United States Patent [19]

Villiger et al.

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[45] **May 21, 1974**

[54] **MULTI-LAYER FABRIC**

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[73] Assignees: **Arova Schaffhausen AG,** Schaffhausen; **Losinger AG,** Berne, both of, Switzerland

[22] Filed: **May 22, 1972**

[21] Appl. No.: **255,908**

Related U.S. Application Data

[63] Continuation of Ser. No. 46,240, June 15, 1970, abandoned.

[52] **U.S. Cl.** **139/384,** 138/408

[51] **Int. Cl.** **D03d 3/00**

[58] **Field of Search** 139/384, 410

[56] **References Cited**

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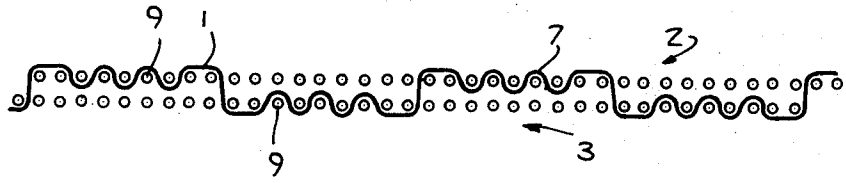
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[57] **ABSTRACT**

Multi-layer fabric in which the layers are joined by threads extending therebetween to connect the layers while allowing same to be spaced a limited distance apart.

6 Claims, 6 Drawing Figures



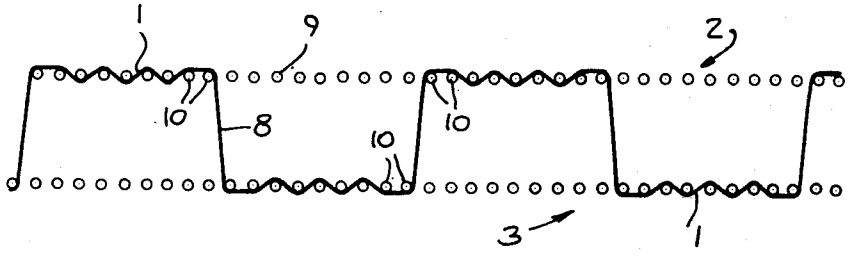


Fig. 1.

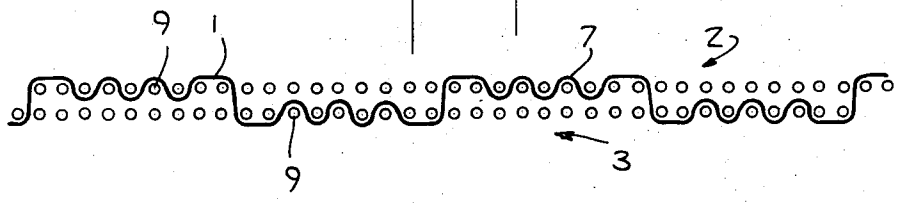


Fig. 2.

