United States Patent

Gidge et al.

[15] **3,673,048**

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[54] APPARATUS FOR MAKING NON-WOVEN PILE MATERIAL

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[52] **U.S. Cl.** **156/510**, 156/72

[51] **Int. Cl.** **B32b 31/20**, B32b 5/02

[58] **Field of Search** 156/510, 72, 516

[56] **References Cited**

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3,325,323	6/1967	Forkner	156/72
3,359,147	12/1967	Miller	156/72
3,390,034	6/1968	Hull	156/72

Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—J. V. Doramus
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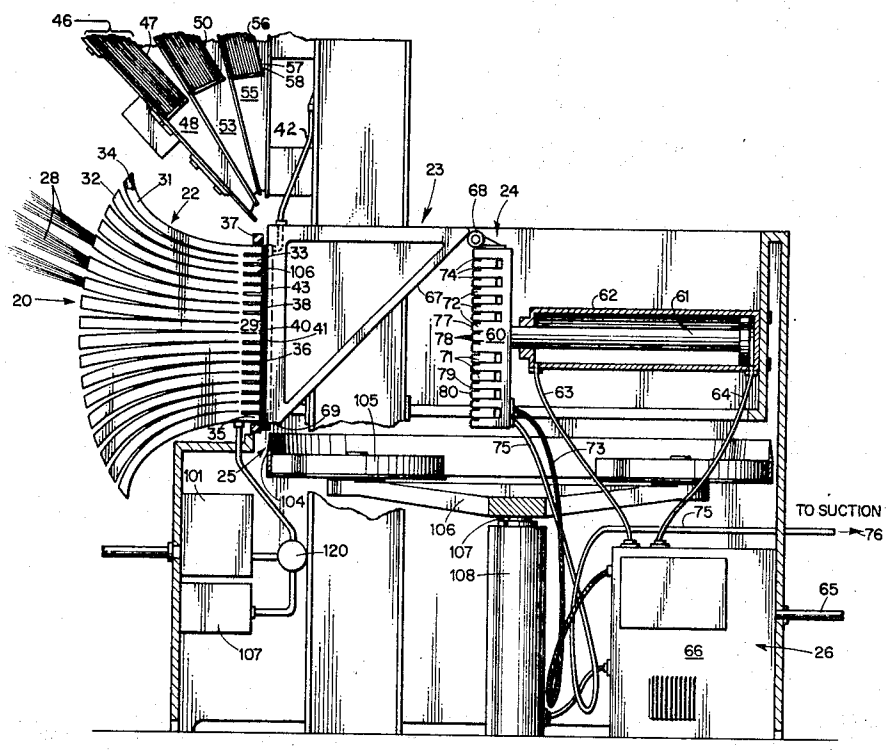
[57] **ABSTRACT**

A plurality of tows of parallelized strands are supplied to a head to present a compacted, but unconnected, mass of fiber ends in a selected pattern. The exposed ends of the mass are then joined into a unified backing by heat fusing or the like. The mass is then moved out of the head, in a pile length increment by engagement with the pull the strand mass and tension the fiber ends, whereupon the mass is then severed transversely, to form a pile-bearing piece, tile or block of the desired color pattern, density, and pile height.

20 Claims, 11 Drawing Figures



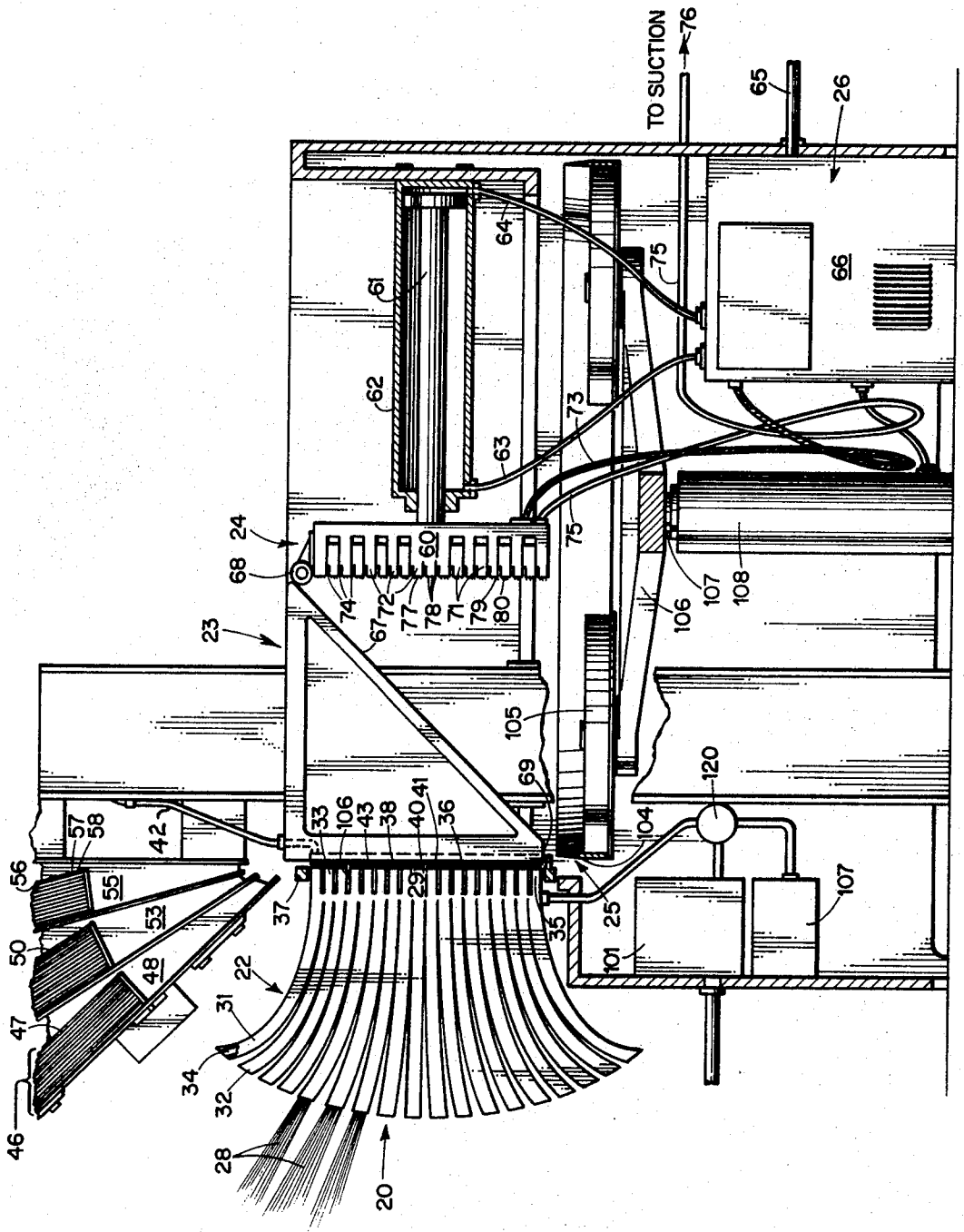


Fig. 1.

