July 5, 1960 R. S. MacCAFFRAY, JR 2,943,470

WARP KNITTED PILE FABRIC HAVING EACH PILE END BOUND ENTIRELY IN ONE WALE

Original Filed Nov. 8, 1957 9 Sheets-Sheet 1

Fig. 1.

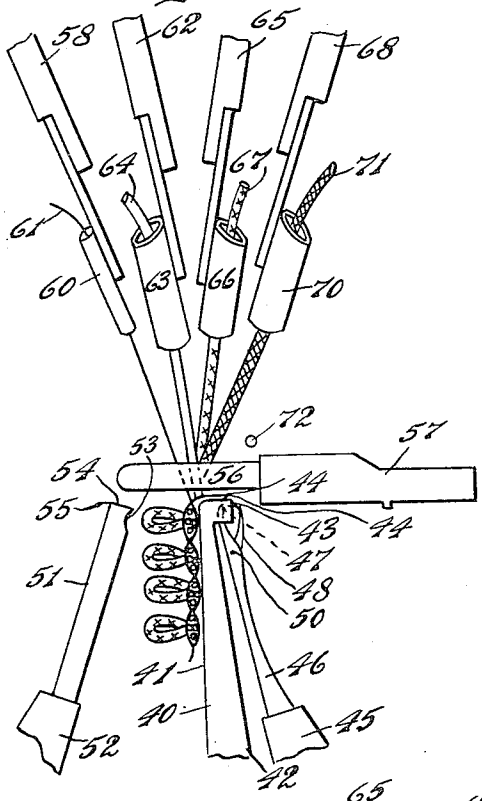


Fig. 3.

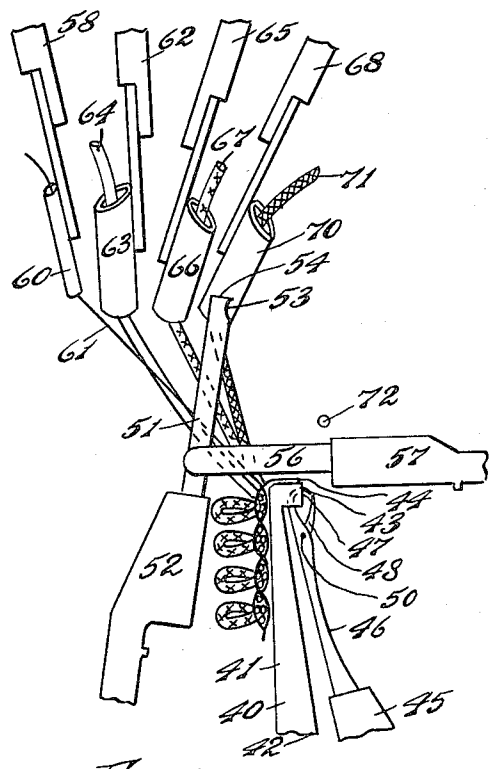


Fig. 2.

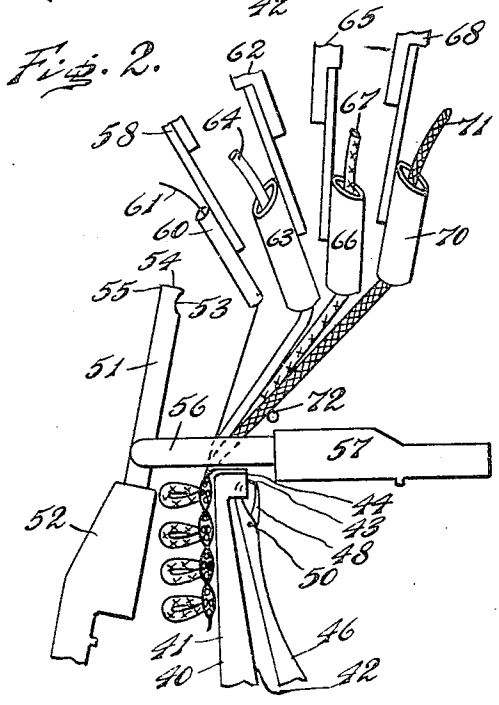
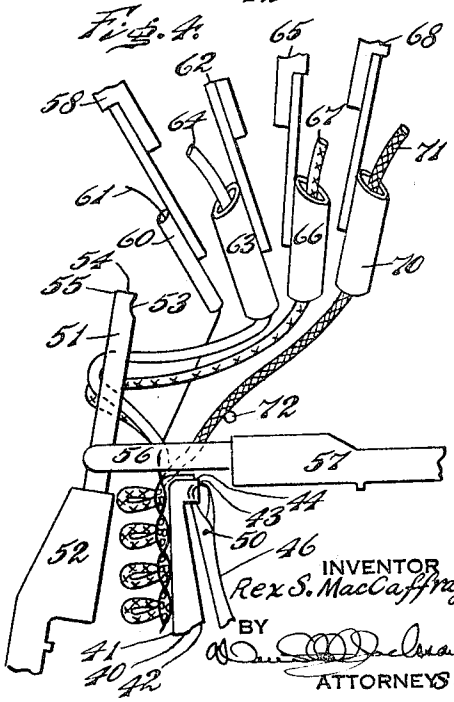


Fig. 4.



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Fig. 1a.

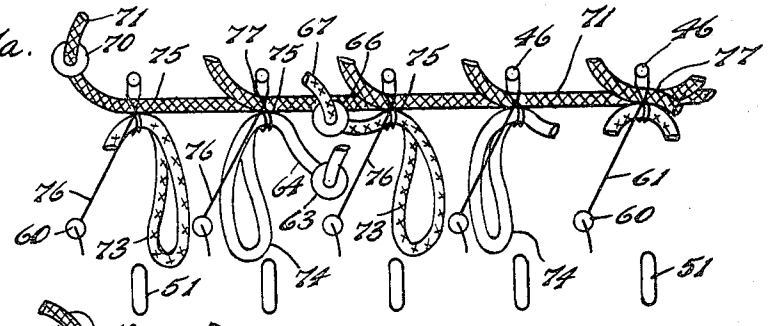


Fig. 2a.

