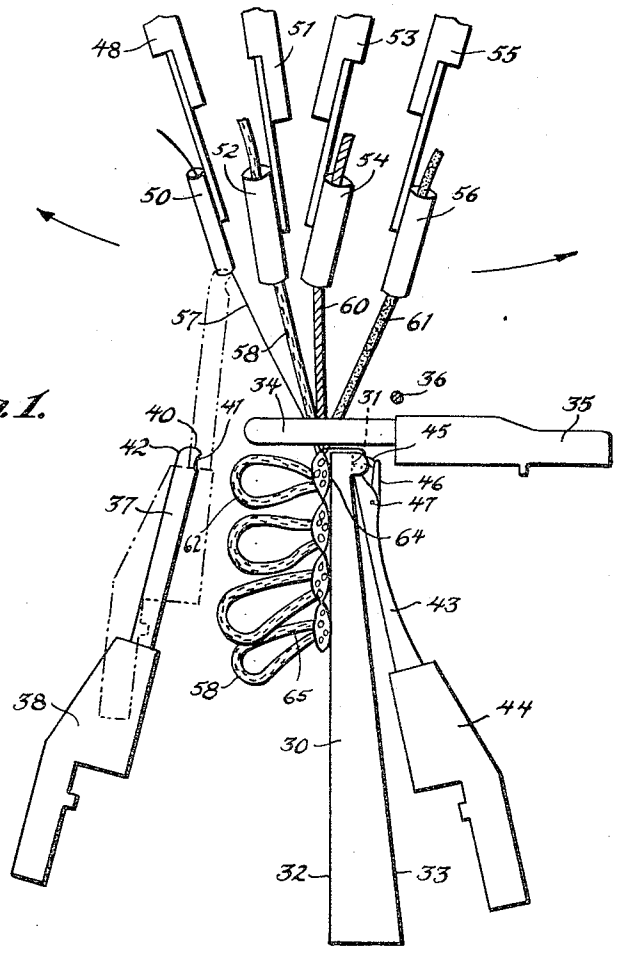
Aug. 23, 1960 R. S. MacCAFFRAY, JR 2,949,754

WARP KNITTING METHOD

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Fig. 1.



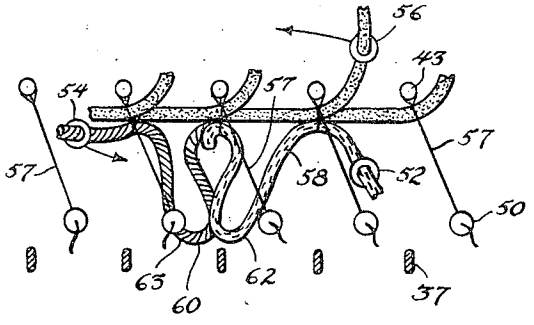




Fig. 1a.

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WARP KNITTING METHOD

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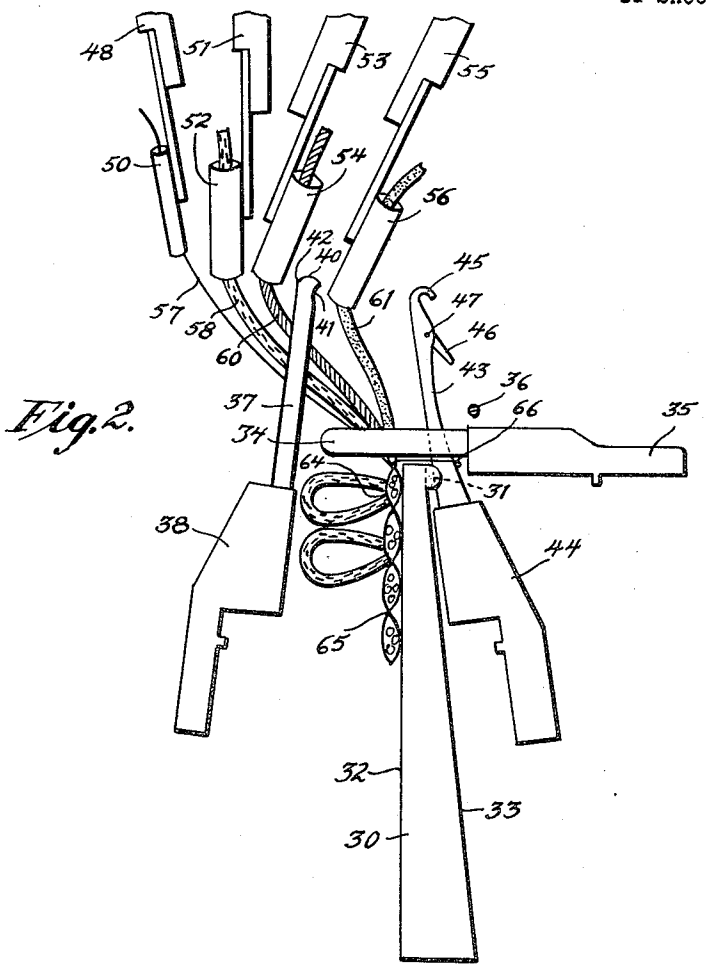



Fig. 2.

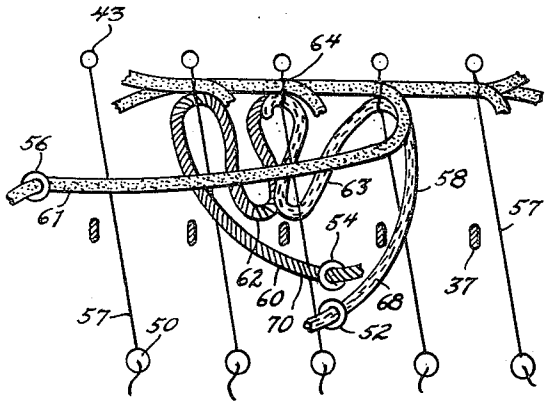



Fig. 2a.

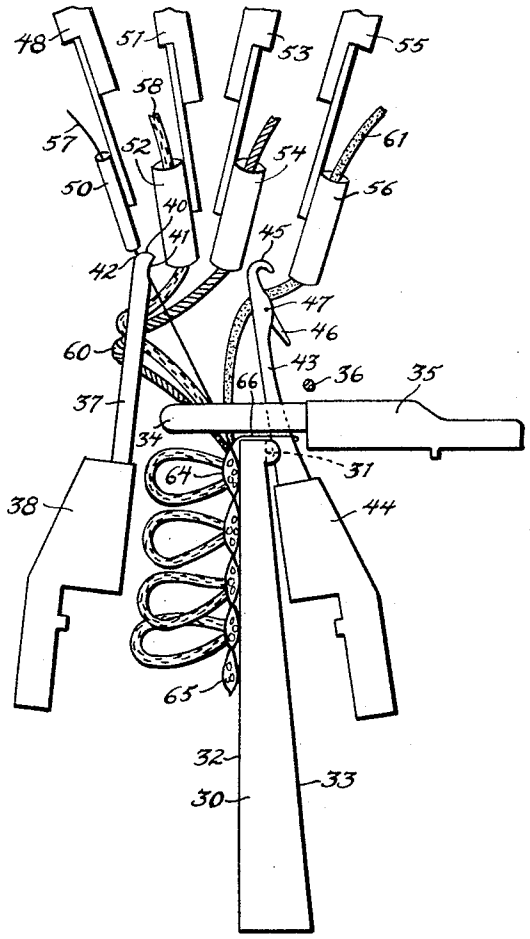
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WARP KNITTING METHOD

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Fig. 3.



