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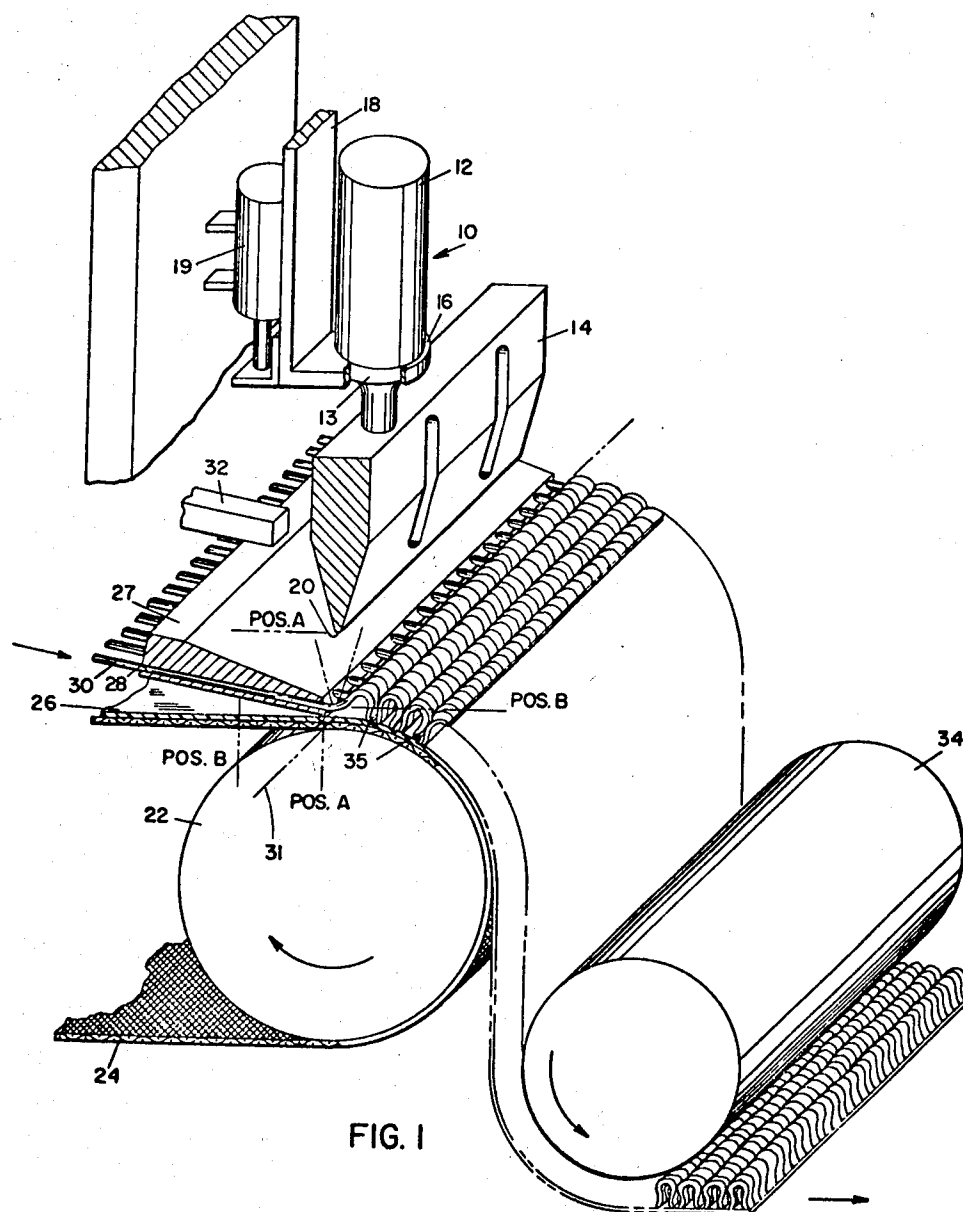
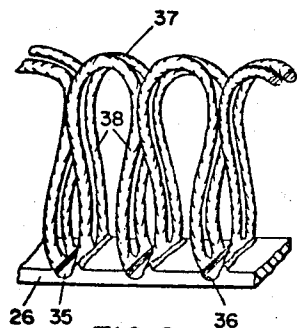
C. W. CARPENTER

