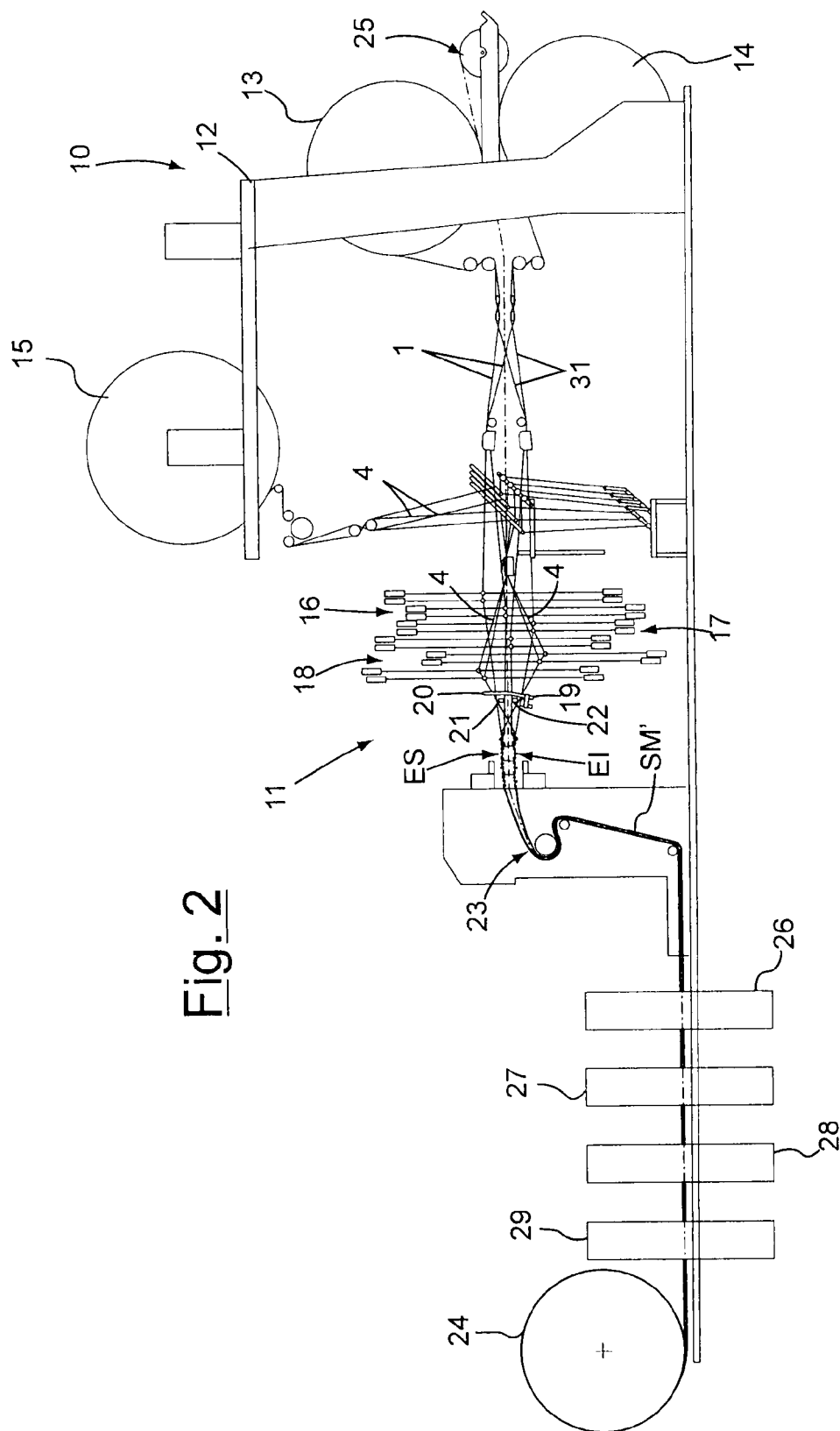


Fig. 2

Fig. 3a

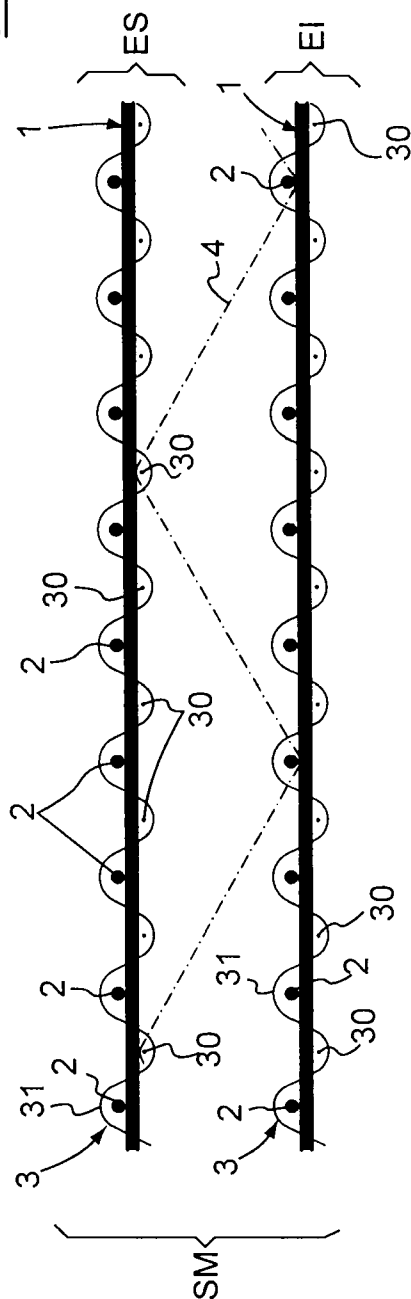


Fig. 4a