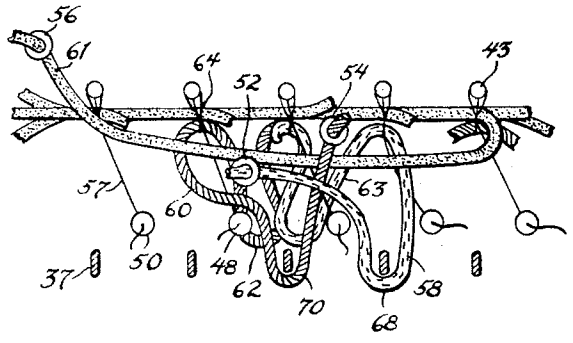




Fig. 3a.

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WARP KNITTING METHOD

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Fig. 4.

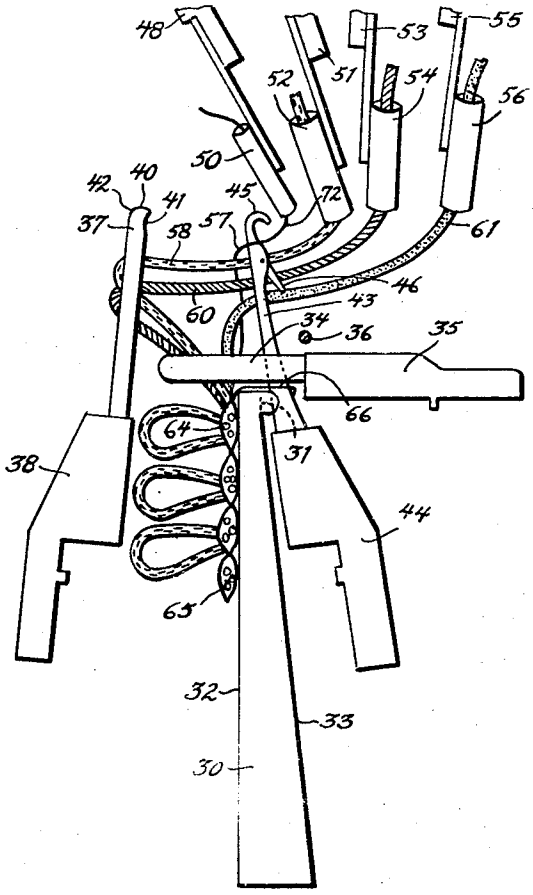
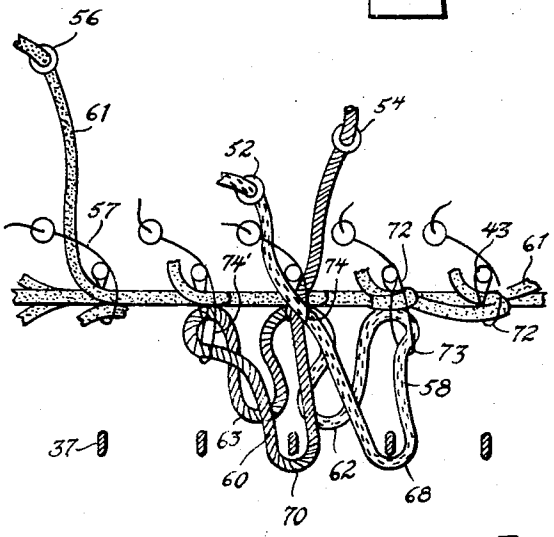



Fig. 4a.




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WARP KNITTING METHOD

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Fig. 5.

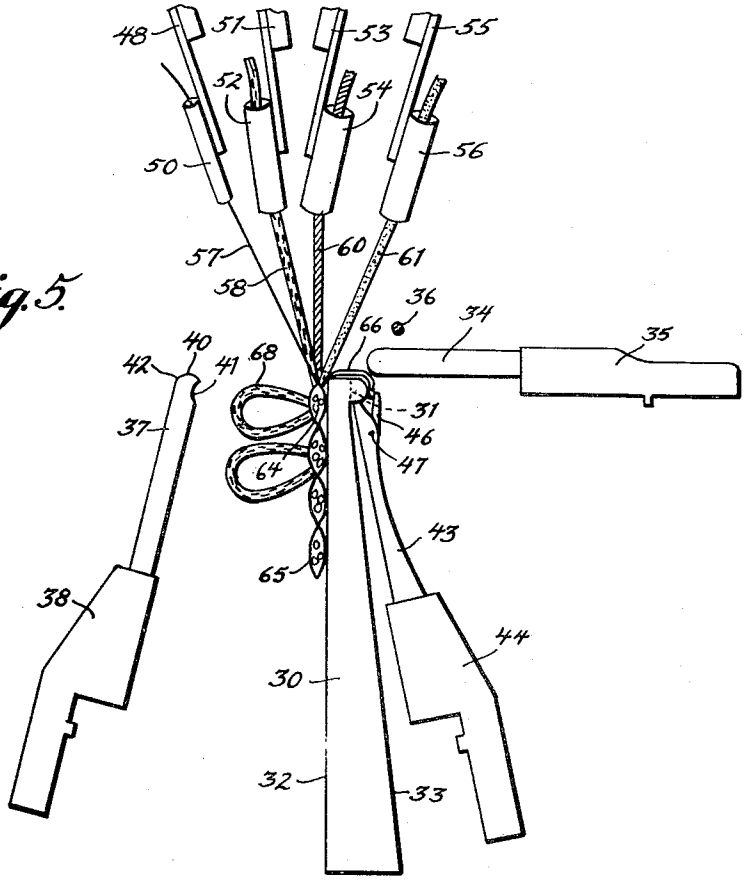
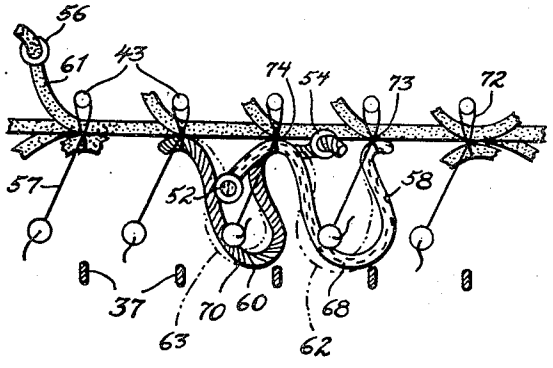



Fig. 5a.