3,708,384

PILE FABRIC

Original Filed Nov. 29, 1968

2 Sheets-Sheet 1



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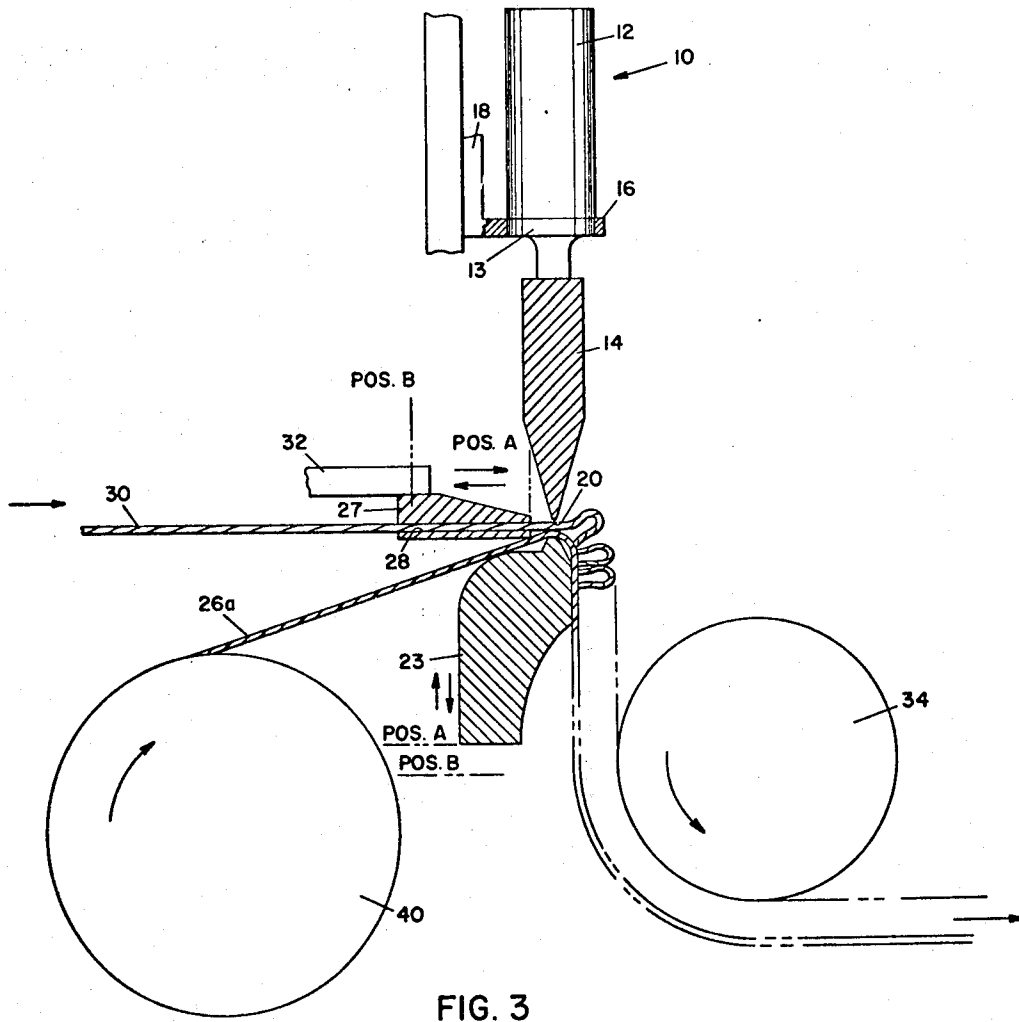
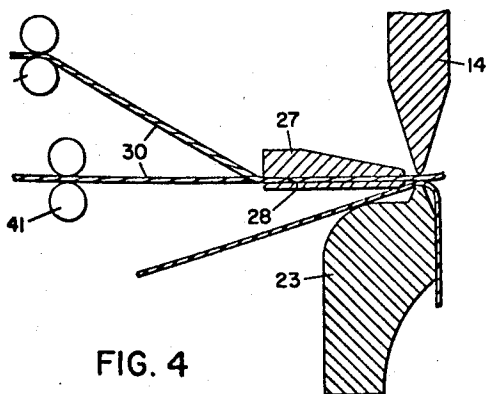
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3,708,384

PILE FABRIC

Charles W. Carpenter, Wilmington, Del., assignor to Hercules Incorporated, Wilmington, Del.

Application Nov. 29, 1968, Ser. No. 780,038, now Patent No. 3,640,786, which is a continuation-in-part of application Ser. No. 731,221, May 22, 1968, now abandoned. Divided and this application Oct. 16, 1970, Ser. No. 81,596

Int. Cl. B32b 31/16; B29c 27/08; D04h 11/04
U.S. Cl. 161—65 6 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to pile fabrics having the pile and backing fusion bonded at the points of contact without loss of orientation in either the pile yarn or the backing, if an oriented backing is used, between the bond points.

This application is a division of Ser. No. 780,038, filed Nov. 29, 1968, now U.S. Pat. 3,640,786, which in turn is a continuation-in-part of my prior application Ser. No. 731,221, filed May 22, 1968, now abandoned.

The present invention relates generally to pile fabrics and, more particularly, to fusion-bonded pile fabrics, and to a method of making the same.

