June 25, 1963 B. ROMANIN 3,095,338

WEB-LIKE CONTINUOUS TEXTILE STRUCTURE

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FIG. 1A

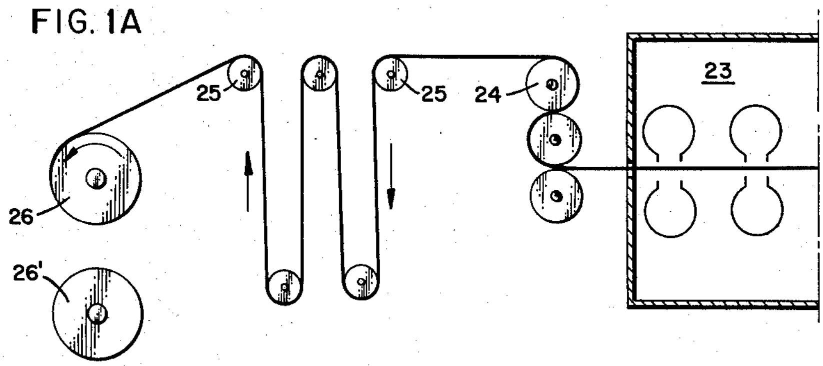

FIG. 1B

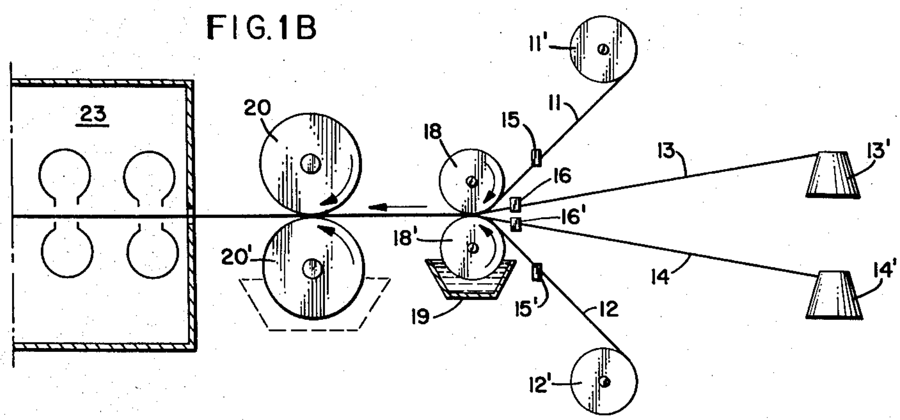

FIG. 2

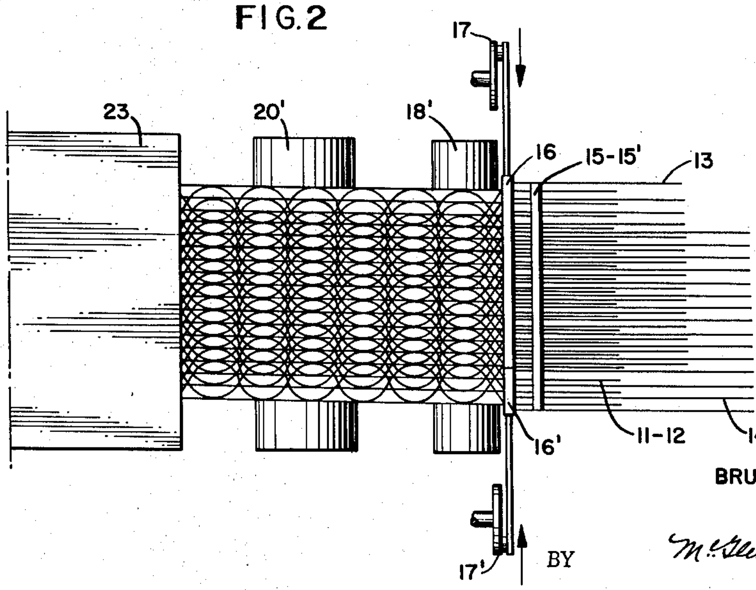

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FIG. 3

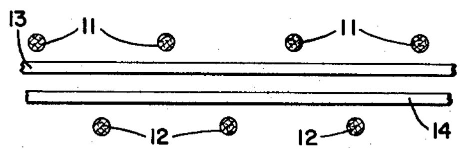


FIG. 4

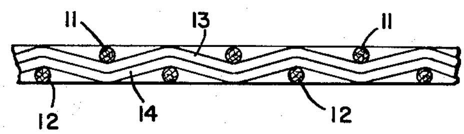


FIG. 5

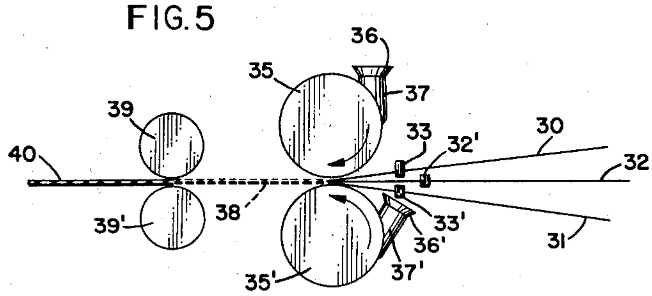
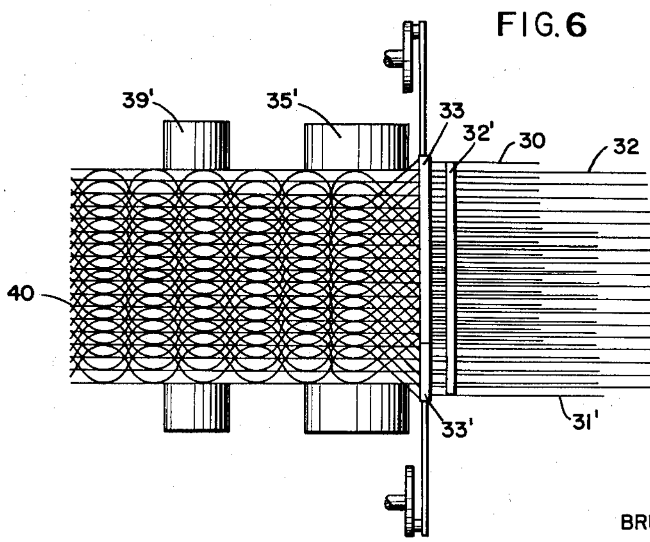


FIG. 6



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WEB-LIKE CONTINUOUS TEXTILE STRUCTURE

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1 Claim. (Cl. 154—46)

The object of the present invention is a new textile structure and a process for manufacturing the same.

It is known that all textile fabrics comprise two sets of textile yarns, that is, the warp and the weft, which are woven together in a known manner by the usual looms.

Some uses, particularly industrial ones, require fabrics that can be mass-produced at a high speed and at a low cost.

The ordinary looms do not match these requirements, because, with rare exceptions, the traditional weaving of fabrics demands certain preparatory operations on the yarns, such as for instance, preparation of the warp and spooling of the weft. Besides, looms always produce at a low speed because of the complicated motions required by ordinary weaving.

Attempts have been made to substitute for the ordinary woven fabrics for certain purposes, the so called non-woven fabrics consisting of short fibres which are arranged in a layer and are bonded by bonding substances to form a sheet but the products thus obtained have a limited range of applications, and are defective as to flexibility and strength, inasmuch as their mechanical characteristics, owing to the fact that the textile material incorporated therein is discontinuous, depend essentially on the bonding material.

It is an object of the present invention to provide a new textile material consisting of continuous filaments or yarns which are not woven, but are arranged in a plurality of planes, in part with a rectilinear and in part with an undulated lay-out, said filaments or yarns suitably crossing and being adhesively connected to one another, so as to develop a tensional resistance, both in the longitudinal and the transversal directions. Said textile material may constitute a finished or an intermediate product, and may be used alone, or impregnated or associated with different fluid or sheet materials, and may be subjected to thermal and mechanical treatments, but all the operations pertaining to the utilization of the said material are not a part of the invention and may be accomplished by methods and means known in the art.