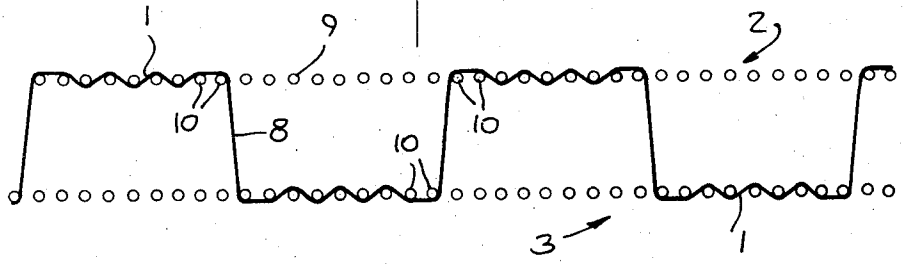
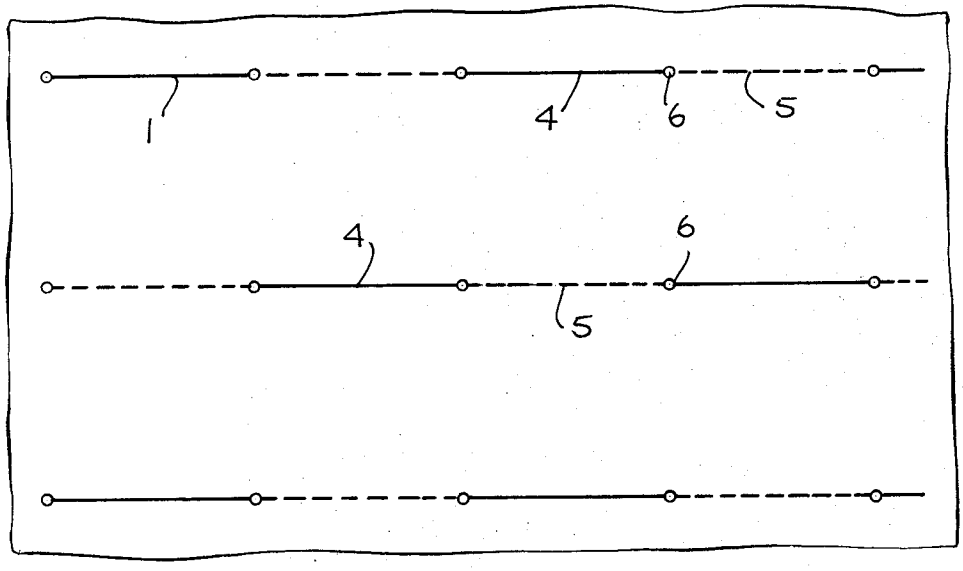


Fig. 3.



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Fig. 4A.

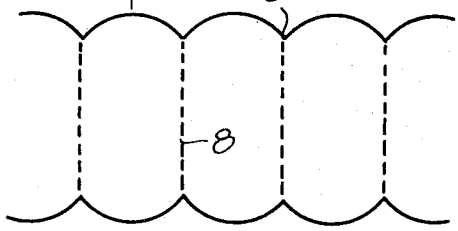


Fig. 4B.

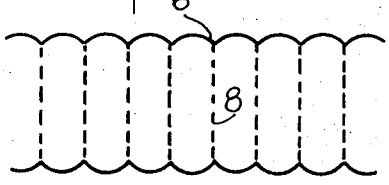
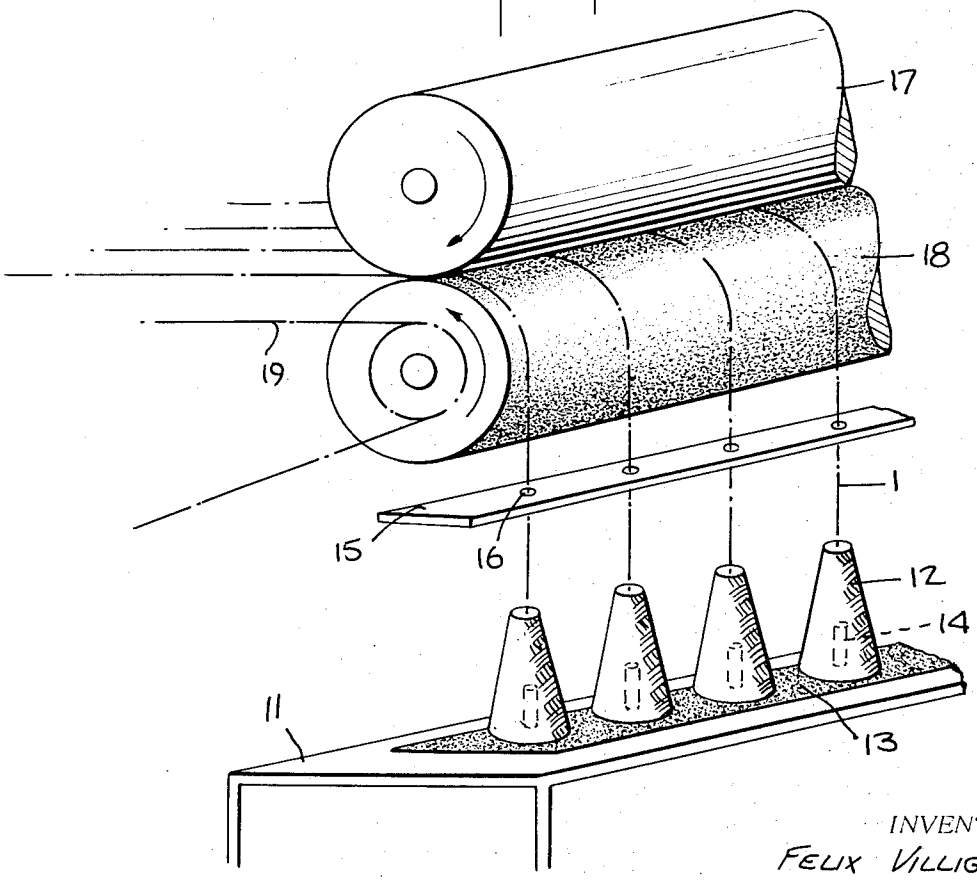


