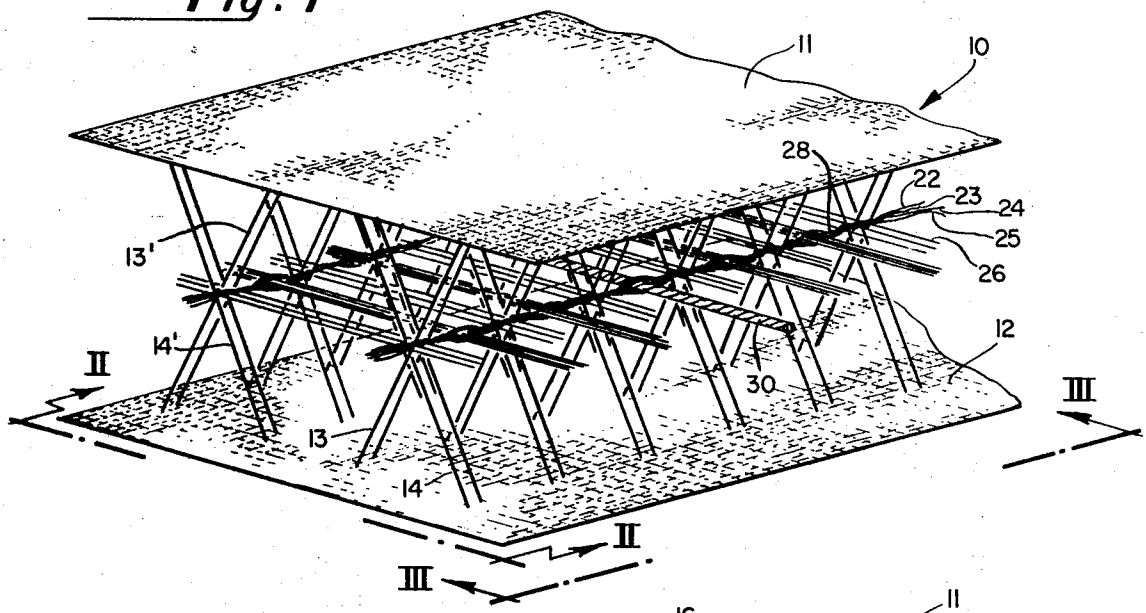
June 30, 1970 J. T. HAYES ET AL 3,517,707