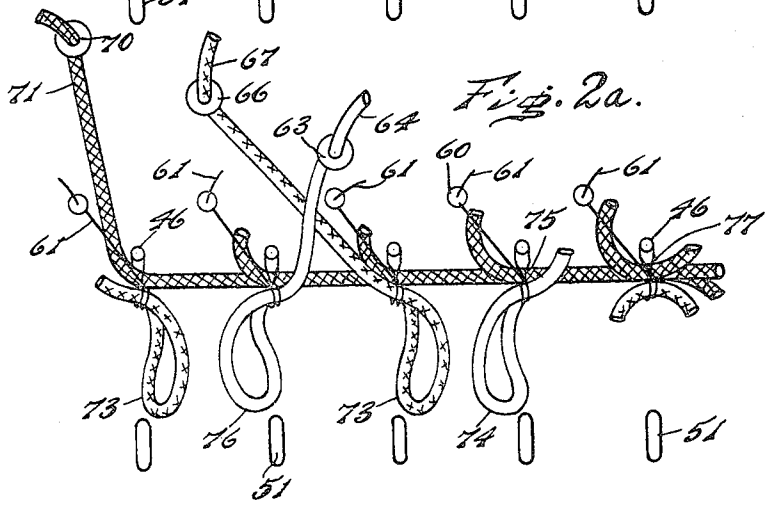
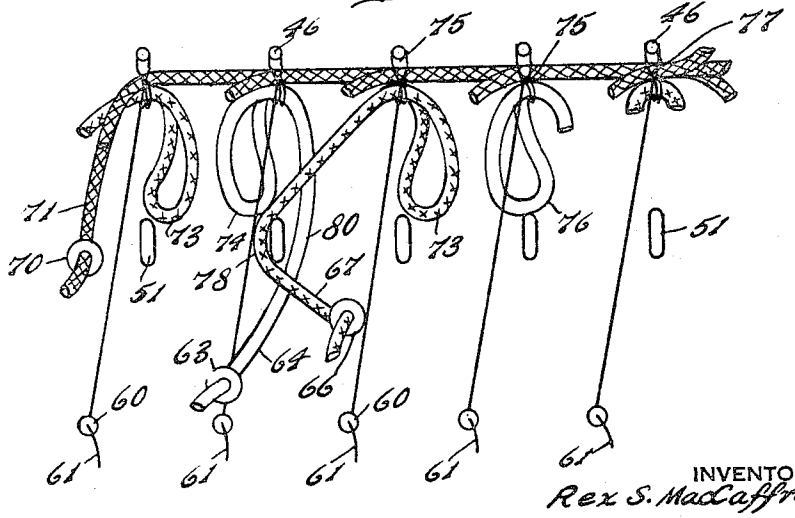


Fig. 3a.



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Fig. 4a.

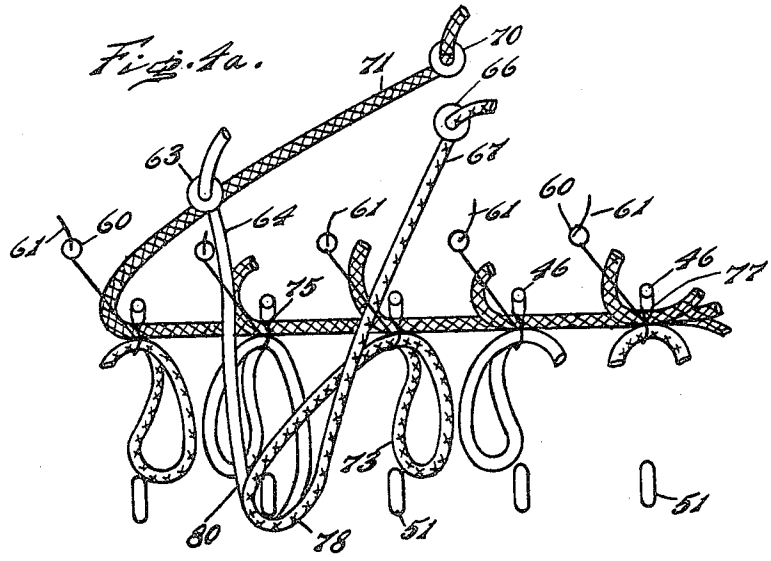
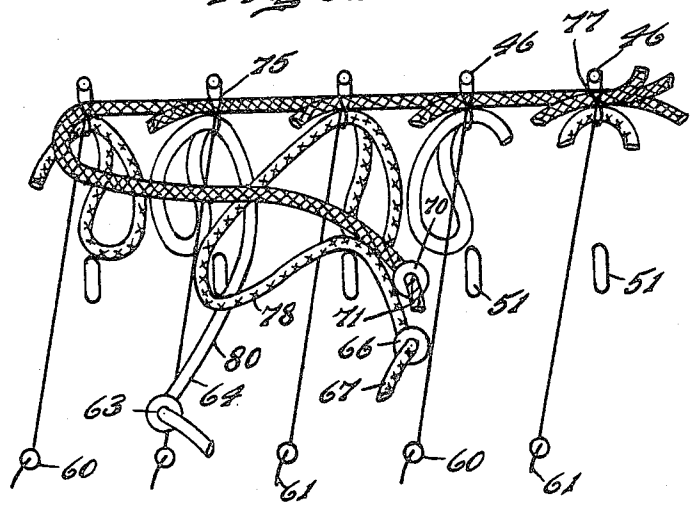


Fig. 5a.



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Fig. 5.

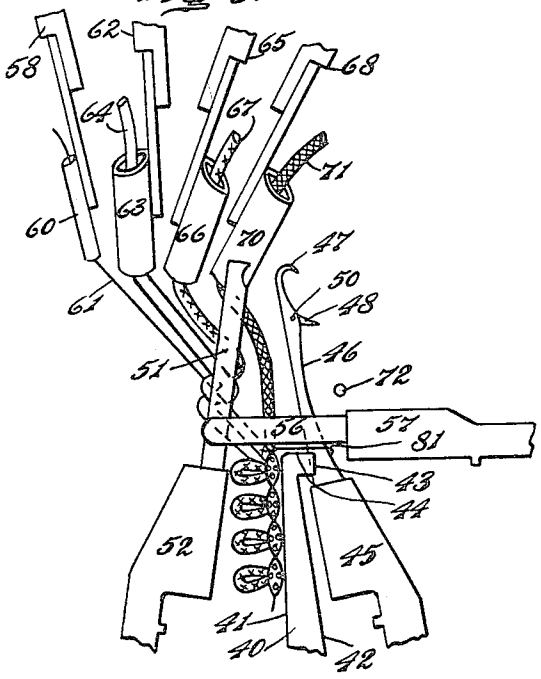


Fig. 7.

