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METHOD AND APPARATUS FOR MAKING DIMENSIONALLY STABLE NONWOVEN FABRIC

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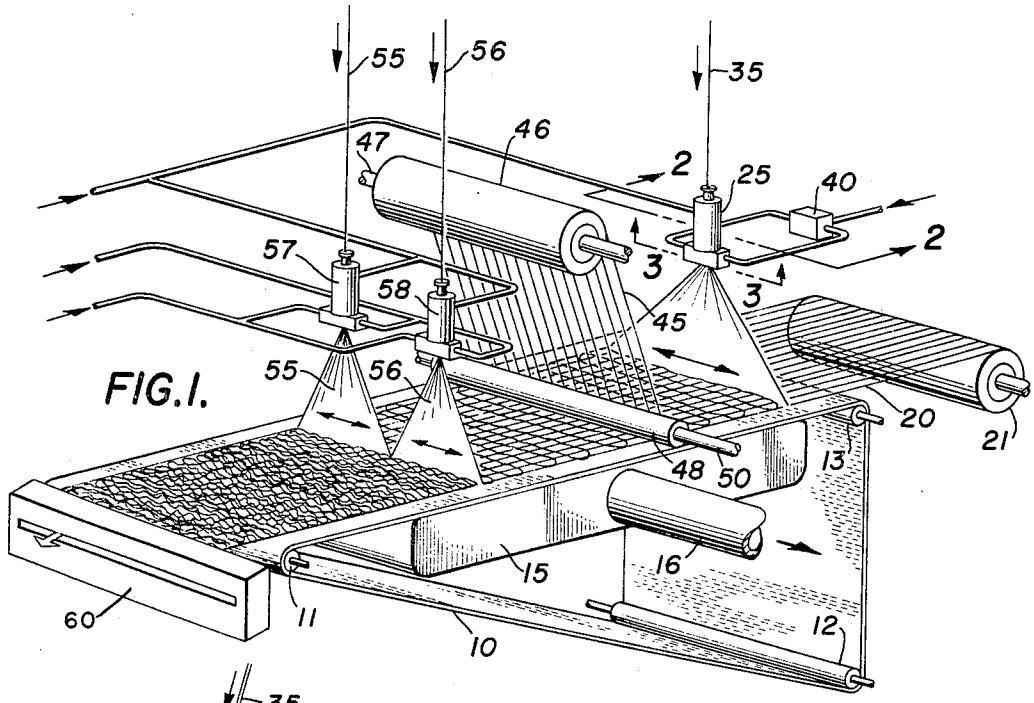

FIG. 1.

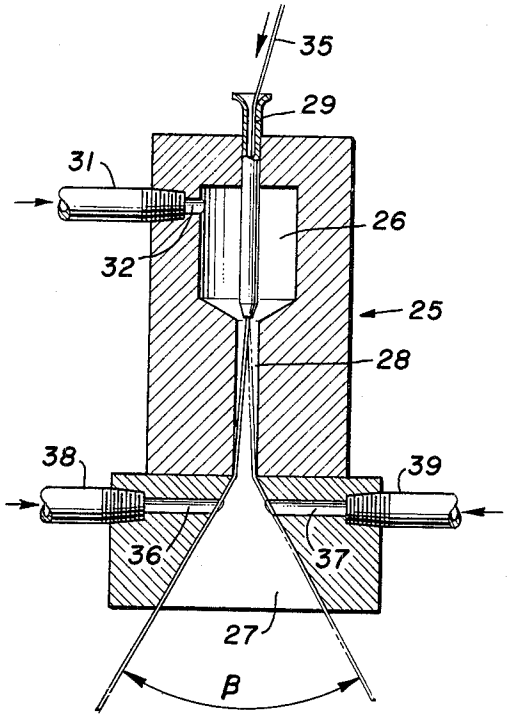

FIG. 2.