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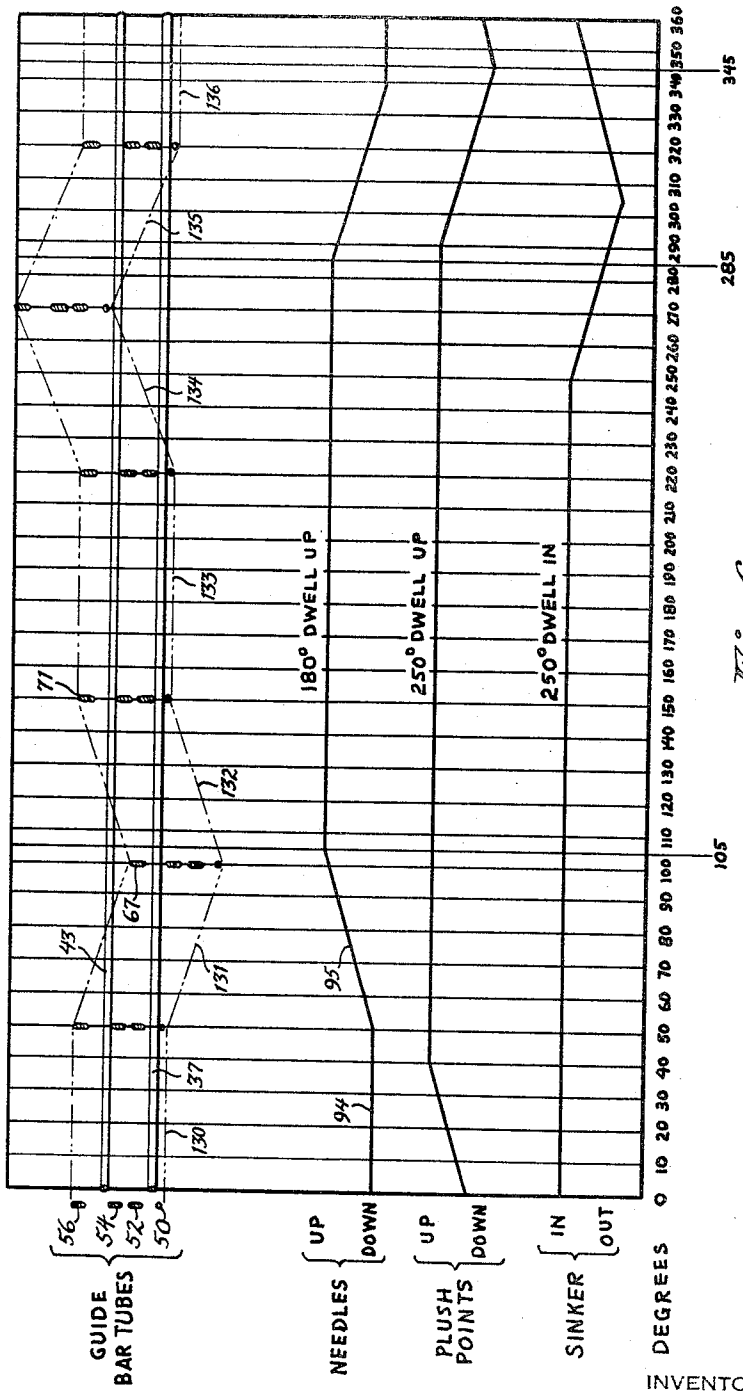



Fig. 6.

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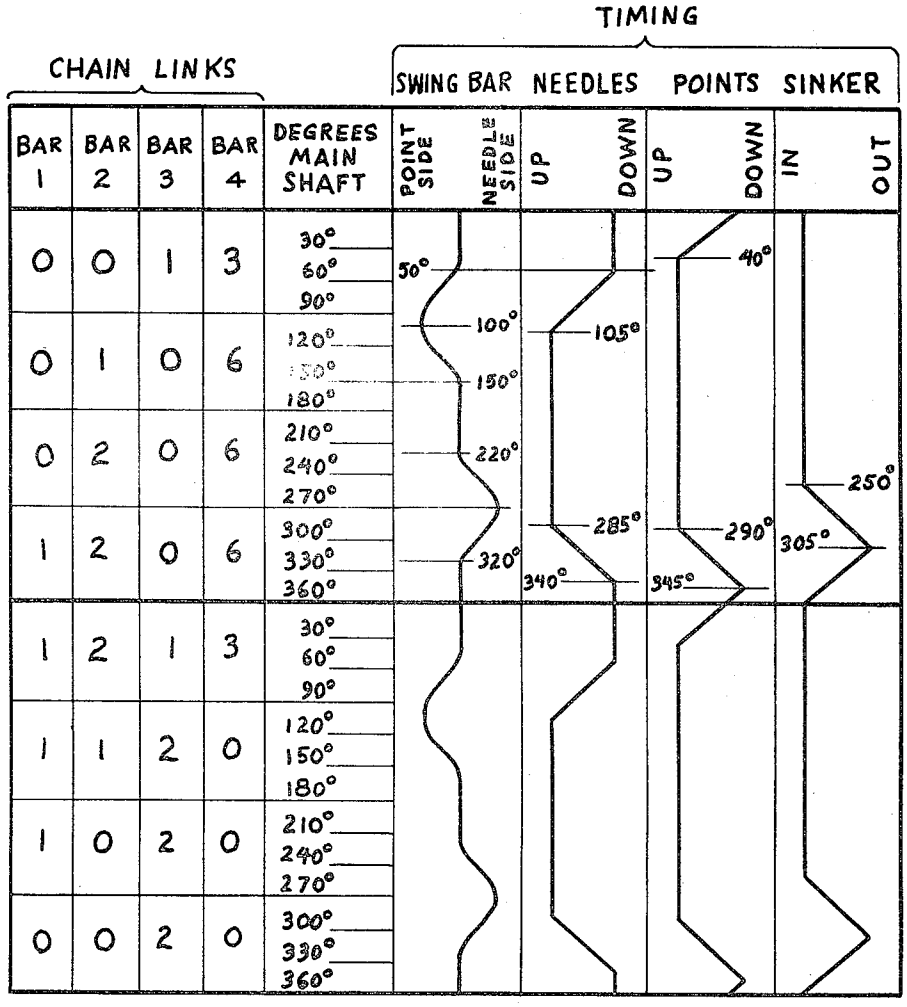



Fig. 7.

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WARP KNITTING METHOD

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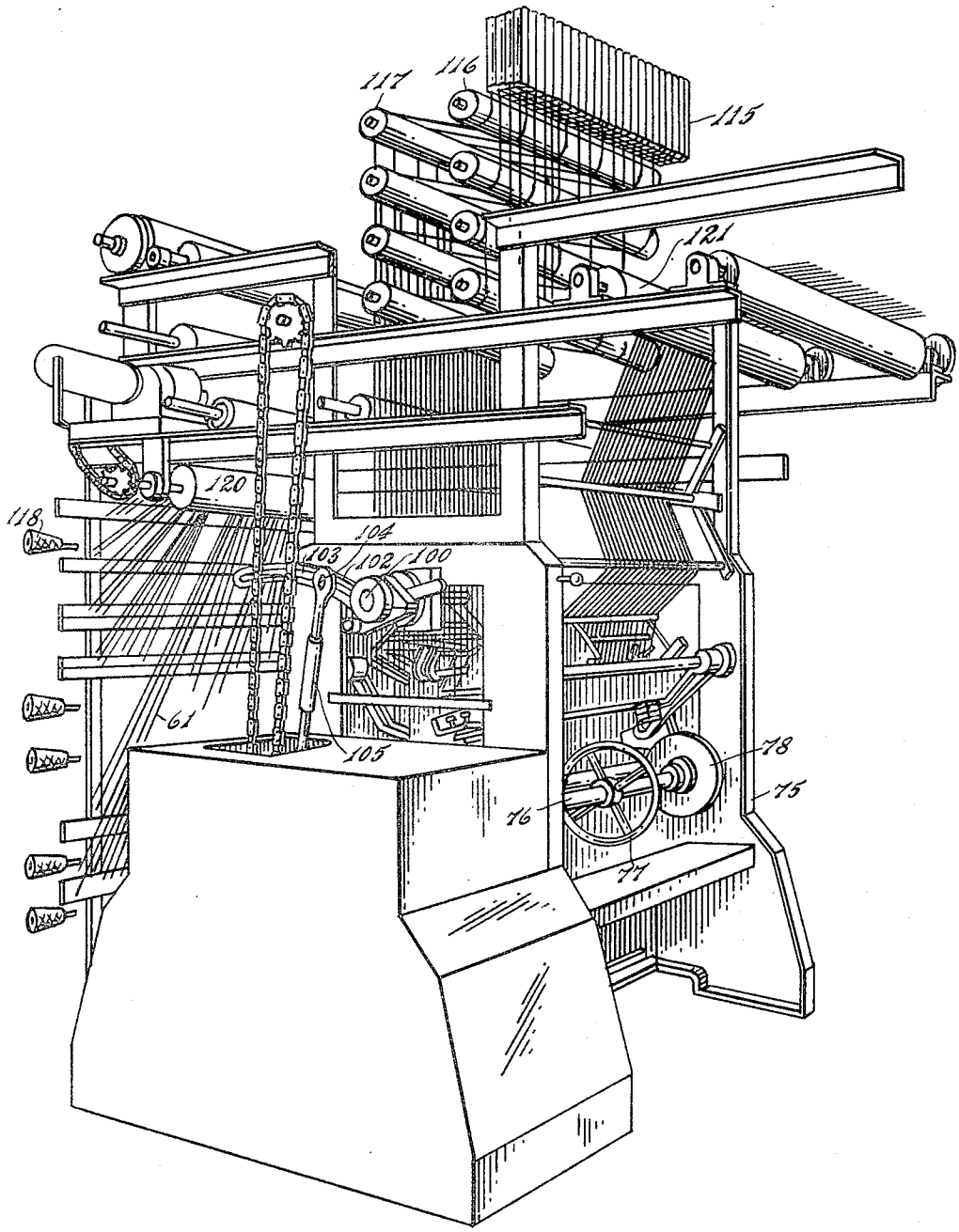