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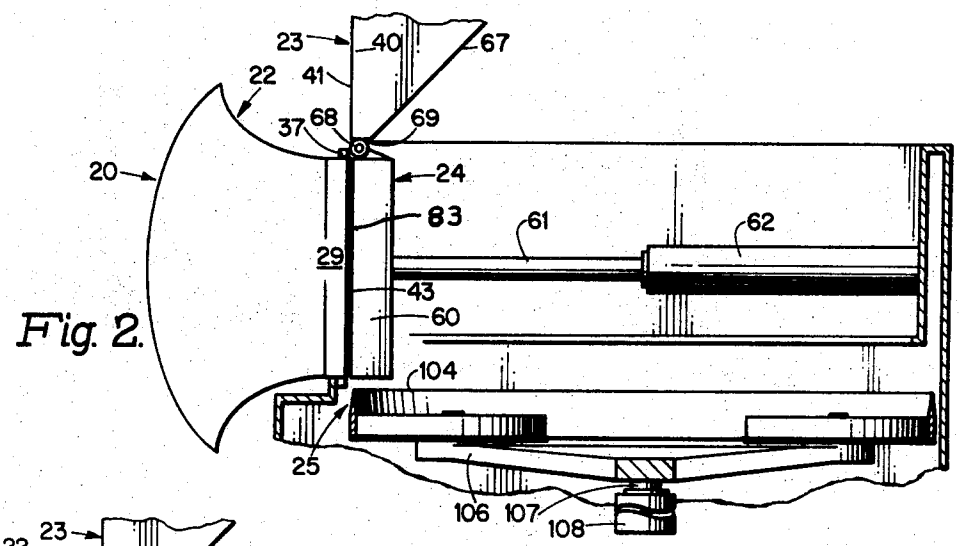
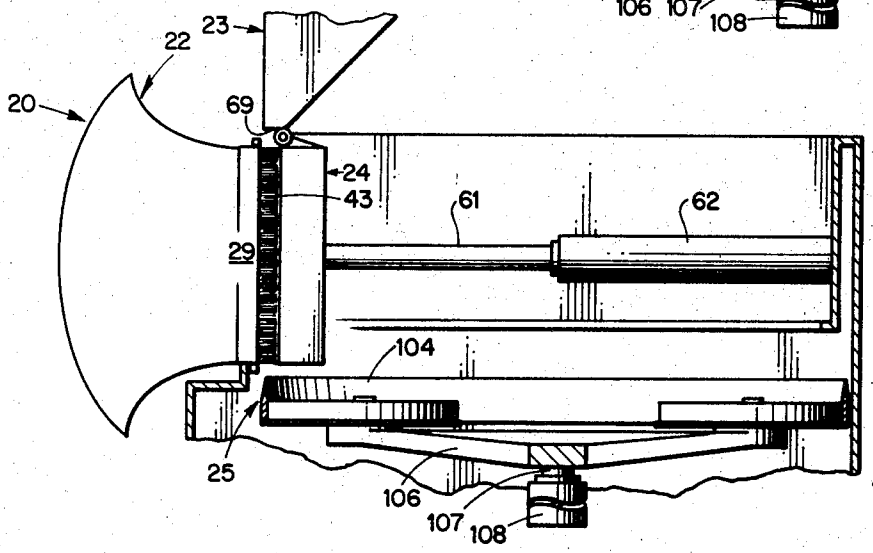


Fig. 2.



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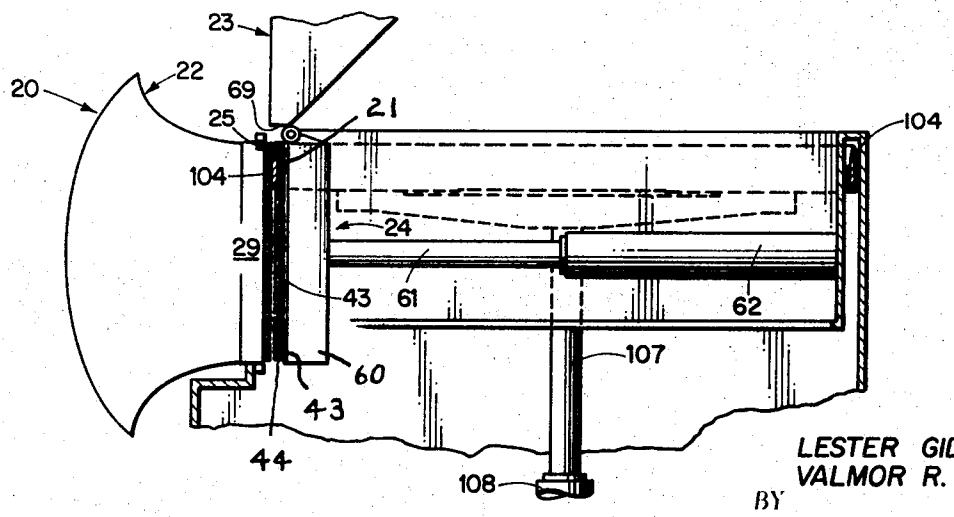

Fig. 4.

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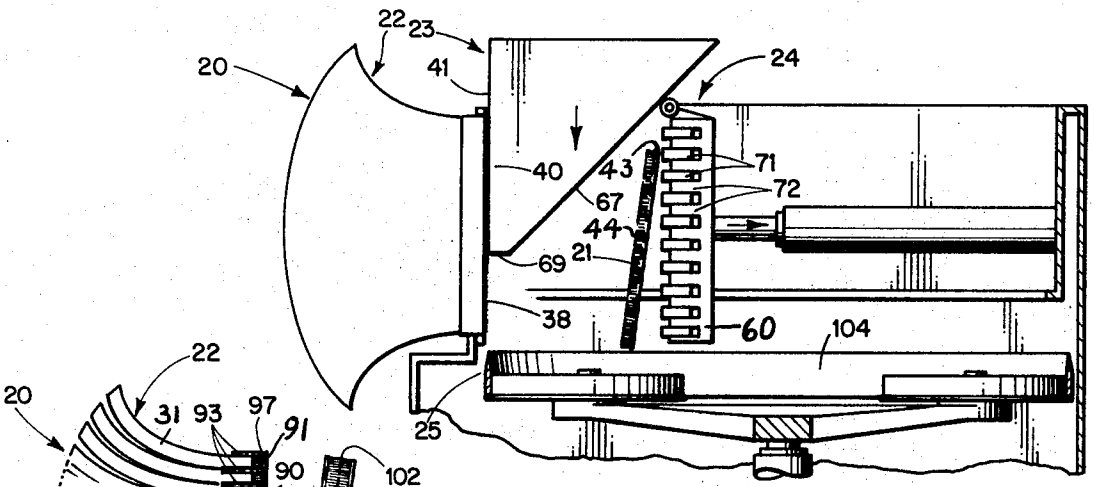