The process which is an object of this invention is characterized in that the filaments or yarns are arranged in the desired straight and undulating paths in mutual crossing relation and are set in their respective configurations and mutual positioned relationship.

More particularly, it is characterized in that a plurality of sets of yarns are continuously advanced in one direction, that concurrently there is imparted to a part of said sets of yarns an alternating rectilinear motion in a direction substantially perpendicular to said advancing direction and in one or more planes fixed in space, that a pressure is applied to all sets of yarns along a line fixed in space, substantially perpendicular to the aforementioned advancing direction, and displaced forwards in the aforementioned advancing direction with respect to the aforesaid fixed plane or planes, and that concurrently with the application of pressure or successively, the sets of yarns to which the aforementioned motions have been imparted, are set in their resulting undulated paths and positioned relationship with one another and with the other yarns. Said paths are substantially sinusoidal. Their shape and amplitude depend on the amplitude and speed of the alternative motion and of the advancing motion. Pressure, heat, or adhesives, separately or jointly, may be used to set the yarns in their paths.

Preferably, the yarns are advanced by the same means which apply pressure to the yarns. To that end, the yarns are gripped between two surfaces tangent to one another, for example cylindrical or partly cylindrical and partly plane surfaces, which surfaces at the point at which they are tangent, move in the direction and with the speed required to advance the yarns.

Yarns of any nature are suitable for carrying out the invention, for instance: cotton, waste silk, flax, jute, wool and other natural short fibres; artificial and synthetic short fibres, such as spun viscose, spun acetate, polyamide, polyester, acryl, polyvinyl alcohol, polyvinyl chloride and vinyl copolymer fibres, and olefinic fibres, such as polyethylene and polypropylene; natural continuous filaments and filament yarns, such as silk, artificial continuous filaments and filament yarns, such as viscose rayon and cellulose acetate, and synthetic continuous filaments and filament yarns of the same classes as the synthetic fibres above listed; and inorganic yarns, such as glass yarns.

Whenever adhesive are required, any known adhesive may be employed, such as for instance rubber latex adhesive; epoxide polyester resins and vinyl resins; natural gums and glues both vegetable and animal, and so on.

The invention will be better understood from the description of the following embodiments, with reference to the appended drawings, wherein:

FIGURES 1_A and 1_B, which integrate each other, diagrammatically illustrate in vertical view, the operation of an embodiment of the invention;

FIG. 2 is a plan view of FIG. 1_B;

FIGURES 3 and 4 illustrate the formation of the textile structure, and

FIGURES 5 and 6 illustrate, in a manner analogous to FIGURES 1_A, 1_B, and 2, another embodiment.

According to the first embodiment, illustrated in FIGURES 1_A, 1_B and 2, the yarns are divided into four sets, and precisely, two sets **11** and **12**, which unwind from cones or loom beams **11'** and **12'** (loom beams being shown in the drawing) and two sets **13** and **14** unwinding from cones **13'** and **14'**. Yarns **11** and **12** pass through two stationary combs **15** and **15'**, and yarns **13** and **14** pass through movable combs **16** and **16'**. Said combs **16** and **16'** have an alternating motion in the direction indicated by the arrows in FIG. 2, which is imparted thereto by actuating means schematically indicated as wheels and connecting rods **17** and **17'**, but which may be of any structure, and said combs respectively engage groups of yarns **13** and **14** to which they impart an alternating motion.

Yarn groups **11** and **12** which pass through combs **15** and **15'** have a straight rectilinear motion. For this reason the yarns **11** and **12** will be called "warp" yarns and the movable yarns **13** and **14** will be called "weft" yarns. Since the upper yarns **11** (with reference to FIGURES 1_A and 1_B) of the warp are displaced with respect to the lower yarns **12**, and the weft yarns **13** and **14** pass between the two groups, when all the yarns are gripped by the rolling mills **18** and **18'**, they are crushed so that the weft yarns become engaged as illustrated in FIGURES 3 and 4. The cylinders **18** and **18'** of the rolling mills rotate in the direction marked by the arrows and advance the yarns at the desired speed. The actuating means of cylinders **18**, **18'** may be of any nature and are not shown. The cylinders, besides pressing and drawing the yarns, also serve to apply an adhesive material by any suitable device, for instance by means of a trough **19** arranged below cylinder **18'**, which latter dips into the adhesive. The adhesive may be applied by means of cylinders **20** and **20'**, in all those cases in which this is preferred to avoid incrustation of the cylinders 18, 18', especially when the combs are placed very close to the cylinders, as it is normally preferable.