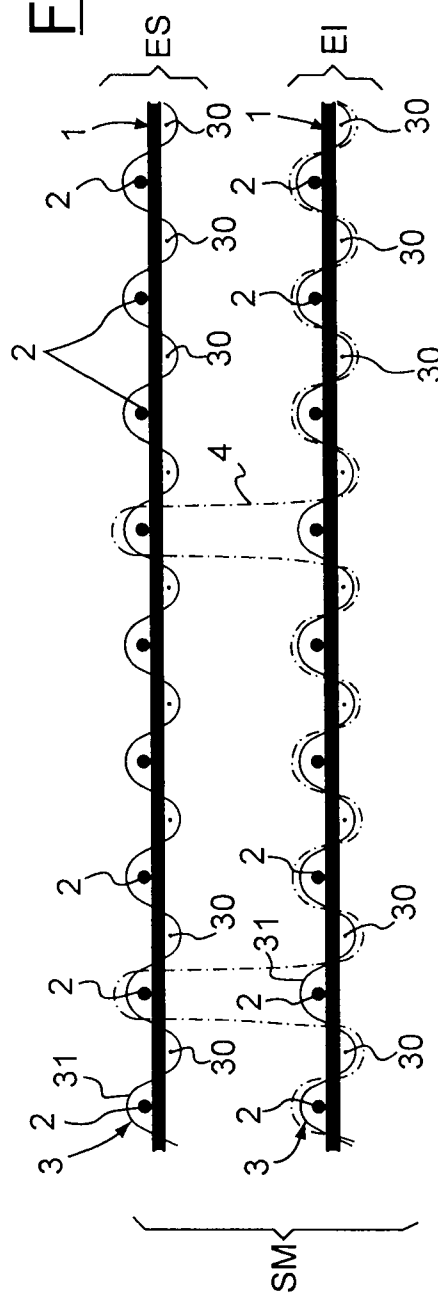


Fig. 3b

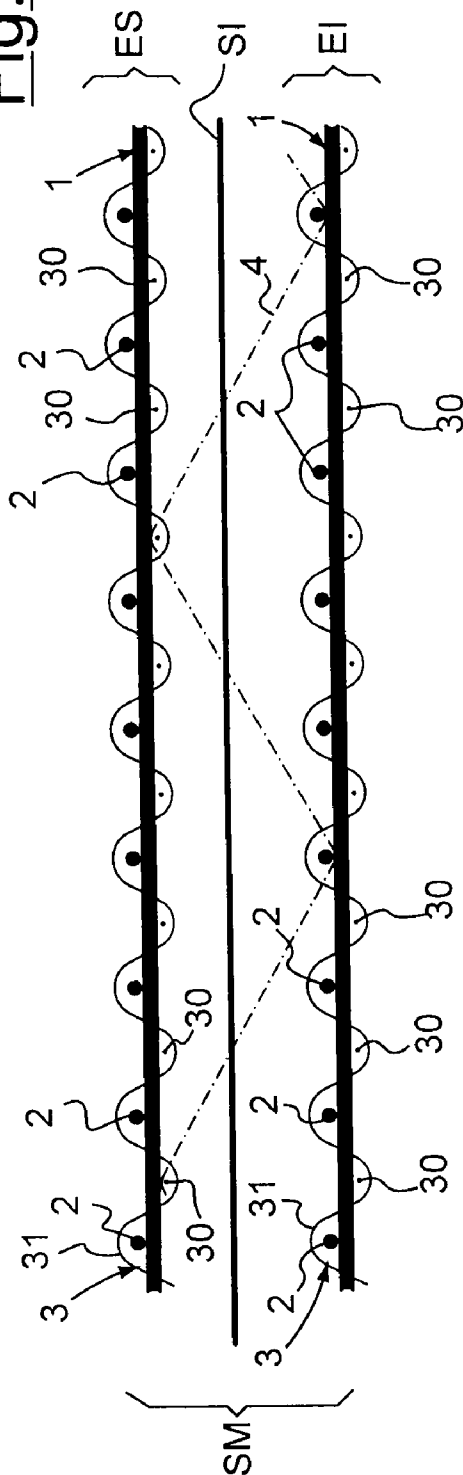
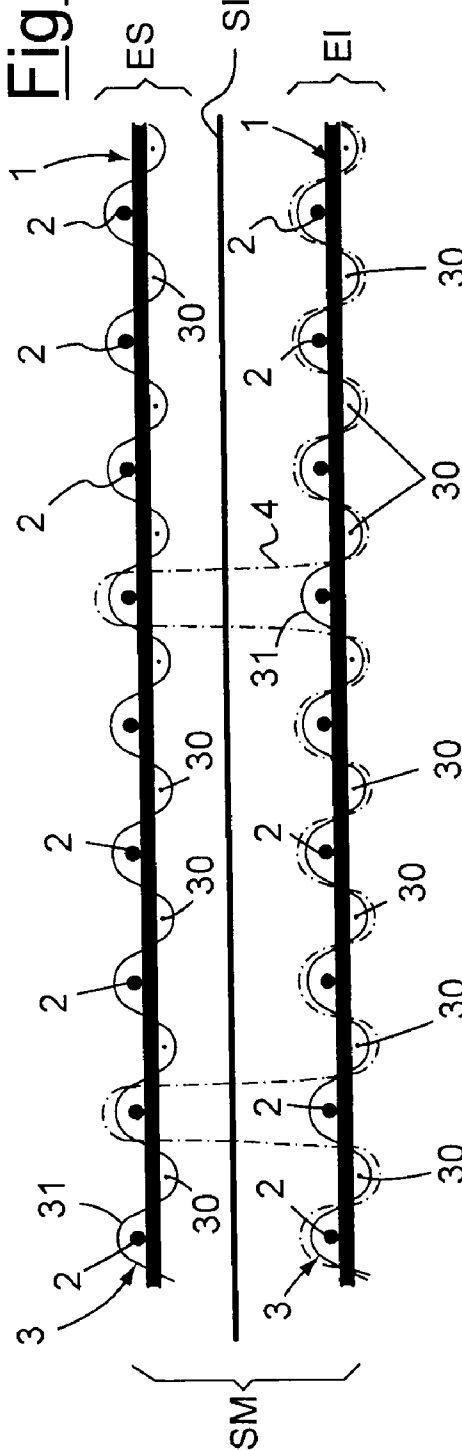


