May 14, 1963 J. T. SHORT 3,089,442

TUFTING METHOD AND APPARATUS

Filed May 3, 1962 3 Sheets-Sheet 1

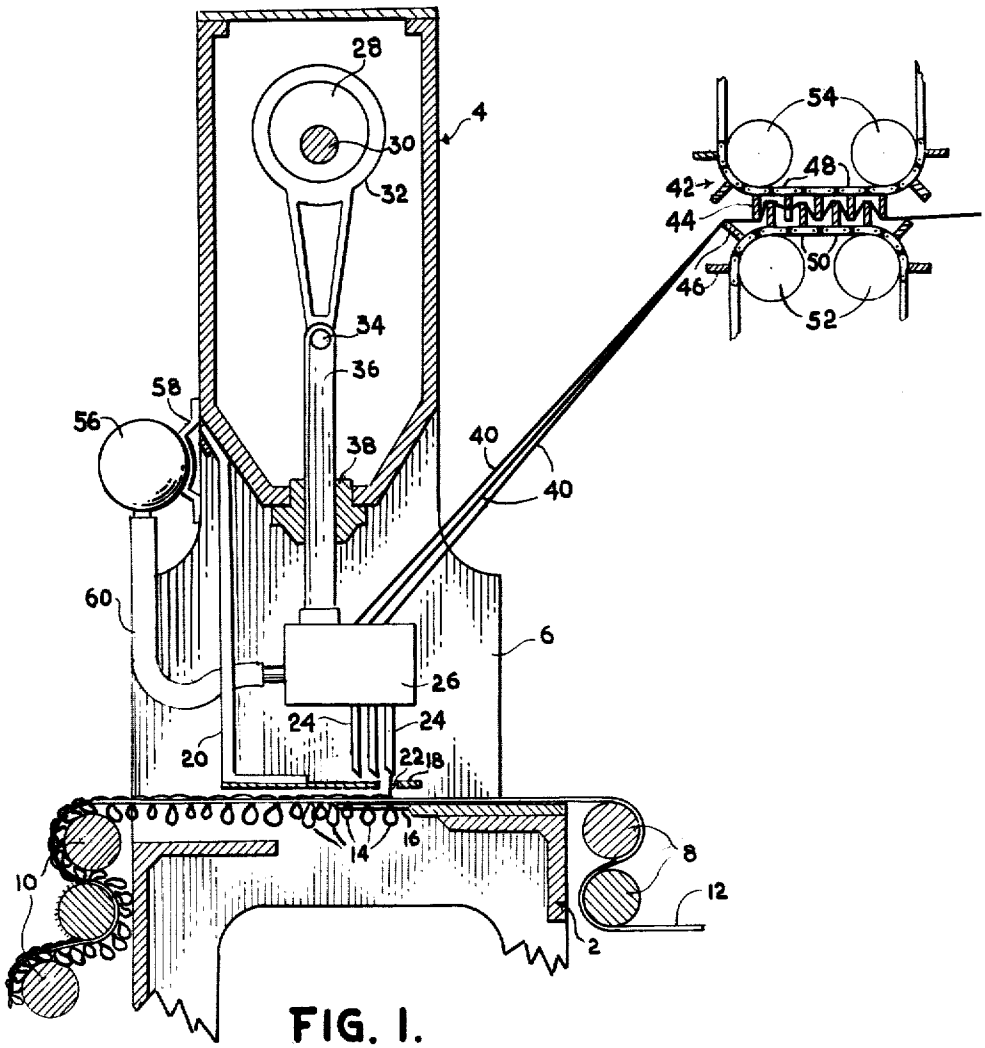

FIG. 1.