DUAL WALL FABRIC WITH REINFORCING STRANDS

Filed Oct. 1, 1968 2 Sheets-Sheet 1

Fig. 1



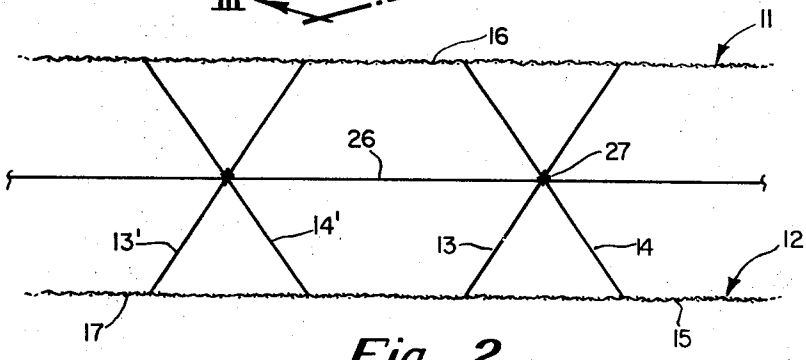


Fig. 2

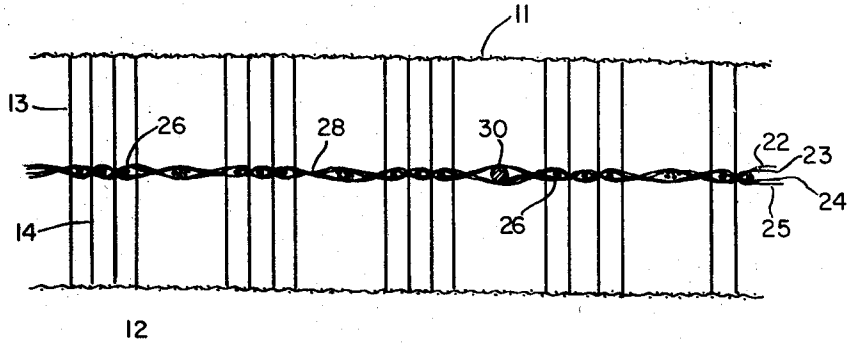


Fig. 3

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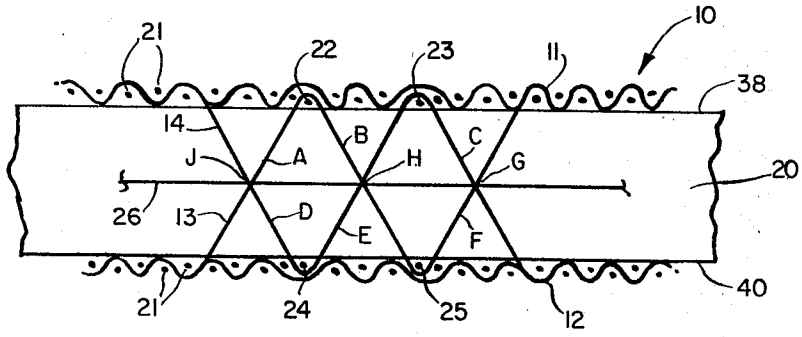


Fig. 4

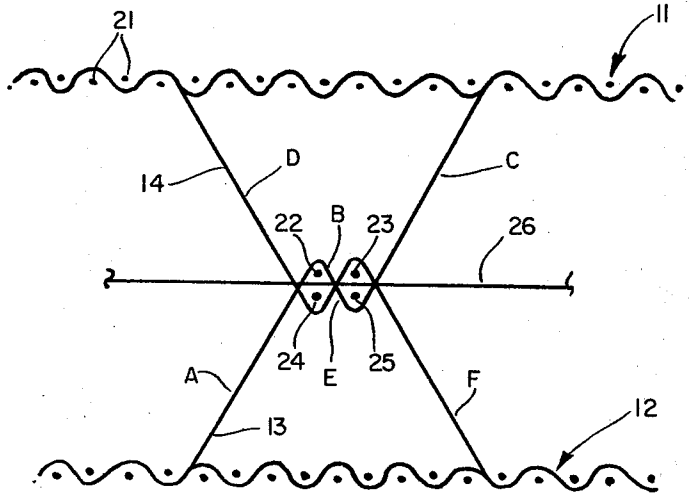


Fig. 5

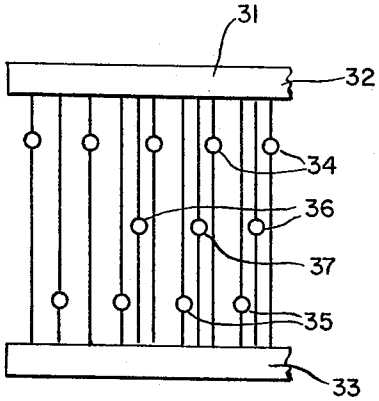


Fig. 6

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3,517,707

DUAL WALL FABRIC WITH REINFORCING STRANDS

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Continuation-in-part of application Ser. No. 702,925, Feb. 5, 1967. This application Oct. 1, 1968, Ser. No. 764,138

Int. Cl. D03d 11/00

U.S. Cl. 139—410 17 Claims

ABSTRACT OF THE DISCLOSURE

A dual wall fabric is provided, with integrally woven warp direction drop threads which extend back and forth a plurality of times between opposed fabric layers, when the fabric layers are spaced by warpwise extending spacing gauges. The connecting or drop threads engage or loop around weft threads disposed above and below the gauges adjacent associated fabric layers, with the weft threads being supported by the gauges prior to removal of the fabric material from the gauges. The fabric material can be expanded upon removal from the gauges, in a manner utilizing weft and warp strands as reinforcing strands.

RELATED APPLICATIONS

This is a continuation-in-part of our earlier filed application, Ser. No. 702,925, filed Feb. 5, 1967.

BACKGROUND OF THE INVENTION

In the weaving industry, it has long been known to weave dual wall fabrics, wherein opposed fabric layers were connected by strands of thread or the like. In some instances, such connecting strands have comprised integrally woven warp direction strands, such that the entire fabric including connecting strands could be woven on a single loom, as part of a unitary operation. In weaving dual wall fabric, gauges are often used to maintain the preliminary spacing between opposed fabric layers to a predetermined height, which spacing may be increased upon removal of the fabric material from the gauges. However, it has generally been necessary, either immediately prior to or subsequent to removal of the fabric material from the gauges, in order for the connecting strands between fabric layers to be operative to permit expansion of the dual wall fabric, that weft strands about which the connecting strands are looped be removed or otherwise discarded, in that their function of supporting connecting strand portions during formation of the material was completed. Thus, it has been commonplace to remove such dummy picks or weft strands after the completion of the formation of the unexpanded fabric material. One example of making a fabric material by a method having some similarities to that described immediately above is disclosed in the patent to Neisler No. 2,848,018, issued Aug. 19, 1958.

