METHOD AND APPARATUS FOR MAKING KNITTED PILE FABRICS

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FIG. 3A.

FIG. 8A.

FIG. 10A.

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METHOD AND APPARATUS FOR MAKING KNITTED PILE FABRICS

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This invention relates to the method of making knitted pile fabrics and to apparatus adapted to this purpose.

Warp knitted pile fabrics are known in the textile art. In order, however, to manufacture such knitted pile fabrics, not only in a solid color, but in variations of pattern, color and design, there are only two known methods that have proven successful. One of these methods of the prior art involves the use of a Jacquard machine which is widely used not only in the knitting art but also in the weaving art. The other method for obtaining patterns and color variations in warp knitted pile fabrics requires the use of shifting bars which, in turn, are operated in a sidewise, back and forth movement as outlined in the recent G. E. Herrnstadt Patent No. 2,718,132.

The present invention overcomes certain of the limitations of the above-mentioned prior art in the following respect: The use of the Jacquard machine leaves a great number of face yarn ends afloat and, therefore, runs a lot of dead yarn into the fabric where they serve no useful purpose to the consumer of the final product. Furthermore, the amount of colors and the extent of the pattern are inherently limited by the Jacquard mechanism.

In the second method mentioned above in which shifting bars are used, the pattern is limited more or less to geometrical designs and, since there is a limit to the number of shifting bars which can successfully be used in a warp knitting machine of such type, the amount of colors used within such geometrical patterns is also limited.

Therefore, it is a primary object of this invention to provide in cooperative relation with a warp knitting machine additional mechanism adapted to make pile fabrics in which any design, no matter how intricate, may be reproduced in an unlimited color range within such design.

Furthermore, it is another object of this invention to provide a method for making pile fabrics on a warp knitting machine in an unlimited design and color range whereby the pile height of such fabric is readily varied by several mechanical adjustments, as will be explained in a latter part of this specification.

Specifically, it is an important object of the invention to adapt a warp knitting machine to the manufacture of heavy pile fabrics, such as carpet and the like, wherein the speed of making heavy pile fabrics in unlimited color and pattern range greatly exceeds that of any of the methods known heretofore.

Another purpose of this invention is to provide a method of forming pile tufts within a warp knitting machine whereby the U of the tuft is created by warp ends zig-zagging between adjacent wales as they extend walewise.

Another object achieved by the present invention is the adaptation of a known flat bed knitting machine without basic changes in itself to combination with spool frames serving as tuft supplying units and thereby adapting the flat bed knitting machine to the making of pile fabrics without making basic changes in the knitting apparatus as such.

It is a still further object of this invention to provide a novel method for making knitted pile fabrics without the usually necessary proportional distribution of colors, walewise and coursewise, respectively; and to afford a method which also provides the possibility of distribution of tufts of different color, no matter how unlimited, between adjacent wales and successive courses, as may be desired.

A still further object of this invention resides in the method of making carpet on a knitting machine having the novel combination set forth herein, which carpet has all the advantages of woven fabrics, such as are known in the carpet art as chenille or Axminster carpeting, without losing freedom of design and coloring in such carpeting, and at the same time gaining speed in manufacturing by virtue of the inherent rapidity of the knitting process.

For example, although chenille carpeting is known as one of the finest of the soft surface floor covering fabrics both in color and design as well as in quality, this product has lost a great deal of its popularity on the market because of the tremendous expense of making it, requiring as it does a double weaving process. On the other hand, Axminster carpeting has been for many years one of the leaders in sales volume. It is from the art of Axminster weaving that there has been here adapted the overhead spool frames for combination with a knitting machine.

The spool frames of the Axminster loom are essential to its commercial success because they provide prerarranged and set color tufts distribution per pile row of carpet. However, Axminster looms have met more and more competition from the ever-improving mechanisms of other carpet making methods. If fifteen pile rows of Axminster carpet can be inserted per minute, it is considered high speed production. But the use of these spool frames in combination with a flat bed knitting machine, as taught by the method of this invention, will increase the speed of making carpet at least five times over the speed of the present Axminster loom, and at least twelve to fifteen times over the speed of the chenille loom. Furthermore, the final knitted fabric will equal in quality and appearance that of the woven fabric.

Therefore, it is another object of the invention to provide the feed of face yarn into the pile fabric from separate units, such as the spool frames used in Axminster looms, said spool frames, in the case of patterned fabrics, being set according to prerarranged design for each pile row of repeat within a pattern. These spool frames are in use dipped in and out so as to provide a given length of pile tuft.

From the previous discussion it will be understood that the product of the invention is not limited to patterns and multiple colors alone, but may be embodied as pile fabrics in solid colors. An advantage in employing such spool frames for solid color pile fabrics resides in the fact that very often a great amount of yardage of the same color is required for the same run. Pile fabrics, as is well known, require more poundage of pile yarn per square yard than flat fabrics and there is a limit to the amount of yarn that can be dyed within the same dye lot. In using the spool frames in a knitted pile fabric for a solid color product in large quantities, the setter of the spools can mix a number of dye lots in such a manner that the various dye lots are distributed in different parts of the pile fabric, pile row by pile row, by which practice it is possible to avoid streaks or lines of any definite visible shadings within the total yardage produced.

A still further object of this invention, especially for the carpet industry, is the avoidance of the complications
and limitations of the Jacquard machine in combination with a flat bed knitting unit. Since most of the larger carpet looms at present use such spool frames with a warp knitting machine, as provided by this invention, avoids the usage of Ja-

3 quard machines. With Jacquard machines, designing requires technical skill. The threading has to be done in accordance with a pattern and, thereafter, cards have to be held in order to bring those pile ends into motion as required for each course and even then one is still limited in the amount of colors used within a pattern.