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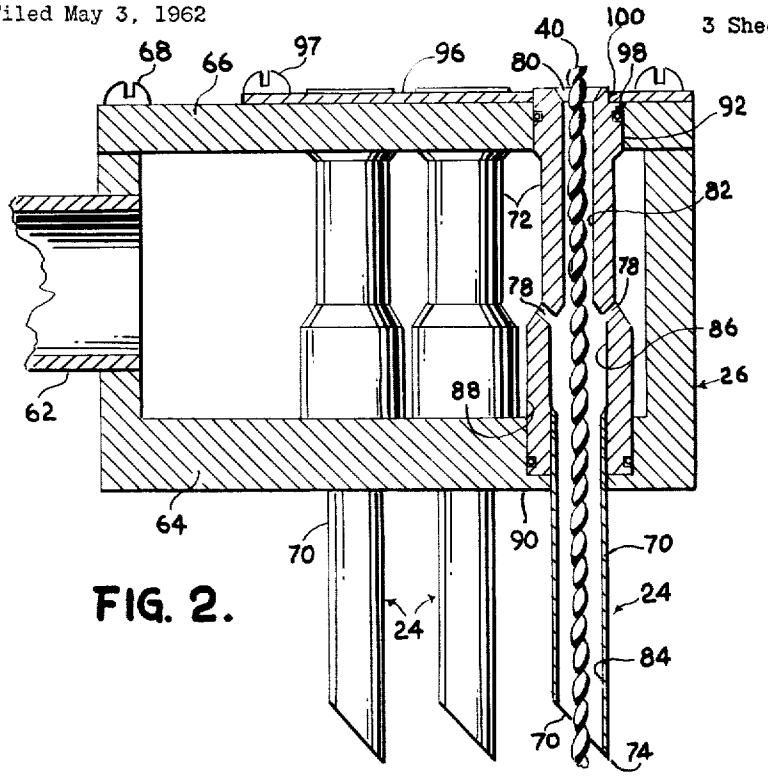

FIG. 2.

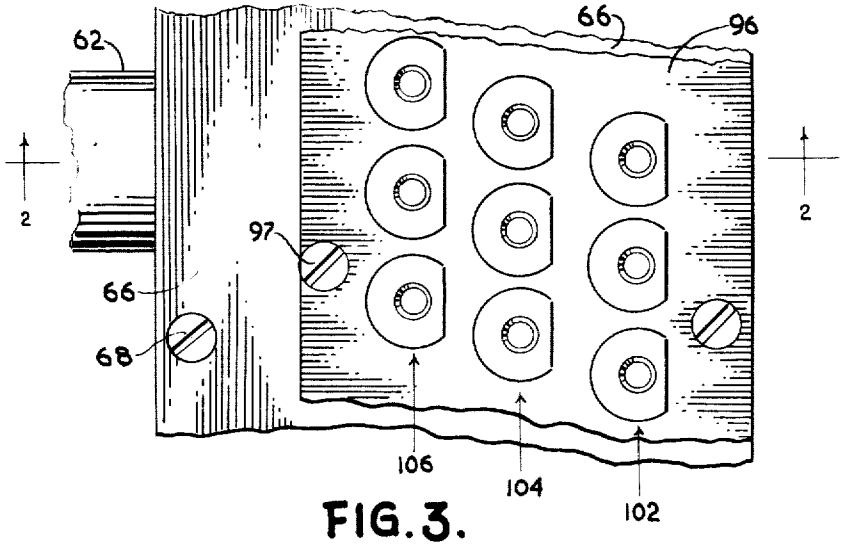

FIG. 3.

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TUFTING METHOD AND APPARATUS

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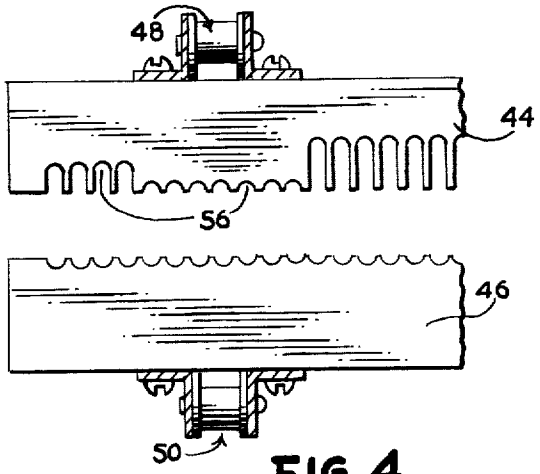

FIG. 4.

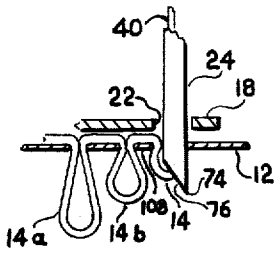

FIG. 5.

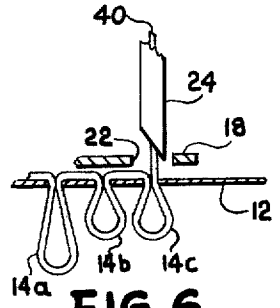

FIG. 6.

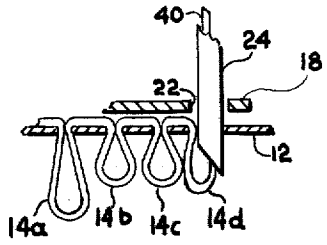

FIG. 7.