SUMMARY OF THE INVENTION

The present invention seeks to provide an improved multiple wall fabric, wherein connecting strands are provided in the form of reinforcing strands disposed at an intermediate level between opposed fabric layers, connecting the drop threads together. Such connecting strands may be in the weft direction, and may be further reinforced by strands disposed in the warp direction at the same level, being connected to and intertwined with the drop threads at intersections thereof, preferably if the drop threads form X-shaped configurations. Some such intermediate connecting strands may be of rigid construction, for example of wire construction, for additionally rigidifying the dual wall fabric for various uses, such as for imparting strength to the fabric during cement containment.

Accordingly, it is a primary object of this invention to provide a novel reinforced plural wall fabric.

It is a further object of this invention to provide a fabric of the type mentioned immediately above, wherein integral connecting strands are in turn, connected to one another at a predetermined location between opposed fabric layers.

It is yet another object of this invention to accomplish the above object, wherein such connecting strands extend in both the weft and warp directions.

It is a further object of this invention to accomplish all of the above objects, wherein the distance between opposed fabric layers is expandable after manufacture of the fabric.

It is a further object of this invention, to provide a novel fabric of the type mentioned immediately above, and the method of manufacture thereof, wherein the expansion of the fabric to a greater distance between opposed fabric layers initiates the placement of reinforcing strands at the desired level.

Other objects and advantages of the present invention will become readily apparent to those skilled in the art, as well as uses for the same, such as for containment of various substances, all within the spirit and scope of the invention, as defined in the claims.

In the drawings:

FIG. 1 is a top perspective view of a portion of fabric constructed according to this invention, wherein opposed fabric layers are illustrated in their expanded condition, connected by warp strands interwoven with the layers, and wherein the warp strands assume generally X-shaped configurations, having reinforcing weft and warp strands connecting their crossing points.

FIG. 2 is a schematic view of the fabric of FIG. 1, taken generally along the line II—II of FIG. 1, and wherein the generally X-shaped configuration of the drop connecting strands is clearly illustrated, with the view being that which one would observe looking in the weft direction.

FIG. 3 is an end view of the fabric of FIG. 1, taken generally along the line III—III of FIG. 1, and looking in the warp direction, and wherein the intertwining of intermediate weft strands with intermediate warp strands and drop threads is clearly illustrated.

FIG. 4 is a fragmentary schematic view of a pair of opposed fabric layers, with the view looking in the weft direction, and wherein the connecting strands are illustrated, looped about weft strands, with the weft strands being illustrated as being maintained in spaced relation by a gauge, and with an intermediate warp strand being illustrated disposed alongside the gauge.

FIG. 5 is a fragmentary schematic illustration of the material of FIG. 4, after removal of the same from the warp-directed guides of a loom, and with the fabric expanded to its final spacing, and with the interconnection of the intermediate weft, warp and drop threads being clearly illustrated.

FIG. 6 is a fragmentary view of an aligned series of harness frames, each carrying a set of heddles which together accommodate the carrying of face and back cloth warp strands, intermediate warp strands alongside guides, and drop warp threads, according to this invention.

Referring now to the drawings in detail, reference is first made to FIG. 1, wherein there is illustrated a dual wall fabric, generally designated by the numeral 10, in

its expanded condition, and comprising upper and lower opposed woven fabric layers **11** and **12**, respectively.

The fabric layers **11** and **12** are connected by a plurality of warp direction drop threads or strands **13** and **14**.

With reference to FIG. 2, and to the right-most strand **14** illustrated therein, it will be seen that the strand **14** is interwoven with the fabric layer **12**, at the portion indicated by the numeral **15** thereof, and extends in angular disposition, as viewed in FIG. 2 toward the upper fabric layer **11** in which it is woven integrally therewith at the portion indicated by the numeral **16** thereof, that same strand **14** then leaving the portion **16** of layer **11**, to again traverse the distance between the opposed fabric layers **11**, **12**, to enter an end portion **17** of the layer **12**, the strand **14** being represented by the numeral **13'** to indicate an oppositely angularly directed connecting thread portion extending between the portion **16** of layer **11** and the portion **17** of the layer **12**. The integrally woven connecting strand **13** is similar in the manner in which it is connected between the opposed fabric layers **11** and **12**, but the strand **13** is oppositely directed, to cooperate with the strand **14** to define a generally X-shaped configuration when expanded as illustrated in FIG. 2.