Pile fabrics useful for example as carpeting, are conventionally manufactured either by weaving wherein a face or pile yarn is woven into a backing, or by tufting wherein the pile yarn is needle-tufted through a backing at spaced points to form upstanding loops or tufts projecting from the face of the backing and with the so-called back stitch extending along the back or underside thereof between the spaced loops or tufts. In both weaving and tufting, the portion of the pile yarn between the successive loops or tufts is consumed in the backing. Tufted fabrics also require means such as an adhesive coating over the underside of the backing to hold the pile against being pulled out, which coating is applied in a separate operation that represents an additional expense in the manufacture of the fabric. Also, in the course of the tufting operation, the backing, and particularly a weft or filler element in the form of strips or ribbons of oriented plastic material, may be ruptured by the tufting needles resulting, inter alia, in a pile fabric of poor tensile and tear strength.

Accordingly, it is an object of the present invention to provide a pile fabric and a method for making the same which avoid the disadvantages of tufting and weaving. A further object is to provide a pile fabric wherein the pile yarn and backing are fusion-bonded and wherein there is no substantial loss of the orientation or crimp in the pile yarn or backing between the bond points. A still further object is to provide a pile fabric and method of making the same wherein there is a substantial reduction in the pile yarn required for a given coverage and surface effect. Another object is to provide a pile fabric and method wherein the strength of the backing is not unduly weakened in the course of incorporating the pile yarn therewith. Yet another object is to provide a process of making fusion-bonded pile fabrics wherein there is a minimum shrinkage of either the pile yarn or the backing and will not pull out in normal use.

The process of the invention comprises continuously forming a series of U-shaped tufts of oriented thermoplastic yarns upon the surface of a thermoplastic backing such that the legs of each tuft contact the backing, and applying sonic energy at the points of contact of the yarn and backing to heat and fusion-bond the yarn to the backing at such points.

The pile fabric of this invention is characterized by a thermoplastic backing and an oriented thermoplastic pile yarn that is fusion-bonded sonically to the backing. A feature of the fabric of this invention is that, by virtue of the yarn-to-backing bonding by sonically induced fusion, only the bond points are caused to undergo any significant rise in temperature, thereby avoiding any loss in the original levels of orientation between bond points in the yarn and in the backing if the backing is also oriented. Because the orientation levels are thus preserved, the resulting pile fabric exhibits improved properties, such as resilience, tensile strength, and the preservation of any previously introduced bulk or crimp and the consequent coverage. The construction provides substantial savings in pile yarn, does not involve the use of adhesives or solvents, requires no binding along a cut edge, is run-proof in that each loop or tuft is integrally fused to the backing, is of high tensile strength, and better masks or covers the backing member by virtue of the fact that the pile yarn is bonded on rather than tufted through the backing.

As employed herein, the term "fusion bonding" normally denotes a bonding by melting the yarn and backing at the points of contact. However, the bond may comprise both fusion and mechanical interlocking, wherein those portions of the bond receiving the most intense sonic excitation are in fact fused and the less excited portions are partially softened and plastically deformed. Where the two components that are to be joined, that is, the yarn and backing, having more than a small difference in melting points, the bonding operation can be controlled to provide a high proportion of mechanical interlocking wherein a softened or melted portion of the lower melting component, which is preferably the backing, is deformed about and thus interlocks with the higher melting component. Such an arrangement would be useful, for example, with yarn composed of a blend of filaments.

Ultrasonic welding devices usually comprise an alternating current generator having an output with a frequency in the ultrasonic range (for example, about 20,000 cps.), a transducer assembly or sonic converter, and a sonic amplifier or horn. The transducer assembly comprises a transducer element which is preferably a piezoelectric crystal or a magnetostrictive device wherein the electrical output of the generator is converted by the endwise expansion and contraction of the transducer element in response to the varying voltage placed across it into mechanical vibrations at the same frequency as the electrical output of the generator. The sonic amplifier is connected to the output end of the transducer element and is operative to amplify the magnitude of the vibrations transmitted longitudinally therethrough.

In the fusion bonding of two or more thermoplastic elements by the use of a sonic device of the above type, the horn is vibrated perpendicularly to an anvil surface and against the thermoplastic elements interposed therebetween to effect alternately compression and relaxation of the thermoplastic material at the indicated sonic frequency. This working of the thermoplastic material generates heat at the points of contact between the thermoplastic elements sufficient to fuse the same without raising the temperature of the thermoplastic elements in the area that is not directly between the horn and the anvil. The rate at which the temperature of a given mass of thermoplastic elements is raised and the level to which it is raised is determined by the pressure between the thermoplastic elements, which is determined in turn by the bias on the horn and the geometry of the horn tip, by the properties of the thermoplastic elements such as their thermal conductivity, modulus of elasticity and

coefficient of friction, and by the sonic energy imparted to the thermoplastic elements as measured by the force, magnitude and velocity at which the horn tip is driven.