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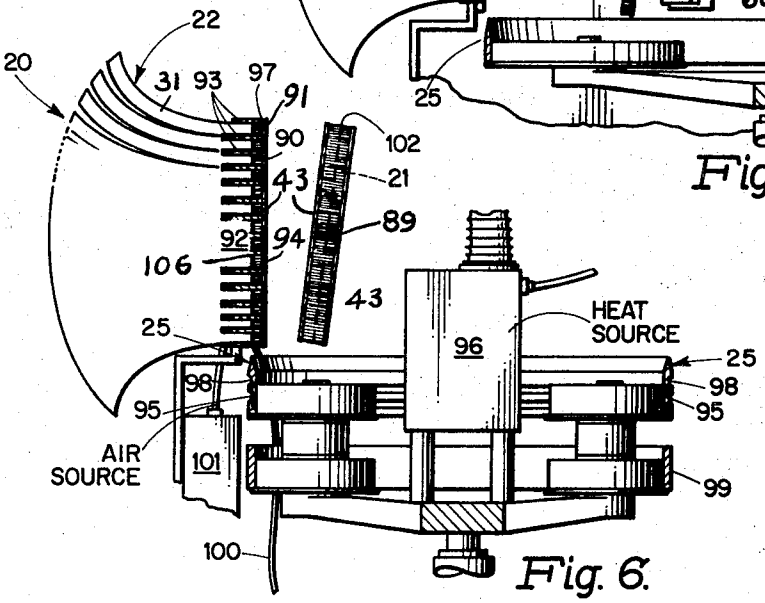

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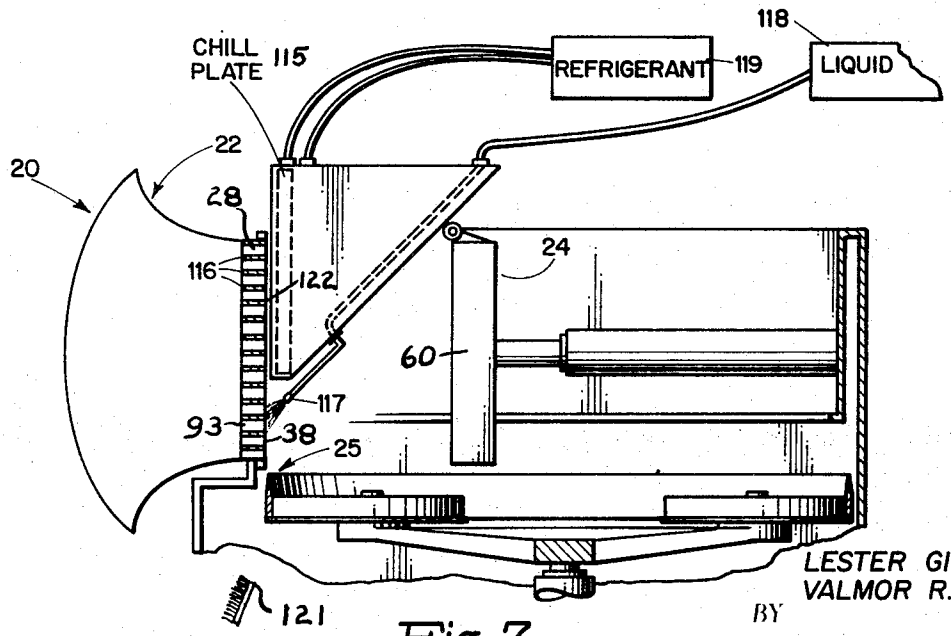

Fig. 7.

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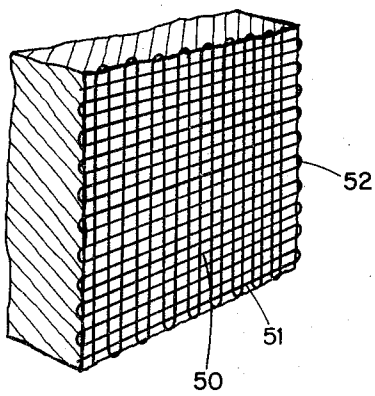
Fig. 8.



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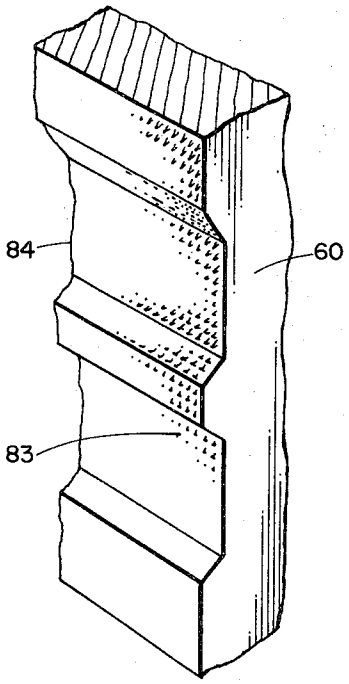
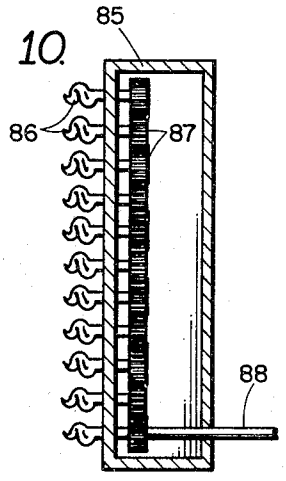


Fig. 10.



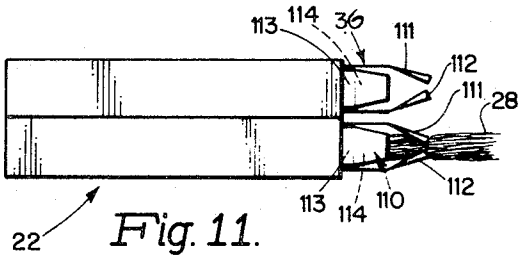


Fig. 11.

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APPARATUS FOR MAKING NON-WOVEN PILE MATERIAL

BACKGROUND OF THE INVENTION

In the textile art, looms have long been used to weave a backing fabric from which an upstanding pile projects, often by providing floating yarns which are cut to create velvet, velveteen, or the like. Woven rugs are similarly made, and by the use of complicated, loom mechanism, particular color patterns can be obtained. It has also been possible to produce short pile non-woven fabric by flocking methods wherein the pile is erected vertically by static electricity with the tips embedded in a plastic backing. Color patterns are more difficult to achieve in flocking, and both weaving and flocking require costly machinery and considerable time of manufacture.