With particular reference to FIGS. 4 and 5, the manner in which the strand **14** reaches the condition in FIG. 2 is more clearly illustrated. During the weaving process, the opposed layers **11** and **12** are woven on a loom, with the layers **11** and **12** being separated by a plurality of gauges **20** which extend in the warp direction, the gauges **20** being spaced one from another in a manner not illustrated, across the machine in the weft direction. Thus, the spacing of the opposed layers **11** and **12** may be carefully controlled and selected depending upon the particular series of gauges **20** utilized.

In the illustration of FIG. 4, all of the threads **21** which extend in the weft direction are woven into their respective layers **11** or **12**, with the exception of the weft strands **22**, **23**, **24** and **25**, which are supported and maintained in spaced relation against their associated fabric layers **11** and **12** by the gauges **20**, but which are not interwoven or connected with either of the fabric layers **11** or **12**, except perhaps at the selvage (not shown) of the fabric **10**, if the same is desired. Thus, the weft strands **22**, **23**, **24** and **25** are maintained in the position illustrated in FIG. 4, only by the presence of the gauges **20**.

A plurality of extra warp direction strands **26** are provided, carried on a loom by a creel or the like, with the strands **26** being disposed alongside guides **20** and being unwoven with either of the fabric layers **11** or **12**, but being disposed between the weft strands **22** and **23** on one hand and the weft strands **24** and **25** on the other hand.

As the fabric **10** is removed from the guides **20**, or as the original spacing limitation between opposed weft strands **22**, **23** and **24**, **25** is otherwise removed, the fabric layers **11** and **12** are free to expand in the vertical direction, as viewed in FIG. 5, to a predetermined spacing between the opposed layers **11** and **12**. With the guides **20** removed, the weft strands **22** and **25** are free to approach each other along the strand portion B of the thread **13**, as the length of the strand portion B diminishes due to the expansion of the strand portions A and C of the connecting thread or strand **13**. Similarly, the weft threads or strands **23** and **24**, about which the drop thread **14** is looped approach each other along thread portion E as the thread portion E diminishes due to the expansion of the distance between the layers **11** and **12**, and the attendant elongation of the portions D and F of the drop thread **14**.

As the weft strands **22**, **23**, **24**, and **25** approach one another near the crossing point **27** of the drop threads **13** and **14**, they form a cable-like configuration **28**, which is intertwined both with the drop threads **13** and **14** and with a plurality of generally parallel-disposed warp strands **26**, which are trapped between the weft strands **22** and **23** on one hand and **24** and **25**, on the other hand. Thus, the weft strands **22**, **23**, **24** and **25** cooperate with warp strands **26** to define an intermediate rigidifying fabric layer, spaced between the opposed fabric layers **11** and **12**, a predetermined distance, dependent upon the number of crossings of the strands **13** and **14** across the gauges **20**, and upon the desired elevation of the crossing points G, H and J during formation of the fabric material **10** on the gauges **20**. It is to be noted, that the particular elevation of the intermediate layer formed by the dummy picks or attached weft strands **22**, **23**, **24**, **25**, and the warp strands **26** can therefore be controlled, but will generally be disposed near the middle of the distance between the fabric layers **11** and **12**. Accordingly, it is to be understood that the term X-shaped configuration used herein is not to be construed as being limited to a perfectly symmetrical X, but that the cross-over points of the different legs of the X-shaped configuration, such as those G, H and J, may be at any desired elevation, as may be the elevation of the cross-over points of the X-shaped configurations formed by the legs **13** and **14** of drop threads, which comprise the cross-over points **27** be disposed at any selected intermediate distance between the layers **11** and **12**.

The warp strands **26** may be disposed in groups, to also give a cable-like configuration, or may be singularly or individually carried by the weft-direction cables **28**. Alternatively, the warp direction strands may comprise rigid wire **30**, such as steel, pipe, electrically conductive wire, resistance wire for purposes of heating an article to be made by a filled fabric material **10**, hollow conduit or any other strand-like structure, the only limitation being those placed upon the utilization of the same by the particular loom upon which the material **10** is to be woven.

