Dec. 1, 1964 P. F. MARSHALL 3,158,982

NAPPED TEXTILE FABRICS

Filed Nov. 29, 1962 2 Sheets-Sheet 1

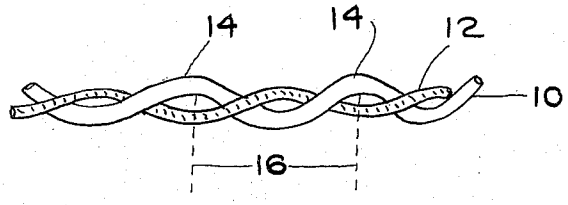


FIG. 1

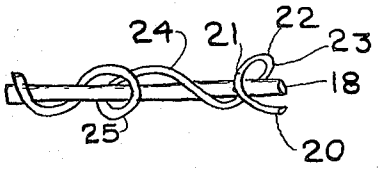


FIG. 2

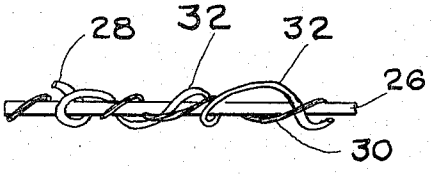


FIG. 3

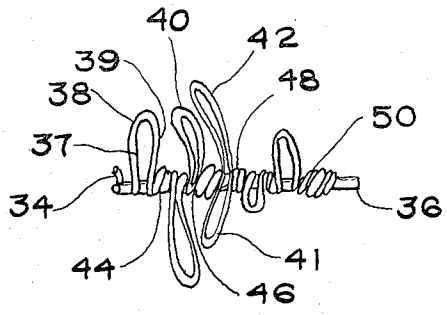


FIG. 4

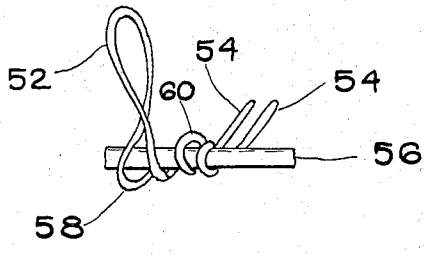


FIG. 5

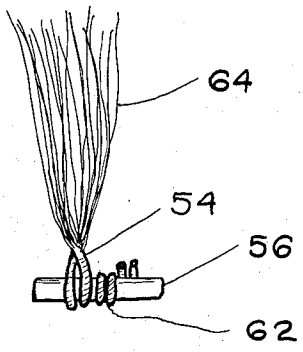


FIG. 6

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NAPPED TEXTILE FABRICS

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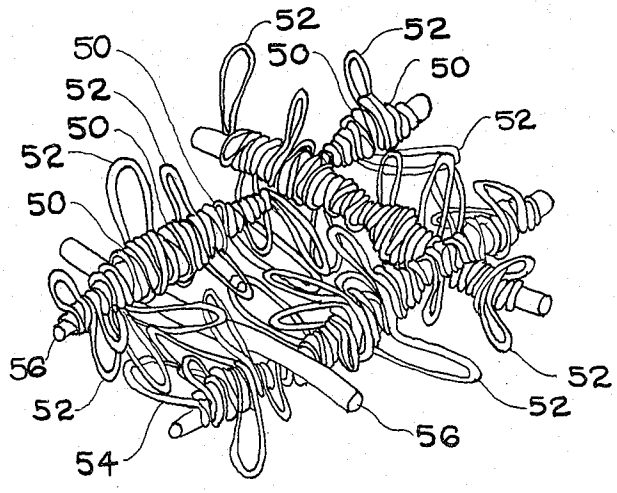