Because of the combination of the advancing motion due to cylinders 18, 18' and the alternating motion due to the combs 16, 16', the two yarn sets 13 and 14 become laid out on undulating paths, approximately shaped as sinusoids, the amplitude and shape of which depends on the amplitude of the stroke of the combs, the frequency of the alternating motion of the combs and the peripheral-speed of the cylinders 18, 18'. To cause the undulating paths of the yarns of the two sets to cross one another, the alternating motions of the combs are so controlled that their speeds are at any moment equal and opposite. As seen in FIGURES 1_A and 1_B, the two combs are arranged one above the other, or more exactly are displaced one with respect to the other in a direction which is perpendicular both to the advancing direction of the yarns and to the direction of their alternating motion.

Thereafter, the resulting structure is dried in an oven **23**, which is preferably rectilinear and may be a hot air, radiation, or dielectric loss oven, or an oven of different construction.

After drying, and while the fabric is still hot, it is preferably energically rolled, whereby the different sets of yarns are forced practically onto a single plane, with a resulting considerable improvement in the strength of the bonding and in the appearance of the fabric. Rolling mill **24** is not described as it is a normal textile rolling mill, provided with one or more paper-coated cylinders, alternating with steel cylinders.

The temperatures of the cylinders of the rolling mill are between 100° C. and 110° C. if a rubber latex adhesive is used, and between 120° C. and 140° C. if a synthetic resin adhesive is used. After passing through the rolling mill, the textile material is wound on beams **26**, **26'** after passing through a reserve **25** which assures that there is the time to pass from one to the other beam in winding up the material.

After the treatment hereinbefore described, the yarns are mutually set in their straight or undulating crossing paths and there is obtained a textile structure or non-woven fabric, which is the object of the invention, and is well visible in FIG. 2. Theoretically, the four yarn sets lie on four different planes, but in practice, because of the pressure to which they have been subjected, they tend to bend the one around the other, departing from these respective planes, and creating almost a weave between the various yarns which greatly increases the resistance of the textile structure.

To give a numerically precise example, one may employ two warps **11** and **12** consisting each of five of spun viscose yarns 20/1 per cm. of width, and two wefts **13** and **14** consisting each of five spun viscose yarns 12/1 per cm. of width. The advancing speed is 20 metres per minute. The frequency of the alternating motion of the combs is 460 periods per minute and the amplitude of this alternating motion is 4 centimetres. The total number of yarns is not specified because it is proportioned to the width of the finished article. In the example above described, cylinders **18**, **18'** and **20**, **20'** are not heated.

The counts hereinbefore specified yield a structure having a good strength in both directions. However, if resistance in one direction, for instance, that of the warp, is most desired, the count of the yarns in the other direction will be suitably decreased, and/or their spacing will be increased. As adhesive, a vinyl acetate resin in emulsion, plastified in a greater or lesser measure with butyl phthalate, according to the desired rigidity, is used. To obtain a stiff hand, a purer or lightly plastified resin (for instance with 10–15% of plastifier on the dry resin) is used, whereas a soft hand is obtained by using up to 50% of plastifier on the dry resin.

When the adhesion between the yarns is obtained by means of a liquid adhesive applied on cylinders **20**, **20'**, or by any other means, there is no substantial difference in the treatment when the type of adhesive is varied. The criteria which are set forth herein are applicable to any embodiment of the invention. In any case the intensity of the squeezing action to which the article is submitted in the rolling mills must be regulated, and if the resins are absorbed with difficulty by the yarns, wetting agents should be introduced in the adhesive bath, or the trough or the reservoirs containing the adhesive should be heated. Rubber latex (normally a pre-vulcanized latex) may also be used as adhesive; in that case, it would be useful to add casein to stabilize the bath and possible also fillers (for example, calcium carbonate). When rubber latex is used, it is preferable that the drying temperature should not exceed 100° C. It is always possible to add to all the resins, as well as to the latex, colouring matter to obtain any desired colour of the fabric.