Fig. 8.

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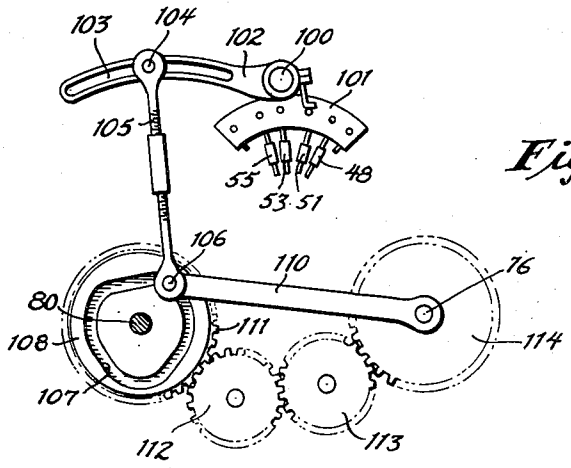



Fig. 9.

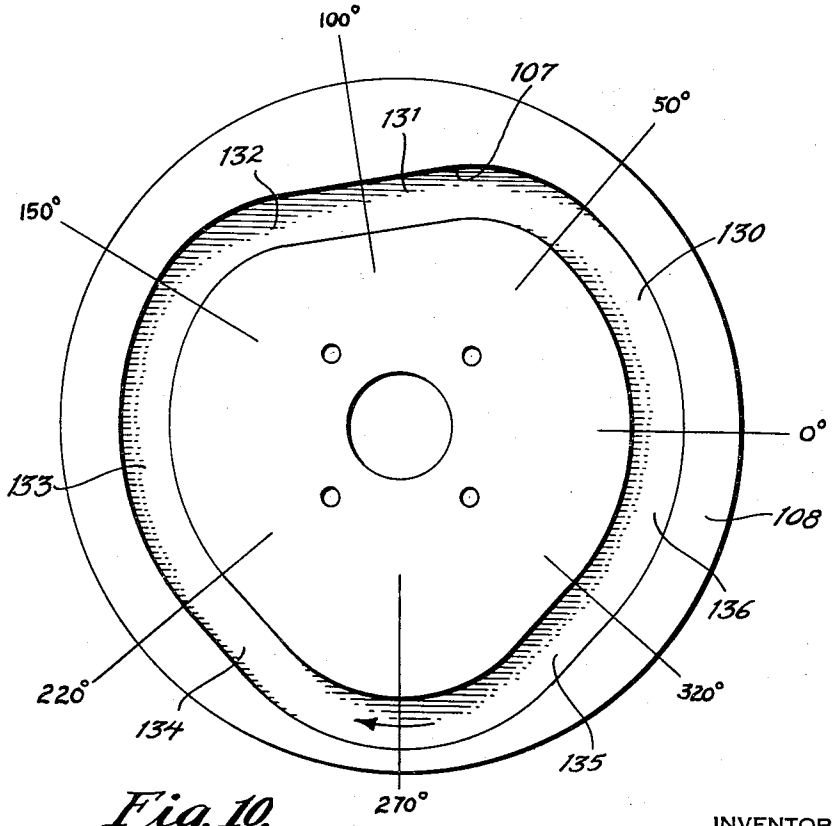



Fig. 10.

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WARP KNITTING METHOD

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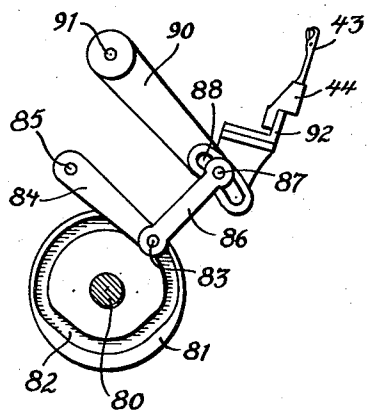



Fig. 11.

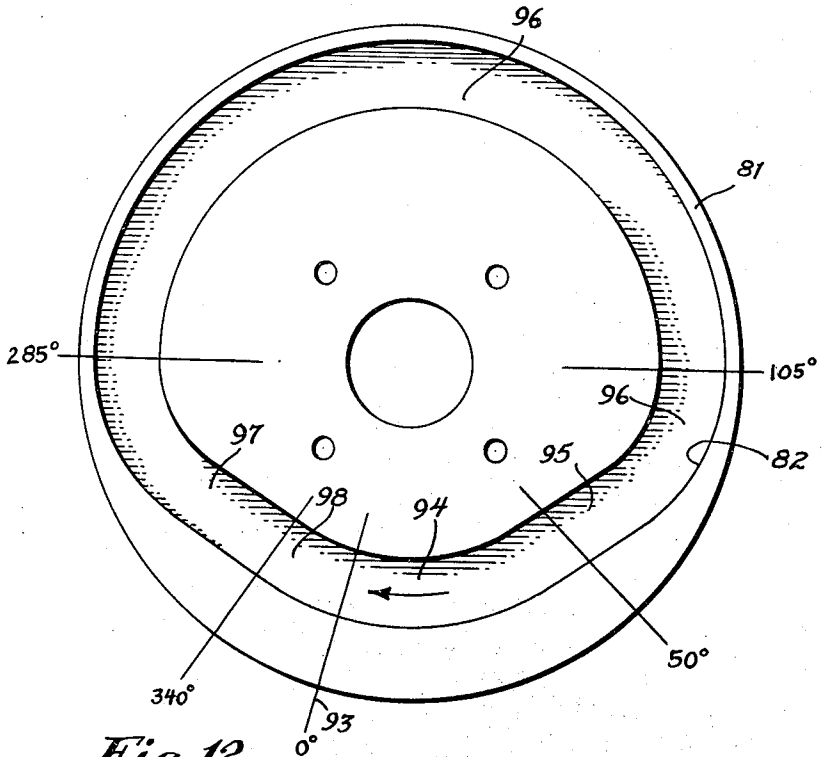



Fig. 12.

