A device for manufacturing articles of a type disclosed in U.S. Pat. No. 3,499,807 in which manual manipulation of the pile-forming basic units has been eliminated to facilitate production on a continuous basis. The device utilizes a multiplicity of unenclosed basic pile units which are maintained in compressed condition by vacuum means prior to delivery in predetermined serial positions onto a horizontal surface, at which point the units execute controlled expansion to fill the available space on said surface, and be subsequently transferred to be adhered to an adhesively coated backing to form a completed article.

17 Claims, 13 Drawing Figures
DEVELOPMENT FOR MANUFACTURING ARTICLES HAVING A NON-WOVEN PILE

This invention relates generally to the field of manufacture of non-woven pile articles, and more particularly to an improved device and method for accomplishing this purpose. Reference is made to my prior U.S. Pat. No. 3,499,807 which discloses the manufacture of such articles manually, and to my co-pending application Ser. No. 229,065 filed Feb. 24, 1972, now abandoned in favor of application Ser. No. 436,640, filed Jan. 25, 1974, which discloses and claims a related invention.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

Briefly stated, the present invention contemplates a device which forms the elongated lengths of compacted fibers in a severable casing, and which places a plurality of such lengths of fiber-filled tubing in mutually parallel spaced relation such that they can be simultaneously advanced to a cutting station at which point all of the pile units which are required to extend across the width of a completed backing web are simultaneously severed. The length of fiber-filled tubing which is to be cut, projects beyond a supporting housing, and the severing operation is performed while the free ends of the elongated lengths of compressed fiber are held in contact with a vacuum means which supports the free ends of the fibers, while the end to be cut is supported by the housing. The cutter passes close to the supporting housing as the cutting action progresses. Thus, sufficient rigidity is given to the part of the fibers being severed, that the height of the pile unit may be substantially as low as desired. In addition, the mechanical complexity of the device, as compared with that disclosed in the above mentioned co-pending application is materially simplified. In one embodiment in the present disclosure, the severing of fibers to form individual pile units takes place after the removal of the confining band or sleeve, and the fibers are held in laterally compressed relation solely by the presence of vacuum means which engages the free ends of the severed fibers.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, to which reference will be made in the specification, similar reference characters have been employed to designate corresponding parts throughout the several views.

FIGS. 1a and 1b are a fragmentary view in perspective of an embodiment of the invention.

FIG. 2 is a fragmentary view in perspective showing means for radially compressing axially oriented fibers in the formation of an elongated length of encased oriented fibers.

FIG. 3 is a fragmentary view in perspective showing an alternate step in the severing of elongated links of compressed fiber, characterized in the removal of the casing prior to severance.

FIG. 4 is a fragmentary view in perspective showing an alternate form of construction facilitating the expansion of fibers useful when working with certain types of oriented fibers.

FIG. 5 is a view in perspective showing another alternate form of construction.

FIG. 6 is a view in elevation showing fiber orienting means employed when pile forming units of a particular pattern are desired.

FIG. 7 is a view in elevation corresponding to that seen in FIG. 6, but showing certain of the component parts in altered relative position.

FIG. 8 is a schematic side elevation view showing a further alternate construction.

FIG. 9 is a fragmentary perspective view showing an alternate construction for expansion of fibers.

FIG. 10 is a fragmentary perspective view illustrating an anisotropic friction material used as film for enclosing fibers to form a pile unit.
FIG. 1 is a schematic view showing a hexagonal type packing pattern.

FIG. 12 is a schematic view showing a fiber density control means.

FIG. 13 is a schematic view showing yet another construction for fiber expansion.

DETAILED DESCRIPTION OF THE DISCLOSED EMBODIMENTS

Before entering into a detailed consideration of the disclosed embodiments, a brief review of the methods employed in the prior art is considered apposite.

As set forth in my above mentioned prior U.S. Pat. No. 3,499,807, the disclosed method includes the steps of forming a plurality of basic pile units, each having a plurality of elongated fibers, the axes of which are aligned to mutually parallel relation, the fibers being surrounded by a sleeve which maintains a plurality of said fibers in relatively compressed condition. These individual units are then placed upon a surface, and within an enclosure preventing expansion of the fibers beyond a desired area when the sleeves are subsequently removed. The ends of the fibers are secured to a desired adhesively coated surface, usually a textile web.