Fig. 5.



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MULTI-LAYER FABRIC

This invention relates to multi-layer fabrics in which the layers are joined by threads passing between the layers whereby the layers can be pulled apart by a limited distance to provide space therebetween. Such fabrics are useful for retaining hardenable compositions prior to hardening.

Fabrics of the class described above and comprising two layers are used, for example, in the strengthening of shores and embankments and in lining reservoirs, canals and the like; and in the formation, below the surface of bodies of water, of members of various shapes and contours. The fabric, generally sealed e.g., by stitching around its edges, is laid in the form of a mat at the place to be strengthened and is subsequently filled under pressure with a hardenable composition such as, for example, liquid concrete. During the filling process, the mat is pressed into the contour of the substrate on which the mat is laid. Where liquid concrete is used, a solid concrete base or wall is then obtained upon subsequent setting.

On pressure filling the space between the layers of the fabric, the surface of the fabric is formed in cross-section into a series of arches with the width of each arch corresponding to the distance between adjacent threads or filaments joining the fabric layers. The constrictions which, as a result occur in the final hardened concrete or other composition, lead to a reduction in the strength thereof. It is therefore desirable to reduce the difference in thickness as between the points of maximum constriction and the points of maximum arching by increasing the number of threads or filaments joining the two layers of the fabric and thereby providing a larger number of smaller arches.

In essence, we contribute by our invention a two-layer woven fabric which can be readily produced with a relatively large number of threads joining the two layers and which is useful for retaining hardenable compositions prior to hardening.

According to one feature of the present invention, we provide a two-layer woven fabric for use in retaining hardenable compositions prior to hardening which comprises two layers of fabric material, each of the layers including ground warp threads and warp threads woven to between the said layers, and the interconnecting warp threads being longer than the ground warp threads whereby the layers can be pulled or drawn apart to an extent limited by the excess length of the interconnecting warp threads over that of the ground warp threads to provide a space between the layers. This excess length of the interconnecting warp threads is held in an orderly, non-entangling fashion by being loosely woven among the several weft threads in the layers so that this excess length becomes distributed in the form of small loops held in place by the adjacent weft threads. Thereafter, when the layers are pulled apart, as by the injection of a hardenable composition, the loops tighten above the respective weft threads and the excess interconnecting warp thread length is taken up by these interconnecting warp threads in the regions thereof which extend between the fabric layers.

According to a further feature of the present invention, we contribute a method of producing a multi-layer woven fabric for use in retaining hardenable compositions which comprises weaving a two-layer fabric with ground warp threads and in addition warp threads which are delivered at a higher speed than the ground warp threads and which are woven alternately into the two layers of the fabric material.