Fig. 4b



**METHOD AND APPARATUS FOR
CONTINUOUS PRODUCTION OF A TEXTILE
STRUCTURE RESISTANT TO PERFORATION
AND PENETRATION AND TEXTILE
STRUCTURE THUS OBTAINED**

[0001] The present invention refers to a method and an apparatus for continuous production of a textile structure resistant to perforation and penetration and to a textile structure resistant to perforation and penetration thus obtained. By textile structure resistant to perforation and penetration it is meant to indicate a multi-layer structure at least partially made with so-called "ballistic fibers", i.e. with fibers having high strength, tenacity and elastic modulus, like, purely as an example, fibers of polyaramid, polyvinyl alcohol, polyacrylonitrile, polybenzoxazole (PBO), polyolefin, polyamide, glass or carbon.

[0002] Such textile structures generally have characteristics of flexibility and are used for example to manufacture bullet-proof, fragments-proof or knife-proof personal armor. Moreover, if they are suitably treated, for example by impregnation with a thermoplastic or thermosetting matrix or by coupling with external coating layers, they can take on characteristics of rigidity. In this case, they are used to make helmets, armor or any other rigid item that must offer resistance to perforation and penetration of bullets, fragments, pointed or sharp objects and the like.

[0003] Currently there are different types of structures that are resistant to perforation and penetration and different processes for producing them.

[0004] In particular, the known types are at least the following:

[0005] Structures comprising at least two overlapped layers, each of which, in turn, comprises a bundle of unidirectional ballistic fibers that are parallel to one another. The ballistic fibers of one of such two layers are differently oriented to the ballistic fibers of the other layer; generally, the ballistic fibers of one layer are oriented by an angle comprised between 0° and 90° with respect to the ballistic fibers of the layer overlapping it. The two overlapped layers of ballistic fibers are joined together in various ways. For example this can be by stitching, by interposition between them of a binding layer or by impregnation of the ballistic fibers constituting the two layers with a binding material and subsequent possible application of pressure and/or heat treatment. Structures falling into such a type are described for example in EP 0 683 374 and U.S. Pat. No. 7,148,162, both to Andrew D. Park, and in EP 0 805 332 and US 2004/0045428, both to Citterio.

[0006] Structures as described for example in EP 1 241 432, to Teijin Twaron GmbH.

[0007] Structures comprising a fabric made of ballistic fibers and having at least one surface that has at least one portion coated with an elastomer on which a plastic film is applied. Structures of this type are described for example in U.S. Pat. No. 6,846,758 B2 to A. Bhatnagar (Honeywell International Inc.).

[0008] In greater detail and with particular reference to structures comprising at least two layers of unidirectional or semi-unidirectional ballistic fibers, overlapping one another, the following is noted.

[0009] EP 0 683 374 B1 (Andrew D. Park) describes a panel having a structure that comprises a first layer, consisting of a bundle of unidirectional ballistic fibers parallel to one another, and a second layer, also consisting of a bundle of unidirectional ballistic fibers parallel to one another and overlapping the first so that the ballistic fibers of the second layer are arranged at 90° with respect to the ballistic fibers of the first layer. Each of the first and second layer in turn consists of a laminate, which is produced from a bundle of unidirectional ballistic fibers that are fed by a creel yarn package or by a warp beam. Such ballistic fibers, passing through a thread guide, are deposited parallel to one another on a plane. The layer of ballistic fibers thus obtained passes over a roller that applies a film of thermoplastic material (polyethylene) to one of the two faces thereof. The assembly thus obtained passes through a pre-lamination group and the laminate thus produced is wound around a take-up beam. In order to produce the panel, two laminates are unwound from the relative take-up beam and are overlapped one another so that the ballistic fibers of one are oriented at 90° with respect to the ballistic fibers of the other and their face coated with the film of thermoplastic material (polyethylene) faces outwards. The two laminated layers thus overlapped are then subjected to heat action so as to melt the film of polyethylene that covers and encapsulates the ballistic fibers.