For a more detailed understanding of the present invention, reference is made to the accompanying drawings, in which:

FIG. 1 is a schematic illustration in perspective and partly broken away and in section of an embodiment of the present invention especially adapted for processing non-self-sustaining backings, such as a non-coherent or unbonded mat of thermoplastic filaments or fibers.

FIG. 2 is a fragmentary view in perspective of a pile fabric made by the embodiment of the invention illustrated in FIG. 1.

FIG. 3 is a view similar to FIG. 1 of another embodiment of the invention, which embodiment is especially adapted for processing self-sustaining backings.

FIG. 4 is a view similar to FIG. 1 of another modification of the invention.

Referring now to FIG. 1, there is shown a sonic device or tool 10 which includes a housing 12 enclosing a sonic transducer (not shown) and a sonic amplifier 13 having a horn or sonic head 14. Since the details of the transducer do not constitute a critical part of the present invention and are in themselves well known, it is not believed to be necessary that the transducer be any further disclosed herein.

The sonic device 10 is carried by a support means comprising a bracket 16 on a bar 18 that is adapted to be moved endwise to raise and lower the sonic device 10 into and out of operative position relative to the work. The actuating means for the sonic device 10 comprises for example supporting means (not shown) mounting the bar 18 for endwise movement and a double acting pneumatic cylinder 19. The cylinder 19 is preferably operated by a cycling mechanism (not shown) that provides an adjustable dwell of the bar 18 at both ends of its stroke and that also energizes the sonic transducer in timed relation to the movement of the sonic device 10. For example, in operation, the horn 14 may be moved into engagement with the work and energized for a brief interval to effect a bond, after which there is a brief dwell to allow partial cooling of the bond before the horn is moved out of engagement with the work.

In the embodiment of the invention illustrated in FIG. 1, backing member 26 comprises an elongated thermoplastic sheet-like member having an indefinite length and having a width corresponding to the desired width of the pile fabric. The backing member 26 is supported and advanced endwise by feed means comprising an endless belt 24, preferably in the form of a screen that is entrained about a drive drum 22 disposed below the horn 14. The drum 22 may be heated if desired in order to preheat the elements being joined and thereby increase the speed of the operation. The belt 24, together with the drum 22 which backs up the belt 24, serve not only to advance the backing member 26 to the bonding line, that is, the area or line 31 on the anvil member that is opposed to the working face 20 of the horn 14, but also serve as the anvil member against which the work is compressed by the horn 14 during bonding.

A tuft forming mechanism for forming tufts in a pile yarn 30 is disposed above the belt 24 and in advance or upstream of the horn 14. This mechanism comprises a bar 27 having a plurality of bores that define individual yarn tubes 28 through which the individual pile yarns 30 are threaded. The spacing between the tubes 28 determines the gauge or spacing between the pile yarns in the fabric. Each of the bores 28 is dimensioned relative to the respective yarn 30 to impose a frictional drag upon the yarn threaded therethrough whereby the yarns will be pulled through the tubes 28 when the bar is moved away from the bonding line since the yarns are then anchored to the backing member by the bond that was just formed, but will be gripped by the bar 27 when it is moved toward the bonding line so

that, insofar as it is not restrained by a tension exceeding the frictional grip thereon, it will be advanced with the bar 27. The bar 27 is carried by a bracket 32 which in turn is supported by supporting means (not shown) for reciprocation of the bar 27 in a direction to move the yarn output ends of the tubes 28 toward and from the bonding line 31.

After being discharged from the belt 24, the pile fabric is advanced endwise over guide means such as the idler roll 34 to a take-up (not shown).

In operation, the pile yarns 30 are supplied from a suitable source (not shown) and are guided in a sheet-like array to and threaded through the tubes 28 of the bar 27. In the starting point of a loop-forming cycle, each of the pile yarns 30 is secured to the backing member 26 along the bonded line 35 that was formed in the immediately preceding bonding operation, and the bar 27 is disposed in its bonding position, i.e., position A in FIG. 1, wherein the output ends of the tubes 28 are adjacent to the bonding line 31. The bar 27 is then retracted relative to the bonding line 31, that is, moved to position B in FIG. 1, so that, with the yarns 30 secured to the backing member 26 at the bonded line 35, the yarns are pulled through the tubes 28.