An additional object of the invention is to provide a new combination for fine gauge pile fabrics, such as upholstery or the like, in which spool frames of a finer gauge than in the carpet industry will be employed, so that for the first time knitters of fine gauge pile fabrics will be able to engage in the production of expressive designs and colors without the limitation of the shift bars and associated mechanisms.

Still another object of this invention is the provision of a method and mechanism for the manufacture of pile fabrics on a flat bed knitting machine provided with spool frames. This basic method and apparatus combination enables the manufacturer of knitted pile fabrics to use the minimum amount of pile yarn for such pile fabrics and to predetermine the usage of the pile yarn for each fabric by virtue of the fact that every tuft has a given length and that no pile yarn is wasted by running dead, back and forth, or up and down, respectively.

The foregoing and other objects and advantages of the method and apparatus of this invention will be more fully understood from the following detailed description of the preferred embodiment and modifications thereof, when taken in conjunction with the accompanying draw-

ings, in which:

Combination Figs. 1 and 2 taken together show a complete top plan view of a warp knitting machine embodying certain parts being cut away for clarity, and the front of the machine being at the bottom and the back being at the top of these figures;

Fig. 3 is a vertical section of the machine of this invention, taken on line III—III of Fig. 1 and showing the pile yarn feeding, forming and cutting mechanisms in operative relation to the knitting needles and their driving means; Fig. 3A is an enlarged longitudinal section of the needle bed and needle driving means;

Fig. 4 is a partially diagrammatic top plan view of a novel fabric of interconnected construction that may be made in accordance with the method of this invention;

Fig. 5 is a partial side elevation of an end portion of one of the pile yarn supply and feed units;

Fig. 6 is an end elevational view of the unit of Fig. 5;

Fig. 7 shows an isometric end view of the drawing of pile yarn ends from one of the units illustrated in Fig. 5, and indicates its use in the production of U-shaped pile tufts;

Fig. 8 is a further isometric view showing the backing weft guides above the needle bed and their relationship to the needle bed and the needles;

Fig. 8A is a face view of an enclosed cam for the weft motion; viewed on line 8A—8A of Fig. 2;

Fig. 9 is another isometric view showing the backing weft guides above the needle bed and the warp yarn guides in relations assumed in the initial formation of a fabric constructed as shown in Fig. 4; and in which the weft guides have shifted to the right as a group, and within pile yarns showing course 45.

Fig. 10 is a further isometric view of a subsequent step in the sequence of operations showing the diagonal extension of the warp threads imparting a U-shape to the pile yarn ends before cutting;

Fig. 10A is a face view of an enclosed cam for the warp motion; viewed on line 10A—10A of Fig. 2;

Fig. 11 is an isometric view similar to Fig. 10 and showing the withdrawal of the needles and completion of the sidewise extension of the warp threads in forming a U-shaped tuft;

Fig. 12 represents a still further step in which opposed cutting blades are advancing to sever the pile yarn ends;

Fig. 13 is a side elevation view partially sectioned of another inventive embodiment in which grippers are utilized for tuft insertion; and

Figs. 14, 15 and 16 show respectively in additional side elevations successive steps in the operation of a modified form of gripper that may be used for tuft insertion.

As shown in Fig. 4 the warp knit base fabric comprises stitches or stitch loops forming warpswise rows, or weaves, 1, 2, 3, 4, and weftswise rows, or courses, a, b, c, d, and interconnected by portions of the warp ends extending diagonally from each stitch to the other stitches in an adjacent wale located, respectively, in the adjacent courses, each knitted warp end thus extending forth and back in zig-zag fashion between two mutually adjacent wales.

Inlaid threads w are also provided, which undulate warpside across several wales. Pile tufts t of U-shape extend under and around the diagonally extending, stitch interconnecting, portions of the knitted warp ends.

As shown in Fig. 1 and Fig. 2 combined, the knitting machine embodies within it Axminster type spool frames, and includes a rectangular framework, a plurality of longitudinally spaced frames 27, 29 and 31, and end frames 33 and 35. Power for operating the knitting machine is derived from a main drive shaft 37 extending adjacent and parallel to the back of the framework 26 and driven by a belt-rotated pulley 39 as shown in Fig. 1. A needle drive shaft 41 lies above the main drive shaft 37, and a front warp shaft 42 is suitably supported for rotation near the front of the knitting machine. A front pile yarn cutting blade 43 (Fig. 3) is operated by the front warp shaft 42 extending on the forward portion of the knitting machine, and a cooperating rear cutting blade 45 is reciprocated in opposition thereto by connection with the needle drive shaft 41. A stationary guide 47 extending widthwise of the machine underlies the front cutting blade 43; and another stationary guide 48 extending similarly and at an obtuse angle relative to the blade guide 47 underlies the rear cutting blade 45.

A spool holding frame 49 extends longitudinally in parallel relation above the front and rear blades 43 and 45, and their guides 47 and 48 as seen in Fig. 3. In this same figure a weft bar 50 carrying a plurality of backing weft guides 51 is located below the needle guide bed 52, and backing weft ends are suitably fed thereto. The weft bar 50 is given reciprocating and up and down movements by means of a reciprocating and oscillating shaft 50A to which it is secured by arms 50B. 50C is held by a collar 50C which is fastened to said shaft (Figs. 1, 2 and 3). Warp stitch threads T are also suitably fed in a conventional manner and threaded through individual warp guides 59 such as are employed in conventional flat bed knitting machines, and leading therefrom to respective needles located in needle bed 52 as indicated generally in basic assembly 56, the pertinent parts of which are shown in Figs. 8 through 11.