It will be apparent that the method does require considerable hand labor, as well as a degree of skill, both in the formation of the individual units, which is accomplished by radially compressing axially oriented fibers in a cylinder, which cylinder is subsequently severed into short lengths transversely of the principal axis thereof; and the subsequent placing of the individual units on the surface, following which the sleeves are removed. In the above mentioned co-operating application, these operations are performed mechanically.

The present disclosure contemplates a device operating in a somewhat similar manner, but in which mechanical complexity and operational sequence has been materially simplified.

In accordance with the embodiment disclosed in FIGS. 1a and 1b, the device, generally indicated by reference character 10, comprises broadly: fiber cylinder unit forming means 11, cylinder unit horizontal advancement means 12, cylinder unit incremental advancement means and pile unit former 13, transfer, transport and advance mechanism 14, film removal means 15, film cutting means 16, pile stripping means 17, pile density sensing means 18, pile expansion means 19, and web laminating means 20.

The forming means 11 serves to integrate a continuous length of synthetic resinous film 24 of polyethylene or material possessing similar properties, and oriented spun fiber or tow 25 to form a sausage-like cylindrical unit 26 which is periodically severed into segments of equal length. Disposed in a fiber compression area 27 is fiber compression means 28 (see FIG. 2) which includes a series of parallel shafts 29 supporting idle rollers 30 which serve to laterally compress continuous lengths of fiber between a film forming funnel-shaped member 31 and an endless belt 29a. The belt is supported by a pair of parallel shafts 30a, so that the fibers advance with the belt while being compressed to an approximately circular cross section with substantially uniform tension throughout. This construction overcomes the problem of forming a fiber-filled tube in which the relatively centrally disposed fibers are under tension differing from that of fibers which are relatively peripherally located, this situation creating a problem when the fiber-filled tube is transversely cut to form individual pile units, as will be more clearly apparent hereinafter.

The member 31 includes a pair of laterally extending flanges 32 having openings 33 accommodating a pair of heat sealing rollers 34 and 35 which serve to seal the edges of the film 24 and provide a tab in the finished pile unit which functions to orient the unit and form a means for grasping the film surrounding an individual pile unit to facilitate its removal when it is no longer required. Prior to severance into individual pile forming units, the rollers 34-35 form a laterally extending continuous strip 36 which emerges with the remaining parts of the film 24 from the smaller end 37 of the member 31. This movement is of a continuous nature, under the action of feed rollers 38 and 39. The cutting station 40 includes a continuously driven toothless band saw blade 43 which passes over a pulley 44 and mounted on a dual motion mechanism 41 and 42 with an axial guide member 45. The dual motion guide means 41 and 42 moves the blade both transversely of the axis of the fiber cylinder, and simultaneously advances at the same speed as the feed rollers 38 and 39, thereby cutting the cylinder squarely.

The horizontal advancement means 12 includes a flexible belt 49, the outer surface 50 of which is provided with a plurality of elongated guides 51 each accommodating a cylindrical segment of oriented fibers. The belt 49 is incrementally driven by a pair of rollers, one of which is indicated by reference character 52 under the action of index means (not shown) which permits successive guides 51 to be positioned opposite extruded lengths from the forming means 11.

The incremental advance means 13 includes a pair of endless chains, one of which is indicated by reference character 56, the chains supporting therebetween a plurality of transverse shafts 57 having pendant followers 58 engaging the ends of cylinder segments, generally indicated by reference character 59 to transfer the same to fixed guides 60. Each of the guides 60 is provided with incremental advancement means over its entire length operated by a rotating shaft 63 having offset cranks 64 and toothed snubbers 65. At the forward end 66 of the fixed guides 60 a cutting means 67 is provided, including a toothless band saw 68 and guide rollers, one of which is indicated by reference character 61; which cause the blade to move in a vertical path. A driven roller 70a and grinding wheel 70b sharpens the blade continuously. The individual pile units 71 are severed, each consisting of oriented compressed fibers 72 and a sleeve or band 73 having a tab 74 thereon.