Immediately upon completion of the tuft-forming cycle and as the bar 27 is being withdrawn, the horn 14 is raised from position B, which is its bonding position, to position A, and the drum 22 is indexed to advance the backing material endwise a distance equal to the desired tuft spacing, that is, the distance between successive bonded lines 35. The bar 27 is then advanced toward the bonding line 31 from position B to position A, during which movement the frictional engagement between the tubes 28 and the yarns 30 threaded therethrough causes the yarns 30 to be advanced with the tubes. Thus, the lengths of the yarns 30 between the output ends of the tubes 28 and the preceding bonded line 35, which are the lengths of yarn that were pulled through the tubes 28 when the bar 27 was retracted, are bowed upwardly from the backing member 26 to provide tufts of yarn, each of which is in the form of an inverted U upstanding from the backing member 26 with the one leg thereof secured at its end to the backing member 26 at the bonded line 35 that was just formed and the other end held adjacent to the backing member 26 at the bonding line 31 by the respective tube 28. Assuming that the yarns 30 are supplied in a substantially tension-free condition or under a tension that is sufficiently low that it will not cause the yarns 30 to slip in the tubes 28, the length of the retracting stroke of the bar 27 determines the length of yarn that is drawn through the tubes 28 and thus the height of the tuft to be formed.

In the final step of the tuft-forming cycle, the horn 14 is lowered from position A to position B to engage the yarns and to force them against the backing member along the bonding line under the predetermined bonding pressure, and is energized to form a new bonded line 35.

The cycling mechanism for the horn 14 is adjustable to provide for adjustment of the time that the sonic transducer is energized. The energization of the transducer is initiated as soon as the horn 14 has been moved to its bonding position, that is, to position B in FIG. 1, and may be initiated for example by switch means that responds to movement of the horn 14. With a horn that is biased to the bonding position, for example by pneumatic means, when the horn 14 arrives at the end of the stroke, it also exerts a bias on the work and thus provides a bonding pressure which can be adjusted by adjustment of the line pressure. With a given bonding pressure, the length of time that the transducer must be energized to produce the desired bond is determined essentially by the energy input and the physical characteristics of the yarn and the backing member. The yarn beneath the working face 20 of the horn 14 may be completely fused to the backing member 26 so that it has in effect lost its identity as yarn, as illustrated at the bonded line 35 in FIG. 2,

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or may be surface bonded. At the same time, that portion of the backing member 26 that is beneath the working face 20 of the horn 14 was also heated and was displaced by the working face 20 to provide a groove 36.

In accordance with the above, the pile fabric that is formed consists of a plurality of pile yarns 30 arranged in a spaced parallel manner lengthwise of the backing member 26 and fusion-bonded thereto at the bonded lines 35 extending transversely of the backing member 26 in a spaced parallel arrangement. For a uniform appearance and performance, the pile yarns 30 and the bonded lines 35 are both preferably equally spaced. Arranged in this manner, the pile yarns 30 define a series or rows of tufts 37 extending lengthwise of the fabric and consisting of the successive tufts formed in the individual pile yarns between the successive bonded lines 35 upon successive tuft-forming cycles, and series or rows of tufts extending transversely of the fabric and consisting of the tufts that are formed in the individual yarns in one tuft-forming cycle.

As illustrated in FIG. 2, each of the tufts 37 is upstanding from the backing member 26 and has legs 38 spaced apart endwise of the backing member 26 the distance through which the backing member 26 is advanced upon each cycle, which is herein termed the tuft spacing, and secured at their ends to the backing member 26 along the bonded lines 35.

At each bonded line 35, the thickness of the backing member 26 is reduced by the groove 36. Since the grooves 36 weaken the backing member 26 and in an extreme case may be so deep as to sever or substantially sever the backing member 26, they are preferably kept at a minimum consistent with the effective bonding of the yarns 30.

In the illustrated embodiment, the cycling mechanism for the horn 14 is also designed to provide an adjustable dwell of the horn 14 in the bonding position after the sonic transducer has been de-energized in order to provide for cooling and setting the bonds between the yarns and backing member.

One of the significant features of this invention is that the heating of work is localized and occurs essentially at the interfaces of the thermoplastic elements or in other words is focused precisely in the area in which the bond is formed. This not only minimizes power requirements, but also enables the materials to be brought very quickly to their bonding temperatures and minimizes the amount of heat that must be dissipated to reduce the temperature of the bond and thus set the same. Cooling and setting of the bond is accomplished more rapidly by the heat dissipation effect of the horn 14 which is not heated and thus remains cool during the bonding so that it can adsorb and thus conduct heat from the bond. The heat sink capacity of the horn 14 is sufficient to cool the bond to setting temperature within a very short dwell period after bonding. During this time, the horn 14 remains in its bonding position to hold the yarns 30 in place and thus to insure that they will set properly.