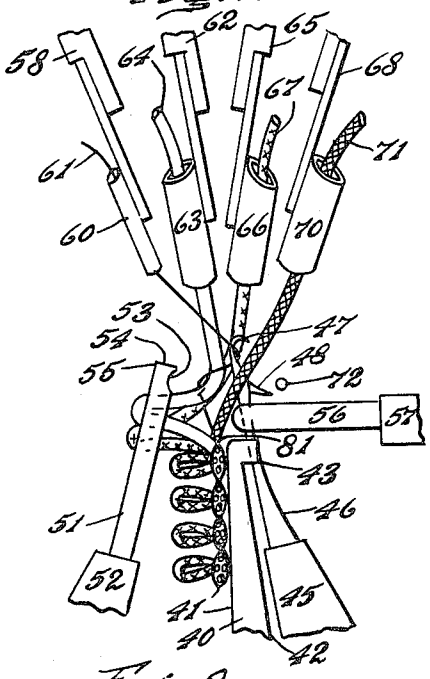


Fig. 6.

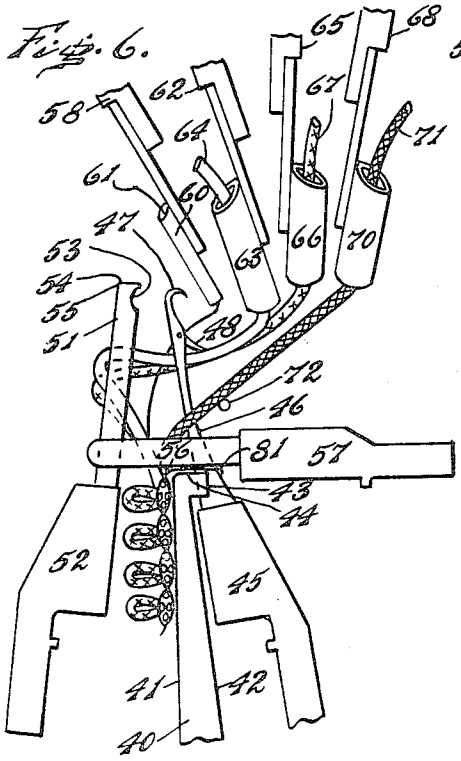
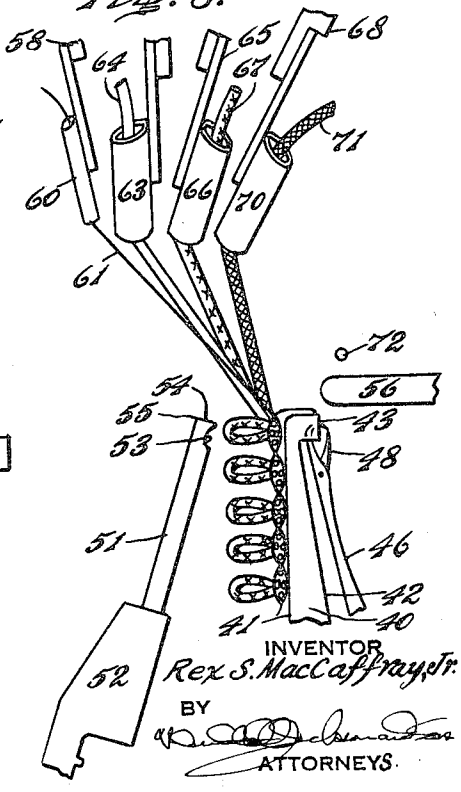


Fig. 8.



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Fig. 6a.

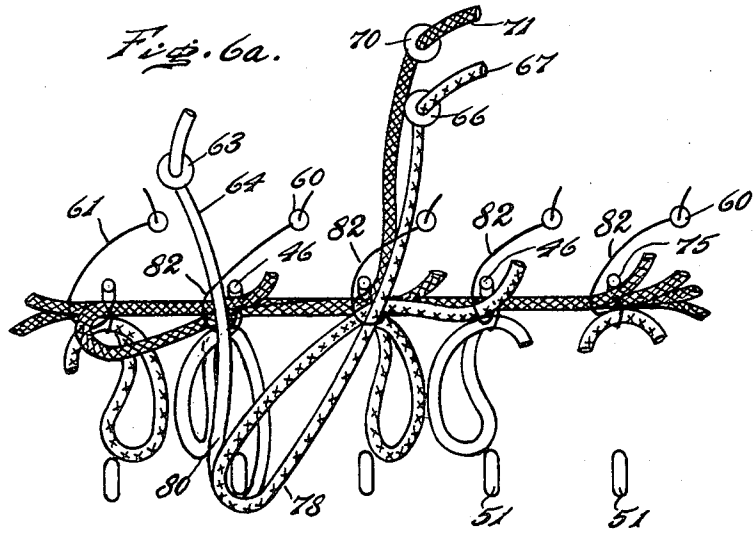


Fig. 7a.