The transfer and transport mechanism 14 includes a pair of side plates, one of which is indicated by reference character 80, and mounting a pair of transverse shafts, one of which is indicated by reference character 81, each shaft supporting a roller (not shown) in turn supporting an endless belt 83. The outer surface of the belt 83 mounts rows of receptor elements 84, each row including a plurality of individual box-like members bounded by side walls 86, and end wall 87 having a tab receiving slot 88 therein and a base surface 89. Each base surface includes a circular vacuum area 90 to retain a received pile unit 71 until such time as it is deposited on a horizontal endless belt 92, at which time the vacuum is turned off. The movement of the receptor members is along a path indicated by the broad arrow.
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91, under the action of cam means (not shown) so that at the time a pile unit is received, it abuts the end thereof prior to the severing of the same from the elongated cylinder of which it is a part prior to such severance. Further movement brings the open ends 93 of the members 84 to the film cutting means 16 which comprise piercing blades 94 which pierce the film surrounding each pile unit so that it ruptures, following which nip rollers 95 and 96 of the film cutting means 15 rotate to remove the cut sleeves or bands, and allow the compressed pile fibers to partially expand into a square shape. The nip rollers 95-96 are parallel to each other, the former being mounted on a vertical driven shaft 97 by a spline connection 98 with a pinion 99 meshing with a gear 100 on the shaft 101 which is powered.

The pile stripping means 17 serves to separate the retained pile fibers 105 from the receptor 84 and operates much in the manner of a spatula. It includes a stripping wall 102 having slots 103 accommodating the side walls 86, and comes into action as the receptor members 84 are slightly elevated as indicated by the path of the broad arrow 118. With continued movement of the transfer, transport and advance mechanism, the receptor members move above the now horizontal path of expansion of the fibers. Fibers move leftward as seen in FIG. 1a to the pile density sensing means 18, at which point they are still relatively compact. Live steam may then be injected through the grillwork which comprises the first station 106, a second station 107 again sensing pile density after partial expansion caused by the steam, and the passage of the partially expanded fibers 115 between the pile expansion means 19 which comprises upper and lower belts 110 and 111 which are driven synchronously by upper and lower rollers 112 and 113, respectively. The increased speed of belts 110 and 111 relative to belt 20 determines how much expansion or contraction will occur at the station. Several stations (not shown) may be used, each causing a further expansion or contraction.

The web laminating means 20 is disposed above a second endless belt 117, on which the expanded fibers 127 continuously advance. A driven roller 119, synchronized with belt 117, is one of a plurality (not shown) which guides an adhesively coated web 120 to contact the upper ends of the fibers, following which the web and adhered fibers move leftward into an oven (not shown) a distance sufficient to permit the adhesively coating to cure, following which the web may be suitably spooled or folded as required.

In other applications, where high density of fibers is required, the belts 110 and 111 are driven at a lower speed than belt 92, thereby causing the fibers to compress.

FIG. 3 illustrates an alternate embodiment of the cutting means comprising the invention which differs from the primary embodiment principally in that the sleeve which surrounds the fiber cylinder is peeled back in banana-like fashion prior to the cutting of the individual pile units. The fiber-filled tube 133 is supported by a housing 129. The free ends of the fibers are close to but not touching the surface 132 of a plate 131 to which a vacuum source 130 is attached. The film 134 which contains the fibers 138 in a state of compression, is slit axially by a cutter 135. The cut ends of the film 136 are grasped by nip rollers which feed the free ends 136 into a vacuum means (not shown) and are held out of the path of the cut-off blade 139. The clearance between the fibers 138 and the surface 132 is equivalent to the thickness of the blade 137. As the cutting action proceeds, the cut fibers are held by the vacuum while the blade completes its cut. The plate 131 advances to the next station and the blade returns to the beginning of its stroke, following which the tube is advanced a distance equal to the height of the pile unit desired to complete the cycle.

FIG. 4 illustrates a modification, generally indicated by reference character 40 which permits even expansion of the fibers by maintaining the vertical fiber retaining walls in converging relation to reduce fiber-to-wall friction to a minimum. Thus, a fixed horizontal surface 141 is provided with slitting side guides 142, the angle of which is predetermined whereby when the compressed fibers of any given pile unit are released, they may expand with a minimum of friction along the walls. By experimentation, a precise "slip angle" is determined, and the guides 142 are set accordingly. FIG. 5 shows a somewhat similar principle in which the individual pile units are maintained in spaced lateral relation, rather than juxtaposed, in order to provide adequate room for relatively frictionless expansion. Thus, in this embodiment, generally indicated by reference character 160, the transfer unit 151 includes a plurality of receptor members 152 provided with slitting side walls 153 which converge along lines 154, and which guide lateral expansion of the fibers.