The warp ends 1a, 2a, 3a, 4a, 5a, 6a, 7a, etc., are threaded through warp yarn guides 59, etc., which are clamped individually to guide bar 58 by resilient spring clips 60 of U-shape (Fig. 9). This warp yarn guide bar 58 is in turn connected with a bracket or adapter 53 (Fig. 3) for shifting sidewise machine formed, and forth by mechanism to be described and in a manner to produce the novel pile fabric construction of Fig. 4.

Fig. 2 shows at the right end a common drive unit for the weft bar 50 and the warp yarn guide bar 58.

Two conventional bevel gear drives, 57 and 55, are taken from the back needle shaft 41, which is supplied with power from the main drive shaft 37 through belt

77, as indicated in Figs. 2 and 3. The first of these drives 57 extends transversely between the needle shaft 41 and the warp shaft 42 at the right of the loom frame 25, and the second drive 55 extends parallel thereto and provides for the related movements of the weft and the warp bars 50 and 58, respectively, as explained more fully hereinafter.

A backing weft shifting cam having a cam track formation provides a positive guiding means for a follower roller moving in an undulating closed path including spaced dwells of equal duration separated by arcuate segments of varying radii for shifting the backing weft guides across a plurality of needle spaces in one direction, and across a like number of needle spaces in the opposite direction during each revolution of the needle drive shaft to which the shifting cam is geared for uniformly timed rotation and thus produces the required back and forth shifting of the bar carrying the weft guides and connected with shifting rods.

The warp yarn shifting cam has a track formation receiving and guiding a follower means in an undulating closed path having a pair of opposed short dwells and an opposed pair of long dwell by means of a backward drop between a long dwell and a short dwell, a long rise between said short dwell and the other long dwell, a short rise between the other long dwell and the other short dwell, and a long drop between the last-mentioned short dwell and the first-mentioned long dwell. Warp cam 69 produces the timed sidewise motion of the warp yarn guide bar 58, the warp yarn cam 69 being geared for uniformly timed rotation through a cross shaft 117 driven by needle shaft 41.

The novel construction and mechanisms of the combination of the knitting units of the knitting machine with the spool frame will now be explained, with particular reference to the arrangement as shown in Figs. 2 and 3. In these figures the backing weft guide bar 56 is located immediately above the needle bed 52, and backing weft ends of jute or the like are conventionally fed and threaded through each one of a set of weft yarn guides 51 of the flat bed knitting machine. The warp yarn guide bar 58 is carried by the bracket arm 62a that is mechanically actuated to shift it sideways and back and forth in such a manner as to produce a novel fabric construction as shown in Fig. 4. The warp guide bar 58 serves as a mechanism to lead a warp thread around the needles 53 etc., as it may be necessary in accordance with a fabric construction involved. Below the bracket arm 62a (Fig. 3) which carries the warp yarn guide bar 58 is the oscillatable front warp shaft 42 which operates said guide bar 58 through a plurality of spaced collars 64, each having an integrally connected arm 64a, by means of which the warp yarn guide bar 58 may be reciprocated in timed relation to shifting of the weft ends by bar 50. A rod 65 to which the collars 64 are fixed moves the warp yarn ends 1a, 2a, 3a, 4a, 5a withwise of the knitting machine framework 25 in the manner shown in Figs. 9 and 10. This is accomplished by means of the warp yarn cam 69 designated "warp yarn cam" in Fig. 2.

The needles 53 in this preferred form are operated by a plurality of cams 66 of the enclosed type, which rotate with the needle drive shaft 41. Each cam 66 operates a yoke bar slide 68 through a yoke bar slide follower 65 and a yoke bar pivot 34. The yoke bar slide 68 has a top yoke bar slide 72 and a lower yoke bar slide 74 which interconnects with a needle drive 76. While in some cases the needle drive shaft 41 may be operated by the main drive shaft 37, it has been found that the strain in the case of wide looms, such as are used for rugs, can be reduced by having an additional shaft from which the needle drive shaft 41 is driven. For this reason there is shown as one of the preferred forms the separate main shaft 37 having the belt rotated pulley 39 for actuating the needle drive shaft 41 through a belt 77. In Figs. 3 and 3A there are shown the parts of the loom framework 25 on which the needle driver 76 and its needle driving bar 78 rest. The rearward end of the lower yoke bar slide 74 is supported and guided for the related movements of the weft and the warp bars 50 and 58, respectively, as explained more fully hereinafter.

It is preferred, as shown in Fig. 9, to use needles 53 that have a pivoted latch L near the outer ends such as are well known in the art. Between the needle driver 76 and the lower yoke bar slide 74 a hinge 85 is provided to relieve the strain, as it has been found that the unseated part is apt to break in the absence of such a measure. The needles 53 are pulled backwardly by a return pull member 87, which engages needle butts 53a of each needle (Fig. 3A). The return pull member 87 is interconnected by cap screws 85 to the needle driver 76 that pushes the needles in the forward direction.

In order to have a good tape for the fabric itself as it comes off the loom, it is desirable to keep the fabric under as much tension as possible. Therefore, in the preferred embodiment of the apparatus there is provided an idler roller 100, which is well polished and mounted for rotation about a fixed horizontal axis, as shown in Fig. 3. The roller 100 leads the fabric downwardly as it comes from the needle bed 52 and with a reversing of direction onto a take-up roller 102. In accordance with the fabric produced by the loom, the take-up roller 102 should either be covered with sand paper, cord clothing, or other rough, gripping material that will prevent slippage.