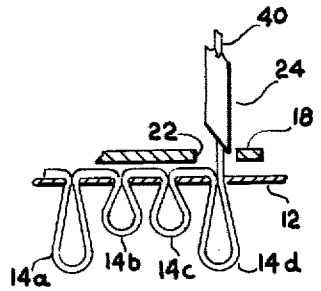

FIG. 8.

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United States Patent Office 3,089,442 Patented May 14, 1963

3,089,442

TUFTING METHOD AND APPARATUS

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Filed May 3, 1962, Ser. No. 192,242
11 Claims. (Cl. 112—79)

This invention relates to the making of pile fabric, and more particularly, to a multiple needle tufting machine and method of producing wide yardage goods such as floor covering materials.

Multiple needle tufting machines have been in general use for a number of years. In a typical commercial installation of the type used prior to the present invention, the formation of pile loops or tufts is accomplished through the interaction of needle and looper elements disposed on opposite sides of a backing sheet. Both the needles and the loopers are arranged in long rows extending transversely of the backing sheet and the backing sheet is advanced longitudinally. Each of the needles has an eye near its free end through which a pile yarn is threaded. All of the needles move together toward and away from the backing sheet. As a needle moves towards the backing sheet, it carries with it a pile yarn and projects or inserts a loop of this pile yarn through the backing sheet, and then the looper element moves into the pile loop to hold the loop as the needle is withdrawn from the backing sheet.

With this type of equipment the maximum loop height that can be produced is determined by the position of the looper elements relative to the backing sheet. However, shorter loops may be formed by various backdrawing techniques in which yarn is withdrawn from loops that have been released by the looper elements. Such techniques had been used extensively in the production of floor covering materials having high-low pattern effects.

Although these known methods and machines will serve to produce a range of commercially acceptable products, many difficulties have been encountered in actual manufacturing operations. The equipment must be considered as delicate, both from the standpoint of the fine adjustments that are required and from the standpoint of the ease and frequency with which many of the parts may be bent or broken. Moreover, production is slower than is desired, and the maintenance of a high degree of product uniformity is difficult. The use of certain otherwise desirable pile yarns, such as texturized multifilament nylon, has proved to be particularly troublesome.

It is a general object of this invention to provide improved tufting methods and apparatus that will overcome these disadvantages. A more specific object of the invention is to provide new tufting methods for producing yardage goods at higher speeds and with greater reliability than has been possible heretofore and to provide apparatus of simple and sturdy construction which can be used with facility in carrying out such methods.

In a preferred embodiment of the invention, the pile yarns are inserted through the backing sheet by hollow needles having yarn delivery channels through which air is caused to flow at high velocity. The air streams apply forces to the pile yarns tending to project these yarns from the open ends of the needles, but these forces may be overcome by holding forces applied to the yarn passing to the needles. In the invention these holding forces are applied by suitable yarn delivery means that serve to release to the needles controlled amounts of yarn during each loop forming cycle.

The formation of loops is brought about by moving the hollow needles back and forth so as to periodically project their discharge ends through the backing sheet and then withdraw the needles from the backing sheet. As a needle enters the backing sheet, the pile yarn is inserted in the form of a loop. Then, as the needle is withdrawn, the loop is left in the fabric. The amount of yarn supplied to a loop during a loop forming cycle determines the height of the formed loop, and since the air stream will project from the needle all of the yarn that is supplied to the needle by the yarn delivery means, loop height may be controlled by controlling the yarn delivery means.

A more complete understanding of the invention and an awareness of many of its advantages will be gained from a consideration of the following detailed description of the embodiment illustrated in the accompanying drawing, in which:

FIGURE 1 is a somewhat diagrammatic transverse cross sectional view of a multiple needle tufting machine constructed in accordance with the invention;

FIGURE 2 is a vertical cross sectional view taken along the line 2—2 in FIGURE 3 and illustrating the hollow needle and the needle carrier assembly for the machine shown in FIGURE 1;

FIGURE 3 is a partial plan view of the needle and needle carrier assembly;

FIGURE 4 is an exploded view illustrating in elevation portions of a pair of intermeshing pattern bars of the type used in the yarn feeding means shown in FIGURE 1; and

FIGURES 5, 6, 7, and 8 are diagrammatic views illustrating pile loop forming operations carried out by the machine of FIGURE 1.

The frame of the machine includes a base portion 2 and an upper housing unit 4 extending from one side of the machine to the other. Uprights 6 located at the ends of the machine support the upper housing unit 4 in spaced relation to the base portion 2 of the frame, and suitable fabric feeding and guiding means including rollers 8 and 10 advance a backing sheet 12 across the base portion 2 in the zone between the uprights 6 in a conventional manner. The backing sheet 12 ordinarily is a woven jute fabric, but any suitable material may be used.

