HOLLOW NEEDLE TUFTING APPARATUS

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This invention relates to a tufting apparatus wherein strands are fluid propelled.

In my prior applications, Ser. No. 192,242, filed May 3, 1962, now Patent No. 3,089,442, and Ser. No. 236,054, filed Nov. 7, 1962, there are disclosed tufting mechanisms of the general type with which this invention is concerned.

Each of these applications features a tufting apparatus including a reciprocable needle bar provided with a plurality of needles through which strands are fluid propelled.

The present invention pertains to the general type of needle bar structure disclosed in these prior applications and presents improved needle and needle mounting arrangements by means of which a uniquely effective strand feeding action may be achieved.

In tufting mechanisms particular consideration must be given to obtaining a smooth strand feed which is accurately correlated with a pattern control mechanism. The concept of fluid propelling strands in a tufting machine has provided a particularly satisfactory and effective technique for pattern controlled tufting, however, even with the fluid propelling concept, consideration of particular aspects of needle configurations and mounting arrangements have been required.

A foremost consideration pertains to the obtaining of a smooth strand feed so that accurate pattern control may be maintained. Where fluidly bountiful strands are being tufted, particular attention must be paid to adequately supporting the strands as they are being fluid propelled so that a consistently uniform quelling action is obtained.

In propelling strands comprised of loosely twisted fibers, particular care must be observed during the fluid propelling operation to prevent strand separation. The needles through which strands are fed must produce as little drag effect on strands as possible so that the impediment of feeding is prevented and strand tearing or separation due to drag forces is avoided.

Additional consideration must be given to providing a fluid propelling arrangement which economizes on the quantity of fluid required to effectuate a desired rate of strand feeding.

The manner in which strand feeding needles are mounted upon a needle bar for reciprocation therewith must not be overlooked. Needles must be mounted so as to minimize or avoid needle loosening tendencies which would create vibration and impediment of tufting action. The manner in which needles are secured in a needle bar should facilitate the easy and convenient replacement or initial insertion of needles for maintenance or pattern changing purposes. In addition, the needle mounting arrangement should be characterized by a positive sealing action to avoid fluid leakage and by a positive needle orienting and holding structure.

In recognition of the considerations heretofore noted, there is presented through this invention a unique and improved needle configuration in combination with a particularly effective needle mounting structure.

The present invention entails an apparatus comprising a hollow needle bar adapted to reciprocate toward and away from fabric to be tufted, i.e., a tufting zone. The needle bar includes first wall means having a plurality of first apertures. The needle bar further includes second wall means spaced from the first wall means and disposed between the first wall means and a zone of fabric tufting. The second wall means includes a plurality of second apertures aligned with the first apertures of the first wall means. The needle bar defines an enclosed manifold chamber which is in communication with a source of pressurized fluid.

A plurality of tufting needles are provided, each of which includes a strand passage extending longitudinally therethrough and having pressurized fluid passage means intersecting an intermediate portion thereof and communicaing with the manifold chamber. Each is rigidly mounted in the needle bar and secured at one portion in a first aperture of the first wall means and secured at another portion in a second aperture of the second wall means. Each second aperture of the second wall means has an annular abutment associated therewith which is adapted to engage and prevent outward movement of a tufting needle. Each first aperture of the first wall means is provided with releasable holding means for securing a needle in the needle bar.

Each tufting needle is characterized by a unique combination of strand receiving, fabric penetrating, and intermediate portions. The strand receiving portion of each needle has a first cylindrical passage of uniform diameter, one end of which defines a strand inlet. The fabric penetrating portion of each needle has a second cylindrical passage of uniform diameter and terminates in a strand outlet. The intermediate portion of each needle is disposed between the strand receiving and fabric penetrating portions and has a third cylindrical passage of uniform diameter which is less than that of the diameter of the first cylindrical passage of the strand receiving portion. The aforesaid fluid passage means intersect the intermediate portion of the needle and are preferably symmetrically disposed about the axis of the needle and inclined toward the fabric penetrating needle portion.