While there is but limited novelty in the knitting mechanism that has been explained, subsequent reference to a consideration thereof will be helpful to a full understanding of the present invention which embodies the knitting mechanism as part of the inventive combination.

A plurality of like spool units 104, 104, 104, etc. are set into a parallel pair of endless and like lengths of sprocket chains 109 and 110, each having sprocket length links 112 intermediate sprocket length links 114 that are longer than the sprocket length links 112 which carry the spools. For simplification only a few of the sprocket units 104, 104, 104, etc. are shown in Fig. 3, but it is to be understood that as many of these spool units are put on the chain length links 112, 112, 112, etc. as there are rows of courses of repeat and design required. The spool units 104, 104, 104 etc. are carried forward mechanically by four pairs of shaft mounted sprockets 116, 116, each of which has four end points or teeth 118. Each pair of said shaft mounted sprockets 116 is tightly interconnected to a sprocket chain shaft 126, 127, 128 or 129. In Fig. 3 the upper left corner sprocket shaft 128 is positively driven by the needle drive shaft 41 and rotates one-quarter turn as often as the course moves. The mechanism for producing the one-quarter turns comprises a pinion gear 130 on sprocket chain shaft 128 disposed outwardly of the adjacent sprocket chain 109, a larger intermeshing driving gear 131 turning on a fixedly mounted sub shaft 132, a ratchet wheel 133 secured on the outer face of the intermeshing driving gear 131 for rotation therewith and a pawl 134 pivoted on the outer end of an arm 135 having its inner end mounted for relative pivotal movement on the sub shaft 132. A connecting rod 136 is pivotally connected to its upper end to the arm 135 and connected at its lower end with the needle drive shaft 41 so as to impart intermittently a partial rotation to the ratchet wheel 133 sufficient to produce a one-quarter turn of the sprocket chain shaft 128 as required. For further details with respect to such spool units, see Coyle Patent No. 2,140,463.

It is now in order to explain in detail the individual spool units 104, etc., which are specifically shown in drawings Figs. 3, 5, 6 and 7. These spool units 104, etc., while common and familiar to the art of rug and carpet weaving, are an innovation in the knitting field.
Each spool unit 104 consists of three main parts: First is a spool axle 150 which extends from a spool body 152 into a bearing and spool support 154, secondly a spool head flange 156 and its attached mechanisms to hold it in place without unrolling, and finally, a tube frame 158 with its attached tubes 159, etc. The spool body 152 with its spool head or spool head flange 156 may be as long as desired. It is preferably made of wood or light metal and the spool head flange 156 should be strong enough to withstand the pressure of warp and the warp tension to which the tubes are wound on it. For each space between the warp stitches one pile tuft end PT will be wound on the spool body 152 (Fig. 7). The total width of the spool body 152 will hold as many pile tuft ends as there are spaces between the warp stitches and said tuft ends will be distributed colorwise for one specific pile row, in the case of a patterned and colored design, as the designer’s sketch may require. It has been found that the width of one spool should not extend to more than 36 inches. Of course, there are fabrics which are woven in greater widths, such as certain uphosteries, in which one of the most desired widths is 54 inches, and floor coverings in which the width may extend up to 18 feet. In the case of the wider widths looms used for this invention it is preferable to use a number of spool bodies 152 which are aligned in one row and interconnected and on which the yarn is wound according to a predetermined pattern for one of the units of the spools definitely selected for a definite pile row in each course of the fabric. When using the spool units 104 certain things are of the utmost importance, such as the steadiness of said units when they are carried around by the chains until they are again selected for insertion of tufts in the fabric. When cylindrical units such as these are filled with yarn, one of the dangers is that the yarn induces a rotation of the spool body 152 and thereby releases itself. A spring pressed (160) spool brake 155 secured from the tube frame 158 stops the spool body 152 and prevents it from spinning freely. At the end of the spool brake 155 the support 154 keeps the spool head 156 in place. Also extending from the tube frame 158 are the spool axle 150, the spool support 154 and spring latches 163 and 164 interconnected by pressure spring 166. By virtue of the spring latches 163 and 164 the spool units 104 are attached to the spool length of chain 109 and 110 (Figs. 1 and 2) and are held by the same. As will be understood from the above explanation, the spool unit 104 with its spool head flange 156 and its spool axle 150 are originally separate from the spool body 152 and with all the pipes of individual and closely spaced yarn tubes 159, etc. are attached to each tube frame 158. The yarn tubes 159 have at their respective upper ends a flared mouth formation 159m tapering toward the bottom of each tube.

In the preliminary setting yarn is put on the spool bodies 152, in tube frames 158, and through tube 159. The setters use various methods of threading the original face yarn ends, which have been previously wound around the spool body 152 and inserted through the flared mouths 159m and the tubes proper 159. There is a definite reason for providing the tubes 159 with flared mouths 159m, in order to use knots in the face yarn ends and, during the operation of the loom, these knots will break as they feed into the tubes 159 if they do not have a chance to work their way slowly thereinto through a flared mouth. This has been proven in the past in Aixminster looms and is a practical addition to this invention.

The spool units 104 are either numbered or, in some cases, provided with flanges of different color so that the worker responsible for putting such spool units into the spool lengths of chain pairs 109, 110, can do so by following a predetermined color arrangement.

Consideration will now be given to the operating means by which the spool units 104 carrying the pile yarn ends 200 to 206 are dipped to insert their attached yarn tubes 159 in between the warp ends 1, 2, 3, 4, 5, 6, 7, etc. as illustrated in Fig. 3 and Figs. 10 to 12.