The crown or working face 20 of the horn 14 is preferably as narrow as possible, for example, in the neighborhood of from about 0.010 to about 0.025 inch in width, in order to minimize the sonic energy that is required to produce the desired bond and the width of the bonded line 35. With the pile yarns 30 bonded to the backing member 26, the strength of the connection is not a function of the width of the bonded line 35. The appearance and performance of the fabric are also improved by a bonded line 35 of minimum width. Inasmuch as a length of the pile yarn 30 is consumed in forming the bonded line 35, a bonded line of minimum width represents a minimum loss of pile yarn and thus maximum coverage with a given quantity of yarn. There is also a reduced tendency for "grinning," that is, for the bonded line 35 to show on the face of the fabric, which is a condition that is particularly acute in forming a pile fabric over curved surfaces such as in the floor of an automobile.

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The horn 14 is preferably elongated to provide a working face 20 that is as long as possible consistent with uniform results, which under the present state of the ultrasonic art, would appear to be about twelve inches. It is contemplated that fabrics wider than the width of a single horn can be produced by the use of a plurality of horns which may be arranged end-to-end or in another manner such as a staggered or stepped relation to minimize the effect of a gap between adjacent horns.

As mentioned above, it is preferred that the yarn and backing be so chosen as to exhibit a minimum differential in their melting points, for example, less than about 20° C., to insure a mutual inter-fusion of both the backing member and the yarn in order to form an optimum bond at a high production rate. Where the differential in melting points is relatively large, there may be incomplete fusion of the higher melting component or excessive fusion of the lower melting component.

Attention is now directed to FIG. 3 wherein there is illustrated a modification of the present invention that is particularly adapted for processing self-sustaining backings such as films, as opposed to non-self-sustaining backings such as unbonded nonwovens. In lieu of the continuous belt arrangement of FIG. 1, backing member 26a, illustrated in the form of a self-sustaining film, is fed to the bonding line directly from a supply roll 40. In this embodiment of the invention, there is provided a separate anvil member 23 that is mounted for vertical reciprocation between its bonding position A and its retracted position B while the sonic device 10 is stationary. The looping bar 27 is mounted for horizontal reciprocation between a retracted position B and a bonding position A and having the desired number of the yarn bores or tubes 28. Except for the fact that it is the anvil and not the horn that is moved to and from the work, the operation of the embodiment of FIG. 3 is similar to that of FIG. 1.

With reference to FIG. 4, there is illustrated a further embodiment of the invention in which there is provided a plurality of yarn feed rolls 41 and 42. In the previously disclosed embodiments of the invention, the frictional engagement of the pile yarns 30 in the yarn tubes 28 is relied upon to pull the individual yarns from their supply packages and the height of the tufts is determined essentially by the stroke of the bar 27. This arrangement is satisfactory for relatively simple set-ups wherein there is a limited number of pile yarns and there is no significant tension required to pull the yarns from their supply packages and the height of the tufts is determined essentially by the stroke of the bar 27. However, when there is a large number of pile yarns so that the supply packages of some are located remote from the bonding line and are directed over various guides and/or through guide tubes which impose different tension on the different yarns, the bar 27 may slip relative to some yarns and thus produce variation in the pile height in the fabric.

Yarn feed means such as the rolls 41 and 42 is used to pull the yarn from the respective supply packages and present a predetermined length thereof in a substantially tension-free condition to the bar 27 upon each tuft-forming cycle. For a pile fabric having a uniform pile height, all of the yarns 30 may be fed by a single yarn feed means. For a patterned surface wherein the pattern is defined by variations in the pile height of the different yarns, the yarns may be fed by different yarn feed means which themselves are operable at different speeds. Thus the yarn fed to any particular yarn tube 28 on any particular tuft-forming cycle may be less than the length required to form a loop of maximum height so that as the bar 27 advances to its bonding position, the yarn is restrained and thus retracted through the tube 28.

Various yarn feed means such as those commonly employed with tufting machines may be used to provide the desired control of the individual pile yarns.

Pattern or surface effects in the pile fabric may be achieved by cutting the tufts 37 such as by shearing to

provide a cut pile effect or a mixed cut pile and loop pile effect. As herein used, it is contemplated that the term tuft will refer generically to pile such as the loops 37 as well as to pile which may be originally formed as loops but are either simultaneously or subsequently cut or sheared to provide cut pile or mixed cut pile and loop pile.

In addition to providing pile height control by a controlled yarn feed for each yarn or a selected group or groups of yarns, variation in the height of the tufts may be provided by forming the yarn tubes 28 independently and actuating them by a pattern mechanism to vary the stroke of the different tubes.

In the above described embodiments of the invention, the sonic device 10 was energized only with the horn 14 in its operative or bonding position, that is, it was energized after the horn was moved into its operative position and was de-energized before it was moved out of its operative position so that the actual bonding cycle was determined by the energization interval of the device. However, it will be apparent that the device 10 can be continuously energized and the bonding time can be determined by the interval that the horn 14 is maintained in its operative or bonding position relative to the work.