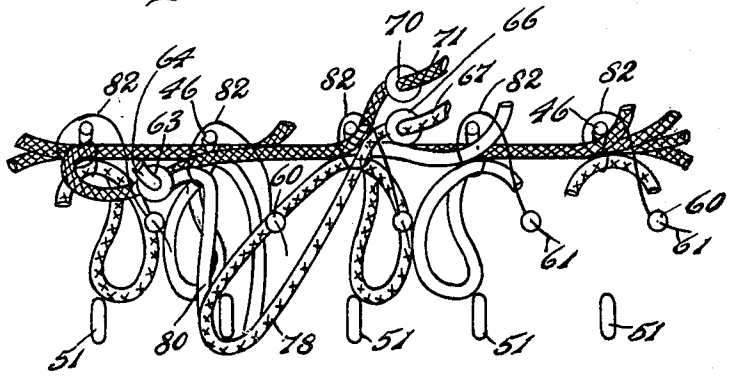
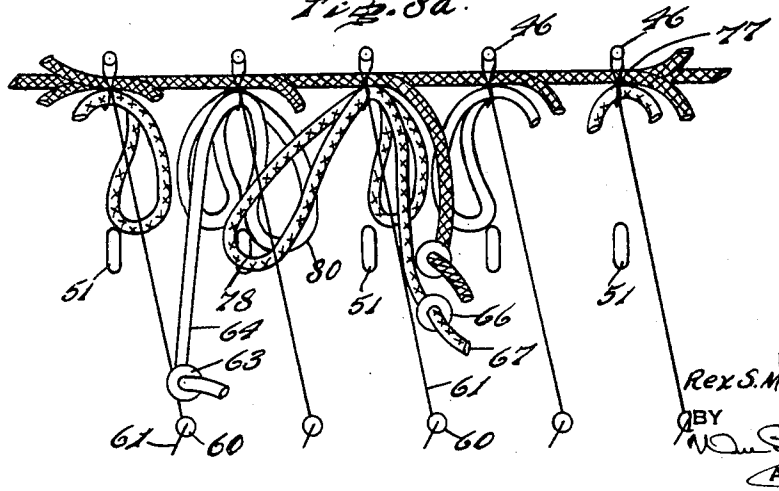


Fig. 8a.



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Fig. 9.

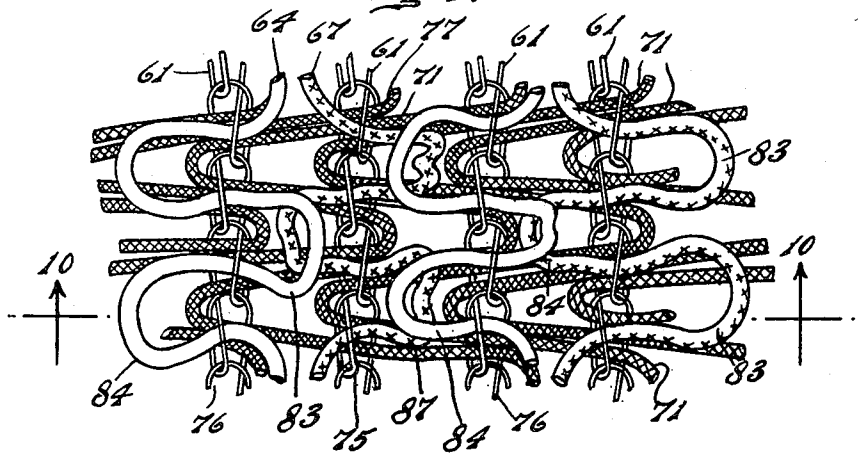
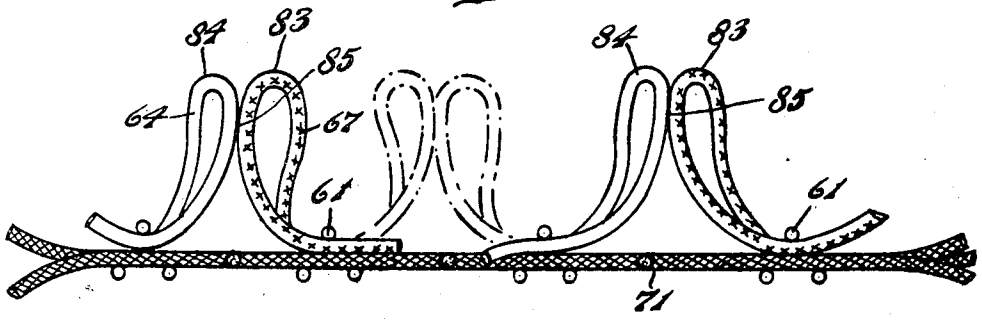


Fig. 10.



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Fig. 11.

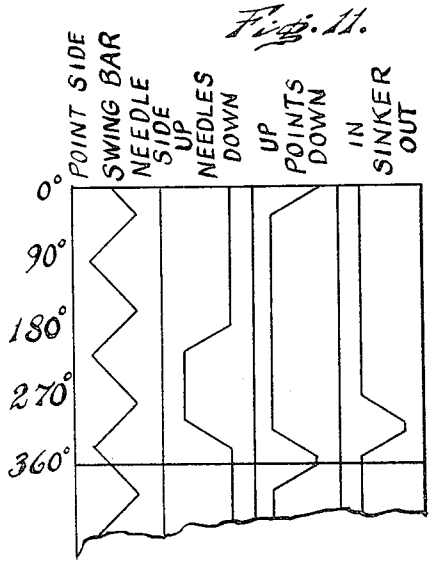


Fig. 13.

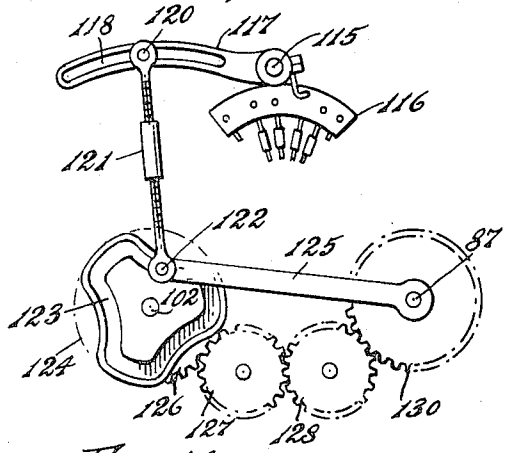


Fig. 14.

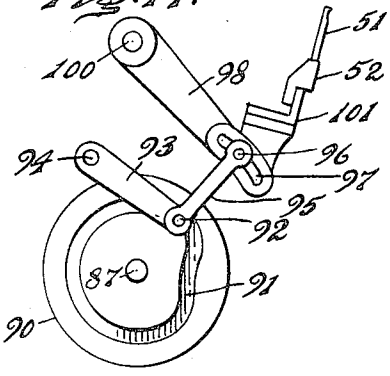


Fig. 16.