In this connection it is to be observed that the spool frame 49 is mounted for pivotal body movement on the sprocket chain shaft 128 and extends over the needle drive shaft 41 as shown in Fig. 3. This arrangement makes it readily possible for a dipping rod 49r or the like to be connected between an intermediate part 49a of the upper horizontal part of the lower plate 67 carrying a roller follower 67r engaging the single lobe plate cam 66, which is turned by the needle drive shaft 41. Therefore, in a one-cycle course of the loom the set of yarn tubes 159 presented to the insertion and cutting station between the cutting blades 43 and 45, as shown in Fig. 3, will be operated and counted on the base fabric as U tufts, in accordance with Figs. 9 and 10.

The tying in of the pile ends by the warp yarn ends before severing, as shown in Fig. 12, makes it possible for predetermined upward movement of the spool units 104 from their bottommost position to draw off the required length of pile yarn that, upon severing, will provide U-shaped tufts of uniform height.

After the spool units 104 are all in the respective pairs of chain length links 112 and after the warp threads and the backing wefts have been properly threaded, the method of making the desired knitted pile fabric can proceed as follows:

To further explain this method reference is now made to Figs. 8, 9, 10, 10A, 11 and 12 of the drawings.

Fig. 8 shows backing weft guides 51, 51a, 51b, 51c, 51d, 51e, 51f, 51g, 51h, 51i, each positioned on adjacent needle guides 54, 54a, 54b, 54c, 54d, 54e, 54f, 54g, 54h, 54i, lying within the needle bed 52. Fig. 8 also illustrates the preferred mode of inserting backing wefts w. As may be seen by close observation of this figure, the backing wefts, for example, b are fed back and forth in successive courses across three of the needles 53. The needle bed 52 has within it needle guides 54 and the basic assembly of flat bed knitting machine elements is designated by numeral 56.

By this procedure it is necessary only to thread one backing weft through each backing weft guide, such as 51, to obtain multiple results. The first of these is avoidance of running of chain stitches, which is so common in knitted fabrics, and the second is provision for more than one backing weft per course without having to thread multiple backing wefts through the backing weft guides. "Tentative" A knitting machine manufactured by Herrnstadt Patent No. 2,718,132. Depending on the type of fabric to be made, this is, by way of example, an important feature of a pile fabric.

The kind of material to be used for the backing weft threads depends on the type of fabric desired as the end result. In the case of floor coverings, jute and paper threads have proved to be the most practical materials since such types of materials have the additional property of holding out the fabric and preventing shrinkage widthwise. In pile fabrics such as uphostelry linen would serve the same purpose, but cotton, wool or some of the synthetic fiber threads may also be used.

Fig. 8 illustrates the initial steps in the method of manufacturing one fabric construction in accordance with this invention, and is shown in Fig. 4.

Fig. 8 shows the tubular backing weft guides 51, 51a, etc., which are firmly held in position 50 (Figs. 3, 9). In Fig. 11 the backing weft guide 51 feeds a backing weft thread 21w between needle guides 54a and 54b wherein is located needle 300 with its closed needle latch L holding warp thread that is threaded through warp yarn guide 59d and is clamped by virtue of its resilient spring clip U onto guide bar 56 (Fig. 11) carried by the bracket 62 (Fig. 3). At the same time it may be seen that the backing weft 21w is fed at this point by a corresponding weft guide 51 (Fig. 11)
between needle guides 54a and 54b within the needle bed 52 and that said backing weft 21 w extends across the warp stitch 1 which is held by needle 300 with its closed latch L. Backing weft 22 w is fed from backing weft guide 51a between needle guides 54d and 54e and is bound in by warp stitches 1 and 2. Backing weft 23 w is fed by backing weft guide 51b between needle guides 54c and 54d and bound by warp ends 1, 2 and 3 held by the succeeding three needles 300, 301 and 302, with their respective latches L closed. Backing weft 24 w is fed through backing weft guide 51c and the space between needle guides 54d and 54e with their respective needles 300 and their closed latches L. Backing weft 25 w is fed from backing weft guide 51d between needle guides 54a and 54f and their respective needles 301 and 302 with their closed latches L. Backing weft 26 w is fed from backing weft guide 51e now in the position between needle guides 54f and 54g with their respective needles 305 and 306 and their closed latches L. At this point the needle 300 leads warp stitch from warp thread 1, needle 301 from warp thread 2, needle 302 from warp thread 3, thread 303 from warp thread 4, needle 304 from warp thread 5, needle 305 from warp thread 6, and needle 306 from warp thread 7. All these warp threads are guided by the warp yarn guides 53 and needle guides 58. The weave is formed between creels or beams to needle guides 53 in needle guide 54. As may be further observed from Fig. 11, backing weft threads 21v, 22v, 23w, 24w, 25w, 26w, 27w, etc., are to be bound in by the bights of the loops which needles 300, 301, 302, 303, 304, 305, 306 presently hold. Fig. 9 merely shows the base fabric of backing wefts combined with a series of warp stitches, but without any pile yarn inserted therein. As previously mentioned, this figure primarily indicates the method for making the type fabric shown in Fig. 4.