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Fig. 13.

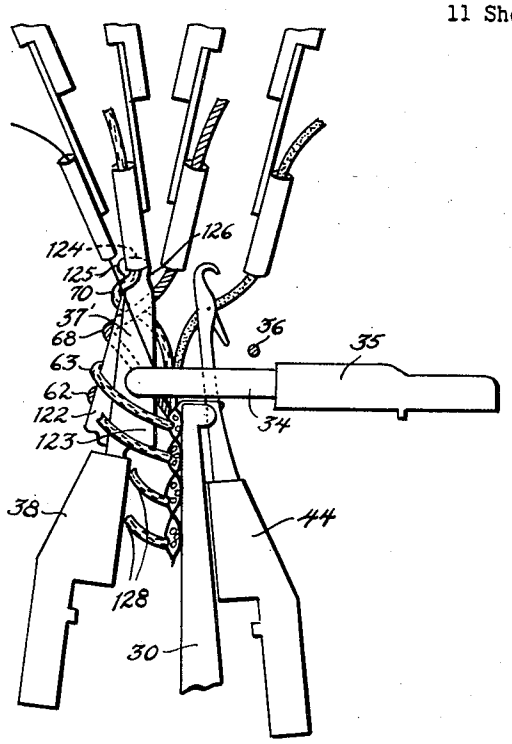
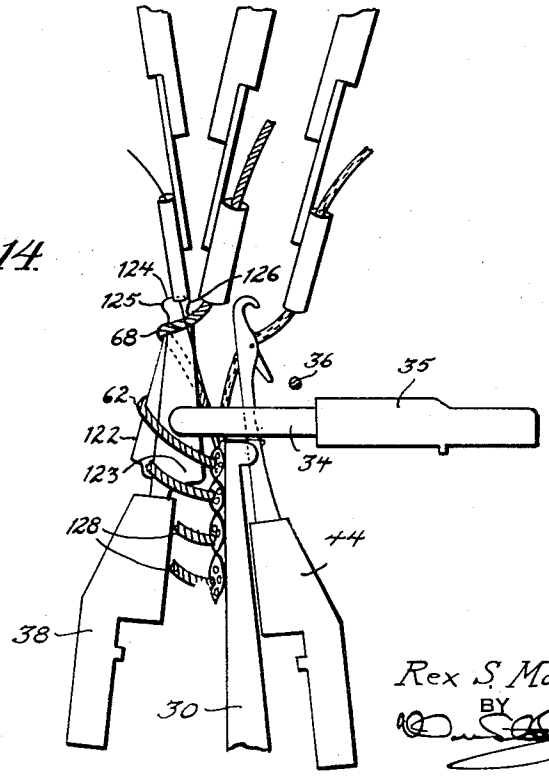



Fig. 14.




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United States Patent Office

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Patented Aug. 23, 1960



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# WARP KNITTING METHOD

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Filed Sept. 27, 1957, Ser. No. 686,720

3 Claims. (Cl. 66—85)

The present invention relates to warp knitting methods for producing pile and flat textile fabrics.

This application has been divided and the claims directed to the warp knitting machines are being embodied in my divisional application Serial No. 771,808, filed November 4, 1958 for Warp Knitting Machine.

A purpose of the invention is to increase the operating speed of warp knitting machines, especially those suited for knitting relatively heavy fabrics, such as carpets, rugs, upholstery fabrics, over-suitings, or other plush and pile fabrics. The invention is also applicable in some cases to warp knitting of flat fabrics.

A further purpose is to allow more time for shogging pile yarn and backing yarn for positions approximating zero degrees and 180 degrees in the cycle.

A further purpose is to reduce the abrasion and strain on the yarn which is being knitted by shortening the path it traverses.

A further purpose is to facilitate warp knitting of high pile fabric and reduce the necessity for high swing bar speeds in the warp knitting of high pile fabrics in relation to machine speed.

A further purpose is to reduce the need for maintaining heavy tension to prevent the formation of loose loops in connection with the swing bar operations of a warp knitting machine.

A further purpose is to arrange the guide bars unevenly on the swing bar with respect to the arcuate angle, so as to provide a convenient gap between the guide bar carrying the backing yarn and the nearest guide bar carrying the pile yarn.

A further purpose is to accomplish the entire warp knitting cycle by one forward swing of the swing bar and one back swing of the swing bar, with intermediate dwells, avoiding the need for the additional forward swings and back swings used in prior practice.

A further purpose is to facilitate warp knitting by using an intermediate position or dwell of the swing bar to take the place of a swing.

A further purpose is to raise the needles before the last shogging of face yarn takes place, and in some cases while backing yarn is shogging.

A further purpose is to shog face yarn and/or backing yarn at zero degrees or the beginning of the cycle when the guide bars are in a straddling relation to the plush points.

A further purpose is to move all guide bars forward of the needles only once in the cycle, relatively early rather than late, and to raise the needles at that time in the cycle.

A further purpose is to employ a swing bar cam which has a dwell or midposition near the beginning of the cycle, then a swing to the front, then a swing back to near the midposition, continuing throughout a dwell, then a swing fully to the back, then a swing forward to near midposition, followed by a dwell near midposition, completing the cycle.

A further purpose is to employ a needle bar cam which



will raise the needles relatively early in the cycle and preferably at about 100 degrees, or when the swing bars are forward, and will start to lower the needles at about 300 degrees or immediately after the knitting yarn has looped the needles.

A further purpose is to employ the novel swing bar cam and needle bar cam in cooperation.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the numerous embodiments which appear in my invention, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figures 1 to 5 are diagrammatic vertical sections showing different positions of the main operating parts, including the plush points, needles, sinker comb and swing bars, Figure 1 corresponding to zero or 360 degrees, Figure 2 corresponding to 100 degrees; Figure 3 corresponding to 150 to 220 degrees; Figure 4 corresponding to 270 degrees and Figure 5 corresponding to 340 degrees.

Figures 1*a* to 5*a* are diagrammatic enlarged fragmentary top plan views showing the yarn positions in formation of the fabric, respectively agreeing with Figures 1 to 5. In these views in general, multiple ends of knitting yarn are shown, and multiple ends of backing yarn broken away, but only two ends of pile yarn, one from each guide bar, the remaining being omitted for clarity in illustration.

Figure 6 is a cam layout diagram in which the ordinates show respective positions of the guide bar tubes, needle positions up and down, plush point positions up and down, and sinker positions in and out, and the abscissae show the angular positions throughout the cycle.

Figure 7 is a pattern chain and cam layout diagram for two cycles, illustrating the relation of chain links to the cams already mentioned.

Figure 8 is a diagrammatic perspective showing a warp knitting machine according to the invention, conveniently used for placement of the other mechanism.

Figure 9 is a diagrammatic end elevation showing the swing bar cam and related mechanism.

Figure 10 is an enlarged front elevation of the swing bar cam, with angular positions shown.

Figure 11 is an end elevation of the needle bar cam and related mechanism, which is typical also of the plush point cam mechanism except for the cam details (for which see Figure 6).

Figure 12 is an enlarged front elevation of the needle bar cam of Figure 11.

Figure 13 is a view corresponding to Figure 3 showing the knitting of a cut pile fabric in accordance with the invention.

Figure 14 is a view corresponding to Figure 13, but showing only one pile yarn guide bar.