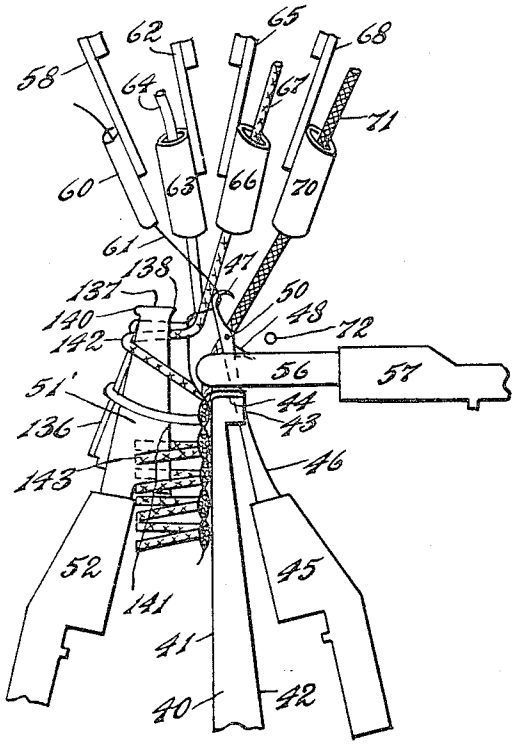
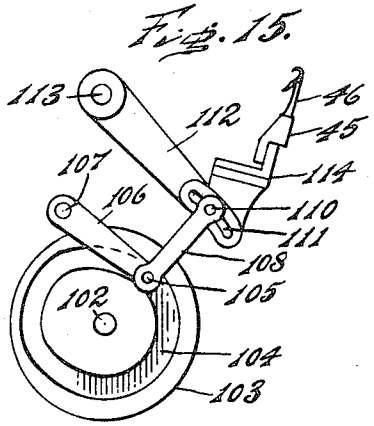


Fig. 15.



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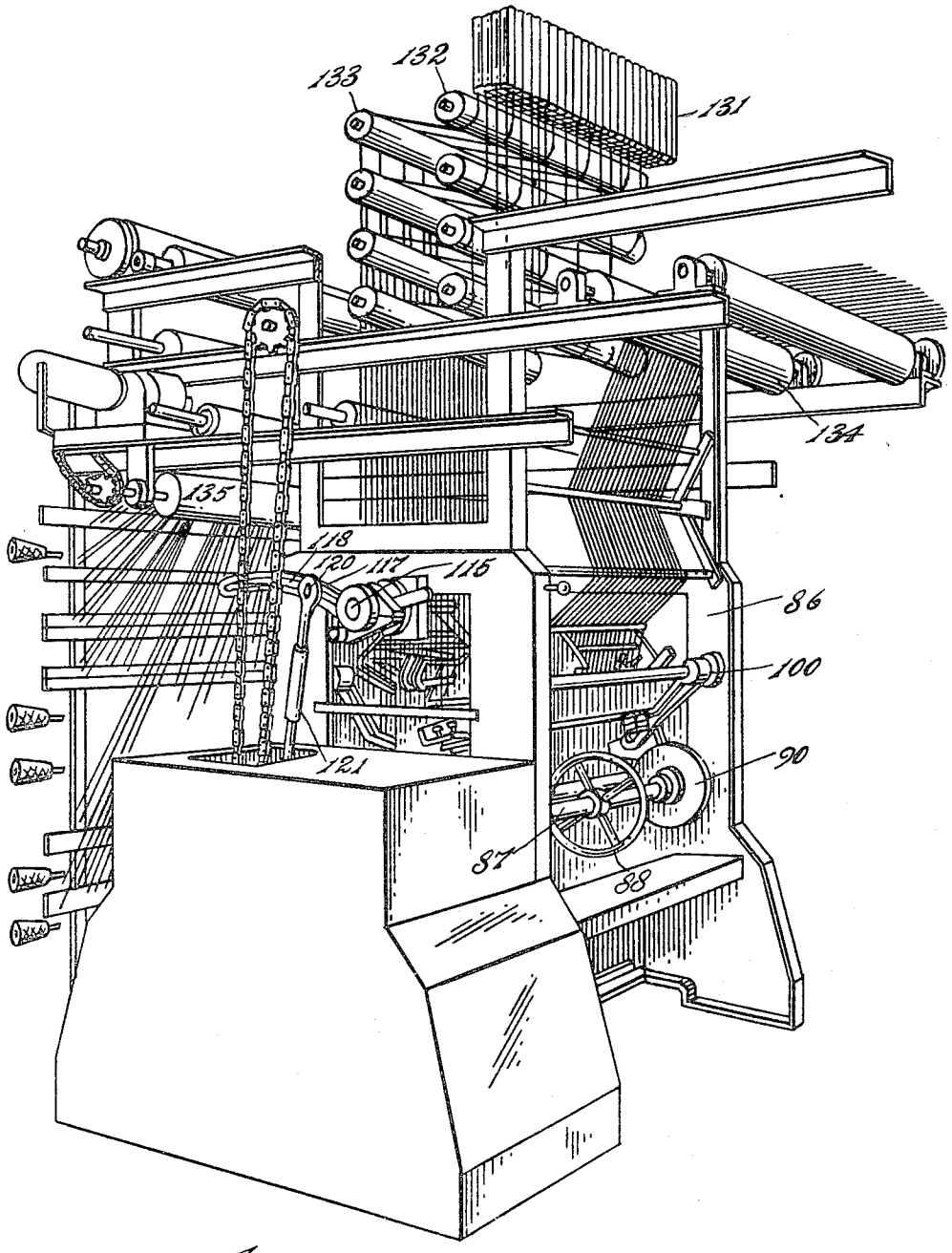


Fig. 12.

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Fig. 17.