FIG. 9 shows an alternate embodiment of the expansion station which differs primarily in the method by which the fibers are expanded to their final density. The relatively compressed fibers 140a are brought in contact with a porous surface 141a through which live steam and/or air 142 is injected. The flow rate and pressure of the steam and/or air is controlled such that a fluidized bed of fibers is formed whereby the fibers are levitated and do not touch the surface 141a. The fibers are contained laterally by endless belts 142a which are driven at the same speed as the fibers, the movement of which is indicated by arrow 143. The divergence of endless belts 144a are arranged in converging relation and cause the fibers to compact laterally back to the original width. However, because the belts move at the same speed as the forward motion of the fibers, and the very low friction between the fibers and the porous plate, the expansion in the machine direction is maintained. The emerging fibers are expanded in the machine direction, and dimensions in the width are restored to the original conditions at entry.

FIGS. 6 and 7 illustrate one of a set of guide plates 190 each having a central opening 191 and peripheral openings 192 formed by septums 193. This guide plate determines the path of fibers prior to the formation of the fiber cylinder, each opening carrying fibers of different color, so that with axial rotation about the center of the plate, the pattern formed by the fiber cylinder may be rotated, to rotate the pattern. Guide plate 190 is sufficiently larger than the compressed fiber cylinder such that the friction effects between the fibers and the guide plate are minimal.

FIG. 8 illustrates a still further simplification of vacuum transfer, and differs from the embodiment shown in FIG. 3 in the provision of a porous belt 160, suitably
tially uniform length held in juxtaposed relation to each other only by lateral compression applied to the periphery of the pile unit such that upon release of the peripherally applied lateral compression the fibers of the pile unit are movable relative to each other, means for providing a surface to receive a plurality of said pile units, means for serially transferring pile units from said forming means to said surface, said last mentioned means including wall structure having portions each selectively engageable with the free ends of oriented fibers comprising a pile unit, means for delivering pile units each into endwise engagement with a wall portion while maintaining the fibers of the pile unit hold together only by lateral compression, vacuum means communicating with said wall portion for maintaining said pile unit in contact with said wall portion, and maintaining said fibers in relatively compressed condition during transfer to said surface; and means disengaging said fibers from said wall portion after transfer of said fibers to said surface; whereby said compressed fibers may expand in a direction perpendicular to the axis of said pile unit to merge with the fibers of adjacent pile units, and means for adhering the ends of said expanded fibers to a planar web to form said article.

2. A device in accordance with claim 1, further characterized in said means for forming a plurality of basic pile units including means for forming an elongated continuous tube having a principal axis of severable material, means for compressing fibers along an axis perpendicular to the axis of said tube, and for progressively sealing said tube about said compressed fibers, means for severing said continuous tube into predetermined lengths, the ends of which are in a plane perpendicular to the longitudinal axis of the fiber-filled tube, and means serially positioning said lengths in juxtaposed parallel relation, and further characterized in said delivering means including a cutting station and means for simultaneously incrementally advancing said lengths to said cutting station for substantially uniform transverse cutting of said lengths to form said plurality of basic pile units.

3. A device in accordance with claim 2, in which said severable material is a film in which said film is simultaneously cut with enclosed fibers, and further comprising means for subsequently storing, transporting and severing said film from each of said pile units to permit expansion of the fibers thereof.

4. A device in accordance with claim 2, in which said severable material is a film and including means for progressively peeling said film from a forward end of each of said lengths to expose incremental segments of compressed fibers in the area of said cutting station.

5. A device in accordance with claim 2, in which said means for forming a tube includes means for forming a tube of a grooved film, the axis of the grooves of which are perpendicular to the longitudinal axis of the tube to provide anisotropic friction properties facilitating retention of fibers within individual basic pile units, and facilitating the removal of the film from fibers in a direction perpendicular to the principal axis of said basic pile unit.