FIG. 7

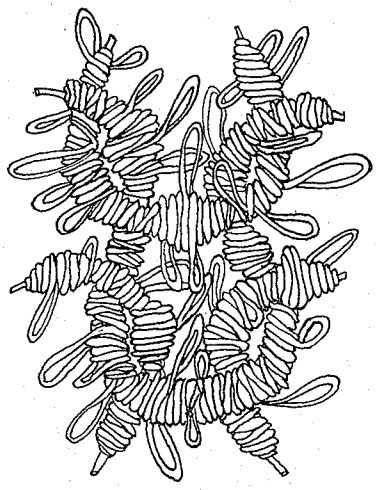


FIG. 8

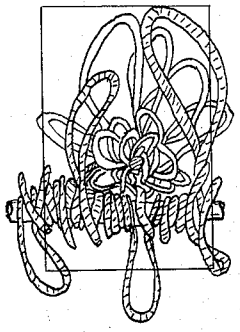


FIG. 9

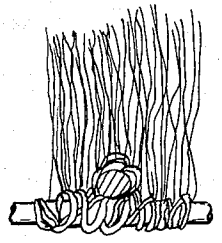


FIG. 10

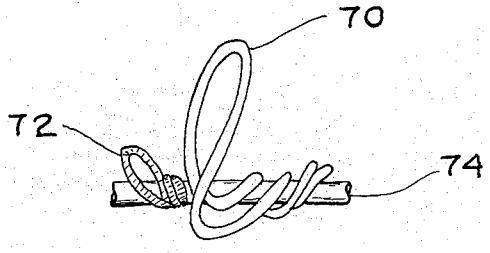


FIG. 11

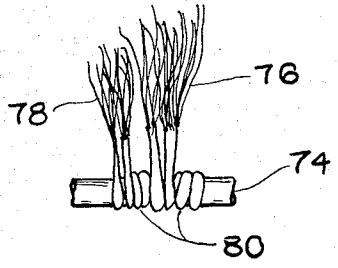


FIG. 12

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3,158,982

NAPPED TEXTILE FABRICS

Preston F. Marshall, Walpole, Mass., assignor to The Kendall Company, Boston, Mass., a corporation of Massachusetts

Filed Nov. 29, 1962, Ser. No. 240,942
7 Claims. (Cl. 57—140)

This invention relates to napped textile fabrics, and more particularly to a textile fabric in which the nap is of superior length, is substantially lint-free, and tightly anchored into the fabric. The present application is a continuation-in-part of my copending application Serial Number 212,922, filed July 17, 1962, which is in turn a continuation of my applications 160,090, now U.S. Patent 3,076,307, and 858,694.

In my application Serial Number 212,922, I describe the preparation of textile fabrics made from wrapped yarns in which a wrapping strand is doubled into loops, which are then wrapped in doubled configuration around a core strand. The ends of these loops extend generally perpendicular to and radially from the central axis of the core strand, and project outwardly there beyond to a varying degree.

I have found that when woven or knitted fabrics comprising yarns of this nature are napped, an unexpectedly long and fleecy nap of varying fiber length is readily raised, the nap is securely anchored to the fabric, and there is no appreciable decrease in the tensile strength of the fabric.

Napped fabrics in general are characterized by a raised surface of projecting fibrous or filamentary ends on one or both faces of the fabric. The napping process is conducted on a machine which consists basically of a large cylinder, around which are mounted a number of small rollers covered with card clothing. These smaller rolls are frequently arranged so that some of them are driven clockwise and some counterclockwise, and they may run at the same or at different speeds. By this arrangement, the wire clothing teeth on the rolls revolving in the direction of travel of the cloth (the pile rolls) tend to advance the cloth, while the rolls revolving in the opposite direction (the counter-pile rolls) work against the cloth. The smaller rolls are driven at a higher speed than the cloth travels through the machine, so that the action of the wire teeth, brushing on the fabric surface, raises a nap or pile. Napping imparts to a fabric a feeling of thickness, softness, and warmth, and is widely used in the preparation of blankets, sweaters, children's clothing, linings, and the like. By covering up the spaces between the yarn interstices of fabrics, napping smooths out weave irregularities, and in general will upgrade a fabric. Perhaps the commonest form of a napped fabric is cotton flannel, in which a base cloth such as a soft-filled sheeting, is napped. The teeth of the napping roll engage the fibers of the thick and softly twisted filling yarn to form a raised fibrous surface on the fabric. In napping fabrics composed of conventional spun yarns, however, there is always a certain strength loss, as well as considerable broken fiber, lint, and loosely-anchored short fibers which tend to become disengaged from the base cloth either in finishing, or during the stressing and flexing which the fabric is subjected to in use. The length of fibrous nap that can be raised is also limited, being obviously only a fraction of the average fiber length.