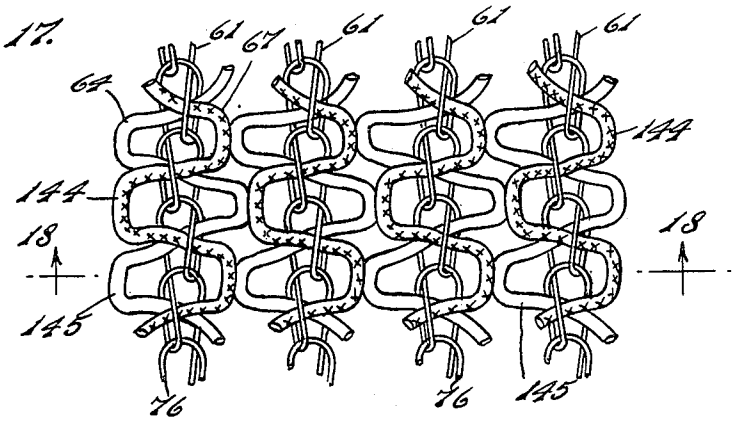


Fig. 18.

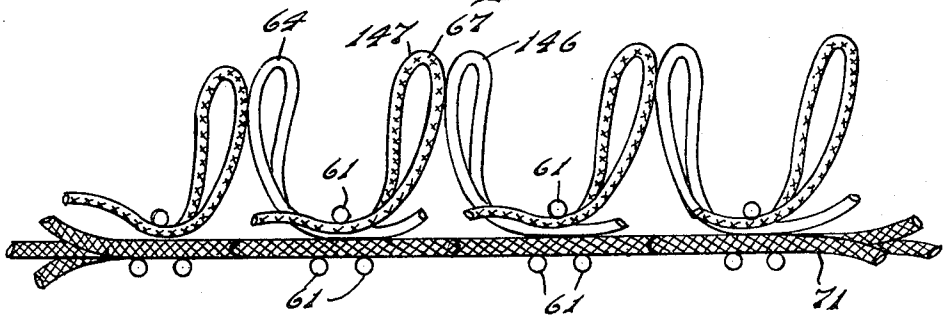
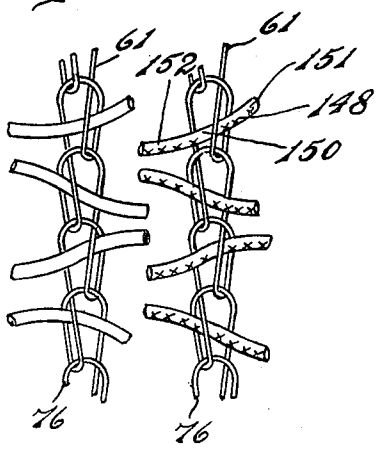


Fig. 19.



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United States Patent Office

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Patented July 5, 1960

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WARP KNITTED PILE FABRIC HAVING EACH PILE END BOUND ENTIRELY IN ONE WALE

Rex S. MacCaffray, Jr., Boiling Springs, Pa., assignor to C. H. Masland and Sons, Carlisle, Pa., a corporation of Pennsylvania

Original application Nov. 8, 1957, Ser. No. 695,325. Divided and this application Dec. 30, 1958, Ser. No. 783,745

2 Claims. (Cl. 66—191)

The present invention relates to warp knitted pile fabrics, such as carpets and rugs.

The present application is a division of my copending application Serial No. 695,325, filed November 8, 1957, for Machine and Method For Making Warp Knitted Pile Fabric Having Each Pile End Entirely In One wale.

A purpose of the invention is to provide a warp knitted pile fabric in which the consumption of pile yarn is reduced to a minimum, avoiding lay-in of face yarn from chain to chain or course to course.

A further purpose is to accomplish the bind of each pile yarn end entirely from a single knitted chain and to carry each pile yarn end immediately up into a pile projection again after it is bound without any intermediate lay-in stretch.

A further purpose is to alternately project pile projections from a knitted chain on opposite sides, and preferably to provide mutual support between opposed pile projections, projecting opposite adjoining pile projections in the same course.

A further purpose is to form the pile of pile warp ends in warp knitting by shogging alternately in opposite directions to form loops within the same wale, and preferably oppositely to the shogging of a guide bar for another frame of face yarn.

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 in which my invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figures 1 to 8 are diagrammatic stepwise vertical sectional views illustrating the positions of the operating parts at different stages of the knitting cycle.

Figure 1 corresponds to the position of zero or 360 degrees of the cam; Figure 2 corresponds to the position of 30 degrees; Figure 3 is for 90 degrees; Figure 4 is for 150 degrees; Figure 5 is for 210 degrees; Figure 6 is for 270 degrees; Figure 7 is for 300 degrees and Figure 8 is for 330 degrees.

Figures 1*a* to 8*a* respectively are diagrammatic enlarged plan views showing the formation of the knitted fabric according to Figures 1 to 8. These views show several knitted chains, but illustrate only one backing yarn end, with fragments of others, and illustrate two frames of pile yarn ends, with one end of each frame shown, and omitting the others.

Figure 9 is a diagrammatic fragmentary top plan view of a fabric of Figures 1 to 8 and 1*a* to 8*a*.

Figure 10 is an enlarged fragmentary coursewise section on the line 10—10 of Figure 9.

Figure 11 is a cam diagram showing the operation of the main elements of knitting.

Figure 12 is a diagrammatic perspective of a knitting machine in accordance with the invention.

Figure 13 is a diagrammatic end elevation of the guide bar operating mechanism employed in the knitting machine of the invention.

Figure 14 is a diagrammatic end elevation of the plush point operating mechanism of the invention.

Figure 15 is a diagrammatic end elevation of the needle bar operating mechanism of the invention.

Figure 16 is a view similar to Figure 7, but illustrating a cutting plush point.

Figure 17 is a view similar to Figure 9, showing a two-frame warp knitted pile fabric of the invention with an end of each pile frame in each wale, omitting the laid-in back.

Figure 18 is an enlarged section on the line 18—18 of Figure 17.

Figure 19 is a fragmentary plan view of a cut pile fabric according to the invention, omitting the backing and showing only a single pile frame.

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

In the prior art practice of warp knitting of pile fabrics, the usual procedure has been to form a loop or tuft and bind it in a knitting chain, and to shog to carry the pile yarn end to another wale, in the same or a succeeding course to complete the loop between the wales and to bind in such loop by the knitted chain in such other wale. This method of knitting, while productive of a satisfactory pile formation, does not provide for economical utilization of pile yarn.

I have discovered that by modifying the manipulation of the pile warp ends, I can greatly improve the coverage or economical utilization of pile yarn and at the same time gain definite structural advantages.