With particular reference to FIG. 6, there is illustrated a harness frame **31**, such as would be used with a loom set up for the manufacture of the fabric **10** of this invention, having upper and lower supporting portions **32** and **33**, respectively, with the frame **31** carrying respective upper and lower sets of heddles **34** and **35**, each of the heddles having eyes **35** for carrying warp strands for weaving face cloth and both cloth, respectively. Those intermediate heddles **36** would be carried on a separate harness frame (behind frame **31**) and would carry the warp strands **13** and **14**. Heddle **37** is also carried on a separate harness frame (behind frame **31**) and may be used to carry a strand **26** to form an intermediate rigidifying layer, if desired, of the fabric material **10** of this invention. Thus there is readily seen the manner in which the warp strands **26** may be maintained in position during the formation of the dual wall fabric material **10**, with the opposed fabric layers **11** and **12** being carried over gauges **20**.

It will be noted, that although gauges **20** have been illustrated as being the means for obtaining an original predetermined spacing between the opposed fabric layers **11** and **12**, any other suitable spacing means may be utilized, to maintain the original spacing of the dummy picks or weft strands **22**, **23**, **24** and **25**, which would then allow the dummy picks **22**, **23**, **24** and **25** to approach one another, in the manner illustrated in FIG. 5.

It will further be apparent to those skilled in the art, that any suitable thread or yarn may be utilized in the formation of the fabric **10** of this invention, such as nylon, polypropylene, or other split film yarns, also including yarns made of fiber glass, polyvinyl chloride and polyolefin yarns of various types.

Although numerous uses are presented for the subject matter of this invention, it is contemplated that one such use would be in the area of cement containment,

whereby cement, concrete or the like may be inserted between the opposed fabric layers **11** and **12**, either in dry form, later to be wetted down in order to harden, or pumped between the layers **11** and **12** in slurry reform, with the wires **30** disposed therebetween being adapted to strengthen a concrete structure thus formed, by providing tension characteristics for such a concrete structure. Furthermore, by replacing the wires **30** with conduit or the like concrete constructions may be formed with passageways for electrical wiring, moisture seepage, or any of a variety of other uses.

It will further be noted, that in the illustration of FIG. 1, the dummy picks **22**, **23**, **24** and **25** produce, along with the drop threads **13** and **14**, an interweaving of the leno type. It is also to be noted, that a weave such as that illustrated in FIG. 1 is adaptable to double shuttle Jacquard weaving giving rise to the possibility of weaving a top piece at a 45 degree right-hand twill, with the bottom piece of back cloth at a 45 degree left-hand twill. Still further, it will be noted from FIG. 2 that the X-shaped configurations are arranged linearly when viewed in the weft direction, but that the stirrup or drop thread placement may be arranged in more random fashion, to avoid alignment of the drop threads **13** and **14** when viewed in the weft direction. Still further, any variety of fibers, tapes, flexible tubing, slit non-woven strands, and wire may be utilized as comprising the center warp strands **26** of the material **10** of this invention.

The use of the material of this invention for cement containment has been indicated as preferred, but containment of other materials such as resins including polyesters and epoxys are also contemplated, particularly with fiber glass strands.

It will be apparent to those skilled in art that various modifications may be made in the details of construction of the fabric of this invention, as well as in the method of manufacture, and in the use thereof, without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A dual wall fabric expandable from a formative height between layers to an increased height between layers, comprising opposed fabric layers integrally woven with connecting drop threads, each said drop thread being woven into each of the opposed fabric layers and providing means facilitating expansion of the distance between opposed fabric layers, including first strands intertwined with and connecting said drop threads at a predetermined location between said layers, and spaced from said layers, with said intertwined and connecting relationship of said first strands relative to said drop threads in combination with the spacing of the first strands from the layers being present only in the expanded or increased height condition of the fabric layers, wherein second strands are provided extending between said first strands in connecting relation, said second strands being located at said predetermined location between said layers defining a planar matrix with said first strands.

2. A dual wall fabric expandable from a formative height between layers to an increased height between layers, comprising opposed fabric layers integrally woven with connecting drop threads, each said drop thread being woven into each of the opposed fabric layers and providing means facilitating expansion of the distance between opposed fabric layers, including first strands intertwined with and connecting said drop threads at a predetermined location between said layers, wherein second strands are provided extending between said first strands in connecting relation, said second strands being located at said predetermined location between said layers defining a planar matrix with said first strands, wherein said drop threads comprise warp threads woven to cross in generally X-shaped configurations, said first strands comprising weft direction strands and connecting crossing points of said configurations.