In the next step, which is shown in Fig. 11 of the drawing, the method of understanding the warp thread 21 w, which prior to this step was positioned between needle guides 54a and 54b in backing weft guide 51, now shifts to a position sidewise between needle guides 54b and 54c. Backing weft 22w, with its guide 51a, now shifts from the prior position to the right of needle 301 to the present position between needle guides 54c and 54d. All other adjacent backing weft shift accordingly sidewise as many needle guides (three) as described by the shifting of weft guides 51a and 51b, since they are all stationarily set into the weft bar 50 to which the shifting mechanism 58a is attached. At the same time, move sidewise to their determined position as explained above, the tubes 159, etc., are dipped in between the warp ends. The tube 159 carrying pile yarn end 200 is shown to dip between warp threads 1 and 2; pile yarn end 201 fed from the next of said tubes is dipped between warp threads 2 and 3; pile yarn end 202 is dipped between warp yarns 3 and 4; pile yarn end 203 is dipped between warp yarns 4 and 5; pile yarn end 204 is dipped between warp threads 5 and 6; and the remaining pile yarn end 205 is shown dipped between warp threads 6 and 7.

The next part of the preferred method of making one of the fabrics, as shown in Fig. 4, will be described in connection with Fig. 11 herein the guide bar 58 carrying the warp guides 59 moves in a direction opposite to the direction the backing wefts 21 w, etc. have moved. Before proceeding further, it is to be observed that the sidewise movement of the warp threads, by virtue of the movement of the pile machine, is a direction opposite to the movement of the backing wefts by the guide bar 59. It is entirely possible that both the warp guide bar 58 and the backing weft guide bar 50 move sidewise in the same direction. Nevertheless, it has been found that there is some advantage to moving them in opposite directions. One reason is that the various parts are not forced in one direction and, therefore, produce a more balanced action of the machine. Another reason is that, if the inserted pile tufts are not all intended to lie in one direction, it is advantageous to make this movement of the bracket 58 in one sidewise position, first in one course and then in the opposite direction in the successive course. While warp yarn guide 59 in Fig. 10 is aligned with needle 300 by its connection with warp thread 1, it is by its right sidewise movement, as shown in Fig. 11, being fed into the needle head of needle 301; and the needles 300, etc. have come out and opened their latches L to grab the following stitch. As the warp thread 1 moves from its prior position opposite needle 300 to the right opposite needle 301, it puts a bend or a U into the face yarn end 200 b and immediately thereafter it is being tied in by the retracting needle 300 hocking warp thread 2. Thus it will be seen what happens in the pile forming process as in Fig. 11: Tube 159 moves upwardly between the same needle guide spaces 54d and 54e where it originally entered. But its pile yarn end 200, which prior to this was just dipped between the warp ends 1 and 2, is being held by warp end 1 which now has been moved sidewise by the mechanism of the guide bar 58 which carries the yarn guide 59 for warp yarn 1. Warp yarn guide 59 is now tying in the pile end 201 with the help of warp end 2. The same operation is repeated for the adjacent pile ends 202, etc. and the corresponding tubes 159. The needles 53 will now withdraw into the needle guides 54 in the needle bed 52 with the help of the mechanism for the return pull member 87 (Fig. 3A) and the latches L will close to drop the stitch of the prior course and pull in the new stitch.

But one other step is necessary, namely, to cut off the length of the pile yarn ends 200, 201, etc. from the tube frames 158 so that the pile yarn is severed and can be carried forward with the remaining part of the fabric which has been formed. Therefore, for further simplification of this invention, there is shown one of the methods of cutting off the pile yarn ends 200, etc., which are fed from the tube frames 158 through the set of tubes 159. As explained hitherto, during the action of the course as described in Fig. 10, the individual pile yarn tubes 159 have moved upwardly to a predetermined position, and are retracted depending on the length of pile tuft desired. In Fig. 12 there is shown one of the cutting means which has been most successful, namely, a front pile yarn cutting blade 43 and a rear cutting blade 45 (Fig. 3). The rear cutting blade 45 is mounted on the back of the frame 25 as shown in Fig. 13. Depending on the width of the machine there are many brackets or stationary guides 48 of the type shown, or similar types, as may be needed for the width of a machine in order to keep the rear cutting blade 45 as perfectly straight as possible. The rear cutting blade 45 has a ground edge and is operated by a rod 45 r pivotally connected at its rearward end to a pivotally mounted lever 45 l having a follower roller 45 j intermediate its length cooperating with a plate cam 43 c, driven by the needle drive shaft 41 in timed relation.

The front knife blade 43 also has a stationary guide or bracket 47, and is operated in like manner by a rod 43 r pivotally connected at its rearward end to a pivotally mounted lever 43 l having a follower roller 43 j intermediate its length cooperating with a plate cam 43 c turned by the front warp shaft 42. The front pile yarn cutting blade 43 also has a ground edge and is provided with as many brackets or stationary guides 47 (Fig. 3) as may be necessary in a different machine, but pivotally mounted lever 43 l having a follower roller 43 j intermediate its length cooperating with a plate cam 43 c, driven by the needle drive shaft 41 in timed relation.
This is exactly what should take place now: The weft guides 51, etc. are in their downmost position and remain stationary to provide clearance for the rear cutting blade 45. The bracket 62a carrying warp yarn guide bar 56 bearing guides 59, etc. (Fig. 3) remains stationary also, at the lowest point, to provide clearance for the front pillow knife cutting blade 43 itself. The rear cutting knife 45 with its ground edge moves toward the pile ends 200, etc. below its tubes 159, etc. and goes in absolutely straight. The front cutting knife 43 is moved forward towards the pile ends 200, etc. below its tubes 159, etc. to meet the edge of the back knife 45 with its front edge. The rear cutting blade 45 goes in absolutely straight, laterally, and therefore requires the same type of mechanical motivating means for as many brackets as it may have. The pile yarn cutting blade 43 may be operated with slightly different timing from one end to the other end through mechanical means; it is thus possible to provide not only a cutting action by direct pressure when the edge of the pile yarn cutting blade 43 and the edge of the rear cutting blade 45 meet, but also a scissor-type action. It has been found in wide machines that straight compression of blade edges is not as effective as that obtained by giving one or the other knife a scissor-type action. A different timing with mechanical means attached to the brackets of front pile yarn cutting blade 43 provides such a scissor-type action in combination with the final compression action upon total meeting of the edges of blades 43 and 45. Such timing for progressive cutting action widthwise of the machine is obtained by adjustment of the lengths of the rods 43-1 between the front blade 43 and their respective lever 43-1 and the lengths of the rods 45-1 and the respective levers 45-1.