In the fabric of the present invention, unlike that of the prior art, mutual lateral support is obtained between pile projections, and pile projections are in effect associated in opposite acting couples or pairs, which are urged against one another.

Accordingly, for a given yarn composition and pile height, a much more resilient pile is obtained which has less tendency to pack or felt and which resists matting.

In accordance with one of the aspects of the invention, whether I employ a single frame or pile yarn guide bar, or multiple frames or pile yarn guide bars, the pile yarn ends are always shogged or manipulated in each course opposite to the loop forming manipulation of the preceding course, but they are fastened in the same wale indefinitely so that if the structure could be imagined brought into a single plane in plan, the pile yarn ends (prior to cutting where they are cut) are of serpentine formation bound in the stitches of a single chain at the opposite sides of each loop.

Where a single frame of pile yarn is to be used, it will preferably be cut.

Where two or more frames of pile yarn ends are employed, whether of the same color or of different colors, very desirable fabrics can be obtained whether cut or uncut. In this case it is preferable to shog each pile yarn guide bar in a particular course opposite to the other pile yarn guide bar, so that the loops of the two frames are opposed to one another and mutually support. This can be accomplished by an alternate thread-in, in which there are ends-in of pile frame A in the even numbered tubes and ends-out or seeded in the odd numbered tubes, and ends-out or seeded of pile frame B in the even numbered tubes and ends-in at the odd numbered tubes. This can also be accomplished using a complete thread-in of both frames, each having an end-in in each one of the pile yarn guide bar tubes.

Considering first the form of Figures 1 to 8 and 1*a* to 8*a*, which shows the operation using noncutting plush points, in a fabric which is either entirely uncut or cut

and uncut, but shown at the position of a noncutting plush point, it will be evident that Figure 1 illustrates the condition at zero or 360 degrees.

A stationary vertically extending trick plate **40**, as well known in the art in knitting machines of this character, is generally of tapered cross section, having a side **41** extending generally vertically and supporting the fabric being formed and removed by suitable take-off mechanism, and a side **42** suitably slightly converging and adjoining the needles. The trick plate at the top has a suitable needle guiding portion **43** and a flat top **44** beneath the level of the sinkers. The warp knitting loom employed is of the double needle bar type, one needle bar mounting supports **45** for a series of latch needles **46** of well known type which extend vertically and are guided by the trick plate. The latch needles as shown in Figure 1 have hooked ends **47** at the top directed away from the trick plate and latches **48** pivoted at **50** and in one position closing against the hook ends.

The other needle bar in the device of the invention, at the opposite side of the trick plate, is equipped with plush points **51** instead of needles, mounted on supports **52** in the illustration of Figures 1 to 8. The plush points are for producing uncut loops and take the form of metallic strips having hook portions **53** on the side toward the needles, blunt upper ends **54** and fillets **55** at the ends on the sides remote from the needles.

Immediately above the trick plate and adapted to move across it, there is a sinker comb **56** mounted on a sinker support **57**.

Suitably positioned above the sinker and extending horizontally clear across the machine is a swing bar which carries positioned thereon a horizontally slidable guide bar **58** which carries tubes or eyes **60** for knitting yarn **61**; then next behind there is a horizontally slidable guide bar **62** which carries tubes or eyes **63** for guiding pile yarn **64**; then next behind is horizontally slidable guide bar **65** which carries tubes or eyes **66** for guiding a second frame of pile yarn **67**; then next behind is a horizontally slidable guide bar **68** which carries tubes or eyes **70** for guiding backing yarn **71**. A latch wire **72** extends across the back of the machine as well known.

Considering first Figures 1 and 1*a*, corresponding to zero dgerees or 360 degrees on the cams, the first step of the new cycle is being taken after completion of the last stitch. The needles **46** and the plush points **51** are down or retracted, the sinker comb **56** is advanced or forward, and the swing bar with the guide bars on it is in mid-position and moving back.

If desired, shogging of the pile yarn and backing yarn will take place at the position of Figure 1. It is decidedly preferable to shog pile yarn at this position, although the shogging of backing yarn at this position is entirely optional.

As shown in Figure 1*a*, the thread-in is an alternate staggered thread-in in this form, there being an end of pile yarn frame A in each alternate trick or wale, and an end of pile yarn frame A omitted or seeded in the alternate tricks or wales. The thread-in of pile yarn frame B is just the reverse, since it has its ends-in in the tricks where pile frame A has its ends omitted or seeded. In many cases the pile yarn ends of the different frames will be of different colors.

Thus the previously formed loops **73** of Figure 1*a* are made from ends of pile yarn **67** on guide bar **65**, while the previously formed loops **74** in the adjoining tricks on either side are made from pile yarn ends **64** on pile yarn guide bar **62** of the opposite pile frame. These loops are bound in by stitches **75** of chains **76** which also grip bundles **77** of backing yarn **71**.

Figure 2 corresponds to 30 degrees of advance of the cycle. The position of the needles and of the sinkers is the same as that of Figure 1. The guide bars are now all the way at the back, out of line with the plush points, and the plush points **51** have just completed their forward or upward motion.

Figure 2*a* shows the position of the yarn ends, which is that of Figure 1*a* except for the guide bar position.

Figures 3 and 3*a* correspond to the position of 90 degrees in the cycle. The swing bar, and the guide bars for the knitting yarn and the pile yarn have moved to the front, and, as shown in Figure 3*a*, the pile yarn guide bars **62** and **65** each shog in opposite directions to carry pile yarn **64** and **67** respectively in opposed new loops **78** and **80** around the plush points.

Figures 4 and 4*a* show the position at 150 degrees in the cycle. The swing bar has moved back, carrying with it the guide bars, while the positions of all of the other knitting elements remain the same. The pile yarn guide bars **62** and **65** now continue to shog in the directions in which they had shogged at the position of Figure 3, to complete the formation of the loops **78** and **80**, wrapping the pile yarn around the front of the plush points. Backing yarn **71** also shogs to form the lay-in or weft of the backing at this point.

The position of Figures 6 and 6*a* corresponds to 270 degrees in the cycle. All shogging except that of the knitting yarn has been completed at Figures 4 and 4*a*. In Figures 5 and 5*a*, the face yarn and the knitting yarn guide bars have moved forward past the plush points. The needles have advanced or raised and the latches have been opened by the previous knitted stitch **81**, while the previous knitted stitch has moved down on the needles below the latches, leaving the hooks of the needles open and the latches down.