It has, therefore, been proposed to nap a fabric composed of wrapped yarns, with the object of engaging the wrapping strand only with the teeth of the napping roll. However, due to the geometry of wrapping in conventional wrapped yarns, their use offers only limited improvement in napped fabrics composed thereof, as will appear more fully herein below.

It is an object of this invention to provide a napped fabric comprising wrapped yarns in which the nap is of exceptional length, is firmly anchored to the base fabric, and is relatively free from lint and broken fibers.

It is a further object of this invention to provide a napped fabric comprising yarns wrapped with a plurality of strands which comprise filaments of different stiffness, to effect a mixed filamentary nap.

The invention will be more clearly understood in connection with the accompanying drawings, in which:

FIGURE 1 represents a conventional plied yarn, of two ends twisted together.

FIGURE 2 represents a wrapped yarn of the type known as a loop yarn.

FIGURE 3 represents a wrapped yarn of the type known as boucle.

FIGURE 4 represents a wrapped yarn suitable for use in the napped fabrics of this invention.

FIGURE 5 represents a characteristic section, including one loop, of the yarn of FIGURE 4.

FIGURE 6 represents the loop of yarn of FIGURE 5 after napping.

FIGURE 7 represents a section of fabric woven from the yarn of FIGURE 4.

FIGURE 8 represents a section of fabric knitted from the yarn of FIGURE 4.

FIGURE 9 represents a pair of intersecting yarns of FIGURE 4, characteristic of the yarn interlacings of FIGURES 5 and 6.

FIGURE 10 represents the rectangularly-enclosed section of FIGURE 9, after napping.

FIGURE 11 represents a section of a double wrapped yarn suitable for use in this invention.

FIGURE 12 represents the yarn of FIGURE 11 after napping.

All of the drawings are obviously highly magnified to show structural detail more accurately.

The element in common of the yarns of FIGURES 1 through 4 is that the yarn is composite: in FIGURE 1, two yarns **10** and **12** are twisted together, and although one yarn, due to thickness, may rise above the plane of the composite yarn, as at **14**, when such a yarn is napped it may be broken through entirely at the points **14**, so that the section **16** lying between these points **14** is only lightly engaged in the fabric, if indeed it does not fall out entirely. If this is avoided by breaking only some of the fibers at **14**, it is obvious that the fullest and loftiest nap possible is not being realized.

Similar considerations apply to the loops **22** of the conventional loop yarn of FIGURE 2, where a wrapping strand **20** is wrapped, with a true twist, around a core strand **18**. If the wrapping strand is completely broken through at **22**, there is the danger of short pieces of cut yarn. Additionally, since the wrapping strand is singly wrapped, end-around-end fashion, the lifting action of a wire napping tooth on the loop **22** will cause loop **24** to flatten out along the core strand axis, or to disappear entirely. It is a drawback of conventional wrapped yarns that the loops are interconnected, and that tension on one loop will cause other loops to disappear. This is true to a considerable extent of the boucle yarn of FIGURE 3, even though a binder strand **30** is wound around the assemblage of core strand **26** and wrapping strand **28**. The loops **32** are still vulnerable to disappearance when tension is applied to a nearby loop.