According to a yet further feature of the present invention, there is provided a loom delivery device for use in the delivery of interconnecting warp threads in the weaving of a two-layer woven fabric according to the invention as hereinbefore defined, which device comprises a bobbin carrier for supporting warp thread bobbins, a bar which in use serves to guide and adjust the position of warp threads delivered for weaving and drive rolls arranged for synchronous operation with the warp beam drive of the loom whereby in use warp threads from the bobbins can be delivered to the loom at a speed which is at a controlled ratio to the speed of delivery of ground warp threads.

In the two-layer fabrics according to the invention, the excess length of the interconnecting warp threads is present as loops in the fabric prior to pulling or drawing apart of the fabric layers. When pulled or drawn apart, for example by using a stretching device or by delivering a hardenable composition between the two layers, the layers can be separated by an extent which is limited by the amount of the excess length of the interconnecting warp threads over that of the ground warp threads.

The two-layer fabrics according to the invention can readily be produced with a relatively large number of changeovers of interconnecting warp threads. Such fabrics having particularly good resistance to the action of internal pressures can thus be obtained.

If the two layers of the fabric leaving the loom after production in accordance with the invention are separated from one another, e.g., by pouring liquid concrete into the fabric whilst sealed around its periphery, then the interconnecting threads joining the two layers are subjected to considerable tensile stress as soon as their total excess length has been drawn from the fabric. At the places where the interconnecting warp threads leave one fabric layer in order to transfer through the space between fabric layers to the other fabric layer and where they pass across a final weft thread, this leads to a particularly high localized stressing of this weft thread. If this weft thread breaks then the subsequently stressed weft threads break, so that the fabric tears. To enable the fabric to withstand a high internal pressure and also to allow other weft threads of a material of lower strength to be used, we provide both fabric layers with reinforcing weft threads at the places where the interconnecting warp threads change from the one fabric layer to the other. In a preferred embodiment, we cause the interconnecting warp threads to pass over two reinforcing weft threads either before or after points of changeover from one layer to the other. In a particularly preferred embodiment according to the invention, the interconnecting warp threads pass over double reinforcing weft threads both before and after points of changeover from one layer to the other.

Where the fabric layers can be drawn apart by a relatively large distance, i.e., with a relatively long excess length of the interconnecting warp threads, we have found that it is not particularly advantageous to draw out this excess length from the fabric layers by pouring in liquid concrete or other hardenable composition; but instead, that it is preferable to pull apart the fabric layers with a stretching device. In this way, we reduce the

mechanical stressing of the interconnecting warp threads, which on pulling apart is increased by the pressure exerted by the concrete or other hardenable composition.

There has thus been outlined rather broadly the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several purposes of the invention. It is important, therefore, that the claims be regarded as including such equivalent construction as do not depart from the spirit and scope of the invention.

A specific embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings, forming a part of the specification, wherein:

FIG. **1** is a schematic sectional representation of a two-layer woven fabric in accordance with the present invention prior to drawing out the excess length of the interconnecting warp threads, the sectional plane being in the warp direction;

FIG. **2** is a sectional representation of the fabric of FIG. **1**, but with the fabric layers drawn apart to the limited extent permitted by the excess length of the interconnecting warp threads over that of the ground warp threads;

FIG. **3** is a plan view of a cutaway portion of the fabric of FIGS. **1** and **2** with a schematic representation of the path of the interconnecting warp threads;

FIGS. **4***a* and **4***b* are cross-sections of two-layer woven fabrics in accordance with the present invention with the points of changeover of the interconnecting warp threads spaced apart by different distances; and

FIG. **5** is a schematic perspective representation of a delivering device according to the present invention for delivering warp threads to a loom used in the production of two-layer woven fabrics in accordance with the present invention.