If these knife edges are made of material such as tempered steel, grinding of the same would be required not less frequently than probably every one to two months.

Another practice provided on this machine is the use of a backbiter. Fig. 9a shows the arrangement of a backbiter 60 which will then be slightly elevated to shift the backing weft threads 21w, etc., in a sidewise direction opposite to that of the previous course. At the same time the front pile yarn cutting blade 43 retreats to provide clearance for the dip of the spool frame units 104 in the successive course and also to provide a cutting sweep for the front knife blade 43 itself. The back cutting blade 45 downward into place in time to be that the front knife blade 43 and the back knife blade 45 withdraw and, as the backing weft guide bar 50 starts to shift sidewise, the chain sprocket shaft 128 turns the shaft mounted sprockets 116 to carry another spool frame unit 104 upwardly and to move another spool frame unit 104 downwardly into place in time to be that the front knife blade 43 and the back knife blade 45 dip between designated warp ends for the following course. The only difference in the following course in the action of pile forming for fabric construction as shown in Fig. 4 will be that warp end 1 will move sidewise with the help of the shifting mechanism (Fig. 10a) attached to rod 65, moving brackets 62a, etc. and warp end 1 will again be opposite needle 269 after the course has been completed (Fig. 10).

It has been noted that the method illustrated in Figs. 7 through 12 has been successfully used in making a fabric in the manufacture of cotton.
the understanding of the operation of the loom combination of spool units and a flat bed knitting machine wherein such a grip is provided. This allows for the accurate placing and spacing of the gripper jaws 224 and 225 relative to each other and to the other components of the loom. This simplifies the operation of the gripper and makes it easier to maintain a consistent grip on the spool units.

After the cutting of the flat bed knitted fabrics, the gripper jaws 224 and 225 remain in position to hold the spool units. This allows for a more efficient and accurate operation of the loom, as the gripper can easily grip the spool units and move them as needed. The simplicity of the gripper design, combined with its ability to maintain a consistent grip on the spool units, makes it an ideal component for use in loom and knitting machines. As shown in Fig. 14, warp end 1 is immediately alongside the upwardly moving gripper jaws 224 and 225, which allows for the easy and efficient operation of the loom.

In conclusion, the gripper shown in the figures is a simple and effective component for use in loom and knitting machines. Its ability to maintain a consistent grip on the spool units, and its ease of operation, makes it an ideal component for use in such machines. The simplicity of the design, combined with its efficiency, makes it a valuable addition to the field of textile manufacturing.
shown in Figs. 4 and 11, the more number of courses per
minute the machine may be operated. Since the invention
resides basically in the novel method of making a pile
fabric by combination of two known procedures, the
value of speed in manufacture is of paramount impor-
tance.

In the present invention the tuft insertion itself is per-
formed at the time when a needle guide 59 wraps around
warp end 1, etc., and around the needles 300, etc. (Fig.
10). This takes place as follows: The pile end 200 is
inserted between the warp end and the needle which is
now out of the needle guides 54d, e, g, with its latch open.
Needle guides 59, etc., holding warp end 1, etc., then
swivel around so that the needle 300 forming a loop and laying
said loop of the warp yarn within the hook end of needle
300, etc. As the needle retracts the pile end is being
bound in by either the bight of the stitch or around the
warp yarn which has been formed by a previously ex-
plained action of the warp yarn and the warp yarn guides.
After the pile ends 200, etc., have been cut off, tufts 30,
etc. will be within the fabric.

The construction disclosed has another advantage when,
In loosely manufactured fabrics, a back sizing is applied.
Sizing of starch, rubber, polyvinyls and other known
materials will give these tufts a strong bond of adherence
to the backing formed by the backing wefts w, a, b, etc.,
in combination with the U's of tufts 280, etc.

So far as spool frames are concerned it is emphasized
that the combination of spool frames and knitting
machines as specifically disclosed herein are especially adap-
ted for the production of pile fabrics simulating such
woven fabrics as are known as plush, velvet, chenille
velvet, chenille carpeting and Axminster carpeting. While
this invention is primarily directed to the production of
cut pile fabrics and to knitting machines having a greatly
varied capacity for design in unlimited color distribution,
loop pile fabrics may also be made, although they will
not have the same advantages of greatly varied design and
multicolor.

In making a loop pile fabric only one tube frame is
used and hooks or other pile forming means are provided
for creation of the loop pile.

The yarns used for the pile ends of the fabrics referred
to herein may be of wool, cotton, rayon, acetate or other
synthetic yarns, depending principally on the type of
fabric which is required in the end use of the consumer.

It will be apparent that many other changes and modi-
fications may be made in the apparatus and method as
herein disclosed without departing from the principles
of this invention. Therefore, this invention is to be limited
only as required by the prior art and the scope of the
appended claims.