Describing in illustration but not in limitation and referring to the drawings:

In the prior art, in knitting fabrics such as carpets, rugs, upholstery, plush and the like, using warp knitting looms, it has been usual practice to employ three swings of the swing bar to the front and three swings of the swing bar to the back per cycle (a cycle being the interval required for a complete course of stitches). This is not only time consuming, causing the total elapsed time of the cycle to increase, but it complicates the practice from the standpoint of manipulating the yarn ends. Where high pile is being made, either considerable time is lost in swing bar motion, or high swing bar speeds must be used.

On each of these swings, relatively large yarn stretches are formed, and except where these stretches result in take-up of yarn in the fabric, the tension must be sufficient to pull the yarn back through the guide tubes or eyes on the next reverse swing. This causes repeated

stretching of the yarn and is abrasive to the yarn, requiring the use of higher quality yarn than would otherwise be needed, and also in some cases damaging the yarn.

In accordance with the present invention, I have reorganized operation of the swing bar, and at the same time correspondingly modified the needle bar operation, so as to minimize the number and arc length of swing bar motions, and avoid these unnecessary swings. Correspondingly, the speed of the machine is increased and it is possible to avoid or lessen damage to yarn, utilize less expensive yarn, and in proper cases reduce yarn tension.

In accordance with the invention, I suitably increase operating speed, in some cases as much as 100 percent (to 300 to 400 courses per minute), and correspondingly modify the yarn tension.

One of the advantages of the invention is that more time is allowed for shogging face yarn and/or backing yarn at zero degrees or 180 degrees, or some approximately similar time in the cycle.

In the preferred embodiment of the invention, the entire knitting cycle is accomplished by one forward swing and one back swing of the swing bar, with dwells at appropriate points, avoiding the other forward and back swings previously used. The dwells are not for mechanical advantage, but particularly to avoid extra working of the yarn.

The needles are raised before the shogging of face yarn to place it around the plush points, and also desirably while backing yarn shogs.

All guide bars are forward of the needle positions only once in the cycle, and the needles are raised at that point.

In one embodiment of the invention, shogging takes place at zero degrees with the guide bars placed at intermediate or dwell position.

In the preferred form of swing bar, the guide bars instead of being angularly symmetrically placed as in the prior art, are more widely spaced between the backing yarn guide bar and the next face yarn guide bar, than between other guide bars.

The invention will find its widest application in many cases in a warp knitting machine employing special modified swing bar cams and needle bar cams, as set forth more in detail below.

Considering now the stepwise diagrams of Figures 1 to 5 and 1*a* to 5*a*, with reference particularly to Figures 6 and 7 showing related cam positions, the warp knitting machine according to the present invention will suitably comprise a generally vertically extending trick plate 30 having needle guiding notches 31 at the needle side near the upper end, and provided with converging side faces 32 on the plush point side and 33 on the needle side.

Above the trick plate, sinkers 34 are supported and manipulated in and out by a sinker comb 35, as well known in the art. A latch wire 36 as well known is placed above the sinker comb on the needle side.

Plush points 37, in this case of the type intended to knit uncut pile, are supported on a plush point support 38 which is mounted on the plush point bar as well known in the art. The plush points in Figures 1 to 5 inclusive suitably have a flat top 40, a hook recess 41 at the needle side near the top, and a fillet 42 at the opposite side adjoining the top.

Latch needles 43 are supported on needle supports 44 which are mounted on a needle bar, as well known. The needles have hook ends 45 and latches 46 pivoted at 47, and are suitably of conventional latch needle type.

Supported and swinging on the swing bar in order from front to back of the machine, there are a knitting yarn guide bar 48 having tubes or eyes 50, a first pile yarn guide bar 51 having tubes or eyes 52, a second pile yarn guide bar 53 having tubes or eyes 54, and a backing yarn guide bar 55 having tubes or eyes 56. It will be evident of course that the guide bars while swinging with the swing bar, are individually shogged by the pattern control mechanism as well known in the art.

It will of course be evident that the number of guide bars will vary with the particular fabric design, and the presence in the illustration of two pile yarn guide bars rather than one or three or some other number is merely by way of example. (See Figure 14 for one pile yarn guide bar.) Likewise the presence of one backing yarn guide bar rather than some other number is merely exemplary.

Starting from front to back, the respective guide bars feed knitting yarn 57, then pile yarn A identified at 58, then pile yarn B identified at 60 and lastly backing yarn 61.

In the position of Figures 1 and 1*a*, the sinker comb is in, across the end of the trick plate and across the top of the needles, the plush points 37 and the needles are down, and the swing bar is in what is referred to throughout this application as an intermediate dwell position, as best seen in Figures 6 and 7. It will be evident from Figure 6 that the relative spacing from front to back of the guide bars and the eyes or tubes thereon is abnormally wide between backing yarn eyes or tubes 56 and the adjoining set of pile yarn eyes or tubes 54. This is intended to permit shogging of backing yarn in two steps, in one case before the needles are raised and in the other case where the eyes of the guide bars straddle the plush points. It will be evident, of course, that this feature of the invention need not be employed where shogging of backing yarn is completed before the needles are raised.

Referring now again particularly to Figures 1 and 1*a*, it will be observed that previous loops of pile 62 and 63 are shown which were formed from the different pile frames on the previous cycle, as well as a backing stitch 64 produced on the previous cycle. Ahead of these recently formed fabric portions at the knitting point, there is a strip of fabric 65 extending indefinitely to a suitable take-up mechanism, as well known.

At the position of Figures 1 and 1*a*, the pattern chain links change register, providing for shogging of pile yarn, or of backing yarn, or of both pile yarn and backing yarn. It will be understood that if pile yarn is to be shogged at this position, it will also permissibly be shogged at the 100 degree position, to be discussed, and/or also at the 180 degree position, to be discussed, but that of course while shogging at an individual position is optional, there must be shogging of pile yarn at at least two of these positions. It will also be evident that while backing yarn may be shogged at the zero degree position, it may also be shogged at the 100 degree position, to be discussed, but that shogging of backing yarn must occur at one of these positions.

It will be evident that the position of Figure 1 in the present cycle differs from the position of Figure 1 in the prior art, in that, while the swing bar is at an intermediate position in each case, in the novel operation of the present invention the swing bar is at dwell at zero degrees, whereas in the prior art the swing bar was in the process of a swing from front to back. It will be evident that a preferred chain link selection is to use a combination of link "needle" numbers of zero for the knitting yarn guide bar, zero for pile yarn guide bar 51, "one" for pile yarn guide bar 53 and "three" for the backing yarn guide bar 55, as seen in Figure 7.

As will be evident particularly from Figures 6 and 7, between the position of zero degrees and 40 degrees, the plush points raise, while all other components retain the same position.

In Figure 2, corresponding to 100 degrees, the condition is shown in which the needles 43 have raised, as shown on Figures 6 and 7, between 50 degrees and 105 degrees. The previous loop 66 of knitting yarn slips down from the hook 45 and causes the latch 46 to open as shown. Before the needles go up sufficient to interfere, and beginning at 50 degrees, the swing bar has swung forward to the full limit of its stroke, carrying all of the

guide tubes clear of the needles, as illustrated at position 67 in Figure 6. At this position shogging of the pile yarn and optional shogging of the backing yarn takes place. Again it will be evident that if the backing yarn is not to shog here, it will have shogged at the zero degree position or will shog at both positions. On the other hand, if the pile yarn is to form pile projections, the pile yarn will shog at the position of Figure 2. If however, pile is to be omitted at any particular place in the fabric, then the shogging of pile yarn at the position of Figure 2 will be omitted.