[0010] U.S. Pat. No. 7,148,162 B2 describes a laminated panel having a structure comprising two composite layers that overlap one another.

[0011] Every composite layer comprises a bundle of continuous ballistic fibers arranged parallel to one another on a plane and associated with at least one pre-stabilizing net. The pre-stabilizing net consists of a heat-activated adhesive polymer. The two composite layers are overlapped one another so that the ballistic fibers of a composite layer are oriented at 90° with respect to the ballistic fibers of the other composite layer. The outer faces of the two composite layers overlapping one another are coated with a film of thermoplastic material. The assembly thus obtained is laminated with application of pressure and heat to obtain the laminated panel.

[0012] The panels described in EP 0 683 374 B1 and in U.S. Pat. No. 7,148,162 B2 are obtained with discontinuous processes that initially provide the production of the single composite layers or laminates separate from one another and, thereafter, the assembly by overlapping of the single composite layers or laminates, without interposition between them of intermediate layers, and the consolidation of the assembly thus obtained in a multi-layer structure. Such discontinuous processes require that a plurality of separate operations be carried out with consequent long execution times that substantially affect the production costs.

[0013] In order to avoid such drawbacks a continuous production method as described in EP 0 805 332 A2 and in US 2004/0045428 has been proposed. Such a continuous method is carried out with "textile machines" of the so-called "multi-axial" type, produced and marketed for example by Liba Maschinenbau GmbH, which allow different flat layers of unidirectional ballistic fibers to be deposited in succession one after the other and one on top of the other to form a continuous band. Each flat layer consists of a bundle of ballistic fibers parallel to one another and the ballistic fibers of one layer are oriented according to an angle comprised between 0° and 90° with respect to the ballistic fibers of the layer beneath it. During the formation of the band, a film of thermoplastic or thermosetting material is inserted between

the two overlapped layers of ballistic fibers. The layers of ballistic fibers thus overlapped with the interposition of film made of thermoplastic or thermosetting material are then joined through knit stitching. Such knit stitching is carried out with needles that pass through the thickness of the various overlapped layers binding them with a binding thread. The band thus obtained then passes through a lamination group and is wound in a roll.

[0014] Such a method also has a series of drawbacks.

[0015] A first drawback consists of the fact that, whilst it is a continuous method, it requires large available spaces and in any case involves substantial production times. Indeed, the formation of every single layer of unidirectional fibers takes place through a respective thread-comb head, for which reason in order to make a multi-layer structure it is necessary to provide different thread-comb heads, one after another along the line of forward movement of the band being formed. Each layer of fibers starting from the second is then deposited on the underlying layer previously formed by a respective thread-comb head.

[0016] Another drawback consists of the fact that the fibers of each layer that are deposited by a respective thread-comb head can deviate from the unidirectionality required, compromising the properties of resistance to penetration and to perforation of the panel thus obtained.

[0017] A further drawback consists of the fact that if the ballistic fibers of two successive layers had a relative orientation of $0^\circ/90^\circ$, the subsequent knit stitching thereof would not make it possible to obtain a panel with symmetrical structure, which is however necessary for ballistic purposes. In order to obtain such a structure it is forced and limited to deposit the ballistic fibers of two successive layers with a relative orientation of $\pm 45^\circ$.

[0018] Yet another drawback consists of the fact that the knit stitching of the various overlapped layers limits the choice of film to be interposed between two successive layers of ballistic fibers; such a film, indeed, since it has to be passed through by needles, cannot have high tenacity. Moreover, the penetrating needles can damage the ballistic fibers themselves.

[0019] The last but not least drawback of such a known method consists of the fact that the frames of "multi-axial" machines with which it is carried out have a fixed width that cannot be modified. This obviously constitutes a great limitation to application if one considers the fact that the market often requires panels of different widths.

[0020] EP 1 241 432 B1, on the other hand, describes a multi-layer structure consisting of two weft and warp woven fabric pieces and wherein the warp threads of one of the two fabric pieces and the weft threads of the other of the two fabric pieces consist of ballistic fibers. The other threads, weft and warp respectively, of the two fabric pieces consist of binding threads. The two fabric pieces are overlapped and joined together for example by stitching, by lamination or by impregnation with resins.

[0021] This last method is also discontinuous and foresees the weaving of each of the two fabric pieces on a respective traditional loom for the weft and warp weaving. Each of the two woven fabric pieces is then wound up in a roll. The two fabric pieces are then overlapped and laminated together with the interposition between them of an adhesive film or glue. The assembly thus obtained is then subjected to subsequent finishing treatments.

[0022] The weaving of each of the two fabric pieces with a respective traditional loom for the weft and warp weaving requires long execution times and equally high investment and management costs.

[0023] These drawbacks in terms of productivity and costs are worsened even further by the subsequent assembly and coupling operations of the woven fabric pieces that are carried out successively and in separate stations.