What I claim as novel is:
1. In a machine for making knitted pile fabrics having
pile tufts bound therein, the combination comprising
a flat bed warp knitting machine including means for
interconnecting a web backing with chain knitted warps,
a spool frame mounted over the bed of the knitting
machine, and a plurality of grippers movably mounted
to grip and withdraw individual lengths of pile yarn from
a spool of the spool frame and to insert the respective
withdrawn lengths of tuft yarn between adjacent warp
ends.

2. In a machine for making warp knitted pile fabrics,
the combination comprising a flat bed knitting machine,
a spool frame mounted for dipping movement above the
bed of the knitting machine, a plurality of pile yarn
feeding tubes extending downwardly from the spool
frame, and for dipping the spool frame and the yarn
feeding tubes in between the warp rows.

3. The combination of claim 2 including blade means
for cutting the pile yarn ends upon each dipping of the
spool frame.

4. In a machine for making knitted pile fabrics, the
combination comprising a needle bed extending laterally
across the front of said machine, a plurality of latch
needles operating within said needle bed of said machine,
a plurality of weft feeding and shifting tubes extending
over the outer edge of the needle bed, an endless chain
carrier, a plurality of pile thread spool units rotatably
mounted on the carrier, a tube frame detachably attached
to each spool unit in longitudinally spaced relation, a
transferring device for bodily moving said spool units
and presenting each unit in turn to a pile end insertion
position over the warp ends which are drawn toward the
needle bed by said needles, means for manipulating the
free end of each pile thread completely to loop it around
at least one warp end drawn toward the needle bed
by the needle drive shaft, a cam mounted on the drive
shaft, means interconnecting the needles with the drive
shaft to drive and return the needles in the needle bed,
means for holding the free ends of the looped pile threads
above the ground warp threads during the tuft forming
and stitching operation, and cutting means responsive
to operation of the needle drive shaft to cut off the inserted
pile thread ends from the tube frame.

5. In a machine for making knitted pile fabrics, the
combination comprising a needle bed extending laterally
across the front of said machine, a plurality of latch
needles movable within said needle bed of said machine,
a plurality of weft feeding and shifting tubes extending
over the outer edge of the needle bed, an endless chain
carrier above the needle bed, a plurality of pile thread
spool units rotatably mounted on the carrier, a plurality
of yarn feeding tubes attached to each spool unit in
parallel longitudinally spaced relation, a transferring de-
vice for bodily moving said chain carrier and presenting
each spool unit in turn to a pile end insertion position over
the warp ends drawn toward the needle bed by said
needles, means for manipulating the free end of each pile
thread completely to loop it around at least one warp end
drawn toward the needle bed, a needle drive shaft,
a cam mounted on the drive shaft, means interconnecting
the needles with the drive shaft to drive and return the
needles in the needle bed, means for holding the free
ends of the looped pile threads above the ground warp
threads during the tuft forming and stitching operation,
and opposed blade cutting means responsive to operation
of the needle drive shaft for severing the pile thread ends
from the yarn feeding tubes of the spool units.

6. In a machine for making knitted pile fabrics having
pile tufts bound therein, the combination comprising a
flat bed warp knitting machine including means for
interconnecting a web backing with chain knitted warps,
said backing mounted over and across the bed of the knitting
machine, a plurality of latch needle spool units rotatably
supported on the
spool frame and having individual yarn feeding tubes
extending therefrom, means for moving the spool frame
toward and away from the bed of the knitting machine,
and cutting means arranged to operate between the bed
of the knitting machine and the yarn feeding tubes of
individual spool units as said spool units are moved into
position over the bed by the spool frame.

7. In a machine for making knitted pile fabrics having
pile tufts bound therein, the combination comprising a
flat bed warp knitting machine for interconnecting a weft
backing with chain knitted warps, a spool frame mounted
over and across the bed of the knitting machine, a plu-
arity of pile yarn spool units rotatably supported on the
spool frame, a plurality of yarn feeding tubes extending
outwardly from each yarn spool unit, and a row of grip-
per units extending in parallel spaced relation with
the machine, each gripper unit having a pivotally con-
ected pair of jaws for gripping and manipulating an
end from one of a spool tube, means for moving a spool
unit toward and away from the bed of the knitting
machine in timed relation course by course to bring
the proper pile yarn of a designated spool unit into inserting
position as the pattern may require.
8. In a machine for making warp knitted pile fabrics having pile tufts bound therein, the combination comprising a flat bed warp knitting machine for concurrently knitting a plurality of wales of warp stitches wherein each knitted warp end extends back and forth diagonally between warp stitches in adjacent wales, means for laying in a plurality of weft ends back and forth in undulating paths across several of said wales concurrently with said knitting, whereby to interlock the fabric, and means for individually introducing in timed relation a pile tuft yarn end under and around a diagonal warp end between stitches in adjacent wales as they are knitted and prior to binding the pile tuft yarn end.

9. In a flat bed knitting machine for warp knitting pile fabrics the combination therewith of a spool frame, a plurality of spool units mounted on the spool frame, means mounting said frame for movement toward and away from the needle bed of the machine and means for moving the spool units toward and away from the needle bed in timed relation to the knitting cycle.

10. In a machine for making warp knitted pile fabrics having pile tufts bound therein, the combination comprising a flat bed warp knitting machine for knitting a plurality of wales of interconnected warp stitches wherein each knitted warp end extends back and forth diagonally between warp stitches in adjacent wales, individually threaded spool units arranged for feeding pile tuft yarn ends under and around the diagonal warp ends as they are knitted, and means for advancing the spool units in timed relation to the knitting operation in order to bring the proper pile yarn of the designated spool unit into inserting position as the pattern may require.

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