In Figure 2, the link members about to register for the shogging are for example knitting yarn guide bar "zero," pile yarn guide bar 51 from zero to one, pile yarn guide bar 53 from one to zero, and backing yarn guide bar 55 from three to six. In each of the cases where chain links are referred to they are different in the next cycle as shown in Figure 7.

Figure 2*a* shows the formation of new loops 68 and 70 by wrapping pile yarn around the plush points by virtue of the shogging of guide tubes 52 and 54.

Between the positions of 105 degrees and 285 degrees, the needles remain up in dwell, and between the positions of 40 degrees and 290 degrees the plush points remain up in dwell. The sinker comb remains in until the position of 250 degrees.

Between the position of 100 degrees and 150 degrees, the swing bar with the guide bars has swung to its intermediate dwell position, as indicated at 71 in Figure 6, and remains at that dwell position until 220 degrees.

Figure 3 shows the relationship of the parts at 150 degrees, with guide tubes or eyes 56 for the backing yarn behind the needles and the other guide tubes or eyes in front of the needles. At the position of 180 degrees, the pile yarn is optionally shogged, and if there are two guide bars carrying pile yarn as shown in Figures 3 and 3*a*, the one which is moving in the same direction as the one in which the knitted stitch will be formed, must shog if a loop is to be completed around the plush point.

As a result, the wrap-around of yarn forming loops 68 and 70 is completed at the position of 180 degrees and the result is shown in Figures 3 and 3*a*.

For example, in Figure 3 the pattern chain is changing registry from one link to the following. The new link numbers for example may be for the knitting yarn guide bar 48, zero; for the pile yarn guide bar 51, two; for the pile yarn guide bar 53, zero; and for the backing yarn guide bar 55, six.

Between the 250 degree position and the 270 degree position of Figures 4 and 4*a*, the needles and plush points remain up, the sinker comb begins to retract at 250 degrees, and the swing bar begins at 220 degrees to swing from its intermediate dwell position to the limit of its stroke back, reaching the limit of its backward stroke at 270 degrees. At this position the knitting yarn alone shogs, as for example by the combination of chain links as shown in Figure 7, the link for knitting yarn guide bar 48 having a dimension of one needled, for pile yarn guide bar 51 having a dimension of two needles, for pile yarn guide bar 53 having a dimension of zero needles, and for backing yarn guide bars 55 having a dimension of six needles. This results in wrapping the knitting yarn loop 72 into the hooks of the needles to surround the backing yarn, and to surround and prepare to tie in the newly formed pile loops 68 and 70 by gripping them at 73, 74 and 74'. The actual engagement of the yarn in the eye of the needle takes place a few degrees beyond 270 degrees. Subsequent to the position of Figures 4 and 4*a*, the swing bar begins to swing forward to the intermediate dwell position, which it reaches at 320 degrees, and the needles start to retract at 285 degrees, the plush points start to retract at 290 degrees and completely retract at 345 degrees, and the sinker comb continues the motion outwardly so that it is completely out at 305 degrees.

As shown in Figures 5 and 5*a*, by the position of 340 degrees the needles are down, and the sinker comb is beginning to move in again as soon as the needles pass, while the plush points are nearly down, resulting in tightening the stitch to grip the back of the fabric and anchor the newly formed pile loops 68 and 70. The plush points also cast off the newly formed pile loops as they retract.

As the needles retract, the previous stitch is cast off the needles and closes the latches, while the newly formed stitch is held in the hooks of the needles.

The swing bar has now reached the intermediate dwell position, which it is to maintain until the next cycle has advanced to 50 degrees.

It will be evident of course that while, for convenience, numerical values of degrees in the cycle have been used in describing the operation herein, these are intended to be approximate, and will be subject to variation with modifications in fabric design, and also in cam design. It will also be evident that of course the values of chain link designations will depend upon fabric design and vary with the fabric.

The machine of the invention will preferably be a conventional warp knitting machine, which is described by D. F. Paling, Warp Knitting Technology (1952), Chapter 11, Raschel Warp Looms and Chapter 12, Warp Loom Mechanism, with the modifications herein described.

As well known in the art, the machine as shown in Figure 8 comprises a frame 75 which journals a suitably driven horizontal front shaft 76 having a hand wheel 77, carrying plush point drive cams 78, which are suitably conventional. At the back of the machine there is a back shaft 80 shown in Figures 9 and 11, which carries needle bar cams 81, best seen in Figures 11 and 12, each of which having a cam track 82 which receives a roller follower 83 on one end of a lever arm 84, the opposite end of which is fixedly pivoted at 85 on the frame. The follower 83 pivotally connects at one end of link 86, the opposite end of which adjustably pivotally connects at 87 in an arcuate adjustment slot 88, which is at one end of the needle bar arm 90, which pivots on needle bar shaft 91 extending across the frame. Needle bar 92 is supported on a series of needle bar arms, and mounts needle supports 44 for needles 43.

Cam 81 has a zero degree position at 93, assuming the cam is rotating clockwise as viewed in Figure 12, and begins with a dwell 94 to 50 degrees, then a curve of inflection 95, raising the needles, which extends 55 degrees to 105 degrees total, then a dwell 96 from 105 degrees to 285 degrees, then a curve of inflection 97 from 285 degrees to 340 degrees, lowering the needles, and finally a dwell 98 from 340 degrees to 360 degrees.

A swing bar shaft 100 as shown in Figures 8 and 9 mounts swing bar brackets 101, which position guide bars 48, 51, 53, and 55, manipulated by swing bar arms 102, carrying arcuate adjustment slots 103, which position in adjusted position pivots 104 at the ends of adjustable links 105, which at the opposite ends carry roller followers 106 riding in cam tracks 107 of swing bar cams 108.

Each swing bar cam of Figure 10 has a dwell 130 from zero to 50 degrees, then a curve of inflection 131 from 50 degrees to 100 degrees to move the swing bar forward to its maximum position at the point side, then a reverse curve of inflection 132 from 100 degrees to 150 degrees, then a dwell 133 from 150 degrees to 220 degrees, then a curve of inflection backward at 134 to 270 degrees, then a reverse curve of inflection 135 to the intermediate dwell position at 320 degrees, and then a dwell 136, which continues through until 50 degrees on the next cycle. The cam shown turns clockwise.

The follower **106** also pivotally connects to one end of positioning link **110**, the opposite end of which loosely surrounds and engages the front shaft **76**.

The front shaft may be conveniently driven 180 degrees out of phase from the back shaft by gear **111** keyed on the back shaft, meshing with pinion **112** which meshes with pinion **113**, which in turn connects with gear **114** keyed on the front shaft.

The pile yarn is taken from a creel (Figure 8) through guide tubes **115** to feed roll sets organized in pairs **116** and **117**, the yarn passing under one feed roll and over another, and the feed roll sets being selectively driven at different rates according to a pattern control as desired.

The backing yarn enters from a suitable creel or other supply **118** over feed mechanism **120**.

The knitting yarn **57** is introduced from a suitable source over feed mechanism **121**.

It will be evident that while the discussion so far has illustrated the production of fabric having uncut loops, cutting plush points can be used to produce cut tufts or a combination of cutting and noncutting plush points can be used. The detail of the arrangement of cutting plush points is shown in my copending application Serial No. 666,312, filed June 18, 1957, now Patent No. 2,907,-191, for Cutting Plush Points for Carpet Knitting.