In the above described embodiments of the invention, the horn 14 is disposed on the pile surface of the backing member and the anvil means, such as the anvil 23, is disposed at the opposite surface. This arrangement is not critical to the invention. The horn 14 may be arranged at the backing surface while the anvil means may be arranged at the pile surface, in which case, the anvil may be and preferably is formed with a relatively sharp working face comparable to the face 20 of the horn 14.

The embodiments of the invention illustrated in FIGS. 1, 3 and 4 are exemplary only and many other modifications can be made. For example, the desired pile configurations could be formed by the use of an endless belt, wherein the belt has a corrugated surface formed for example by spaced blades upstanding from the belt and corresponding to the desired tuft geometry. Thus, a band of yarns is conformed to the corrugated surface of the belt and the backing material laid thereover. The crests of the blades of the belt function as the anvil surface and the horn is brought to bear directly upon the backing.

The use of the term "thermoplastic" in characterizing the pile fabric components of the present invention is to be understood as including, for example, blended components which may be only partially thermoplastic. For example, the pile yarn may be in the form of a blended yarn containing both thermoplastic and non-thermoplastic constituents. The only criterion is that both the yarn and backing components contain thermoplastic constituents, preferably in a major proportion and having substantially the same melting points, and that the non-thermoplastic constituents are not damaged by the bonding operation. Polypropylene is a particularly suitable thermoplastic material.

The backing may take numerous forms depending upon the particular installation for which it is designed. Some typical forms of backing may be films, including fiber-reinforced films and nettings, nonwovens and backings woven from fibrillated or slit films, and laminations of any one or more of these forms. Further, in the case of a nonwoven backing, the backing may be bonded or otherwise formed into a stable or coherent fabric prior to application of the pile yarn, or it may be loose or non-coherent filaments or fibers that are bonded into a coherent fabric simultaneously with the bonding of the pile yarn. The geometry of the filamentary web may vary extensively, although for best results the filaments in the web should be arranged in a random manner such as achieved by depositing staple fibers from a Rando Weber. Other suitable webs may be formed by cross-lapping or laminating unidirectional filamentary webs.

With a nonwoven backing, it is preferred that the filaments or fibers thereof be oriented to increase the strength

and dimensional stability. With a backing consisting of a thermoplastic film, the film may be unoriented so that it has greater tear resistance and less tendency to become distorted by heat, and can be more readily formed.

The following examples will serve to illustrate further the present invention and its practice, but are not to be taken as a measure of its limitations. The sonic transducer assembly employed was one commercially available from Branson Sonic Power Company of Danbury, Conn., and was designed for an input frequency of 20 kilocycles per second, the transducer of which was a lead-zirconate-titanate piezoelectric element. As supplied, this assembly includes a timing circuit by which the duration of the energizing cycle of the transducer can be controlled. The horns utilized are characterized by a half-wave resonance section made of a titanium alloy, selected for its strength-to-weight ratio to withstand the intense internal stresses generated within the horn element, as well as its excellent sonic conductivity. A conventional time delay mechanism was employed to control the dwell time of the horn against the workpiece for a pre-set length of time after the energizing cycle of the transducer to allow at least a partial solidification of the bond points. The force with which the horn was brought to bear upon the workpiece was provided by a pair of double-acting air cylinders having a 3/4 inch inside diameter that were connected to source of compressed air through a variable reducing valve. The air-cylinder pressures that are reported indicate the relative values of the horn pressure upon the workpiece. The tip or working face 20 of the horn 14 is designed to accommodate the loop configuration being worked, which is to say that is generally characterized by a long, narrow, straight working face 20. The horns employed in the following examples had edge lengths of 3 and 7 1/2 inches, the tip being machined to a width of from 0.20 inch to 0.25 inch with the sides tapered at an angle of 60° to the working edge.

EXAMPLE 1

Utilizing an apparatus similar to that depicted in FIG. 1, an unbonded nonwoven web having a weight of 4.05 ounces per square yard and composed of continuous, uncrimped, 6 d.p.f., draw-oriented isotactic polypropylene filaments was collected upon and conveyed along an endless screen belt 24. Though the method of forming the web does not constitute a critical feature of the present invention, the present web was formed by air-laying a 210/35 yarn by air jet spreaders positioned on one-inch centers and operated at 10 p.s.i.g. to deposit a uniformly random array upon a 16-mesh screen travelling at 11.05 feet/minute, thereby to collect a 4.05 ounce per square yard web. Of course, any desired web weight is readily obtained by varying, for example, the belt speed and/or spreader jet pressure.

A stuffer-box-bulked, continuous filament, draw-oriented polypropylene yarn having a denier and filament count of 3750/210 and 0.75 twist per inch was fed to the bonding station to be formed in a loop configuration upon the previously formed web. Both the pile yarn and the web yarn were further characterized by a melting point of 333° F. and an initial shrinkage temperature of 265° F.