6. A device in accordance with claim 2, including a guide through which fibers pass prior to enclosure within said continuous tube, and means for rotating said guide about an axis parallel to said tube to vary the rotational position of patterns formed within said tube by said guide.
7. A device in accordance with claim 2, further characterized in said means for compressing fibers including moving belt means frictionally engaging exposed surfaces of said fibers to compress the same to substantially equalize the tension between fibers which are relatively centrally located within said tube, and fibers which are relatively peripherally located.

8. A device in accordance with claim 1, including a vacuum chamber, a continuously moving porous belt constituting said wall structure and forming part of said chamber and positioned for receiving successive pile units on an outwardly facing surface thereof, said belt maintaining the relatively compressed condition of the free ends of the fibers comprising said pile units, movement of said porous belt to transport said fibers to a point of release serving to thereby interrupt the communication of a continuous segment thereof with said vacuum chamber.

9. A device in accordance with claim 1, including means supplying a gaseous fluid for levitating and reconstituting compressed fibers to relatively uncompressed state.

10. A device in accordance with claim 1, including a pair of divergingly arranged movable side walls for facilitating the expansion of unconfined fibers.

11. A device in accordance with claim 1, including means for expanding fibers laterally with respect to the principal axis thereof, including a pair of elastomeric endless belts overlying the opposed ends of said fibers, and means for driving portions of said belts at differential speeds to expand the interstitial distance between adjacent fibers.

12. A device as claimed in claim 1, further characterized in the provision of means for controlling fiber expansion including at least one motor driven belt supporting said fibers, means for sensing fiber density at two mutually spaced points along said belt, means generating an electrical signal proportional to the difference in fiber density between said points, means controlling the speed of said motor driven belt, and means superimposing said signal to control said last mentioned means.

13. A device in accordance with claim 1 wherein said wall structure comprises a plurality of receptor members each including a fiber engaging wall portion, and whereby said means providing a surface comprises a moving belt.

14. Apparatus for making a pile article, including a means for supplying at a first locality, successive arrays of substantially axially aligned pile fibers having free ends disposed substantially in a common plane while maintaining the fibers of each array held together only by lateral compression applied to the periphery of the array;
b. means for supporting plural arrays of fibers in side-by-side relation constituting a continuous assembly of pile fibers, said supporting means including means disposed at a second locality for receiving successive arrays of pile fibers; and
c. means for applying an adherent backing to free ends of the fibers of said assembly to produce a pile article; wherein the improvement comprises
d. means including a porous movable surface for transferring arrays of pile fibers from said first locality to said second locality, said surface being engageable with free ends of an array of fibers at said first locality while the fibers are held together only by lateral compression as aforesaid, and being movable, in endwise engagement with an array of fibers, from said first locality to said second locality; and
e. means for applying suction through said porous surface for securely holding the free ends of an array of pile fibers against the surface during movement of the surface from said first locality to said second locality, said suction-applying means including means for controlling application of suction to release the fibers from the surface at said second locality.

15. Apparatus as defined in claim 14, wherein said supplying means comprises
a. means for advancing a substantially axially aligned array of fibers having substantially coplanar free ends into endwise engagement with said porous surface at said first locality while maintaining the fibers held together only by lateral compression as aforesaid; and
b. means for transversely cutting the last-mentioned fibers, while the fibers are in endwise engagement with said surface, to a desired pile fiber length.

16. The method of making a non-woven planar pile article which comprises the steps of: forming at least one length of laterally compressed axially aligned fibers, arranging said length of fibers in juxtaposed mutually parallel relation, simultaneously incrementally axially feeding the fibers comprising said length to a common cutting station while maintaining said fibers held together only by lateral compression, engaging the leading free end surfaces of said fibers with a porous surface and applying suction through said surface to maintain said fibers in compressed condition, transversely severing serial segments of said compressed fibers to form individual pile units, providing a belt for receiving adjacent severed pile units, serially transferring said pile units from said cutting station to a surface of said belt, releasing said pile units and allowing them to at least partially expand upon said surface of said belt and to thereby mutually merge, providing an adhesively coated web, and moving said belt and said web to progressively bring the exposed ends of said merged fibers into contact with the adhesively coated surface of said web to adhere thereto.

17. The method in accordance with claim 15, including the forming of a plurality of lengths of axially aligned fibers each held together only by lateral compression and simultaneously incrementally feeding said lengths to said common cutting station.