[0024] Another drawback consists of the fact that the single woven fabric pieces have low stability due to the presence of the binding threads woven with the ballistic fibers. The binding threads, indeed, have the purpose of allowing the weaving of the ballistic fibers, and for this reason they are generally thin and have low tenacity thus making the fabric structurally not very stable. This makes it difficult to manipulate the single fabric pieces and to overlap them exactly so as to keep the ballistic fibers correctly oriented.

[0025] There are also known textile structures comprising two overlapped layers each of which consists of a bundle of unidirectional and coplanar ballistic fibers, wherein the fibers of one layer are oriented at 90° with respect to the fibers of the other layer and the fibers of the two layers are stabilized by a plain-woven of binding threads interwoven in weft and warp between them. Examples of multi-layer structures of this type are described in WO 02/090866 or in WO 05/028724.

[0026] The purpose of the present invention is to propose a method for continuous production of a textile structure resistant to perforation and penetration that allows a multilayer textile structure to be obtained in a short time and with low investment and management costs and, therefore, with greater productivity with respect to known processes.

[0027] Another purpose of the present finding is to provide a method for continuous production of a textile structure resistant to perforation and penetration that allows a multi-layer textile structure to be obtained that is structurally stable, i.e. in which the ballistic fibers maintain the desired orientation without undergoing deviations or overlapping with respect to one another and without them being damaged.

[0028] Yet another purpose of the present finding is to provide a continuous method that allows to obtain textile structures resistant to penetration and perforation the width of which can easily be modified.

[0029] Another purpose of the present invention is to propose an apparatus for implementing a method for continuous production of a textile structure resistant to perforation that is particularly simple and functional and has reduced overall dimensions.

[0030] These purposes according to the present invention are accomplished with a method for continuous production of a textile structure resistant to perforation and penetration as outlined in claim 1.

[0031] These purposes are also accomplished with an apparatus for implementing the method for continuous production of a textile structure resistant to perforation and penetration as outlined in claim 7.

[0032] These purposes are also accomplished with a textile structure resistant to perforation and penetration as outlined in claim 12.

[0033] Further characteristics are foreseen in the dependent claims.

[0034] The characteristics of the present invention will become clearer from the following description, given as an example and not for limiting purposes, referring to the attached drawings in which:

[0035] FIG. 1 is a side elevational schematic view of an apparatus for implementing the method for producing a textile structure resistant to perforation and penetration according to the present invention;

[0036] FIG. 2 is a side elevational schematic view of an alternative embodiment of the apparatus for implementing the method for producing a textile structure resistant to perforation and penetration according to the present invention;

[0037] FIGS. 3a, 3b, 4a and 4b schematically show section views of possible textile structures obtained with the method according to the present invention.

[0038] In the following description by the expression “textile structure resistant to perforation and penetration” it is meant to indicate a multilayer textile structure made at least partially with so-called “ballistic fibers”, i.e. fibers with high resistance, tenacity and elastic modulus.

[0039] In particular, the present invention refers to a method and an apparatus for continuous production of a textile structure resistant to perforation and penetration of the multi-layer type and comprising at least two fabric elements overlapping one another, each of which is made, at least in part, with “ballistic fibers” having “unidirectional” extension.

[0040] In the following description, moreover, the adjectives “upper” and “lower” are used to indicate the relative arrangement between elements arranged at different heights with respect to a reference plane.

[0041] The method for continuous production of a textile structure resistant to perforation and penetration, according to the present invention, comprises the steps consisting in:

a) simultaneously weaving two fabric elements overlapped and spaced from each other, respectively an upper fabric element ES and a lower fabric element EI, wherein each of the two upper ES and lower EI fabric elements comprises a bundle of warp threads 1 which are at least partially made of ballistic threads and which are arranged parallel to each other on a first plane, a bundle of weft threads 2 which are at least partially made of ballistic threads and which are arranged parallel to each other on a second plane overlapped to the first and oriented at $90^{\circ} \pm 5^{\circ}$ with respect to the warp threads 1 and a stabilization weave 3 interwoven between the warp 1 and weft 2 threads of the two overlapped planes and made of first binding threads 30 and 31;

b) joining, during step a) of simultaneously weaving the two fabric elements ES and EI overlapped and spaced from each other, the upper fabric element ES and the lower fabric element EI to form a multilayer textile structure SM with second binding threads 4 alternately interwoven therein. Step b) of joining the upper fabric element ES with the lower fabric element EI consists of providing a warp or chain of second binding threads 4 and of weaving the latter alternately and according to different schemes in the upper fabric element ES and in the lower fabric element EI.

[0042] The stabilization weave 3 of each of the two upper ES and lower EI fabric elements in turn comprises:

[0043] a weft of first binding threads 30, which are arranged parallel to one another in a bundle on a plane beneath the warp threads 1 and not interwoven with them;

[0044] a warp of first binding threads 31, which are alternately woven with the weft threads 2 (ballistic) and with the weft of the first binding threads 30.

[0045] The method according to the finding also comprises the steps consisting in:

c) inserting, during the weaving step a), at least one intermediate layer SI in the form of strips or threads parallel to the warp direction between the two upper ES and lower EI fabric elements;

d) joining the assembly of the two upper ES and lower EI fabric elements joined together by the second binding threads 4 and between which the intermediate layer SI is interposed to obtain a multilayer textile structure SM'.