As the backing sheet 12 is advanced, it moves through a tufting zone where pile loops 14 are inserted therethrough. In this zone, the backing sheet 12 is supported from below by a plurality of tine elements 16 secured to the base portion 2 of the machine and it is held against substantial upward movement by a presser member 18 carried by bracket means 20 secured to the upper housing 4. The presser member 18 is provided with openings 22 in vertical alignment with the spaces between adjacent ones of the tines 16 and also in vertical alignment with the needles 24 of the machine.

These needles 24 are hollow and are mounted on a needle carrier 26 which is moved down and up cyclically to insert the free lower end portions of the needles 24 into the backing sheet 12 and to withdraw the needles 24 from the backing sheet 12. In the illustrated embodiment, the motion of the needle carrier 26 is a simple reciprocating motion. With this type of needle motion, it is preferred that the advance of the backing sheet 12 be intermittent so that the backing sheet 12 need not move during the portion of the machine cycle when the lower end portions of the needles 24 are inserted into the backing sheet.

The drive for the needle carrier 26 may include an eccentric 28 rotatable with a driven shaft 30 within a bearing member 32. The bearing member 32 is pivotally connected at 34 to the upper end of a push rod 36 mounted for vertical sliding movement in a bearing member 38 carried by the upper housing unit 4 of the machine. The lower end of the push rod 36 is connected rigidly to the needle carrier 26 so that the needle carrier 26 will move up and down as the eccentric 28 rotates about the axis of the driven shaft 30.

It will be observed from FIGURE 1 that there are no loopers or looper operating mechanisms beneath the backing sheet **12** in the tufting zone. This represents a significant departure from the machines in general use prior to the present invention. Such looper elements have always been sources of operational difficulties and maintenance expense. They necessitated fine adjustments in spacing and timing and they were frequently bent or broken during use. Since the present invention requires no loopers, the machine structure has been greatly simplified and it is more reliable in operation.

Pile yarns **40** for forming the loops **14** may be supplied from any suitable yarn supply or source, such as a creel, not illustrated. The movements of the pile yarns **40** from the yarn supply toward the needles **24** are controlled so as to make available to the needles predetermined lengths of yarn sufficient for the formation of stitches containing pile loops of the desired heights. A number of different types of means for controlling the yarns in the required manner are known in the art. The particular means chosen for illustration in the drawings as an example is one that can be used in the production of fabrics having pile of the same height throughout or fabrics having patterns of high and low pile.

In the embodiment shown in FIGURE 1, the pile yarns **40** are positively fed or withdrawn from the yarn source and released in a controlled manner to the needles **24** by a feed mechanism **42** of the notched bar type. This mechanism is well known, and it need not be described in detail here. It will suffice to point out that the pile yarns are engaged by intermeshing pattern bars **44** and **46** mounted on endless carriers **48** and **50** that are guided through a yarn feeding zone by suitable means **52** and **54**. The intermeshing pattern bars **44** and **46** cause the yarns **40** to assume undulating paths as they pass through the feeding zone. As shown in FIGURE 4, the individual pattern bars have notches **56** of varying depths in their edges, so that the lengths of yarn stored in a row of these undulations may be different. When the endless carriers **48** and **50** move a pair of pattern bars **44** and **46** out of the zone of intermeshing, different amounts of yarn may be released to the different needles **24** in a manner well understood in the art. In instances where level pile fabrics are desired, the notches in the pattern bars may be of uniform depths or the notches may be omitted entirely.

The invention also requires means for causing fluid to flow through the hollow needles **24** during at least a portion of each machine cycle. It is presently preferred that this requirement be met by continuously supplying air under pressure to the needles. In the illustrated embodiment, a high pressure air source is represented by a tank **56** carried by bracket means **58** attached to an upper portion of the machine framework. A flexible conduit **60** is provided for conducting the air from the source **56** to a fitting **62** on the needle carrier **26**.

The interior construction of the needle carrier **26** and the manner in which the air is admitted to the hollow needles **24** is illustrated best in FIGURE 3. The needle carrier **26** is made up of a housing **64** and a removable top wall **66**. The housing **64** has bottom, side and end walls, so that when the removable top wall **66** is positioned properly and held in place on the housing **64**, as by screw means **68**, the interior of the needle carrier **26** provides a large internal air chamber or manifold into which air from the flexible conduit **60** may pass through the fitting **62**.

Each needle **24** may be a unitary body, or it may be made up of a plurality of parts that are either connected together or are connected to the needle carrier **26** in such a way as to fix their positions relative to one another. The needle **24** shown in FIGURE 3 is made up of a tip **70** and a shank or body **72** soldered together.