In describing the invention, reference will be made to preferred embodiments of the apparatus as disclosed in the accompanying drawings. In these drawings:

FIGURE 1 is a fragmentary, partially sectioned, perspective view of a needle bar of the present invention in which are mounted a plurality of tufting needles;

FIGURE 2 is an enlarged, sectional, and fragmentary view of a needle bar as shown in FIGURE 1, showing internal details of a tufting needle according to one embodiment of the invention;

FIGURE 3 is a sectional view through a strand inlet portion of the FIGURE 2 needle, as viewed along the section line 3—3;

FIGURE 4 is a sectional view through an intermediate portion of the FIGURE 2 needle, as viewed along the section line 4—4;

FIGURE 5 is an enlarged, sectional view which illustrates an alternative needle embodiment adapted to be incorporated in the needle bar arrangement shown in FIGURE 1; and

FIGURE 6 is a sectional view through an intermediate portion of the FIGURE 5 needle embodiment as viewed along the section line 6—6.

As shown in FIGURE 1, the needle bar 1 of this invention is normally elongate in a horizontal direction and supports a plurality of vertically extending tufting needles 2. Each tufting needle 2 in the needle bar arrangement shown in FIGURE 1 is mounted in alignment with the direction of vertical reciprocation of the needle bar 1 toward and away from a zone of tufting. This tufting zone comprises a zone of horizontal advancement of a backing fabric across the path of reciprocation of the needles 2. Bar 1 may be mounted for reciprocation on support rods 1a, one of which is partially illustrated in FIGURE 1.

As shown in FIGS. 1 and 2, the needle bar 1 includes an upper wall 3 and a lower wall 4, which wall 4 is ver-
tically spaced from the wall 3. Walls 3 and 4, in combination with peripherally enclosing side walls means 5, which circumscribe the bar 1, define a manifold chamber 6. Chamber 6 communicates with a source of pressurized fluid, normally compressed air, through means such as flexible conduit 6a, as described in the above specified patent applications. Side wall means 5 may include cover plate 5c which is detachably mounted on the bar by conventional threaded fasteners 5b as schematically shown in FIGURES 1 and 2. To insure proper sealing action, a resilient gasket 5e of rubber, plastic, or any conventional gasket material may be interposed between the cover and the edges of needle bar walls to which it is secured.

Upper wall 3 is provided with a series of spaced apertures 7 while lower wall 4 is provided with a series of spaced apertures 8. Each aperture 7 in wall 3 is coaxially aligned with an aperture 8 in the wall 4.

Each needle 2, as shown in FIGURE 2, includes a strand receiving portion 9 having an internal, cylindrical passage 10 of uniform diameter. Each needle also includes a fabric penetrating portion 11 which has an internal, cylindrical passage 12 of uniform diameter. An intermediate portion 13 of each needle includes an internal, cylindrical passage 14 of uniform diameter. The diameter of the passage 14 as shown in FIGURE 2, is less than the diameter of the passage 10 in the strand receiving portion 9. Needle portions 9 and 13 may be fabricated as a unitary member and attached to the relatively thin-walled portion 11 by conventional means such as soldering. As shown, fabric penetrating portion 11 may be dimensioned such that its internal passage 12 substantially defines a continuation of the passage 14 formed in the intermediate, strand impelling portion 18 of the needle 2.

Intermediate needle portion 13 is provided with means for directing downwardly inclined fluid jets against a strand being fed through the longitudinally extending strand passage defined by passages or bores 16, 14 and 12. Such air passage means in the FIGURE 2 embodiment comprise a series of separate air passages 15 which intersect the intermediate needle portion 13 and are inclined downwardly and generally toward the fabric penetrating portion 11. Preferably, the angle of inclination 16 between the needle axis and the axis of each passage 15 is acute. Passages 15 will usually by symmetrically disposed about the longitudinal axis of the needle 2. As shown in FIGURES 2 and 4, an inlet 15a of each passage lies within the manifold chamber 6 while an outlet 15b is directed toward the bore 14 and lies in an intermediate portion of strand impelling, intermediate needle portion 13. As illustrated in FIGURE 2, inlet 15a may be dimensioned so as to be larger than the diameter of the passage portion which terminates in outlet 15b. This will tend to reduce the fluid pressure drop across the passage 15 while preserving a desired jetting effect at the outlet 15b.

An annular groove 16 is formed in the outer periphery of the strand receiving portion 9 of each needle 2. An O-ring type gasket 17 is carried within the groove 16 and in its relaxed condition extends somewhat beyond the outer periphery of needle portion 9.