[0046] The joining step d) occurs by hot or cold pressing the assembly of the two fabric elements ES and EI joined together by the second binding threads 4 and interposed between which is the intermediate layer SI.

[0047] The joining step d) is carried out in line with the weaving step of the two upper ES and lower EI fabric elements and the insertion between them of the intermediate layer SI.

[0048] The method according to the finding finally comprises a final step of collecting the multilayer structure SM, SM' whether it consists of the two upper ES and lower EI fabric elements joined together by the second binding threads 4 or it consists of the two upper ES and lower EI fabric elements joined together by the second binding threads 4 between which also the intermediate layer SI is interposed.

[0049] After the possible joining step d) and before the collection step, there can be at least one hot or cold calendering step of the multilayer textile structure SM.

[0050] Again after the joining step and before the collecting step, it is possible to provide a step of applying, for example by impregnation or lamination, to at least one of the two opposite faces of the multilayer textile structure, at least one impregnating substance or at least one surface coating, respectively.

[0051] Preliminarily to the step of applying such an impregnating substance or surface coating, it is possible to carry out one or more washing steps of the multilayer textile structure and/or one or more corona and/or plasma treatment steps.

[0052] The steps indicated above, in particular those of washing, corona and/or plasma treatment, application of at least one surface coating layer and calendering are not described in detail since they can easily be recognized and worked out by the man skilled in the art.

[0053] As an alternative to carrying out the washing, corona and/or plasma treatment steps and subsequent impregnation of the multilayer textile structure, it is possible to use for the weaving of the two upper and lower fabric elements, threads that have already been pre-treated and impregnated in particular with water-repellent substances, including preferably fluoropolymers.

[0054] By ballistic threads, as known to the man skilled in the art, it is meant to indicate threads made of ballistic fibers. In particular, the ballistic fibers are made of a polymeric material selected from the group comprising at least: poly-para-aramid, polycopoly-aramid, polybenzoxazole, polybenzothiazole, polyketone, polyethylene, polypropylene, polyesters with aromatic base, glass, carbon and basalt and the like. Indeed, other types of ballistic fibers are not ruled out.

[0055] In a preferred embodiment of the method object of the invention, the ballistic threads have the following characteristics:

[0056] tensile strength >7 gr/dtex

[0057] elastic modulus >200 gr/dtex

[0058] impact strength >10 J/gr

[0059] density >0.8 gr/cm³

[0060] count comprised between 100 dtex and 10000 dtex.

[0061] On the other hand, with regard to the first and second binding threads, they are made of thermoplastic polymeric material, thermosetting polymeric material, soluble material or their blends.

[0062] It should be specified that, in a possible embodiment of the method object of the present invention, the same first and second binding threads can have ballistic properties.

[0063] If present, the intermediate layer SI is made of thermoplastic polymeric material, thermosetting polymeric material, elastomeric material, viscous material, adhesive polymers and their blends.

[0064] As a non-exhaustive example, the intermediate layer SI is made of a polymer selected from the group comprising at least: polyurethane, polyethylene, polypropylene, polyester, styrene butadiene, polycarbonate, phenol or polyvinyl butyral, polyisobutene, polyisobutylene, natural or synthetic rubber, silicon polymers and the like.

[0065] FIG. 1 represents the scheme of an apparatus 10 for implementing the method according to the finding.

[0066] The apparatus 10 comprises a weaving loom 11 with two overlapped fabric pieces of the warp pile fabric velvet loom type. In its base structure the loom 11 comprises:

[0067] a support framework 12,

[0068] at least one feeding group consisting of a first beam 13 from which the warp of ballistic threads 1 is unwound respectively of the upper fabric element ES and of the lower fabric element EI,

[0069] at least one first feeding group consisting of a second beam 14 from which the warp of the first binding threads 31 of the stabilization weave 3 is unwound respectively of the upper fabric element ES and of the lower fabric element EI;

[0070] at least one second feeding group consisting of a third beam 15 of the warp or chain of the second binding threads 4 of the upper fabric element ES with the lower fabric element EI;

[0071] at least one first order of heddles 16 for the warp, ballistic 1 and binding 31 threads, of the upper fabric element ES and a second order of heddles 17 for the warp, ballistic 1 and binding 31 threads, of the lower fabric element EI,

[0072] at least one third order of heddles 18 for the warp of the second binding threads 4 of the upper fabric element ES with the lower fabric element EI;

[0073] a sley 19 bearing a reed 20 passing between whose teeth are the warp, ballistic 1 and binding 31 threads, of the upper fabric element ES and of the lower fabric element EI, and the warp of the second binding threads 4;

[0074] at least two members 21 and 22 for simultaneously inserting the weft threads, alternately ballistic 2 and binding 30 threads, respectively into the upper and lower warp mouths defined by the orders of heddles for respectively forming the upper fabric element ES and the lower fabric element EI joined together by the second binding threads 4;

[0075] a drawing group 23 of the two upper ES and lower EI fabric elements joined together by the second binding

threads 4 in a multilayer textile structure SM, such a drawing group being arranged downstream of the loom 11;

[0076] a group 24 for collecting the multilayer textile structure SM arranged downstream of the drawing group 23.

[0077] The insertion members 21 and 22 can consist of respective pincers, lances, shuttles or an air jet and they work in cooperation with a so-called "presenter" for the alternating insertion of the weft of the first binding threads 30 and of the weft of the ballistic threads 2.