To achieve a more rapid and less costly non-woven pile material, there have been many proposals heretofore, wherein bundles of parallel strands, such as tow roving, roping, etc., are advanced along a path through a congealing zone, which may freeze the strands into a block, or impregnate the bundle with some other congealing, or hardening substance, whereupon slices are cut transversely from the congealed block, arranged on a backing and fused thereto and then unfrozen, or uncongealed, to become a backed pile fabric.

The frozen block, or slice, type system, is exemplified in U.S. Pat. No. 3,359,147 to Miller of Dec. 19, 1967, and involves the thorough wetting of the strands, the attempt to advance a frozen block of strands by friction engagement, and the attempt to satisfactorily cut the slices from the block, all of which are difficult to accomplish in a commercially acceptable apparatus.

The spraying of a binder, other than water, on the strands to cause them to congeal into a block capable of being severed transversely is exemplified in U. S. Pat. Nos. 2,491,258 and 2,516,559 to Fuhrhop who uses gels as a consolidating medium or other patents in which waxes, amonnium compounds, and the like are suggested as the consolidating medium.

Without using any consolidating medium, it has been proposed, as in U. S. Pat. No. 3,390,034 to Hull of June 25, 1968, to push or extrude the mass of filaments out of a tube, insert a false backing made of card clothing, cut off the slice while supported on the false backing and apply the slice to an adhesive backing, and then remove the card clothing backing. Similarly in U. S. Pat. No. 2,438,156 to Dodge of Mar. 23, 1948, it was proposed to push the mass out of a tube, transversely sever the slice with a hot wire which also fused the tips into a film, and to cut the resulting slices centrally without heat to form individual pile pieces. The pushing of a compacted bundle of fibers through a mold and the attempting to accurately cut a projecting, unsupported mass of fibers, beyond the end of a mold tube, when the mass is free of consolidating medium, has been found to be difficult, especially if the pile is to be long and low in density.

SUMMARY OF THE INVENTION

This invention avoids the use of a zone in which the entire mass of strands is spread apart and sprayed, or otherwise exposed, to a liquid consolidating medium, and consequently avoids the problems of later removal of the consolidating medium. It also avoids any attempt to push a compact mass of flexible strands through a die, mold, or tube, whether congealed or uncongealed, by the use of fluid pistons, or rams, or by the use of sharp edged friction wheels.

Instead of these prior art proposals, in this invention, the parallelized strand material is supplied directly to a head, free of consolidating material, in such a manner that it can be withdrawn, or extracted by a pulling force. The tips of the compacted, unconnected fibers are exposed to form a planar surface which defines the desired pattern, and which may cover an area ranging from a one foot block to a small rug size.

A strand tip unifying element, preferably in the form of a heated plate, is then applied to the exposed fiber tips to fuse, bond, adhere, or otherwise unify the tips into a thin, coherent, integral film-like backing. A strand extraction means, preferably in the form of a barbed, suction plate, is then applied to the film-like backing, preferably while still viscous and tacky, to secure a grip on the mass and withdraw, or extract, it by a force applied to the backing. When the mass has been extracted from the mold head for the desired length of pile, and while the suction plate is still tensioning the fibers into taut condition, the severing means moves transversely to sever the fiber mass and form a pile carrying backing.

In principle, therefore, it will be seen that the feeding and slicing of the pile material of the invention are achieved by forming a film-like backing on the exposed tips of the fibers and then extracting and severing the mass by means of the backing, thereby eliminating the need for any consolidating medium. Using a large enough head, an entire patterned rug complete with backing, can be made in one operation in this invention. Usually, however, the apparatus will produce a succession of individual, identical rigid, or flexible, pile carrying blocks, slices, or pieces, which may be assembled into a composite rug, or other piled product. The invention runs contrary to prior methods in which discrete pile elements are formed and then surface bonded onto an adhesive backing in that, in this invention the mass is first surface bonded to create a backing, and the mass is then severed to divide off the so created discrete pile element with its built-in film-like backing. The backing is formed from the tips while they are firmly held in the head, rather than being formed on a loosely held, limp, projecting mass of fibers to assure that the fibrous pile is normal to the film backing and not bent or distorted.

DESCRIPTION OF THE DRAWINGS

FIGS. **1** to **5** are diagrammatic side elevations showing the cycle of operation of the apparatus of the invention when the preferred fusion plate is used;

FIG. **6** is a similar view of an embodiment in which there is no fusion plate and the heated blade is both the fusion and the severing means;

FIG. **7** is a view similar to FIG. **6**, showing an embodiment in which the fusion is accomplished by a foam or liquid spray and a chill plate;

FIG. **8** is an enlarged front elevation of a fusion plate having a grid of wire loops for incorporation into the film-like backing;

FIG. **9** is a side elevation of a sculptured, or contoured, face on the withdrawal suction plate;

FIG. **10** is a side elevation, in section, showing an extraction plate having a plurality of rotatable augers, or corkscrews; and

FIG. **11** is an enlarged view of the spring-pressed braking means for applying tension on low density bundles of filaments so that they are taut when severed.

DESCRIPTION OF PREFERRED EMBODIMENT

As shown in the drawings, the apparatus **20** of the invention, for making non-woven pile fabric **21**, includes the strand supply means **22**, the the strand end unifying means **23**, the strand extraction means **24**, the strand severing means **25**, and automatic control means **26** for actuating the parts in synchronization.

STRAND SUPPLY MEANS

Strand supply means **22** is free of moisture chambers, spray chambers, strand spreading apparatus, chill jacketed molds or dies, and could be a creel stand supporting a plurality of different colored packages of tow, or other parallelized strand material, synthetic or natural, twisted or crimped, sufficient to continually supply running lengths of the strands **28** to the head **29**. The head **29** comprises a battery of closely-spaced, open-ended cells, **36**, of polygonal rather than circular cross section to eliminate voids, the cells being formed by the terminal ends of a battery of thin walled tubes, or conduits, **31**, curved as shown and preferably each at least 2 or 3 feet in length and about one-half inch in cross-wise dimension.