The tip portion **70** of each needle **24** is a cylindrical tube and its lower end is cut away at an acute angle to the axis of the tube so as to provide a point **74** and a tapered wall **76**. In this embodiment, the angle at which the lower end of the needle tip **70** is cut away causes the outlet opening at the lower end of the hollow needle **24** to face downwardly and forwardly in the direction of the advance of the backing sheet **12**.

The body **72** of each of the needles **24** is also tubular and has an axial opening therein communicating with the axial opening in the tip **70** to provide a flow channel or passageway through the needle.

Downwardly inclined openings **78** in the wall of the needle body **72** provide orifice means through which air may enter the needle passageway. As air moves from the high pressure chamber formed by the interior of the needle carrier **26** through the restricted orifice means **78**, its pressure decreases and its velocity increases so that the air issues from the orifice means **78** in jet form.

It is preferred that the orifice means **78** be such as to reduce the pressure of the air below atmospheric pressure at the outlet of the orifice means. With this arrangement an additional draft of air downwardly through the open upper end **80** of the axial opening in the body **72** is induced.

It will be observed that the internal passageway through the needle **24** shown in cross section in FIGURE 2 includes portions of three different diameters. The yarn inlet portion **82** is of small diameter, the outlet portion **84** is of larger diameter, and an intermediate portion **86** is of still larger diameter. Although this relationship is not essential, it is believed to have some advantages. The small cross section of the inlet portion **82** minimizes air flow through this portion when the pile yarn **40** has been threaded through the needle, and the enlarged portion **86** provides a zone where the air flow patterns may be stabilized somewhat.

Air flows at high velocity through the outlet portion **84** of the passageway from the portion **86** and out of the outlet opening at the lower end of the needle. When a yarn **40** is threaded through the needle **24**, this high velocity air stream applies forces to the portion of the yarn located within and beyond the needle urging these portions downwardly. As a length of yarn is released by the yarn feeding means **42**, it will be fed downwardly through the needle **24** and projected from the lower end thereof.

The body **72** of each needle **24** fits within a circular recess **88** in the bottom wall of the housing **64** and rests against a shoulder **90** at the lower end of the recess. The upper end of the needle body **72** passes through an opening **92** in the top wall **66** of the needle carrier **26** and is held against upward movement by a plate member **96** detachably secured, as by screws **97**, to the top wall **66**. A shoulder **98** on the needle body bears against the under side of the member **96**. Suitable seals, such as O-rings, should be provided to prevent the escape of air from the interior of the needle carrier in the zones where the needles pass through the walls thereof.

As shown best in FIGURE 2, the portion of the needle body **72** that is cut away to provide the shoulder **98** also provides a straight vertical surface **100** that may cooperate with a corresponding vertical surface on the member **96** to assure proper angular orientation of the needle **24**.

FIGURE 2 also illustrates the relationship of the needles **24** to each other. In the illustrated embodiment there are three rows **102**, **104**, and **106** spaced from each other in the direction of the advance of the backing sheet **12** with each extending across the full width of the machine. The needles **24** in the different rows are staggered with respect to each other, so that the axis of a needle in the row **104** and the axis of a needle in the row **106** is located between the axes of adjacent needles in the row **102**. With this arrangement, it is possible to produce pile fabric in which the transverse spacing between longitudinal rows of loops is quite small. In this connection, it should be noted that the number of rows of needles that

may be employed effectively in the machine of this invention is greater than the number that can be employed in a machine having conventional looper elements beneath the backing sheet.

Attention now will be directed to FIGURES 5 through 8 which illustrate diagrammatically the relative positions of the backing sheet **12**, a needle **24** and a pile yarn **40** during portions of two successive cycles of machine operation. In all of these views the backing sheet **12** is shown as having thereon a long or high loop **14***a* and a short or low loop **14***b* formed during earlier cycles of machine operation. FIGURES 5 and 6 then depict operations that take place during a cycle when a low loop **14***c* is being formed, and FIGURES 7 and 8 depict operations that take place during a cycle when a high loop **14***d* is being formed.

FIGURE 5 illustrates the relative positions of the elements when the needle **24** has reached its lowermost position. In moving to this position, the point **74** of the needle would have first penetrated the backing sheet **12** and then the opening so formed would have been enlarged by the passage through the backing sheet of the tapered edge **76** of the lower end of the needle **24**. Of course, enlargement of the opening in the backing fabric to a size sufficient to permit it to receive the full diameter of the tip portion of the needle **24** results in some compression of adjacent portions of the backing strip **12**, as indicated at **108**.