[0078] It should be specified that in the attached figures and in the present description the motorization members, the movement mechanisms, the guide, separating, control and selection members that, as known to the man skilled in the art, fit out and complete the structure of the weaving loom 11, are not represented and described in detail.

[0079] The drawing group 23 comprises at least one pair of pressure rollers parallel and counter-rotating with respect to one another, so-called take up beam, which can be heated.

[0080] The collecting group 24 comprises a beam for collecting the multilayer textile structure SM formed.

[0081] FIG. 2 represents the scheme of an alternative embodiment of the apparatus 10 that differs from the embodiment represented in FIG. 1 in that it comprises a further feeding group 25 of the intermediate layer SI arranged near to the first and second beam 13 and 14.

[0082] Such a further feeding group 25 can consist of a beam from which the threads or the strips of the intermediate layer SI are unwound. Alternatively, it can consist of a roll from which the intermediate layer SI unwinds in the form of continuous film, a group for cutting the continuous film into a plurality of threads or strips parallel to the warp direction being provided downstream of such a roll.

[0083] The cutting group can, for example, consist of a plurality of circular blades mounted on a shaft transversal to the warp direction and cooperating with corresponding counter-blades.

[0084] In such an embodiment the drawing group 23 also carries out the joining of the upper fabric element ES and of the lower fabric element EI, joined together by the second binding threads 4, between which the intermediate layer SI is interposed.

[0085] FIG. 2 also schematically represents further groups that complete the apparatus 10, in particular:

[0086] A hot or cold calandering group 26 interposed between the drawing group 23 and the collecting group 24.

[0087] A washing group 27 of the multilayer textile structure SM, a corona or plasma treatment group 28 of the multilayer textile structure SM and a group 29 for applying, by impregnation or by lamination, at least one impregnated substance or a surface coating onto at least one of the two faces of the multilayer textile structure SM. It should be understood that also just some of the groups indicated above may be provided, for example just the calandering group, or many series thereof even in a different succession. The same groups are not necessary in the case in which threads already pre-treated and impregnated with a water-repellent substance, preferably based on fluoropolymer, are used for the weaving of the two upper and lower fabric elements.

[0088] The calendering, washing, corona and plasma treatment, impregnation or surface coating layer application groups are not described in detail since they are known to the man skilled in the art.

[0089] The operation of the apparatus 10 can be immediately understood by the man skilled in the art, with particular reference to the weaving of the warp pile fabric velvet.

[0090] FIGS. 3a, 3b, 4a and 4b show, schematically and not to scale, possible multilayer textile structures SM obtainable with the method according to the finding, wherein the ballistic threads are indicated with a thick line and the first and second binding threads with a thin line.

[0091] The structures according to FIGS. 3b and 4b respectively differ from those of FIGS. 3a and 4a due to the presence of the intermediate layer SI between the upper fabric element ES and the lower one EI.

[0092] It should also be specified that the path of the second binding threads 4 represented in the attached figures is indicative and an example, with it of course being able to be different, as can be easily understood by the man skilled in the art.

[0093] Thanks to the simultaneous weaving of two fabric elements overlapped and spaced from each other, and their simultaneous joining with the second binding threads, alternately interwoven therein, the method and apparatus according to the present invention make it possible to obtain a multilayer textile structure in a single stage. This makes it possible to reduce production times and costs and, therefore, to increase productivity with respect to known methods.

[0094] The method and apparatus according to the present invention make it possible to obtain multilayer textile structures resistant to perforation and penetration in which the ballistic threads are aligned in the desired direction and do not suffer damage or relative displacements, with a consequent improvement of the ballistic properties. A further stabilization of the ballistic textile structure and improvement of its properties are obtained thanks to the insertion of the intermediate layer between the two fabric elements, said insertion occurring at the same time as the weaving of the two fabric elements and their attachment and joining with the second binding threads.

[0095] The method and apparatus according to the present invention make it possible to obtain multilayer textile structures resistant to perforation and penetration of any width, being it sufficient to modify the number of warp threads.

[0096] The method for producing the textile structure resistant to perforation and penetration and the apparatus for carrying it out thus conceived can undergo numerous modifications and variants, all of which are covered by the invention; moreover, all of the details can be replaced with technically equivalent elements. In practice, the materials used, as well as the sizes, can be whatever according to the technical requirements.

1) Method for continuous production of a textile structure resistant to perforation and penetration, comprising the steps consisting in:

- a) simultaneously weaving two fabric elements (ES, EI) overlapped and spaced from each other, wherein each of the two fabric elements comprises a bundle of warp threads (1) which are at least partially made of ballistic threads and which are arranged parallel to each other on a first plane, a bundle of weft threads (2) which are at least partially made of ballistic threads and which are arranged parallel to each other on a second plane overlapped to the first and oriented at 90° with respect to said

warp threads (1) and a stabilization weave (3) interwoven between the warp (1) and weft (2) threads of said two overlapped planes and made of first binding threads (30, 31);

- b) joining, during said step of weaving said two fabric elements (ES, EI) overlapped and spaced from each other, the upper fabric element (ES) and the lower fabric element (EI) to form a multilayer textile structure (SM) with second binding threads (4) alternately interwoven therein;
- c) inserting, during said weaving step, at least one intermediate layer (SI) in the form of strips or threads parallel to the warp direction between said two upper (ES) and lower (EI) fabric elements;
- d) joining the assembly of the two upper (ES) and lower (EI) fabric elements joined together by said second binding threads (4) and between which said intermediate layer (SI) is arranged to obtain a multilayer textile structure (SM').