A tow, or multiple parallel strand, **28**, of synthetic filaments, preferably of the heat fusible type, such as nylon **6**, or nylon **66**, and in a length equal to the length of a tube **31**, is threaded into the rearward open end **32** of the tube, which is preferably circular in cross section, by insertion of a hooked, or barbed wire, from the open forward end **33** of the tube and drawing each tow into the tube to fill it. Each tube **31** may be of progressively decreasing cross section to compact the unconnected, and unconsolidated, filaments into a mass of increased density, and it will be understood that it would be most difficult to push such a tow through a feed tube, or even to draw it through the tube without pinching it in a nip in the manner of draft rolls. The tubes **31** serve the purpose of not only storing, guiding, supporting, and compacting the strands, but also the inside faces **34** of the tubes produce the correct frictional braking, or retardation, on densely packed strands, so that when the extraction forces are applied thereto, the strands are pulled taut for severing. A spring bias force on the strand for tautening and cutting purposes would pull the strand rearwardly and right out of the tube, so that the retardation force is preferably frictional wall contact for high density strands such as two hundred ends per inch, and is a sidewise spring frictional contact for low density strands, such as 100 ends per inch (FIG. **11**). The tubes **31** may be of any desired length, depending on floor space, density of the ends, the height of the desired pile and other manufacturing considerations.

The face of heat **29** forms a grid, or honeycomb, **35**, of polygonal cells **36**, which may be nine or twelve inches square if a flexible block, or semi-rigid tile, of pile carrying material is to be made for inclusion in, for example, a rug of larger area in a repeat colored pattern. The head **29** and grid **35** may be several feet in dimension to form a small rug, or, preferably, may be about 1 foot in height and 10 or more feet in length to produce a series of elongated piled strips successively. Preferably a peripheral, projecting frame **37** is spring mounted on the head **29** to confine the mass of strands when withdrawn a pile length therefrom, but arranged to yield rearwardly out of the way when the fusion plate advances up to the head **29**.

A particular tube **31** may be all one color of strand, or it may be several colors, and a partition may be inserted across the cell to keep the colors separate. Upon being threaded, the terminal ends of the strands in each cell of the grid **35** are exposed and form a planar face **38**, the ends being unconnected but ready to be fused or otherwise unified into a film-like backing by the strand end unifying means **23**.

STRAND END UNIFYING MEANS

Strand end unifying means **23** is preferably a plate **40**, having a face **41** heated by suitable means, such as electric resistance units flexibly connected by cable **42** to a source of current not shown. The strands **28** are preferably of thermoplastic material having a predetermined melting point, for example, nylon **6**, with a melting point of about **450°** F., nylon **66** with a melting point of **509°** F., or the like, and the face **41** is heated to well above that temperature, for example, to **850°** F. This is for the reason that at such temperature, any accumulation of the nylon on the plate is burned off, and also to permit an instantaneous, short, contact of the face **41** with the planar face **38** of the exposed terminal tips of the mass of strands, to fuse the tips into a cohesive, film-like backing **43**. It is the film-like backing **43** which unifies the mass of strands, and by which the strands may be subsequently handled, withdrawn from the head, held taut for severing, and constituting the backing for the pile **44** on the piece, block, or tile **21**.

The melt viscosity of the selected material of strands **28**, when nylon **6**, is in the vicinity of 200–700 poises. Melt spun polyester filaments may have melt viscosities as high as 26,000 poises and be useable in the method disclosed herein.

The strands are made of heat fusible material such as thermoplastic synthetic polymers. Examples of such polymers include polyethylene; polypropylene; polycarbonates; polyurethanes; polystyrene; copolymers of vinyl acetate and vinyl chloride; the copolymers of vinylidene chloride and a minor proportion of vinyl chloride; linear polyesters of aromatic dicarboxylic acids and dihydric compounds, such as polymeric ethylene terephthalate; linear polycarbonamides (generally known as nylons) such as polymeric hexamethylene adipamide (nylon-**66**) and polymeric **6**-aminocaproic acid (nylon 6) and other fiber-forming thermoplastic polymers.

There are certain strands, such as cotton, wool, and the like, that are not melt fusible and hence, cannot be used alone. Furthermore, certain heat-fusible thermoplastic strands, such as "Acrilan" acrylic fiber made by Monsanto, are not entirely suitable in that due to their high melt viscosities, the molten materials do not readily spread into a desirable continuous unbroken sheet. For such fiber strands, this invention provides a supply **46** of thin plastic sheets, such as the nylon sheet **47**, the sheets being stored in roll, fan-folded, or sheet magazine form, as at **48**, and automatically fed downwardly to cover the planar face **38** of the tips of the non-fusible strands just before the hot plate **40** reaches the tips on its fusion stroke. By this means the hot plate melts the nylon, or other sheet, while the exposed tips of the non-heat fusible strands embed themselves in the film to form the desired backing **43**.

As best shown in FIG. **8**, it has been found useful to apply a grille **50** of fine metal wire **51** to the planar face **38** of the exposed tips, so that the grille will be embedded in the film-like backing **43** when formed by the hot plate **40**. The grille **50** is so dimensioned that it is of slightly greater area than the face **38**, whereby the selvedge loops **52** extend outside the backing entirely around the periphery. Each resulting pile-carrying piece, or tile, **21**, is thus flexible, and can be assembled into a larger rug by bending the adjacent wire loops **52** into a hooked connection. Replacement of a damaged portion is thus easy and no other backing is needed to unify the larger rug. In addition, wire **51** is preferably an electrical conductor so that it is useful as a means to avoid, and discharge, static electricity by suitably grounding the outside loops **52**. The wire grilles **50** may be substituted for the nylon sheets in magazine **48**, or may be contained in a similar magazine **53** ready for use when desired.

A semi-rigid, or rigid, pile-carrying piece, or block **21**, is also obtainable by means of this invention. As shown in FIG. **1**, a magazine **55** similar to magazines **48** and **53**, is provided, or a fan-fold, or roll supply, if preferred, by which a plurality of relatively thick sheets **56** may be individually and successively fed downwardly to cover the face **38** just after the heat fusion stroke. Each sheet **56** is formed of a suitable material **57**, such as asphalt, or rubber tile composition, or the like. Thus the hot plate **40** may be raised to the desired temperature and held in place for the required time to melt the face **38** and form a film backing **43**. The face **58** of sheet **56** is then bonded to the melted tips of the strands to thereby form a pile-carrying tile useful in place of conventional tile to give a carpet-like floor or wall surface.

STRAND EXTRACTION MEANS

Strand extraction means **24** is preferably in the form of a plate **60** carried on the end of a piston rod **61**, reciprocable in a double action, fluid cylinder **62** and actuated by fluid conduits **63** and **64** from a suitable fluid pressure source **65** controlled by automatic control means **26**, which includes a cycle timer **66**. For diagrammatic convenience the hot plate **40** has been shown gravity operated and with an inclined face **67** engaged by roller cam follower **68** carried by extraction plate **60**. Thus, as the extraction plate **60** withdraws with a piece **21**, the fusion plate **40** advances on its fusion stroke, and as the extraction plate advances to engage the film-like backing **43** formed by the fusion plate **40**, the later is retracted. In one embodiment, the fusion plate **40** preferably advances normal to the planar face **38** to avoid wiping or bending the fiber tips sidewise just prior to fusion. A dwell **69** in cam face **67** permits the extraction plate to halt at a pile length distance from face

38, while holding the strands taut for severance and while holding the hot plate out of the way.