Considering the wrapping strand geometry of the yarns described in my application Serial No. 160,090, and illustrated in FIGURE 4, it would be predicted that fabrics made from such yarns would nap poorly or not at all. Since the wrapping strand is disposed around the core strand with false twist, it might be expected that the upward thrust of a napping tooth on a loop such as

at 42 in FIGURE 4 would lead to almost indefinite prolongation of the loop 42, with the consequent disappearance of the adjacent loops 40 and 41. It should be understood that in loop wrapping of yarns of this type, if a loop such as 42 is unwound for a turn or two around the core strand 36, loops 40 and 41 disappear, and the length of loop 42 is increased. This manipulation may be prolonged, without rotation of the core strand, until the entire wrapping strand 34 has been completely freed from the core strand 36. It would be expected, then, that the napping of fabrics made from the yarn of FIGURE 4 would lead to substantial separation of wrapping strand from core strand, unlike the behavior of fabrics composed of the truly twisted composite yarn of FIGURE 2.

In actual napping operations, however, I find that there is a surprisingly unexpected resistance to the separation of wrapping strand from core strand in fabrics made from the yarn of FIGURE 4. Although hand manipulation will separate the two strands, the effect of a napping tooth moving through the loop 42 of FIGURE 4 is to impart an upward thrust of such force and velocity that the tension imparted to the loop 42 is not propagated to the adjacent loops 40 and 41. Instead, there is a tightening of the wrapping strand at the nodes 46 and 48, causing the nodes presumably to engage more securely with the core strand. The violent shock thrust of rapidly revolving napping teeth apparently is of such force that the high loop 42, first engaged by the teeth, is not lengthened at the expense of adjacent loops. Instead, the adjacent loops 40 and 41 appear to be insulated from the behavior of loop 42 by the nodes 46 and 48, which due perhaps to inertia do not slip around the core strand, as they might in response to a low-magnitude pull on loop 42, but instead bite more deeply into the core strand and become relatively fixed thereon.

This may be illustrated more clearly by reference to FIGURE 5, wherein for clarity a single loop 52 is shown as formed from a doubled wrapping strand 54 wrapped one and one-half times around a core strand 56. As indicated at 58 and 60, there is frequently a certain amount of slack available in the wrapped loop.

The tension of napping on the loop 52 effects initially an elongation of the loop to the extent that slack is present, until the slack has disappeared and the base node configuration 60 tightens around the core 56, after which the loop 52 is broken. The repeated combing-out action of the multiple teeth in a rapidly-revolving napper roll has the final effect shown in FIGURE 6, wherein a long soft fibrous nap 64 has been formed by complete rupture of the loop 52, the component strand 54 of the former loop now being drawn tightly around the core 56, as shown at 62. This general tightening of the wrapping strand around the core strand, as at 62 in FIGURE 6, effectively locks the whole combed-out doubled strand 54 into the fabric, even though the continuity of the strand 54 has been destroyed by the breaking of the loop 52.

This is accomplished, moreover, without weakening the fabric, because the wrapping strand 54 is not a stress-bearing element of the structure. Since the core strand 56 is responsible for the tensile strength and the bursting strength of the fabric, and since the core strand is unaffected by the napping operation, the strength properties of the fabric are substantially unaltered by napping.

FIGURE 7 represents a section of a fabric woven from the yarn of FIGURE 4, one yarn being shown as uncovered for the sake of clarity. A continuous multifilament wrapping strand 54 is shown wrapped in looped form, for a multiplicity of turns, around a core strand 56. There are thus formed a multiplicity of outwardly-projecting loops 52, said loops being generally separated by nodes 50 of doubled-strand wrapping around the core strand. On the basis of what has been set forth above in connection with FIGURES 5 and 6, it will be apparent that the loops 52 will act more or less independently to the thrust of a napping wire, and that these loops can be completely broken and combed out into a long nap, with a consequent tightening of the nodular wraps 50 around the core strand. The actual dynamics of the napping action seems to effect a drawing-up into the wire-action zone even of those loops which are depicted as extending horizontally: This is a valuable and unanticipated result in a napped fabric, and may be explained by reference to FIGURES 2 and 4. In the case of a core strand with a wrapping strand disposed thereon in a true twist fashion, as in FIGURE 2, a protruding loop 22 consists of two elements, 21 and 23, passing in front of and behind the core strand 18, respectively. An upward thrust applied to the loop 22 will result only in a lifting action on the composite yarn, with no rotational motion applied to the yarn since the thrust on yarns 21 and 23 tends to turn the yarn in opposite directions: thus the two effects neutralize each other, and the net effect is to lift the yarn slightly until its resistance to further lifting, due to interengagement with other yarns, is greater than the tensile strength of the loop 22, whereupon the loop breaks.