2) Method according to claim 1, characterized in that said joining comprises providing a warp or chain of said second binding threads (4) and then weaving the latter alternately in said upper fabric element (ES) and in said lower fabric element (EI).

3) Method according to claim 2, wherein said joining step occurs by hot or cold pressing said assembly of the two upper (ES) and lower (EI) fabric elements joined together by said second binding threads (4) and between which said intermediate layer (SI) is interposed.

4) Method according to claim 3, comprising a step of applying to said multilayer textile structure (SM, SM') at least one impregnating substance or at least one surface coating.

5) Method according to claim 1, wherein said ballistic threads (1, 2) have the following characteristics:

- tensile strength >7 gr/dtex
- elastic modulus >200 gr/dtex
- impact strength >10 J/gr
- density >0.8 gr/cm³
- count comprised between 100 dtex and 10000 dtex.

6) Method according to claim 1, wherein said intermediate layer (SI) is made of thermoplastic polymeric material, thermosetting polymeric material, elastomeric material, viscous material, adhesive polymers and their blends.

7) Apparatus (10) for implementing the method according to one of claims 1 to 6, characterized in that it comprises:

- a weaving loom (11) with two overlapped fabric pieces of the warp pile fabric velvet loom type which comprises: a support framework (12),

at least one feeding group (13) from which the warp of the ballistic threads (1) respectively of the upper fabric element (ES) and of the lower fabric element (EI) is unwound,

at least one first feeding group (14) of the warp of the first binding threads (31) of the stabilization weave (3) respectively of the upper fabric element (ES) and of the lower fabric element (EI);

at least one second feeding group (15) of the warp or chain of the second binding threads (4) of said upper fabric element (ES) with said lower fabric element (EI);

at least one first order of heddles (16) for the warp, ballistic (1) and binding (31) threads, of the upper fabric element (ES) and a second order of heddles (17) for the warp, ballistic (1) and binding (31) threads, of the lower fabric element (31),

at least one third order of heddles (18) for the warp of the second binding threads (4) of said upper fabric element (ES) with said lower fabric element (EI);

a sley (19) bearing a reed (20) passing between whose teeth are the warp, ballistic (1) and binding (31) threads, of the upper fabric element (ES) and of the lower fabric element (EI) and the warp of the second binding threads (4);

at least two members (21, 22) for simultaneous insertion of the weft threads, alternately ballistic (2) and binding (30) threads, respectively into the upper and lower warp mouths defined by said orders of heddles for respectively forming said upper fabric element (ES) and said lower fabric element (EI) joined together by said second binding threads (4);

a group (23) for drawing said upper (ES) and lower (EI) fabric elements joined together by said second binding threads (4) in a multilayer textile structure (SM), such drawing group being arranged downstream of said loom (11);

a group (24) for collecting said multilayer textile structure (SM) arranged downstream of said drawing group (23), wherein said apparatus also comprises a further feeding group (25) of said at least one intermediate layer (SI) in the form of threads or strips arranged near to said feeding groups.

8) Apparatus (10) according to claim 7, characterized in that said further feeding group (25) of said at least one intermediate layer (SI) comprises a beam from which said intermediate layer (SI) is unwound in the form of threads or strips.

9) Apparatus (10) according to claim 7, characterized in that said further feeding group (25) of said at least one intermediate layer (SI) comprises a roll from which said intermediate layer (SI) is unwound in the form of continuous film, downstream of said roll being provided a group for cutting

said continuous film into a plurality of strips or threads parallel to the warp direction.

10) Apparatus (10) according to claim 7, characterized in that said drawing group (23) comprises at least one pair of pressure rollers parallel and counter-rotating with respect to each other.

11) Apparatus (10) according to one of claims 7 to 10, characterized in that it comprises a group (29) for applying at least one impregnating substance or at least one surface coating to said multilayer textile structure (SM) that is interposed between said drawing group (23) and said collecting group (24).

12) Multilayer textile structure (SM, SM') obtainable through the method according to one of claims 1 to 6, characterized in that it comprises two fabric elements (ES, EI) overlapped and spaced from each other, wherein each of said two fabric elements comprises a bundle of warp threads (1) which are at least partially made of ballistic threads and which are arranged parallel to each other on a first plane, a bundle of weft threads (2) which are at least partially made of ballistic threads and which are arranged parallel to each other on a second plane overlapped to the first and oriented at 90° with respect to said warp threads (1) and a stabilization weave (3) interwoven between the warp (1) and weft (2) threads of said two overlapped planes and made of first binding threads and second binding threads (4) interwoven between said two fabric elements (ES, EI) overlapped with respect to each other, said structure also comprising at least one said intermediate layer (SI) interposed between said two upper (ES) and lower (EI) fabric elements.

13) Structure (SM, SM') according to claim 12, characterized in that said second binding threads (4) comprise warp threads or chain alternately woven in said upper fabric element (ES) and in said lower fabric element (EI).

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