Extraction plate **60** is preferably formed of a plurality of individual, metal strips, or bars, **71** and **72**, extending horizontally and connected alternately in groups so that alternate bars **71** may be advanced beyond the stationary group of bars **72** and then retracted behind the bars **72** of that group. This constitutes a stripping mechanism and the bars **71** are moved by flexible cables **73** under the control of means **26** and timer **66** when the extraction plate is in its rearward position (FIG. **5**). Narrow suction slots **74** are provided between the bars **71** and **72** and connected by flexible conduit **75** to a source of suction **76**. Extending vertically on the planar extraction face **77** formed by bars **71** and **72** are a plurality of hooked barbs **78**, formed by parallel projecting ribs **79** which have been undercut at **80** at spaced distances therealong to form the hooked barbs **78**.

The barbed, suction face **83** of the extraction plate **60**, as shown in FIG. **9**, may be sculptured, or otherwise shaped, in a reverse pattern, as at **84**, so that when it advances, subsequent to the heat fusion step, to engage and grip the still hot and tacky film-like backing **43**, it will impress its shape on the planar face **38** to create the desired obverse sculptured design.

It should be especially noted that the barbed, suction face **83**, upon being pressed against the tacky, hot-melt face **38**, with suction being applied in the slots **74**, not only draws the hot plastic film under the hooked barbs **78**, for firm embedment over the entire surface area, but it also tends to orient the plastic in the film-like backing **43** into a stronger sheet than if heat alone were applied. For example, when the fibers are of nylon 6, and the hot plate **40** has been applied at about **850°** F and retracted and the suction plate **60** is then applied within about one second at about **6–15** inches of suction, the backing is so tough that it is most difficult to tear it by an even pull or even to break it by bending it back upon itself. On the other hand, with all conditions the same, but in the absence of the suction, the backing is somewhat brittle and tends to break and tear more easily.

As shown in FIG. **10**, an extraction plate **85** may be provided with a plurality of spaced rotatable corkscrews, or augers **86**, projecting forwardly and power rotatable by the battery of enmeshed gears **87** and the flexible drive cable **88** powered from the control **66**. The corkscrews **86** are arranged to turn just sufficiently to secure a good penetration in the film-like backing **43** which may be cold and solid, or hot and tacky, so that upon withdrawal they will extract the strand mass from the head for severing. The corkscrews **86** may be used on plate **60** in place of the barbs **78** if desired, and the holes made by the corkscrews **86** close over, upon reverse rotation thereof for stripping, although they may be open if breathing of the fabric is desired.

It will be understood that the suction, hooked-barb, plate **60**, or the cork-screw carrying plate **85**, both are for the purpose of withdrawing, or extracting the strand from the head by pulling on a film-like backing **43** formed by the fusion plate **40**. In one modification of the invention, shown in FIG. **6**, however, the inside face **90** of the film-like backing **91** is used for pushing the strand from the inside out of the head **92**, this being an extraction force as far as the strands **28** are concerned. An open cellular grid **93** is mounted to reciprocate around and between the walls of the cells of a slightly smaller grid **94** formed by the terminal ends of the tubular conduits **31**, so that when the exterior extraction grid **93** moves in the direction of feed, it engages the inside face **90** of film **43**, just as do the hooked barbs **78** or the turned cork-screws **86**, and pulls, or draws, the strand **28** out of head for the desired length of pile **89**. In the embodiment of FIG. **6**, the strand end unifying means **23** and the strand severing means **25** have been combined in one relatively wide endless band-saw blade **95**, which is heated to the desired fusion temperature, such as **450°** to **900°** F. by passage through a heating zone **96**, or by any other convenient means and forms a platelike unifying element similar to fusion plate **40** which melts the terminal ends **97** of the strands on both sides of the cut as it travels through the mass of strands. The blade **95** is not a hot wire, since it is intended to form the film-like backing **43** by wiping contact, and not merely to cut the strands. The hot, wide blade **95** is preferably dimpled as at **98**, for best results, and is preferably followed by, or accompanied by, a cold, wide endless blade **99** for solidifying the backing **43**. In the embodiment of FIG. **6** a film **43** is first formed by blade **95** while the terminal ends of the strands project only slightly from the head. The exterior grid **93** is then advanced, by flexible cable connection **100**, to control **66**, to advance the mass by film **43** a distance equal to twice pile length, whereupon grid **93** is retracted, air from source **101** jetted outwardly from head **92** to tauten the projecting mass, and blade **95** again traversed to sever a double film faced piece **102**. The pieces **102** are later cut centrally into individual pile-carrying pieces **21**.

STRAND SEVERING MEANS

As explained above, the strand severing means **25** is preferably a wide, endless band-saw blade **104**, which may be heated and dimpled as at **95** if used to heat-fuse a film, but which otherwise is simply a sharp-edged wire, blade, or other cutter, and which could be a power disc saw, a laser beam, or any other suitable device. It is shown diagrammatically in FIGS. **1–7**, as trained around sheaves **105** on a vertically movable frame **106** which is raised and lowered by fluid piston **107** and cylinder **108** from a suitable fluid pressure source, under the control of means **26** and timer **66**. The blade **104**, as shown in FIG. **4** moves transversely of the mass of fibers in the space between the head **29** and the suction plate **60** to sever the fibers while held taut between the same. Upon being severed, the backing **43** and its pile **44** is carried rearwardly on extraction plate **60** (FIG. **5**) to the rearward position, whereupon the stripper bars **71** first advance and then retract, to unhook the fabric block, or piece, **21**, to fall into a hopper not shown.

Preferably, the air source **101**, feeds jets of air outwardly from the head **29**, from within the mass, by means of flat, elongated, nozzles, or narrow emission slots, **106**, at high pressure to fluff out the terminal ends of the fibers and maintain the same normal to the face **38** just prior to and during the fusion step, all under the control of valve **120**, means **26**, and timer **66**.

While the prior art has taught various ways of handling tightly compacted bundles of parallelized fibers by pushing the same through a mold, placing a wrapper around the bundle and pushing it, etc., such devices and methods will only produce highly compacted dense pile, and this is not always commercially desirable. This invention therefore contemplates handling less densely compacted bundles, such as 100 ends to the inch, rather than 200 ends to the inch or more, and it will be understood that such a bundle is limp, non-self supporting, and easily bent, or compressed sidewise. In order to provide a braking, or retarding, force even when the bundle of fibers in each cell, or tube, of head **29** is so loose and fluffy as to not be appreciably friction-retarded by the tube walls, the braking means **110** is provided. Braking means **110** is mounted in each cell **36** of head **29** and comprises a first pair of spring leaf clamp arms **111** and **112** which resiliently and yieldably compress the tow from two opposite sides, and a second pair of spring leaf clamp arms **113** and **114** which resiliently and yieldably compress the tow from the other two opposite sides. The less dense tows are thus capable of being pulled out of the cells but only against the adjustable retarding force of the spring arms.