Associated with each aperture 8 in the wall 4 is an annular abutment 18. An O-ring type resilient gasket 19 is carried on the portion 11 of the needle 2 and lies against an annular, abutment defining shoulder 20 formed on the needle 2.

A longitudinally extending, aligning surface 21 extends along the upper portion of each needle 2 so as to be perpendicular to a needle radius as shown in FIGURES 2 and 3. Each aligning surface 21 terminates in a generally upwardly facing abutment shoulder 22.

Each needle 2 is mounted in the walls 3 and 4 in the manner shown in FIGURE 2. More specifically, mounting its O-ring gaskets 17 and 19, the fabric penetrating portion 11 of the needle is inserted into the bar 1 through an aperture 7 in the upper plate 3. The fabric penetrat-
upper end of passage 10. A vacuum or aspiration effect caused by the jetting of air through the passages 15 pulls the strand into the needle so as to avoid any tedious, needle threading by hand. The automatic strand threading advantage of the invention is quite significant. Commercial tufting machines have such large numbers of needles that the time saved with automatic threading is of considerable importance.

A strand being fed through a needle slides more loosely through the strand receiving passage or bore 10 than it flows through the relatively narrow diametered, intermediate or strand impelling passage portion 14. With this arrangement, the outlet of the air passage means, such as the outlets 15 of the passages 15 of the FIGURE 2 needle, lie in maximum proximity to the outer periphery of a strand S as shown in FIGURE 4. As will be appreciated, this proximity of the air passage means outlet to the stabilized strand periphery provides a maximum intensification of the impelling force of pressurized air passing through the chamber 6 through the needle passages 15 to the passage 14.

The ability to position the outlet of the fluid passages immediately or substantially adjacent a strand being fed through a needle passage is a direct consequence of the structural nature of the particular strands with which this invention is concerned. Strands being tufted are ordi- narily multi-component in nature and usually loose bodied so as to be fluid permeable while retaining body cohesive- ness. Because of this strand character, fluid passage outlets may lie immediately adjacent the periphery of a strand being fed and the strand impelling air jets allowed to impinge directly on the strand periphery to exert an impelling force and then pass into the strand interior to move longitudinally with the strand and exit from the strand outlet.

In being laterally confined by the bore 14, both above and below the air passage outlets, due to the manner in which the air passages intersect an intermediate portion of the strand passage 14, the strands are highly stabilized while the impelling force of pressurized fluid is applied. This stabilizing action tends to prevent strand whipping within the needle and provides for a smooth and efficient strand feeding action.

The cylindrical passage 10 of the strand receiving needle portion 9, in being enlarged relative to the strand impelling passage 14, may allow some upward flow of air along the outer periphery of a strand in the strand receiving portion 9 of each needle. This upwardly directed air flow, or blow back, will reduce friction between a strand entering the needle and the needle itself. It may serve to fluff out the fibers of a bouffant or fluffy strand so as to create a strand body more amenable to fluid impelling action in the passage 14. Thus, the enlarged passage portion 10 provides for a smoother strand flow through the needle so as to minimize strand breakage tendencies and contributes to the efficiency of the strand impelling action. In addition, any upwardly directed air flow at the needle inlet 9a facilitates the entry of previously threaded yarns into the needle and tends to support yarns away from the inlet so as to minimize snagging tendencies which might induce strand breakage.

The chamfered strand inlet 9a minimizes friction and drag between strands and needles and thus contributes to the ease of entry of the strands into the needles so as to minimize breakage tendencies. In defining a continuation of the passage or bore 14, the passage 12 of the strand penetrating needle portion 10 contributes to the stabilizing of the strand during the impelling and tufting operation. Where the passage 12, like the passage 14, approaches the diameter of the strand being fed, means are inherently provided for minimizing air leakage so as to reduce the amount of pressurized fluid required to effectuate the desired strand feeding action.

Additional efficiency in strand feeding may be achieved by fabricating the needle of suitable friction easing material. In this connection, it has been found that fabricating the needle portion which provides the strand receiving portion 9 and the intermediate portion 13 of the needle and the strand penetrating portion 11 of stainless steel provides an optimum friction reducing structure consistent with nominal fabricating costs. The needle components may be mutually secured by conventional means such as soldering.