The downward movement of the needle **24** need continue only far enough to expose the outlet opening at the lower end of the needle beneath the backing sheet **12**. The actual feeding of pile yarn **40** into the loop **14***c* being formed is accomplished by the air stream flowing out of the needle **24**. In this connection, it is noted that the feed of yarn **40** into the loop **14***c* may be substantially independent of the movement of the needle **24**. In FIGURE 5, for example, the height of the loop **14***c* is substantially greater than that required for the loop to pass loosely around the leading edge of the outlet opening in the needle **24** but is less than the final height that will be assumed by this loop, even though the needle is at its lowermost position in this view.

As the needle **24** moves upwardly from the position shown in FIGURE 5 to the position shown in FIGURE 6, the air stream continues to feed yarn into the loop **14***c*. The feeding of yarn into the loop **14***c* may continue even after the tip **76** of the needle **24** has moved to a position above the backing sheet **12** to fill out this loop and give it its final height. All of the yarn **40** made available to the needle **24** during the cycle will be fed out of the needle during that cycle, and the height of the loop **14***c* is related directly to the amount of yarn released by the yarn feeding means **42** during the cycle.

The resiliency of the backing sheet material causes the opening formed by the needle **24** to close substantially when the needle **24** is withdrawn. An additional closing action is brought about during the succeeding cycle so that, in the final product, the legs of the loops are held firmly by the backing sheet material.

It will be observed that the total excursion of the needles **24** from their highest points to their lowermost points may be quite small. This makes it possible to operate the machine satisfactorily at speeds higher than the speeds of the machines known heretofore.

FIGURE 7 illustrates the needle **24** in its lowermost position on the next cycle. This view is similar to FIGURE 5, but it will be observed that a greater amount of pile yarn **40** has been fed into the loop **14***d* than had been fed into the loop **14***c* during this portion of the preceding cycle.

FIGURE 8 is similar to FIGURE 6. It shows the elements at a time when enough yarn has been fed into the loop **14***d* to give it its final size.

From FIGURES 5 through 8, it will be evident that the formation of high-low loop patterns in accordance with the present invention does not depend upon the use of backdrawing techniques. With this type of operation each loop is projected by the air stream to its final size.

Although no backdrawing of pile yarn need take place, many of the advantages of the invention may be realized when the operation is set up to effect some backdrawing. For example, if the amount of yarn released to a needle during the down stroke of the needle is substantially less than that required to give the loop being formed a size large enough to permit it to extend loosely about the leading edge of the outlet opening in the needle, some yarn may be drawn back from the preceding loop. However, since this backdrawing is not relied upon for the production of pattern effects it need not be so great as to produce severe tension in the pile yarn, and many of the difficulties heretofore experienced in connection with the backdrawing of thread from previously formed loops are not encountered.

Similarly, if the machine of this invention is set up to effect backdrawing of the yarn from the loop being formed, as by the insertion of a conventional yarn jerker in the yarn path from the yarn feeding means to the yarn inlet opening of the hollow needle, the loop forming operation may still be carried out without experiencing the difficulties that have been characteristic of this type of backdrawing operation as carried out in the past. Since the air streams maintain the yarns under tension at all times, there is no danger that slack in the yarns passing to the needles will cause these yarns to become entangled with each other.

The low and relatively constant tension applied to the pile yarns makes it possible to produce fabric having better uniformity and enhanced pattern definition characteristics. Even the highly elastic filament nylon yarns that have been so difficult to handle with the apparatus used heretofore may be processed with ease.

Although a single embodiment of the invention has been illustrated and described in detail, various modifications and changes will suggest themselves to persons skilled in the art. It is intended therefore that the foregoing description be considered as exemplary only, and the scope of the invention be ascertained from the following claims.

I claim:

1. A multiple needle tufting machine comprising means for advancing a backing sheet along a path, a needle carrier extending across said path, a plurality of hollow needles mounted on said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a fluid passageway therein terminating in an outlet opening in said free end portion of the needle and having a yarn inlet opening spaced from said outlet opening, means for moving said needle carrier cyclically back and forth to insert the free end portions of said needles through the backing sheet far enough to expose their outlet openings on the opposite side of the backing sheet and then to withdraw said needles from the backing sheet, means for positively feeding along paths leading to the yarn inlet openings of said needles controlled lengths of yarn sufficient for the formation of stitches containing pile loops, and means for flowing fluid through said fluid passageways and out of said outlet openings in said needles to move said lengths of yarn relative to said backing sheet out of said outlet openings and away from said needles to form a pile fabric having pile loops extending from said backing sheet to heights related to the lengths of yarn fed by said feeding means.