The dilution of the adhesive baths should be regulated in such a way as to provide a sufficient amount of dry adhesive on the yarn to give a perfect bonding, while at the same time permitting the processing operation to be carried out without incrusting the cylinders. When vinyl acetate resins are used, the amount of dry resin should not exceed 30–35% of the weight of the yarn, and with rubber latices it should not exceed 45–50%.

The two adhesive types mentioned hereinbefore are the most characteristic. The first imparts to the fabric a stiff, semi-stiff or soft hand (depending on the amount of plastifier used) with a slow elastic recovery. The second, on the contrary, provides an elastic finishing with a resilient hand. More or less resilient hand may be obtained by suitable mixtures of vinyl acetate resins and rubber latex; in any case the pH of the vinyl acetate resins should be alkaline.

Vinyl acetate resins may be mixed with many other additives, stabilizers, fillers, waterproofing and crease-proofing agents (of the urea-formaldehyde or melamine-formaldehyde type, and so on). There are practically no limitations in the use of the various resins or adhesives in general, and the equipment does not vary except in the cases in which the resin must be polymerized, or a natural or synthetic polymer must be gelatinized or vulcanized. In those cases, after drying the liquid adhesive, a polymerization, gelatinization or vulcanization chamber will be provided, and the chamber will have such a length and will be kept at such a temperature as a person skilled in the art may know to be required for the particular material used.

In more expensive articles, acrylic resins, which are employed similarly to the vinyl acetate resins, have been found to be particularly useful to obtain a brilliant finish, resistance to washing, stability and elasticity.

To carry out the aforementioned embodiment of the invention, practically any one of the yarns indicated in the general part of this description may be employed. Short fibre yarns, and particularly cotton and spun acetate, are particularly similar to spun viscose yarns, and therefore may be processed without any variation of the example described. Other natural and synthetic short fibre yarns may be processed in a like manner. However, viscose rayon and other artificial and synthetic continuous filament yarns may also be used.

The following criteria, which are valid in general, are employed to determine the advancing speed of the yarns, which is equal to the speed at which the non-woven fabric is manufactured and also to the translational speed of the warp.

The speed of manufacture of the article depends, from the mechanical viewpoint, on the number of bends which it is desired to create and from the resistance of the yarn in view of the frequency of the alternating motion of the comb or combs. Experience has shown that the frequencies tolerated by the yarn in the alternating motion of the comb, are generally in the order of 600/800 strokes per minute. Higher frequencies are possible with high strength yarns. Of course, with a given yarn, the greater the amplitude of the stroke of the combs, and therefore the amplitude of the sinusoids, the smaller is the tolerable frequency. Let us suppose that it is desired to create 30 bends per linear metre at 700 strokes per minute; in that case the advancing speed of the yarn will be 700:30= 23.30 metres per minute. When such high speeds are adopted, it will be suitable not to exaggerate in the eccentricity of the connecting rods which actuate the combs, which can be chosen in this case as 4 cms.

Always operating according to the diagrams of FIGURES 1 and 2 it is possible to process, in a second embodiment, yarns having a softening point sufficiently low that they may be caused to adhere by softening or incipient fusion through the application of pressure and heat. Such yarns are those made of polyvinyl chloride or other vinyl polymers, such as Saran (vinyl chloride-vinylidene chloride copolymer), vinyl acetate yarns and polyolephinic yarns, such as polyethylene and polypropylene. In this case an adhesive may be used or omitted.

If the adhesive is omitted, the cylinders **20** and **20'** will be heated at a temperature sufficient to soften the yarns and provoke their adhesion. On the contrary, if an adhesive is employed, this may be distributed on cylinders **20, 20'** which, in that case, may also be heated, or may be non-heated, and the final bonding of the yarns is effected by the rolling mill **24**, which causes the yarns to soften and adhere the ones to the others, and further causes the adhesive to harden and/or polymerize, if an adhesive has been used.