A horn, as above specified, having an edge length of 3 inches, was utilized to bond simultaneously the filaments of the nonwoven web to one another and to bond the pile yarn to the web. Runs were conducted utilizing various horn pressures and bonding periods, the web being advanced intermittently to provide the desired tufts per inch. In each case, seven rows of tufts per inch were formed. A plurality of pile yarns was supplied by a looping bar such as depicted in FIG. 1 having yarn tubes 28 spaced to provide the desired tuft gauge (the measure of tuft spacing within a given transverse row of tufts). The dwell time signifies the period of time between de-energization of the transducer and disengagement of the

horn. Tuft pull strength, as a measure of bond strength, was determined by a hand-held tension gauge provided with a hook that was engaged with a single tuft. Failure in each case was observed to occur at the junction of the filament with the backing.

A tuft pull strength of 8 pounds, or greater, is considered commercially acceptable for carpet applications, and it is apparent that the sonically bonded constructions according to the present practice are more than adequate. Of paramount importance is the fact that bonding was accomplished rapidly and without significant heating of adjacent regions, thus preserving the original levels of orientation in the pile yarns and in the backing.

EXAMPLE 2

Utilizing an apparatus similar to that depicted in FIG. 3, a pile fabric was constructed utilizing cast, isotactic polypropylene film having a thickness of 10 mils. The pile yarn was a 2600/120 count bulked, continuous filament polypropylene yarn having one twist per inch. The horn had a working face that was seven and one-half inches (7½") long. The anvil 23 provided a smooth surface in lieu of the screened belt 24. Following the procedures of Example 1, the data set out in the table following Example 3 was obtained.

The resultant fabric construction had a uniform and relatively dense appearance, and it is significant to note that such appearance was attained utilizing approximately 29% less pile yarn than required in conventional construction of comparable tuft density and height.

EXAMPLE 3

A Rando Weber was employed to form an air-laid, nonwoven web composed of a blend of 6 d.p.f. polypropylene staple having a melting point of 333° F., 65% being an uncrimped 1¼ inch staple and 35% being a crimped 1½ inch staple having 10 crimps per inch. This web was then bonded by heat and pressure as by passing the same through a pair of heated pressure rolls to a cast polypropylene film having a thickness of 1 mil and a melting point of 333° F. to form a fiber-reinforced film backing member weight, 4.30 ounces per square yard. Following the procedure of Example 1, pile yarn of Example 2 was bonded to this backing material. The bonding conditions and results are set out in the following table.

TABLE

	Bonding time (sec.)	Dwell time (sec.)	Air cylinder pres. (p.s.i.g.)	Pull strength (lbs.)	Tuft gauge (in.)	Pile height (in.)
Example:						
1-----	{0.4	0.1	40	11.1	5/62	1/4
	{0.3	0.1	40	9.7	5/62	1/4
	{0.2	0.1	50	9.3	5/62	1/4
2-----	{0.4	0.1	80	15.0	1/8	1/4
	{0.4	0.1	88	12.4	1/8	1/4
	{0.3	0.1	90	11.6	1/8	1/4
	{0.4	0.1	70	10.0	1/8	1/4
3-----	{0.3	0.1	90	10.6	1/8	1/4
	{0.3	0.1	70	9.8	1/8	1/4

What is claimed is:

1. A nonwoven pile fabric comprising a sheet-like thermoplastic backing member having on the face thereof a plurality of pile yarns of oriented thermoplastic material having a melting temperature comparable to that of the backing member, said pile yarns extending longitudinally of the backing member in a substantially parallel and equally spaced relation and each of said pile yarns being fusion-bonded and mechanically interlocked by sonic energy into said backing member along bonded lines extending generally transversely of the backing member and substantially uniformly spaced longitudinally thereof, said pile yarns having retained their original orientation between the bonded lines and upstanding from said bonded lines in both directions longitudinally of the backing member to provide pile upstanding from said backing member.

2. A pile fabric in accordance with claim 1 in which said pile yarns comprise loops extending in rows longitudinally of the backing member with each of said loops fusion-bonded at the ends thereof to the backing member at an adjacent pair of bonded lines and said loops having retained their original orientation between said bonded lines.

3. A pile fabric in accordance with claim 1 in which said backing member comprises an unbonded nonwoven web of oriented thermoplastic filaments.

4. A pile fabric in accordance with claim 1 in which said backing member comprises a cast thermoplastic film.

5. A pile fabric in accordance with claim 1 in which said backing member comprises a nonwoven web of thermoplastic staple bonded by heat and pressure to a cast thermoplastic film.

6. A pile fabric in accordance with claim 1 wherein the pile yarns have retained their identity as yarn in the bonded lines.

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WILLIAM J. VAN BALEN, Primary Examiner

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