I illustrate in Figure 13 a view corresponding to Figure 3, in which cutting plush points **37'** have knives **122** on their sides remote from the needles, which taper and are relatively farther away from the needles as the knives extend downward from the top. The plush points also have heels **123**, which desirably are substantially parallel with the adjoining surfaces of the trick plate in raised position, and serve to engage and hold the fabric. The plush points desirably have blunt noses **124**, hook ends **125** on the side opposite to the needles near the nose, and hook ends **126** on the side toward the needle adjacent the noses.

The new loops are wrapped around the plush points at **68** and **70**, and previous loops **62** and **63** remaining over the plush points for later cutting, while succeeding loops have been cut to form the tufts **128**.

The chain links are different on the next cycle, as shown in Figure 7.

It will of course be evident that the invention as applied to the cutting plush points may be similar to that already described with reference to the noncutting plush points.

In Figure 14 I illustrate a variant of Figure 13, which is suitably the same except that one pile frame or set of pile yarn ends is provided, whereas in Figure 13 two such pile frames are employed. It will be evident of course, that in utilizing two or more pile frames the thread-in may be alternate, with an end of pile set A in in one trick and out in the next trick, and an end of pile set B out in the one trick and in in the next trick, or ends of pile set A and B may be in each trick, or any other desired thread-in combination will be used, the detail of the particular thread-in forming no part of the present invention.

It will also be understood that whereas the principles of the invention have been explained as applied to a machine using one of the needle bars to carry plush points and the other to carry needles, the invention can also be applied to the production of fabrics such as scarfing or oversuiting, which employ needles on both sets of needle bars and therefore do not produce pile, but produce flat fabrics.

It will be evident that in accordance with the present invention, it is possible to increase the speed of warp knitting, accomplishing more stitches in a given time.

It is also possible, according to the invention, to allow more time for shogging pile yarn and backing yarn at positions adjacent to zero degrees and 180 degrees.

It will further be evident that the results achieved are less likely to damage the yarn, and less exacting as to the requirement of pile yarn tension. The invention utilizes only one full guide bar swing to the front and only one full swing to the back per cycle, with intermediate dwell positions used at other points.

It will also be evident that the procedure, according to the invention, is unusual in that the needles come up relatively early before the last shogging of the face yarn (between the needles and plush points), and suitably while the backing yarn shogs.

When shogging at the 180 degree position, it will also be evident that the guide bars straddle the needles.

An unusual feature of the invention is that the guide bars have moved forward of the needles only once and that the needles are raised at that time.

It will be evident of course that the various cams will suitably be used in groups, or pairs of opposite counterpart cams as well known, either at opposite ends of the machine or in each bay.

It will further be evident that a distinctive feature of the invention is that the needles are raised before the middle of the cycle.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the method shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. The method of warp knitting, in a Raschel type knitting machine having a single set of knitting needles, a single set of plush points, a sinker comb, and at least three guide bars swinging in unison and shogging separately, which comprises starting with the guide bars in the intermediate position of the swing, at intermediate dwell, and the sinker comb advanced over the needles, advancing the plush points to the loop forming position, shogging the guide bars to lay in yarn above the knitting point, swinging the guide bars in unison from the intermediate dwell position to a position at the plush point side, shogging the face yarn guide bar to form pile loops around the advanced plus points, raising the needles while the guide bars are at the plush point side, swinging the guide bars in unison back to the intermediate dwell position, shogging a guide bar to lay in weft yarn above the knitting point between the plush points and the needles, swinging the guide bars in unison to the needle side, shogging the knitting yarn guide bar around the needle hooks to lay knitting yarn into the hooks of the needles, swinging the guide bars in unison back to the intermediate position and dwelling at the intermediate position, retracting the sinker comb and the needles, retracting the plush points, and advancing the sinker comb over the needles, thus completing the cycle, the guide bars during the cycle being swung only once to the plush point side, intermediately remaining in dwell, being swung only once to the needle side and then returning to the intermediate dwell and there remaining for the duration of the cycle.

2. The method of warp knitting, in a Raschel type knitting machine having a single set of knitting needles, a single set of plush points, a sinker comb, and at least three guide bars swinging in unison and shogging separately, which comprises starting with the guide bars in the intermediate position of the swing, at intermediate dwell, and the sinker comb advanced over the needles, advancing the plush points to the loop forming position, shogging a face yarn guide bar and a backing yarn guide bar, swinging the guide bars in unison from the intermediate dwell position to a position at the plush point

side, shogging the face yarn guide bar to form pile loops around the advanced plush points, raising the needles while the guide bars are at the plush point side, swinging the guide bars in unison back to the intermediate dwell position, shogging a different face yarn guide bar to lay in yarn above the knitting point between the plush points and the needles, swinging the guide bars in unison to the needle side, shogging the knitting yarn guide bar around the needle hooks to lay in knitting yarn around the hooks of the needles, swinging the guide bars in unison back to the intermediate position and dwelling at the intermediate position, retracting the sinker comb and the needles, retracting the plush points, and advancing the sinker comb over the needles, thus completing the cycle, the guide bars during the cycle being swung only once to the plush point side, intermediately remaining in dwell, being swung only once to the needle side and then returning to the intermediate dwell and there remaining for the duration of the cycle.

3. The method of warp knitting, in a Raschel type knitting machine having a single set of knitting needles, a single set of plush points, a sinker comb, and a knitting yarn guide bar, a backing yarn guide bar, and at least two face yarn guide bars swinging in unison and shogging separately which comprises starting with the guide bars in the intermediate position of the swing, at intermediate dwell, and the sinker comb advanced over the needles, advancing the plush points to the loop forming position, shogging the backing yarn guide bar to lay in wefts above the knitting point, swinging the guide bars in unison from the intermediate dwell position to a position at the plush point side, shogging one face yarn guide bar to form pile loops around the advanced plush points, raising the needles while the guide bars are at the plush point side, swinging the guide bars in unison back to the intermediate dwell position, shogging the other face yarn guide bar between the plush points and the needles, swinging the guide bars in unison to the needle side, shogging the knitting yarn guide bar around the needle hooks to lay knitting yarn into the hooks of the needles, swinging the guide bars in unison back to the intermediate position and dwelling at the intermediate position, retracting the sinker comb and the needles, retracting the plush points, and advancing the sinker comb over the needles, thus completing the cycle, the guide bars during the cycle being swung only once toward the plush point side, intermediately remaining in dwell, being swung only once to the needle side and then returning to the intermediate dwell and there remaining for the duration of the cycle.



**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,924,649 | Morton | Aug. 29, 1933 |
| 2,012,355 | Schonfeld | Aug. 27, 1935 |
| 2,041,053 | Dunham | May 19, 1936 |
| 2,149,032 | Schonfeld | Feb. 28, 1939 |
| 2,569,096 | Geiger et al. | Sept. 25, 1951 |
| 2,802,355 | Clark et al. | Aug. 13, 1957 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 346,047 | Great Britain | Apr. 9, 1931 |

UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 2,949,754 August 23, 1960

Rex S. MacCaffray, Jr.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 59, for "needled" read -- needle --; column 8, line 46, for "plus" read -- plush --.

Signed and sealed this 4th day of April 1961.

(SEAL)
Attest: ERNEST W. SWIDER

XXXXXXXXXX
Attesting Officer

ARTHUR W. CROCKER
Acting Commissioner of Patents