As shown in FIGS. **1** and **3**, the interconnecting warp threads **1** (of which only one is visible in FIG. **1**) are woven alternately into the upper fabric layer **2** and the lower fabric layer **3**. In FIG. **3**, the path of the interconnecting warp thread is shown schematically by a continuous line **4** or a dotted line **5**, depending on whether the interconnecting warp thread is in the upper or lower fabric layer. It is apparent from this figure that in the embodiment shown, the interconnecting warp threads running parallel in a varying alternating sequence change from the lower fabric layer to the upper fabric layer. At the points **6** where this changeover takes place, the upper fabric layer and the lower fabric layer are joined by the interconnecting warp threads. As the interconnecting warp threads are introduced into the loom at a higher speed than the ground warp threads of the fabric, these interconnecting warp threads "pile up" in the form of numerous small loops between the weft threads, as shown in FIG. **1**, so that in the finished fabric leaving the loom they stand out as caterpiller-shaped threads spaced apart in the fabric. Thus, the excess length of the interconnecting warp thread is held in an orderly, non-entangling fashion by being distributed in the form of small loops, each loop being held in place between adjacent weft threads in each layer. If the two-layer fabric is now sealed, e.g., by stitching its edges, a closed fabric bag results so that by pouring in, for example liquid concrete, the layers **2** and **3** of the fabric can be separated from one another with the excess length of the interconnecting warp threads drawn out from the fabric layers. The loops **7** in the fabric layers thus disappear as the fabric layers are pulled apart and the portion of the excess of the interconnecting warp thread length, which was taken up by the small loops, now becomes taken up by the portion of the interconnecting warp thread extending between the layers; and the remaining of the portion of the interconnecting threads becomes tightly woven about the weft threads in each layer. The interwoven excess length of the interconnecting warp threads then corresponds to the length, as shown in FIG. **2**, of the thread sections **8** joining both fabric layers or the distance between the fabric layers **2** and **3** at the joining points **6**. The stretching of the interconnecting warp threads or the drawing out of their excess length from the fabric layers can also take place in a stretching device, wherein the fabric layers are drawn apart in opposite directions.

Where liquid concrete is fed between the fabric layers, the two-layer fabric assumes the cross-sectional form shown in FIG. **4***a* or **4***b*. Depending on the number of interconnecting warp threads, the fabric form may for example be as shown in FIG. **4***a* or FIG. **4***b* with greater or smaller constrictions at the joining points **6**. A comparison of these figures shows that with a larger number of joining points the distance between the two fabric layers and therefore the thickness of the resulting concrete wall or other hardened mass formed varies less as between the points of greatest arching and the points of constriction. In the embodiment of FIG. **4***b*, there are numerous smaller arches which result in a larger average wall thickness with less deep indentations.

In the embodiment shown in FIGS. **1** and **2**, at the points where the interconnecting warp threads change from the upper to the lower fabric or vice versa, the upper and lower fabrics are each provided with two splicing weft threads **10** which are crossed by the interconnecting warp threads. As FIG. **2** shows, there is a pronounced deflection of the warp threads at these points, so that with strong tension on the thread portions **8** the reinforcing weft threads **10** acting as weft threads in the warp direction are pushed against one another and can therefore together take up the tension concentrating at this point. These weft threads are produced from a particularly strong material. Stronger compression of the reinforcing weft threads as well as the following weft threads because of the tension on the interconnecting warp portions **8** does not take place with the fabric filled, as shown in FIGS. **4***a* and **4***b*, because the weft threads are under tensile stress due to the internal pressure in the composition. The desired number of interconnecting warp threads as well as the desired number of changes from upper to lower fabric and therefore the number of thread portions **8** joining the two fabric layers can be calculated from the internal pressure occurring on filling the space between the fabric layers and the known tensile strength of the in-

terconnecting warp threads. If the fabric is for use on sloping bases, e.g., for strengthening river banks, the resulting internal pressure is obtained from the static pressure level of the hardenable composiiton incorporated between the two layers. When determining the tensile strength of the interconnecting warp threads to be used, account must be taken of the fact that these threads in hardenable compositions such as concrete have substantially reduced tensile strength which, however, can readily be determined by an appropriate test.