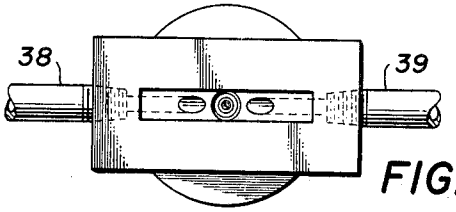

FIG. 3.

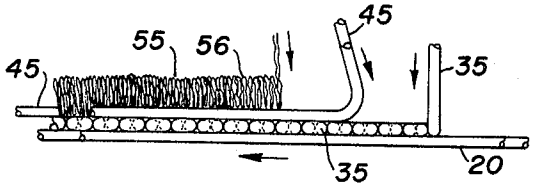

FIG. 4.

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METHOD AND APPARATUS FOR MAKING DIMENSIONALLY STABLE NONWOVEN FABRIC

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ABSTRACT OF THE DISCLOSURE

A nonwoven fabric which is comprised of a nonwoven scrim having parallel longitudinal warp yarns, transversely continuous filament weft yarn and randomly laid filler yarns which are mechanically interlocked into the scrim is manufactured by pneumatically depositing a continuous weft yarn onto a foraminous conveyor belt, laying a plurality of parallel warp yarn thereon and randomly distributing a batt of filler yarns on top of the warp and weft yarns so that upon needle punching, a mechanically bonded fabric is produced which has good strength, drapeability and hand.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to nonwoven fabrics and, more particularly, to a fabric which is comprised of superposed planes formed of parallel yarns with the yarns in each plane being substantially parallel to each other and transverse to the yarns of the other plane and of randomly disposed filler yarns having been needle punched into the yarns comprising the superposed planes.

Description of the prior art

Needle punched fabrics which are reinforced with a woven scrim are relatively expensive due to the cost of weaving the scrim. However, a mechanically bound fabric offers advantages in hand and drapeability when compared to nonwoven chemically bonded fabrics. Nonwoven chemically bonded fabrics have good dimensional stability but are boardy to the touch, lacking in bulk and generally have poor crease resistance and, resultingly, may be used in only limited applications.

While the prior art does show a nonwoven scrim which includes fibers being parallel in the machine direction and a bank of fibers laid thereon which are parallel in the transverse direction, the prior art is silent as to how the fibers residing in the transverse plane may be deposited thereon except in banks of fibers such as shown in U.S. patent application 2,341,620 or by means of a slow moving traversing mechanism such as shown in U.S. patent application 2,704,734. To date, the art does not teach the formation of a nonwoven scrim which is comprised of two planes of yarn, the yarns in each plane being parallel to each other with the direction of the yarns of one plane being transverse to the direction of the yarns of the other plane, the yarn forming the transverse plane being continuous, forming cycles and having straight lengths being parallel and adjacent each other.

SUMMARY OF THE INVENTION

The apparatus of this invention includes an endless foraminous surface which may be mounted on a series of rollers which define a track for such endless motion, a suction box which is positioned beneath a length of the path defined by the foraminous surface, means such as the carrier yarns or elastomeric belts which are fed onto the foraminous surface and which provide a takeup means for the to be deposited yarns, a weft gun for depositing a continuous weft yarn in a direction being transverse to

the direction of movement of the foraminous surface, a warp beam or creeled bobbins for depositing longitudinal warp yarns on top of the weft yarn, means for depositing a web of randomly laid filler yarn or fibers on the previously deposited reinforcing yarns, which may be one or more aspirator jets as shown or a means for laying down thereon a card web or other means as is well known to those skilled in the art, and a needle punching machine for incorporating the filler yarn into the warp and weft yarns and for mechanically bonding the warp and weft yarns together.