In FIG. **7** another modification is shown, in which the freeze consolidation of the prior art is used, but not for the entire strand and not with sidewise application of chill molds. As in the case of the heat fusion plate **40**, the chill plate **115** is applied endwise of the terminal tips **116** of the strands **28**, forming the planar face **38** face **38**, as a plate-like, unifying element, maintained at a predetermined temperature, for joining

the exposed strand ends to each other. Chilling occurs after the face **38** has been sprayed with a moist or liquid water spray from the orifices **117** carried by plate **115** and connected to a suitable source of freezable liquid **118**. Chill plate **115** is connected to a suitable refrigerator mechanism **119**, of a commercially available type and maintained at a temperature of about **40°** below zero to instantly freeze, or frost, the water spray into a film-like backing **122**, in which the tips **116** are temporarily embedded and anchored, the remainder of the strands being free of water and frost or ice. An internal, reciprocal grid, such as **93**, may then extract by pushing from the inside against the frozen backing, or a barbed suction plate **60** may be used as shown to extract. The pile is then cut and the piece **121** deposited on a conveyor for attachment to a backing by melting a portion of the frozen backing and applying an adhesive in the manner of the Miller patent mentioned above.

It will be understood that the apparatus and method of this invention can be used with many other strand materials to make pile products, for example, polypropylene ribbon can be so used. It is for that reason that I use the term "strand," meaning thereby to include filamentary, man-made fibers spun natural fiber yarns, ribbons, tapes, or any other elongated, flexible material intended to form a pile, whether in tow, sliver, roping, roving, or other form, and whether the pile material is to be in shag rug form, wig form, artificial lawn, or ski slope surface, or the like. Similarly, while the invention is especially intended to create colored pattern rug type designs, it is equally useful in making uncolored pile piece goods, for later dyeing into designs.

For materials not readily melt fusible, a melt fusible powder or a melt fusible liquid substance may be sprayed on the terminal tips forming the planar face **38**, just prior to application of the fusion plate. A strippable adhesive can also be used,such as heat-activated adhesives and pressure sensitive adhesives. Such adhesive materials are made from a variety of complex chemical compositions. Typical ingredients used in pressure-sensitive adhesives generally include an elastomer, such as a rubber, tacktifier, such as gum resin, a plasticizer, such as lanolin, fillers and anti-oxidants. "Teflon" (polymeric tetra fluor ethylene) can also be used as a coating on an unbarbed extraction plate, since the piece may be easily stripped from the extraction plate when cooled.

The non-woven, pile fabric product of this invention differs from the products disclosed in prior patents, in that the outstanding portions of the strands, which form the pile, have not been subjected to, or exposed to, ice, or other solidifying mediums so that the medium must later be removed and may have damaged the fibers. Similarly the pile product of the invention can be made by the process thereof, without requiring a dense, compact mass, or bundle, and without requiring that the fibers be short so that they will project unsupported from a head while a knife blade cuts off a slice thereof.

By reason of the formation of the backing film **43**, the suction plate support of the strands during severing and the tautening effect of the suction plate and retarding means **110**, the pile strands **44** can be less dense, non-self supporting and normally limp, but still be held taut and precisely cut to form a smooth face. Similarly, even if the pile has a density of less than one hundred ends to the inch and each strand **44** is several inches in length, for example in a shag rug, it is held taut and precisely cut to form a novel fabric not heretofore obtainable by such a process without solidifying the mass prior to cutting.

The pile fabric product **21**, may be of any desired area, depending on the area of the head **29**, to form a rug, or to be assembled, in any known or desired manner, into a rug or other pile product.

What is claimed is:

1. Apparatus for making a non-woven, pile fabric from a plurality of elongated pile-forming strands, said apparatus comprising:

strand supply means, supporting said strands for withdrawal, said means terminating in a head of predetermined cross sectional area presenting the exposed terminal ends of said strands as a compacted but unconnected mass defining a substantially planar face;

strand end unifying means, including a plate-like unifying element, maintained at a predetermined temperature and operably associated with, and movable relative to, said head for joining said exposed strand ends while said strand ends are supported in said head into a cohesive, film-like backing by which said strands may be withdrawn from said strand supply means;

strand extraction means, including an element engageable with said film-like backing while said strand ends are supported in said head, and operably associated with, and movable relative to, said head, for pulling a predetermined length of said strands from said head by engagement with said backing, and

strand severing means, operably associated with said head, and movable transversely thereof between said head and said film-like backing for severing said withdrawn strands to form a flexible fabric piece having pile of predetermined length projecting from said film-like backing.

2. Apparatus as specified in claim **1** wherein:

said head comprises a grid, or honeycomb openwork, formed of a multiplicity of close spaced open tubular cells, each tubular cell being the terminus of one of a multiplicity of elongated tubular guides, each containing a bundle of strands of a selected color to define a pattern,

each said tubular cell encompassing one of said bundles to offer close support to said strands during severance thereof while maintaining the integrity of said pattern.

3. Apparatus as specified in claim **1** wherein:

said head comprises a multiplicity of closely spaced open cells, forming a honeycomb type openwork to maintain the integrity of a pre-selected colored pattern and each said cell includes two, right angularly disposed pairs of spring braking arms adapted to compact the strands passing therethrough while applying tension thereon against the pull of said extraction means during severing of said strands.

4. Apparatus as specified in claim **1** wherein:

said strands are of fusible plastic material and said plate-like unifying element of said strand end unifying means is a smooth, heated fusion plate adapted to engage said planar face and melt said strand ends to fuse into said cohesive film-like backing.

5. Apparatus as specified in claim **1** wherein:

said strands are of non-fusible material and said strand end unifying means includes a heating member and a thin sheet of heat fusible plastic material interposed between said member and said ends to fuse said ends into said backing.

6. Apparatus as specified in claim **1** wherein:

said strand end unifying means is a hot plate and includes a grille of fine, strong wire having loops projecting entirely therearound, said grille being integrally bonded to said ends during the unification thereof by said hot plate,

whereby the resulting flexible, pile fabric pieces may be assembled together into a pattern by interconnecting said integral projecting loops.

7. Apparatus as specified in claim **1** wherein:

said strand extraction means is a barbed, suction plate, said plate having a reverse sculptured surface in a predetermined pattern,

whereby the pile in the resultant severed piece of pile fabric has an obverse sculptured surface.