FIG. **5** shows an embodiment of a device according to the present invention for delivering the interconnecting warp threads to the entry portion of the loom. It comprises a bobbin carrier **11** on which are placed as many bobbins **12** as there are interconnecting warp threads to be woven into the two-layer fabric. The contact plate of the bobbin carrier is provided with a felt pad **13,** so that the bobbins loosely creeled on pins **14** do not slip on the contact plate. Above the bobbin carrier **11** is arranged a guide bar **15** provided with openings **16** through which are passed the alternating warp threads for subsequent introduction between a pair of rollers **17, 18.** The interconnecting warp threads are held in the gap between these rollers so that their feed rate is determined by the rotational speed of the rollers. To bring about a good contact between the threads and the rollers, one of the rollers is provided with a rubber coating, whilst the other roller has a smooth steel surface. The pair of rollers is driven by the warp beam drive via a chain indicated by the line **19.** As the delivery rate of the pair of rollers **17, 18** must be higher than the delivery rate from the warp beam for the ground warp threads, a suitable gear ratio must be provided. By changing the driving sprockets, a varying excess length of the interconnecting warp threads can be woven into the two-layer fabric, according to the invention. Thus, the delivery rate of the interconnecting warp threads is synchronized with the loom speed, so that the interconnecting warp threads are woven in with a uniform excess length. The change of the interconnecting warp thread from the upper fabric to the lower fabric and vice versa takes place in the conventional manner by controlling the web shafts.

Having thus described our invention with particular reference to the preferred form thereof, it will be obvious to those skilled in the art to which the invention pertains, after understanding our invention, that various changes and modifications may be made therein without departing from the spirit and scope of our invention, as defined by the claimes appended thereto.

What is claimed is:

1. A two layer woven fabric for use in retaining hardenable compositions prior to hardening, said fabric comprising two layers of fabric material in adjacent superimposed relationship, each of said layers including weft threads and ground warp threads woven together, said fabric further including a plurality of interconnecting warp threads, each of said interconnecting warp threads extending back and forth between several successive adjacent weft threads of one layer in loose woven arrangement therewith, for a distance along said fabric and then extending directly to and interweaving with the other layer, the loose woven arrangement of the interconnecting warp threads in said one layer being held between adjacent ones of said several weft threads in the form of several small loops comprised of a predetermined excess length of said warp threads, said two layers being held close to each other by the interconnecting warp threads with the excess length of said interconnecting warp threads being distributed along said fabric in non-entangling configuration, whereby, upon receipt of a hardenable composition between said layers, said interconnecting warp threads are pulled tightly about the several weft threads to permit said predetermined excess length of said interconnecting warp threads to extend between the layers to determine their extent of separation.

2. A fabric as claimed in claim **1** wherein said interconnecting warp threads are loosely woven among the several weft threads of both said layers.

3. A fabric as claimed in claim **1,** wherein the interconnecting warp threads pass over reinforcing weft threads in the said layers at points of changeover from one layer to the other.

4. A fabric as claimed in claim **1,** wherein the interconnecting warp threads pass over double reinforcing weft threads in the said layers at points of changeover from one layer to the other.

5. A fabric as claimed in claim **1,** wherein the two layers are held together around at least part of the fabric periphery.

6. A fabric as claimed in claim **5,** wherein the two layers are sewn together around at least part of the fabric periphery.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,811,480 Dated May 21, 1974

Inventor(s) FELIX VILLIGER and ALBERT GERBER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Title page, insert the following

--[30] Foreign Application Priority Data

September 26, 1969
Switzerland 14573/69--;

Column 1, line 46, after the word "to" insert --extend--.

Signed and sealed this 5th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.