While the carrier yarns may be incorporated into the body of the fabric, it is contemplated that such yarns will be stripped from the fabric after the needle punching operation. If the warp yarn is to be laid onto the foraminous surface prior to the depositing of the weft yarn thereon, the carrier yarn is not needed. By means of the weft gun, the carrier yarns receive a layer of weft yarn, which is directed onto the carrier yarn in a manner so that the sections of the yarn residing between the sides of the foraminous surface are parallel to and substantially adjacent each other and are perpendicular to the direction of travel of the foraminous surface. The weft gun makes it possible to deposit the transverse yarns rapidly enough to make the process economical. The weft gun, as shown, is an aspirator having a diverging exit channel and oppositely disposed control porting in the diverging walls connected to a source of pressurized air. Due to the coanda effect of the aspirated jet stream, the jet and the entrained yarn will hug one side of the channel due to atmospheric pressure forcing the jet to a wall. The introduction of pressurized air into the corresponding control port overcomes the coanda effect causing the jet stream to be directed to the opposite diverging wall. The jet stream and the entrained yarn may be made to self-oscillate by interconnecting the oppositely disposed control ports, as by a tube of suitable length, whereby the self-induced oscillations of the jet occur at a frequency having a sound wave length equal to twice the length of the closed path between the control ports. Thus, the jet can be made to oscillate at the rate of several cycles per second, depositing two "picks" of yarn per cycle. By way of example, a 54 inch wide fabric with 30 "picks" per inch of reinforcing yarn could be produced at the rate of one yard per minute by oscillating the weft gun at 9 cycles per second and feeding the weft gun with yarn at a rate of 1620 yards per minute.

With the weft yarn having been deposited on the carrier yarn, the foraminous surface advances to a position where parallel warp yarns are laid thereon in the machine direction. It can be seen that after the warp yarn is laid on the weft yarn, a nonwoven scrim is formed which is comprised of a plane of parallel warp yarns aligned in the machine direction and a plane of weft yarns having yarn sections which are positioned parallel and transverse to the machine direction. The grid is then passed beneath a set of aspirators which randomly disperse filler yarns onto the top of the warp yarns. The carrier yarns then transport the matt of yarns to a needle punching machine where the filler yarns are needle punched into the warp and weft yarns to form a mechanically bonded fabric at a density of at least approximately 1000 punches per square inch. The carrier yarns are then removed by a simple stripping operation or may be left on the resulting fabric. The filler yarns of this invention includes a plurality of filaments which are flared as they exit the aspirator jets to increase covering power. It is contemplated that the filler yarns may be comprised of continuous, zero twist filaments, a plurality of filaments which are freshly spun from a spinnerette, and a roving which may be broken down into individual filaments by the tension developed on it by the aspirator jet. As has previously been

mentioned, a beam supporting a carded web may be used which lays the carded web comprised of filler filaments onto the nonwoven scrim.

Therefore, an object of this invention is to provide an apparatus for forming a nonwoven web having dimensional stability in the machine and transverse direction and having the characteristics of a nonwoven fabric.

Another object of this invention is to provide a process for forming an unbonded nonwoven fabric having the properties of soft fluffy hand, good strength and adequate drapeability.

A further object of this invention is to provide an apparatus for laying weft yarn in parallel and being transverse to the machine direction at a speed adequate to insure a constant source of weft material for a needle punching operation.

These and other objects of this invention will become apparent when the detailed description is read in conjunction with the drawings in which:

DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a pictorial view depicting the preferred embodiment of the unbonded non-woven fabric forming apparatus employed for carrying out the invention;

FIGURE 2 is a section view taken along lines **2—2** of FIGURE 1 showing the particular arrangement of elements comprising the combination aspirator and traverse mechanism;

FIGURE 3 is a bottom plan view of the combination aspirator and traverse mechanism taken along lines **3—3** of FIGURE 1; and

FIGURE 4 is an enlarged fragmentary view of the layers of yarn prior to needle punching showing the carrier yarn, the weft yarn, the warp yarn and the filling yarn.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, foraminous conveyor belt **10** is supported for endless movement by rollers **11**, **12** and **13** which define a path endlessly followed by conveyor belt **10**. Rollers **11**, **12** and **13** are mounted in conventional bearings (not shown) and at least one of said rollers is positively driven by a motor means (not shown). The length of conveyor belt suspended between rollers **13** and **11** is maintained in a substantially horizontal position and is adapted to receive the various yarns deposited thereon by the apparatus of this invention. Suction box **15** is positioned directly beneath the portion of conveyor belt **10** spanning the distance between rollers **13** and **11**. Suction box **15** encompasses an area at least equal to the total yarn lay down areas. The vacuum created in the suction box **15** is by any common vacuum inducing apparatus (not shown) and is connected to suction box **15** by means of conduit **16**.