8. Apparatus as specified in claim **1** wherein:

said strand end unifying means is a hot plate and includes means for interposing a relatively thick layer of heat settable plastic backing material between said ends and said plate while said strand ends are supported in said head to form a relatively rigid backing on the resultant piece of pile fabric;

whereby said piece forms a pile-carrying plastic tile.

9. Apparatus as specified in claim 1 wherein:

said strand end unifying means and said strand severing means both are formed by at least one heated, endless cutting blade arranged to sever said strands as it fuses the severed portions thereof into a unified film-like backing.

10. Apparatus as specified in claim 1 wherein:

said head comprises a grid, or honeycomb openwork, of open ended, closely spaced cells and

said strand extraction means is a corresponding grid of said cells, mounted to move axially and slidably on said first named grid;

said second named grid advancing said mass of strands out of said head by pushing against the inner face of each successive film-like backing formed by said unifying means

thereby pulling said mass of strands out of said head and maintaining tension thereon during severance.

11. Apparatus as specified in claim 1 wherein:

said strand extraction means is a plate-like support co-extensive in area with said head, said support including a plurality of spaced corkscrew, or auger, elements and means for rotating said elements to penetrate said backing and grip the same for withdrawal.

12. Apparatus as specified in claim 1 wherein:

said strand extraction means is a plate-like support, divided by suction slots into strips alternately axially movable in opposite axial directions and wherein said strips each include a multiplicity of undercut, hook-like barbs,

said suction slots drawing a still melted backing into the undercuts of said barbs to firmly grip said backing and said alternate, axially, movable strips serving to strip said backing from said barbed plate.

13. Apparatus as specified in claim 1 wherein:

said apparatus includes spray means for thoroughly moistening said exposed ends of said strands and cooling the same to just above freezing temperature of said moisture,

and said plate-like unifying element of said strand end unifying means comprises a freeze plate maintained at a temperature of well below said freezing temperature, and applied endwise to said exposed ends to unify said ends into said film-like backing.

14. Apparatus as specified in claim 1 wherein:

said strand supply means includes a close packed mass of thin walled tubes, each encompassing an individual bundle of said strands and supporting the same during severance, the walls of said tubes frictionally retarding the advance of the bundle therewithin to hold the same taut during said pulling and severance thereof.

15. Apparatus as specified in claim 1 wherein:

said strand end unifying means includes a hot plate for making said planar face tacky and said strand extraction means includes an extraction plate divided into a plurality of individual metal strips connected alternately in groups, one group being movable relative to the other, said strips having an extraction face with a plurality of sharp elements thereon

and mechanism for advancing and retracting said strips when said extraction face is pressed against said tacky planar face.

whereby said sharp elements obtain a grip in said tacky backing while orienting the material thereof.

16. Apparatus for making a non-woven pile fabric of relatively low density of pile from continuous, filamentary, synthetic strand material, said apparatus comprising:

strand supply means, including a grid of open-ended, tubular conduits defining a predetermined pattern and supporting tows of various colors in compacted, but unconnected, condition for withdrawal, with the mass of exposed strand ends defining a planar face;

strand end unifying means including a plate, heated to well above the melting point of said strands, and movable toward and away from said face to fuse said ends into a cohesive, film-like backing,

strand extraction means including a plate, having sharp elements thereon adapted to be embedded in said backing, when in melted condition, and having stripper mechanism thereon, said plate being movable toward and away from said face to grip said backing, extract a predetermined length of said strands and hold the same under tension;

strand severing means movable transversely between said grid and said retracted extraction means to sever a predetermined length of pile from said strands while said strands are under said tension;

and automatic control means for actuating said unifying means, said extraction means and said severing means successively to produce a plurality of individual flexible pile fabric pieces adapted to be included in an overall pile fabric design.

17. Apparatus as specified in claim 16, wherein:

said strand extraction means includes a plurality of metal strips, each supporting some said sharp elements, and alternately movable toward and away from said planar face and includes means for moving said strips to orient the material of said film-like backing.

18. Apparatus as specified in claim 16 wherein:

said extraction means includes a plurality of strips forming said plate and carrying said sharp elements, mechanism for moving said strips to orient the material of said film-like backing and suction slot means for drawing said material into the grip of said sharp elements.

19. Apparatus for making a non-woven, pile fabric, said apparatus comprising:

strand supply means, including a battery of tubular strand guides, terminating in a pattern head of predetermined area, for parallelizing running lengths of pile-forming strands into a relatively close packed mass of exposed, strand ends in a predetermined pattern framed in said head;

strand end unifying means, operably associated with said pattern head, said means including a hot plate, coextensive in area with said head, and movable toward and away therefrom, for joining said strand ends into a cohesive film-like backing;

extraction means operably associated with said pattern head, and movable relative thereto, said means comprising a barbed, suction plate for contacting said film-like backing and withdrawing a predetermined length of said strands, ready for transverse severance into a pile, and

strand severing means operably associated with said pattern head and movable in a path between said extraction means and said pattern head, said means including an endless band saw for cutting said strands into a flexible, fabric piece having an integral backing with a patterned upstanding pile.

strand extraction means including a plate, having sharp elements thereon adapted to be embedded in said backing, when in melted condition, and having stripper mechanism thereon, said plate being movable toward and away from said face to grip said backing, extract a predetermined length of said strands and hold the same under tension;

strand severing means movable transversely between said grid and said retracted extraction means to sever a predetermined length of pile from said strands while said strands are under said tension;

and automatic control means for actuating said unifying means, said extraction means and said severing means successively to produce a plurality of individual flexible pile fabric pieces adapted to be included in an overall pile fabric design.

20. Apparatus for making a non-woven, pile fabric from a plurality of elongated pile-forming strands, said apparatus comprising:

strand supply means supporting said strands for withdrawal, said means terminating in a head of predetermined cross sectional area presenting the exposed terminal ends of said strands as a compacted, but unconnected, mass defining a substantially planar face;

a strand end unifying plate, mounted to move toward and away from said face, and maintained at a predetermined temperature, said plate joining the exposed ends of said strands into a cohesive film-like backing by which said strands may be withdrawn by pulling from said head;

a strand extraction means, mounted to move toward and away from said film-like backing to engage said backing and advance the same out of said head a predetermined distance, pull the strands taut for severance and then release said backing, and

strand severing means, mounted to move transversely between said head and said film-like backing while said backing is engaged by said extraction means while said strands are held taut thereby, for severing said strands to form a flexible fabric piece with a preformed film-like backing and with a preformed pile or predetermined length projecting from said backing.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,673,048 Dated June 27, 1972

Inventor(s) Lester Gidge and Valmor R. Poulin, Jr.

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

ABSTRACT, line 6 insert "backing and" after "with the" and before "pull".

Signed and sealed this 17th day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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