It will be appreciated that the configuration, dimensioning and proportioning of needle components or features may vary, depending upon the character and size of strands being fed therethrough. It should be noted, however that even with such variations, advantages of the invention will be realized. It is particularly important to recognize that with the present invention a highly effective strand impelling action may be achieved while imposing a relatively light, strand impelling force. As will be appreciated, such a light imposed force will tend to produce a more uniform tufted product due to a substantial avoidance of strand stretching and will minimize strand damaging tendencies associated with the prior art, tufting devices wherein mechanical strand feeding is employed.

The improved needle mounting arrangement of this invention provides a particularly effective degree of needle support and contributes to the ease of needle insertion and changing where desired for maintenance or pattern changing purposes.

The set screw 24 and the camming shoulder 22, in cooperation with the abutments 19 and 20 and the gasket 18, provide a simultaneous sealing and resilient holding action for each needle. The resilience of the gasket 19 tends to prevent the needle from working loose during the reciprocation of the needle bar so as to prevent the occurrence of needle vibration during sustained operation of the apparatus.

The manner in which needles may be telescopingly inserted into the needle bar and locked in place by mere threaded advancement of the member 24 provides a particularly simplified yet effective needle securing arrangement. Semi-skilled personnel may readily be employed for changing or inserting needles. Needle changing may be expediously accomplished with minimum manipulative effort. The cooperation between the needle holder set screw 24 and the orienting needle surface 21 insures proper orientation without the necessity of resorting to complex orienting apparatus or techniques.

The annular groove 16 in association with the gasket 17, and the abutments 18 and 20 in cooperation with the O-ring 19, provide a sealing action between the needle and the needle bar so as to virtually obviate the leakage of pressurized fluid.

The air passage arrangements which have been described, each of which intersects the strand impelling portion of a tufting needle, are characterized by unique, individual advantages. The FIGURE 2 arrangement is characterized by vertically elongate outlet ports formed by the intersection of inclined air passages with the vertically extending bore 14. This arrangement is characterized by relative ease of fabrication and the placing of air passage outlets in maximum proximity to a strand to be propelled. The FIGURE 5 air passage arrangement features a continuous annular passage having an annular outlet lying in the place of the bore 14. The air passage arrangement entails the advantage of an outlet in maximum proximity to a strand being propelled and the further advantage of being continuous in nature so as to enable the imposing of a laterally more uniform strand impelling thrust.