A plurality of carrier yarns **20** are drawn from a warp beam **21** or the like which is positioned rearwardly of roller **13** and across the horizontal surface of conveyor belt **10** in a manner to constitute the machine direction. Carrier yarns **20** are spaced from one-eighth to one-half inch apart and serve only to transport the deposited yarn from the area above suction box **15** to the needle punching machine (not shown). Carrier yarns **20** first receive a continuous length of weft yarn **35** from the combination aspirating and traversing mechanism **25**. Aspirating and traversing mechanism **25** is provided with an annular chamber **26**, a diverging chamber **27** and a passageway **28** which interconnects annular chamber **26** with diverging chamber **27**. The vertical length of the diverging wall of chamber **27** is preferably approximately from 4 to 6 times the diameter of passageway **28**. A hollow stem **29** extends vertically downwardly through the upper surface of mechanism **25** and into close proximity with the entrance of passageway **28** into chamber **26**. The bottom portion of annular chamber **26** is convergingly flared where it joins passageway **28** and the tip of hollow stem **29** is positioned in the converging area so that as air moves under pressure from annular chamber **26** into passageway **28**, a vacuum is created in hollow stem **29**.

The aspirating medium, which may be pressurized air or the like, is introduced from a supply source, (not shown) into annular chamber **26** by means of pipe **31** and passageway **32**. The high velocity of the air entering passageway **28** engages weft yarn **35** with sufficient energy to draw weft yarn **35** from its source and forward the same through passageway **28** into diverging chamber **27**, a diverging chamber **27** comprising the traversing zone.

Traversing of the weft yarn **35** is accomplished by sequentially controlling the low pressure fluid medium such as air that is supplied to diverging chamber **27** from a source (not shown) by means of ports **36** and **37** and supply pipes **38** and **39** which are respectively in communication with ports **36** and **37**. A programmed rotating valve **40** of a well known type may be advantageously utilized in series with pipe **38** and **39** to divert the controlling fluid in an alternating manner predescribed by the desired traversing frequency. Alternatively to utilizing the programmed rotary valve, a fluid oscillator of the type disclosed in U.S. Patent No. 3,016,066 may be interconnected between ports **36** and **37** to generate self-excited oscillations which directly control the reciprocatory action of the jet stream. However, this necessitates different length tubes for different traverse frequencies but coincident therewith obviates the need for a separate source of supply of the control fluid medium. The included angle β of diverging chamber **27** is approximately 60°; however, angle β may be increased or decreased depending upon the traversing width desired and the distance which aspirating and traversing mechanism **25** is placed from the surface of conveyor belt **10**.

Warp yarn **45** is drawn from warp beam **46** which is rotatably mounted on shaft **47**, shaft **47** being supported above conveyor belt **10** by any common means and perpendicular to the direction of travel of conveyor belt **10**. Warp yarn **45** is drawn from warp beam **46** by means of lay down roller **48** which is rotatably mounted in any common support means (not shown) by shaft **50**. Lay down roller **48** is in frictional contact with conveyor belt **10** so that a linear movement of conveyor belt **10** produces rotation in lay down roller **48**. Thus, as conveyor belt **10** moves in the machine direction, lay down roller **48** pulls warp yarn **45** downwardly from warp beam **46** and lays the yarn **45** in parallel on weft yarn **35**.