In the case of fabrics made from the yarn of FIGURE 4, however, the reaction of the yarn to napping is apparently different. If an upward thrust is applied to the loop 38 of FIGURE 4, there will be a tendency for the whole yarn to rotate to a certain extent, since both strand elements 37 and 39 of the loop 38 pass around the same side of the core strand 36. Since napping is generally carried out on relatively open-meshed structures, there is a certain degree of freedom for the yarns of FIGURE 4 to twist or rotate. From examination of the fabrics of FIGURE 7, it will be appreciated that any rotation of the yarns thereof will bring into engagement with the napping teeth certain loops which were previously not available. With the engagement of these new loops, additional loops are brought into play, and since the direction of loop wrapping is marked by reversals, the yarn is rotated first in one direction and then in the other. The net result is that a single pass through a napping machine with a fabric of this nature will result in the breaking of an unexpectedly high proportion of the loops of wrapping yarn, no matter in which direction they were originally oriented.

Similar considerations will govern the behavior of a fabric knitted, as distinct from woven, from this type of yarn, as shown in FIGURE 8, bearing in mind the known differences between the napping of knitted goods versus woven goods.

I have found that any continuous filament wrapping strand may be formed into fabrics and napped according to this invention. The length and softness of the nap, as well as its insulating value, can be controlled by controlling the length and number of the loops, and by the chemical nature, the number of filaments per strand, and the denier per filament of the wrapping strand, as will be apparent to those skilled in the art.

As a further consequence of this invention, I find that the nap or pile raised by this process is characterized by a wide distribution in height, or length, of the individual filaments constituting the nap. This is perhaps due to the fact that the loops of wrapping strand are not even in height, or in the distance to which they extend radially from the core yarn. In my copending application Serial No. 160,090, it is explained that the tendency of the wrapping yarn is "too form a non-uniform series of variously sized loops, which spiral around the core strand generally radially to the yarn axis." Such a non-uniform series is shown in the present application in FIGURES 4, 7, 8, and 9, as typical constructions. When such a non-uniform series of loops is napped, filamentary ends will be found rising to various heights in the pile surface, lending a thick, rich body to the napped fabrics.

It is also within the scope of this invention to produce

napped fabrics in which the filamentary ends constituting the pile are of two or more species. Yarns suitable for the preparation of such fabrics are described in my copending application Serial No. 160,090 as including "a continuous core strand with one or more covering or wrapping strands wound, doubled, or looped thereabout." When a plurality of wrapping strands is used, the nature of the radially-extending loops will vary with the nature, particularly the stiffness, of the wrapping strands. When a plurality of strands is wrapped in a single operation, a soft, readily deformable wrapping strand will customarily form a non-uniform series of loops which project only a short distance from the core strand, whereas a stiffer, less flexible wrapping strand will form a non-uniform series of loops which project a greater distance from the core, on the average. A small segment of such a yarn structure is shown in FIGURE 11, wherein a loop 70 of a rather stiff filamentary strand, and a loop 72 of a separate and more flexible strand, are both shown wrapped around a core strand 74. The result of napping such a structure is shown in FIGURE 12, wherein coarser, stiffer filament ends 76 are shown extending above a bed of softer, more down-like filament ends 78, the filaments being gathered into strand form at their bases, which are snugly wrapped around the core strand 74, as shown at 80.

In this manner I can form napped fabrics which simulate real fur, insofar as the filamentary organization of the pile or nap is concerned. Many furs consist of a layer of soft, fine body hairs, protected by a longer set of coarser hairs known as beard or guard hairs. The presence of two sets of filamentary ends, of differing stiffness or coarseness, as shown in FIGURE 12, simulates a fur structure, especially when coupled with the generally varying nature of the pile due to the loops formed by any one wrapping strand being not completely uniform in height.