While the invention has been described with reference to preferred embodiments of the needle bar and needles carried thereby, certain additions, modifications, substitutions or deletions in the preferred arrangements may occur to those skilled in the tufting art which would lie within the
I claim:
1. A tufting apparatus in which strand means are propelled by a fluid thrust, said apparatus comprising:
   a needle bar;
   said needle bar being adapted to cooperate operatively with fabric means to be tufted; and
   a plurality of strand feeding needles mounted on said needle bar, each such needle comprising:
   a strand receiving portion having a first cylindrical passage of uniform diameter, one end of which defines a strand inlet,
   a fabric penetrating portion having a second cylindrical passage of uniform diameter terminating in a strand outlet, and
   an intermediate portion disposed between said strand receiving and said fabric penetrating portions and having a third cylindrical passage of uniform diameter less than that of the diameter of the first cylindrical passage of said strand receiving portion, and
   fluid passage means transversely intersecting said intermediate portion of each of said needles, said fluid passage means being inclined toward said fabric penetrating needle portion.
2. An apparatus as described in claim 1 wherein the diameter of said third cylindrical passage disposed in said intermediate needle portion is such as to provide substantially uniform peripheral support for a strand propelled therethrough.
3. An apparatus as described in claim 1 wherein said second cylindrical passage of said fabric penetrating needle portion is of substantially the same diameter as the diameter of said third cylindrical passage of said intermediate needle portion.
4. An apparatus as described in claim 3 wherein the diameter of said second cylinder passage in said fabric penetrating needle portion and said third cylindrical passage disposed in said intermediate needle portion is such as to provide substantially uniform peripheral support for a strand propelled therethrough.
5. A tufting apparatus as described in claim 1 wherein said fluid passage means of each needle comprises a plurality of fluid passages circumferentially spaced about the needle axis, each said fluid passage having a fluid inlet communicating with the needle exterior and a fluid outlet communicating with said third cylindrical passage, each said fluid inlet having a diameter which is enlarged relative to the diameter of said fluid outlet.
6. A tufting apparatus as described in claim 1 wherein said fluid passage means of each needle includes a plurality of fluid passages circumferentially spaced about the needle axis, each said fluid passage extending radially from the needle axis and having a fluid inlet communicating with the needle exterior, an annular passage of generally uniform diameter coaxial with the needle axis and communicating the said radially extending fluid passages; and an annular, generally conically configured passage extending from said annular passage of uniform diameter, inclined toward said fabric penetrating needle portion, and having a fluid outlet in communication with said third cylindrical passage.
7. An apparatus as described in claim 1 wherein said strand receiving and strand impelling portion of each said needle is fabricated of brass and said fabric penetrating portion is fabricated of stainless steel.
8. An apparatus as described in claim 7 wherein said strand inlet provided by the first cylindrical passage of said strand receiving portion of said needle is inwardly chamfered.
9. A tufting apparatus wherein strand means are fluid propelled, said apparatus comprising:
   a hollow needle bar, said needle bar comprising:
   first wall means having a plurality of first apertures, second wall means spaced from said first wall means and disposed between said first wall means and a zone of fabric tufting, said second wall means including a plurality of second apertures; said needle bar defining an enclosed manifold chamber;
   said chamber being in communication with a source of pressurized fluid;
   a plurality of tufting needles each including a strand passage extending longitudinally therethrough and having pressurized fluid passage means intersecting an intermediate portion thereof and communicating with said chamber;
   each needle being rigidly mounted in said needle bar and secured at one portion in a first aperture of said first wall means and being secured at another portion in a second aperture of said second wall means; each second aperture of said second wall means having an annular abutment associated therewith adapted to engage and prevent outward movement of a tufting needle; and
   each first aperture of said first wall means being provided with releasable holding means for securing a needle in said needle bar.
10. An apparatus as described in claim 9 wherein the portion of each needle received in a first aperture of said first wall means includes an annular groove and a resilient gasket mounted therein providing sealing engagement between said needle and said first wall means wherein the portion of each needle received in a second aperture of said second wall means includes an annular shoulder and wherein an annular gasket is disposed between said annular shoulder and the annular abutment in said second wall means aperture to provide sealing engagement between said needle and said second wall means.
11. An apparatus as described in claim 10 wherein said releasable holding means comprises, in association with each needle, a threaded member mounted in said first and second wall means and adapted to move transversely of a needle, said threaded member being provided with a frusto-conical needle engaging end, and wherein each needle includes a longitudinally extending aligning surface formed on its exterior which terminates in a generally upwardly facing, camming surface, said frusto-conical end of each said threaded member being adapted to engage an aligning surface and camming surface of a needle to orient said needle and cam said needle toward said second wall means so as to compress the annular gasket disposed between said annular shoulder of said needle and said annular abutment of said second wall means.
12. An apparatus as described in claim 11 wherein each needle comprises:
   a strand receiving portion having a first cylindrical passage of uniform diameter, one end of which defines a strand inlet,
   a fabric penetrating portion having a second cylindrical passage of uniform diameter terminating in a strand outlet,
   an intermediate portion disposed between said strand receiving and said fabric penetrating portions and having a third cylindrical passage of uniform diameter less than that of the diameter of the first cylindrical passage of said strand receiving portion, and
   fluid passage means transversely intersecting said intermediate portion of each of said needles, said fluid passage means being symmetrically disposed about the axis of said needle and being inclined toward said fabric penetrating needle portion.
13. An apparatus as described in claim 9 wherein each needle comprises:
   a strand receiving portion having a first cylindrical passage of uniform diameter, one end of which defines a strand inlet, and
   a fabric penetrating portion having a second cylindrical
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9 passage of uniform diameter terminating in a strand outlet, an intermediate portion disposed between said strand receiving and said fabric penetrating portions and having a third cylindrical passage of uniform diameter less than that of the diameter of the first cylindrical passage of said strand receiving portion, and fluid passage means transversely intersecting said intermediate portion of each of said needles, said fluid passage means being symmetrically disposed about the axis of said needle and being inclined toward said fabric penetrating needle portion.

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