Filler yarns **55** and **56** are pulled from a source (not shown) by means of aspirator jets **57** and **58**, respectively. Aspirator jets **57** and **58** are constructed similar to aspirating and traversing mechanism **25** and function to flare the filaments comprising the filler yarns **55** and **56** and to randomly disperse the filaments onto the scrim formed by weft yarn **35** and warp yarn **45**. With the filler yarn having been laid on the warp and weft yarn, the web proceeds to a conventional needle punching machine **60** by means of carrier yarn **20**.

It is to be understood that the invention is not to be restricted to the preferred embodiment described in the foregoing and as illustrated in the accompanying drawings since various changes and modifications are possible without departing from the scope and spirit of the invention.

What is claimed is:

1. An apparatus for forming a nonwoven fabric comprising:

(a) a collection surface adapted to move through an endless path, said path including a substantially horizontal portion;

(b) means for pneumatically depositing a continuous weft yarn cyclically on said collection surface horizontal portion so that each cycle includes two substantially adjacent and parallel yarn sections arranged

transversely with respect to the movement of said collection surface;

(c) means for laying a plurality of parallelly arranged warp yarns on said weft yarn in the direction of movement of said collection surface and perpendicularly with respect to said parallel weft yarn sections;

(d) means for randomly laying filler filaments on said warp and weft yarn; and

(e) needle punching means for punching said filler filaments into said warp and weft yarn to lock said filler yarn therein.

2. The apparatus of claim 1 wherein said collection surface is foraminous and wherein a suction box is positioned adjacently beneath said collection surface horizontal portion, said suction box being located under said weft yarn depositing means, said warp yarn laying means and said filler filament laying means.

3. The apparatus of claim 1 wherein means is provided by supplying carrier yarns to said collection surface, said carrier yarn receiving said weft yarn and being adapted to be removed from said fabric subsequent to needle punching.

4. The apparatus of claim 1 wherein said weft yarn depositing means is comprised of an aspirating and traversing member defining a pressurized fluid receiving chamber, a fluid exiting chamber having diverging walls, said diverging walls including respectively oppositely disposed inlets, and a passageway connecting said fluid receiving chamber with said fluid exiting chamber, a tubular member extending into said aspirating and traversing member, substantially through said fluid receiving chamber and having an end positioned substantially at the entrance of said passageway, said tubular member receiving said weft yarn, means for introducing pressurized fluid into said fluid receiving chamber, said pressurized fluid engaging said weft yarn while in said passageway and pulling said weft yarn outwardly through said fluid exiting chamber and means for introducing low pressure control fluid sequentially into said diverging wall inlets to deflect said weft yarn.

5. The apparatus of claim 4 wherein said warp yarn laying means is comprised of a warp beam adapted to supply a plurality of warp yarns in parallel to said collection surface in the direction of the movement thereof and a roller means positioned in frictional contact with and transverse to the movement of said collection surface, said roller means by the movement of said collection surface drawing said warp yarns from said warp beam and laying said warp yarns in parallel on said weft yarn.

6. A method of making a non-woven fabric comprising the steps of:

(a) pneumatically depositing a continuous weft yarn cyclically onto a moving collection surface so that each cycle includes two substantially adjacent and parallel yarn sections arranged transversely with respect to the movement of said collection surface;

(b) laying a plurality of warp yarns in parallel on said weft yarn in the direction of movement of said collection surface and perpendicularly with respect to said parallel weft yarn sections;

(c) randomly dispersing filler filaments on said warp and weft yarns; and

(d) punching said filler yarn into said warp and weft yarn to mechanically bond the warp and weft yarns together.

7. The method of claim 6 wherein said method includes the step of supplying said collection surface with carrier yarns which receive said weft yarns, said carrier yarns being adapted to be removed from said fabric after said filler yarns have been punched into said warp and weft yarns.

8. The method of claim 7 wherein said collection surface is foraminous and wherein a vacuum is induced beneath said collection surface to aid the placement of said yarns and filaments on said collection surface.

9. The method of claim 8 wherein said weft yarn is cycled transversely to the direction of travel of said carrier yarns by a pair of oppositely disposed sources of low pressure air supplied at alternating intervals.

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U.S. Cl. X.R.

28—72.2