It will be apparent to those skilled in the art that control of the height of the loops of the plurality of wrapping strands may be effected by selecting strands which vary chemically, so that they have differing bending moduli, or different indices of rigidity. Similarly, if it is desired to have the nap all of one species of filaments, a soft strand of filaments of 1 to 3 denier may be combined with a stiffer strand of filaments of 10 to 20 denier of the same material. The total denier of the strand and the turns of twist per inch also influence the loop height.

The process of making yarns suitable for the napped fabrics of this invention is set forth in my application Serial Number 15,017, now U.S. Patent 3,041,812. It will be appreciated that if a plurality of wrapping strands is applied to a core strand in a plurality of individual operations, preferably in tandem, by suitable control of the air pressure and the rate and tension of feed of wrapping strand a yarn can be made which is the reverse of the yarn of FIGURE 11. That is, by using high air pressure on a stiff wrapping strand, this stiff strand can be wrapped in short loops around the core strand. A second wrapping operation with a lower air pressure on a more flexible strand may be used to create longer loops of this softer strand. Napping a fabric comprising such yarns will result in a pile-like fabric with a long, soft fleecy nap of fine filaments, the fabric showing a marked resistance to matting due to the supporting presence of shorter, coarser, more rigid filamentary ends interspersed among the finer filaments which project furthest from the core strand.

The process of this invention may be applied to a single face of the fabric, or alternate nappings may be carreid out on both faces to give a fabric napped on both sides, as is known in the art. Also, the fabrics may be sheared, brushed, or otherwise processed by the various conventional means which are commonly used to supplement the production of napped fabrics.

Having thus described my invention, I claim:

1. A napped fabric with at least one surface of projecting individual filamentary ends, said filamentary ends stemming from the paired ends of a plurality of broken loops of wrapping strand disposed about a core strand in doubled configuration, both ends of each individual broken loop passing around said core strand in the same direction at the base of said broken loop.

2. A napped fabric with at least one surface of projecting individual filamentary ends, said filamentary ends stemming from the paired ends of a plurality of broken loops of wrapping strand disposed about a core strand in doubled configuration, both ends of each individual broken loop being wound in the same direction around said core strand for a plurality of turns and being secured to said core strand by said plurality of turns.

3. A napped fabric with at least one surface of projecting individual filamentary ends, said filamentary ends being an intermingled mixture of broken filaments of more than one type, said broken filaments stemming from the paired ends of a plurality of broken loops comprising at least two wrapping strands of different types disposed about a core strand in doubled configuration, both ends of the individual broken loops formed in said wrapping strands being wound in the same direction around said core strand for a plurality of turns and being secured to said core strand by said turns.

4. A fabric according to claim 3 characterized by the intermingled mixture of filamentary ends comprising a shorter pile of relatively soft and fleecy filamentary ends and a longer pile of more wiry and resilient filamentary ends, said more resilient fiber ends projecting further from the base of said fabric than said relatively soft filamentary ends, whereby a fur-like material is simulated.

5. The process of preparing a napped fabric which comprises doubling a wrapping strand into loops, wrapping said loops in doubled configuration around a core strand for a plurality of turns, interlacing the resulting wrapped yarn into a textile fabric structure, and subjecting the fabric to a napping operation.

6. The process of preparing a napped fabric characterized by a pile-like surface of intermingled projecting filamentary ends of different types which comprises doubling a plurality of filamentary wrapping strands of different types into loops, wrapping said loops in doubled configuration around a core strand for a plurality of turns, interlacing the resultant multiple-wrapped yarn into a textile fabric structure, and napping the fabric.

7. The process of claim 6 in which the plurality of wrapping strands differ in stiffness whereby the wrapped loops of at least one wrapping strand project radially from the core to a greater average extent than the wrapped loops of other wrapping strands.

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