3. The fabric of claim **2**, wherein said second strands are warp direction strands.

4. The fabric of claim **3**, wherein at least some of said warp direction strands are of wire construction.

5. The fabric of claim **1**, wherein said first strands comprise dummy picks.

6. A fabric material comprising a pair of woven fabric layers having intermediate unbroken connecting threads extending therebetween, each said thread being woven into each of said layers, from an initial formative height condition; including free threads disposed inwardly of said fabric layers in a direction transverse to said connecting threads adjacent associated said layers and with said connecting threads being looped about said free threads in the formative height condition of said fabric; including other strands in engagement with said connecting threads at the juncture thereof with said free threads in the increased height condition said fabric and with said free threads being disposed at a predetermined height location between said layers in intertwined relation with said connecting threads and said other strands in the increased height condition of said fabric.

7. The fabric of claim **6**, wherein said other strands are disposed between said fabric layers during the formative condition of said fabric, in direction substantially normal to said free threads, and extending between said free threads in connecting relation during the increased height condition of said fabric.

8. The fabric of claim **6**, wherein said other strands also comprise connecting threads that cooperate with said previously mentioned connecting threads to cross each other in generally X-shaped configurations in the increased height condition of said fabric.

9. The fabric of claim **8**, wherein said connecting threads are each in looped disposition about a plurality of spaced said free threads in the formative height condition of said fabric, said same plurality of free threads being disposed in intertwined relation about said crossing connecting threads, in cable-like configuration in the increased height condition of said fabric.

10. The fabric of claim **9** including intermediate warp direction strands disposed transverse to the free strands and between said fabric layers during the formative condition of said fabric and extending between said free threads in connecting relation in the increased height condition of said fabric, wherein at least one of said intermediate warp strands is of wire construction and of substantially increased rigidity relative to said threads of fabric construction.

11. A method of making a reinforced fabric material on a loom, with the fabric material being made to comprise opposed fabric layers with connecting threads, with the layers being woven in predetermined spaced relation as determined by warpwise extending spacing means, comprising the steps of weaving the fabric with opposed layers on opposite sides of the spacing means, integrally weaving connection warp threads each to cross the spacing means a plurality of times of unequal number between locations of interweaving the connecting warp threads at opposite ends thereof with the fabric layers, looping the connecting warp threads about weft threads on opposite sides of the spacing means between locations of interweaving the connecting warp threads with the fabric layers, with the weft threads supporting the connecting warp threads looped thereabout, and with the spacing means supporting the weft threads in predetermined spaced relation adjacent fabric layers, discontinuing the weft thread spacing and supporting provided by the spacing means, expanding the fabric to an increased spacing between layers, with the connecting threads simultaneously urging the weft threads toward predetermined spaced relation between fabric layers, and fixing the positions of the weft threads between the fabric layers relative to the connecting threads.

12. The method of claim **11**, wherein the fixing step is effected by the weft threads being urged, upon expansion

of the fabric, to locations between the fabric layers defined by crossing points of a plurality of connecting threads, with the weft threads becoming intertwined with the connecting threads.

13. The method of claim **12**, wherein a plurality of weft threads are urged together into cable-like configuration during expansion of the fabric.

14. The method of claim **11**, including the step of providing extra warp-direction strands between opposed fabric layers during the fabric weaving, with the extra warp-direction strands being unwoven and extending transverse to but spaced between the weft threads, with the extra warp-direction strands effecting the position-fixing step while being urged toward the same predetermined spaced relation between the fabric layers as the weft threads, upon expansion of the fabric.

15. The method of claim **13**, including the step of providing extra warp-direction strands between opposed fabric layers during the fabric weaving, with the extra warp-direction strands extending transverse to but spaced between the weft threads, with the extra warp-direction strands being urged toward the same predetermined spaced relation between the fabric layers as the weft threads, upon expansion of the fabric, with the extra warp-direction strands being supported and confined between the fabric

layers by a plurality of cable-like configurations of the weft threads, to define with the weft threads at least one intermediate reinforcing fabric layer.

16. The method of claim **11**, wherein the weft thread spacing and supporting is discontinued by removing the fabric from warp-direction gauges carried by the loom.

17. The method of claim **15**, wherein the extra warp direction strands are unwoven.

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