2. A multiple needle tufting machine comprising means for advancing a back sheet along a path, a needle carrier extending across said path, a plurality of hollow needles mounted on said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a longitudinally extending fluid pas-

sageway therein terminating in an outlet opening in said free end portion of the needle and having a yarn inlet opening spaced from said outlet opening for receiving a yarn leading from a yarn supply, means for moving said needle carrier cyclically back and forth to insert the free end portions of said needles through the backing sheet far enough to expose their outlet openings on the opposite side of the backing sheet and then to withdraw said needles from the backing sheet, means for positively withdrawing from the yarn supply and releasing to the yarn inlet openings of said needles during each cycle of movement of said needle carrier predetermined lengths of yarn sufficient for the formation of stitches containing permanent pile loops, and means for flowing fluid through said fluid passageways and out of said outlet openings in said needles substantially throughout the periods during which said outlet openings are exposed on said opposite side of said backing sheet to move said predetermined lengths of yarn relative to said backing sheet out of said outlet openings and away from said needles to form a pile fabric having pile loops extending from said opposite side of said backing sheet to heights related to the lengths of yarn released to the yarn inlet openings of said needles.

3. A multiple needle tufting machine comprising means for advancing a backing sheet along a path, a needle carrier extending across said path, a plurality of hollow needles mounted on said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a fluid passageway therein terminating in an outlet opening in said free end portion facing forwardly in the direction of advance of the backing sheet and having a yarn inlet opening spaced from said outlet opening for receiving a yarn leading from a yarn supply, means for moving said needle carrier cyclically back and forth to insert the free end portions of said needles through the backing sheet far enough to expose their outlet openings on the opposite side of the backing sheet and then to withdraw said needles from the backing sheet, means for controlling the movements of the yarns from the yarn supply toward the yarn inlet openings in said needles to make available to the yarn inlet openings of said needles predetermined lengths of yarn sufficient for the formation of stitches containing permanent pile loops, and means for flowing fluid through said fluid passageways and out of said outlet openings in said needles to move said lengths of yarn relative to said backing sheet out of said outlet openings and away from said needles to form a pile fabric having pile loops extending from said backing sheet to heights related to the lengths of yarn made available to said needles.

4. A multiple needle tufting machine comprising means for advancing a backing sheet along a path, a needle carrier extending across said path, a plurality of hollow needles mounted on said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a fluid passageway therein terminating in an outlet opening in said free end portion of the needle and having a yarn inlet opening spaced from said outlet opening for receiving a yarn leading from a yarn supply, means for moving said needle carrier cyclically back and forth to insert the free end portions of said needles through the backing sheet far enough to expose their outlet openings on the opposite side of the backing sheet and then to withdraw said needles from the backing sheet, means for positively withdrawing from the yarn supply and releasing to the yarn inlet openings of said needles during each cycle of movement of said needle carrier predetermined lengths of yarn sufficient for the formation of stitches containing pile loops with the lengths released to different needles during one cycle being different and the lengths released to the same needle in different cycles being different, and means for flowing fluid through said fluid passageways and out of said outlet openings in said needles when said outlet openings

are exposed on said opposite side of said backing sheet to move said lengths of yarn relative to said backing sheet out of said outlet openings and away from said needles to form a pile fabric having pile loops extending from said opposite side of said backing sheet to different heights related to the different lengths of yarn released to the yarn inlet openings of said needles.

5. A multiple needle tufting machine comprising means for advancing a backing sheet along a path, a needle carrier extending across said path, a plurality of hollow needles mounted on said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a longitudinally extending fluid passageway therein terminating in an outlet opening in said free end portion of the needle and having a yarn inlet opening spaced from said outlet opening, means for moving said needle carrier cyclically back and forth to insert the free ends of said needles through the backing sheet far enough to expose their outlet openings on the opposite side of the backing sheet and then to withdraw said needles from the backing sheet, feed means including a pair of endless carriers having intermeshing pattern bars thereon for supporting a plurality of yarns in undulating paths and means for advancing said carriers to release to the yarn inlet openings of said needles during each cycle of movement of said needle carrier predetermined lengths of yarn sufficient for the formation of stitches containing pile loops, and means for flowing fluid through said fluid passageways and out of said outlet openings in said needles to move said predetermined lengths of yarn relative to said backing sheet out of said outlet openings and away from said needles to form a pile fabric having pile loops extending from said backing sheet.