To give a numerically precise example, one may employ two warps of five yarns per cm. of width of spun polyvinyl chloride spun fibre having a count of 40/1, and two wefts of five yarns per cm. of width of the same polyvinyl spun fibre having a count of 30/1. The advancing speed is 25 metres per minute.

The frequency of the alternating motion of the combs is 600 periods per minute and its amplitude is 3 cms. It is possible to operate without an adhesive, imparting to cylinders **20, 20'** a temperature of 120° C. to obtain an incipient softening of the yarns, and complete the bonding on the rolling mill **24**, the cylinders of which are heated to 130° C.

FIGURES 5 and 6 illustrate a further embodiment of the invention in which two wefts and a single warp are employed.

The wefts are indicated at **30** and **31** (the cones or beams from which they unroll are omitted) and the warp at **32**. Combs **33, 33'** impart to the wefts their alternating motion whereas the comb **32'** guides said warp **32**. The adhesive is applied directly on heated cylinders **35, 35'** by means of reservoirs **36, 36'** and spreaders **37, 37'**. The temporarily set textile structure **38** passes between the rolling mill cylinders **39, 39'**, which are also heated, and which transform it into the final structure **40**.

To give a numerically precise example, one may employ for each weft a nylon yarn having a count of 2/70,000 and in the number of 6 yarns per cm. of width, and for the warp a like yarn having a count of 2/70,000 in the number of 6 yarns per cm. of width. The advancing speed is 18–20 metres per minute. The frequency of

the alternating motion of the combs is 600 blows per minute, and its amplitude is 40 mm. If a rubber latex adhesive is used, the temperature of cylinders **35, 35'** is that of the ambient and that of cylinders **39, 39'** is 110–125° C.; if a synthetic resin adhesive is used, the said temperature becomes of 125–140° C.

The diagram of FIGURES 5 and 6 may also be carried into practice by using any of yarns mentioned in the general part of this description.

Many variations may be carried out in the described operations. In place of two or one group of warp yarns and two groups of weft yarns, a single group of weft yarns, or more than two groups of weft yarns may be used. More than two groups of warp yarns may also be used. The application of the adhesive may be carried out directly on the yarns, or these may be previously impregnated with suitable adhesives. Any sheet materials may be coupled with the textile structure by causing it to pass between the rolling mill cylinders **20, 20'** or in rolling mill **24**, according to the characteristics of the sheet. The operations relating to the utilization of the textile structure produced, such as for instance impregnation, may be carried out continuously without first winding up the non-woven fabric. The thermal treatments and the application of pressure may be repeated or may take place in two or more phases. Other variations which may be effected by a person skilled in the art, are within the scope of the invention which has as its object a new and useful textile structure and a process for its manufacture.

What I claim is:

A web-like continuous textile structure comprising two sets of closely spaced organic warp yarns running longitudinally throughout the structure, a third set of similarly closely spaced organic weft yarns interposed between the two sets of the closely spaced warp yarns, each yarn of the interposed weft set of yarns running in a sinusoidal manner longitudinally throughout the textile structure, each sinusoid lying laterally over a plurality of the longitudinally running warp yarns of the first two sets, the amplitude of the sinusoids being greater than the spacing between adjacent warp yarns and smaller than the width of the textile structure, a fourth set of similarly closely spaced organic weft yarns interposed between the third set of sinusoidal weft yarns and one of the two sets of the longitudinally running warp yarns, said fourth set of weft yarns running sinusoidal in alternate phase opposition to the sinusoids of said third set of sinusoidal weft yarns and across the sinusoids thereof, said warp yarns crushed upon the weft yarns and the weft yarns being bent to accommodate the warp yarns, and all of said yarns being bonded at their intersections with one another.

References Cited in the file of this patent

UNITED STATES PATENTS

2,500,690	Lannan	Mar. 14, 1950
2,543,101	Francis	Feb. 27, 1951
2,562,641	Saunders	July 31, 1951
2,704,734	Draper et al.	Mar. 22, 1955
2,738,298	David et al.	Mar. 13, 1956