6. A multiple needle tufting machine comprising means for advancing a backing sheet along a path, a needle carrier extending across said path, a plurality of hollow needles mounted on said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a longitudinally extending fluid passageway therein terminating in an outlet opening in said free end portion of the needle and having a yarn inlet opening spaced from said outlet opening for receiving a yarn leading from a yarn supply, means for moving said needle carrier cyclically back and forth along a path at one end of which the free end of each needle is located between the needle carrier and the backing sheet and at the other end of which each needle penetrates the backing sheet to expose the outlet opening thereof on the side of the backing sheet opposite said needle carrier, means for controlling the movements of the yarns from the yarn supply toward the yarn inlet openings in said needles to make available to the inlet opening of each needle during each cycle of movement of said needle carrier a predetermined length of yarn greater than the distance said backing sheet is advanced between successive ones of the points where said needle penetrates said backing sheet plus twice the minimum distance of penetration through the backing sheet of the edge of the outlet opening of said needle, and means for flowing fluid through said fluid passageways and out of said outlet openings in said needles to move said predetermined lengths of yarn relative to said backing sheet out of said outlet openings and away from said needles to form a pile fabric having pile loops extending from said backing sheet to heights related to the lengths of yarn made available to said needles.

7. A multiple needle tufting machine as defined in claim 6 wherein said means for controlling the movements of the yarns includes means for making available different predetermined lengths of yarn to different ones of said needles during a given cycle of movement of said needle carrier and for making available to each of at least some of said needles different predetermined lengths

of yarn during different cycles of movement of said needle carrier.

8. A multiple needle tufting machine comprising means for advancing a backing sheet along a path, a needle carrier extending across said path, a plurality of hollow needles mounted on said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a longitudinally extending air passageway therein terminating in an outlet opening in said free end portion of the needle and having a yarn inlet opening spaced from said outlet opening, means for moving said needle carrier cyclically back and forth along a path at one end of which the free end of each needle is located between the needle carrier and the backing sheet and at the other end of which each needle penetrates the backing sheet to expose the outlet opening thereof on the side of the backing sheet opposite said needle carrier, patterning means for positively feeding along a path leading to the inlet opening of each needle during each cycle of movement of said needle carrier a controlled length of yarn sufficient for the formation of a stitch including a pile loop, and means for admitting to said passageways jets of air directed toward said outlet openings to impel said lengths of yarn relative to said backing sheet out of said outlet openings and away from said needles to form a pile fabric having pile loop extending from said backing sheet.

9. A multiple needle tufting machine comprising means for advancing a backing sheet along a path, a needle carrier extending transversely of said path and having a high pressure air chamber therein, a plurality of hollow needles mounted on and extending through said needle carrier and each having a free end portion projecting toward the backing sheet, each of said needles having a longitudinally extending passageway therein terminating in an outlet opening in said free end portion of the needle and having a yarn inlet opening at the end thereof opposite said outlet opening, means for moving said needle carrier cyclically back and forth to insert the free ends of said needles through the backing sheet far enough to expose said outlet openings on the opposite side of the backing sheet and then to withdraw said needles from the backing sheet, and means for positively feeding along paths leading to the yarn inlet openings of said needles during each cycle of movement of said needle carrier controlled lengths of yarn sufficient for the formation of

stitches containing permanent pile loops, each of said needles having at least one inclined orifice therein communicating at one end with said passageway in the needle and at the opposite end with said air chamber for directing a jet of air along said passageway toward said outlet opening in said needle to impel yarn relative to said backing sheet out of said outlet opening and away from said needle.

10. A method of making tufted fabric having longitudinal and transverse rows of pile loops extending from a backing sheet comprising a cycle including the steps of advancing the backing sheet longitudinally, forming a transverse row of openings in said backing sheet and simultaneously inserting portions of a plurality of pile yarns through said openings to provide pile loops on one side of said backing sheet each having a leg extending through one of said openings back toward a yarn supply, positively feeding from said supply additional lengths of pile yarn and simultaneously applying to said legs air streams flowing through said openings toward said loops to impel additional lengths of yarn into said loops to enlarge said loops.

11. A method of making patterned tufted fabric having longitudinal and transverse rows of pile loops of different heights extending from a backing sheet comprising a cycle including the steps of advancing the backing sheet longitudinally, forming a transverse row of openings in said backing sheet and simultaneously inserting portions of a plurality of pile yarns through said openings to provide pile loops on one side of said backing sheet each having a leg extending through one of said openings back toward a yarn supply, positively feeding from said supply additional lengths of pile yarn and simultaneously applying to said legs air streams flowing through said openings toward said loops to impel additional lengths of yarn into said loops to enlarge said loops, said cycle being repeated indefinitely while feeding different lengths of yarn to at least some of said air streams during different cycles.

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