The position of Figures 6 and 6*a* corresponds to 270 degrees in the cycle. All guide bars have moved to the back of the plush points and needles, and the new stitch is ready to be formed as shown by loops **82** (Figure 6*a*) of knitting yarn surrounding the bundles of backing yarn and surrounding the new pile loops **78** and **80** to bind the pile loops. The knitting yarn guide bar is now shogged to place the knitting yarn around the needles beneath the hooks and above the latches.

Figures 7 and 7*a* at 300 degrees show the guide bars moving to the front and midway in their swing. The sinker comb **56**, which has been in position across the fell and across the end of the trick plate above the plush points, is now retracting to clear the ends of the needles and the needles are beginning to retract, causing the latch to be closed by the previous stitch. The plush points in this form retract, either ahead of the needles, behind the needles or with the needles as desired.

Figures 7 and 7*a* also show the condition just before casting off, the pile loops being raised around plush points behind the plane of the drawing of Figure 7.

Figure 8 corresponds to 330 degrees and shows the stitch completed and locked. The sinker comb is fully retracted and is now about to advance again to the position of zero or 360 degrees as shown in Figure 1. Figure 8*a* shows the new loops **78** and **80** completed and cast off.

Figures 9 and 10 show knitted pile fabric produced by the technique of the invention.

It will be noted that in each trick the pile loops oppositely project from and are bound into the same chain, to form what might be described as right hand loops **83** and left hand loops **84**. Since there is always a right hand loop **83** from one chain which is abutting against a left hand loop **84** from the next chain, as best seen in Figure 10, since the guide bars of the pile frames are always shogging oppositely, it will be evident that mutually supporting or leaning engagement occurs at **85**, which assures that the pile projections will tend to remain upright, will be resistant to flattening, and will be of superior resilience.

This condition exists throughout the fabric, where the loops are arranged in pairs, each with an opposite counterpart supporting loop at one side.

It will also be evident that the bind of the chain **76** is at the front of the fabric, and each pile loop, after it is bound, immediately rises again in a new loop, without any requirement for lay-in, so that an extremely economical and efficient utilization is made of the pile yarn. Even where for other purposes it is desired to employ lay-in of pile yarn, it will be evident that the principle of the invention can be used in particular areas to obtain efficient utilization of pile yarn in between lay-in.

The operation of knitting in accordance with Figures 1 to 10 is illustrated by the cam diagram of Figure 11, which shows in the ordinate the angular position throughout a complete cycle.

The left column indicates swing bar position between the point side and the needle side. The next column shows needle position up or down. The next column shows plush point position up or down and the last column at the right shows sinker comb position in or out.

Figure 12 illustrates the warp knitting machine diagrammatically and Figures 13, 14 and 15 show actual cam mechanism.

The warp knitting machine of the invention may be as described in D. F. Paling, Warp Knitting Technology (1952), Chapter 11, Raschel Warp Looms, and Chapter 12, Raschel Warp Loom Mechanism, with slight modifications as described herein.

The machine of Figure 12 has a frame **86** which journals a suitably horizontal front shaft **87** having a hand wheel **88** and carrying plush point drive cams **90**, one of which is best seen in Figure 14, which has a cam track **91** receiving a cam follower **92**, which pivotally connects to the free end of a lever **93**, having a fixed pivot on the frame at **94**. The pivotal connection of the follower **92** also pivotally connects to one end of a link **95**, which at the far end has a pin **96** which adjustably pivotally connects in an arcuate slot **97** on plush point arm **98**, which is keyed on a plush point bar shaft **100** extending horizontally across and journaled in the frame. The plush point cam conforms to the cam layout of Figure 11. The plush point arms **98** carry plush point bar **101** which carries the plush point support **52** and this holds the plush points **51**.

The needle operating mechanism at the back of the machine is identical to that described for the plush points. A rear drive shaft **102** extends horizontally across the machine and is journaled in the frame, mounting needle bar cams **103**, one of which is shown in Figure 15, having a cam track **104** which receives a cam follower **105** pivotally connected at one end of a lever **106** having fixed pivotal mounting **107** on the frame. The cam follower **105** also pivotally connects to the end of the link **108** which at the other end has a pin **110** adjustably pivotally connected in an arcuate slot **111** in the outer end of needle arm **112** which is keyed on needle bar shaft **113** extending across the machine and journaled in the frame. Needle bar **114** is supported on the needle arms and carries needle mounting **45** which positions needles **46**. The layout of the needle cam is shown in Figure 11.

Above the plush points and the needles, swing bar shaft **115** extends horizontally across the machine, is journaled in the frame and carries the swing bar **116** as best seen in Figure 13. The guide bars already described in connection with Figures 1 to 8 are positioned in horizontally slidable mountings with respect to the swing bar **116**. The guide bars are shogged by the pattern control mechanism of the kind shown in Paling above, beginning at page 145.

The swing bar has secured thereto at one end swing bar arm **117** having arcuate adjustment slot **118** which receives an adjustment stud **120**, which pivotally connects to one end of adjustable link **121**, which at the other end has a cam follower **122** which engages in cam track **123** of swing bar cam **124** operating on shaft **102**. A link **125** pivotally connects to the follower **122** at one end and at the other end is loosely supported around front shaft **87**. The front shaft is suitably driven by the rear shaft by gear **126** keyed on the rear shaft and interconnecting through pinions **127** and **128** with a gear **130** keyed on the front shaft.

The pile yarn for the machine comes from a suitable creel through tubes **131** (Figure 12) and each yarn end suitably passes under one roller **132** and over one roller **133** of a particular pair of cooperating feed rollers. Knitting yarn is supplied by a suitable constant feed mechanism **134** (Figure 12) and backing yarn is supplied by suitable constant feed mechanism **135**.

While of course various pattern chain link combinations can be used, the following is an example of a preferred pattern chain link sequence in accordance with the present invention:

Stitches	Knitting Chain Guide Bar	Pile Yarn A Guide Bar	Pile Yarn B Guide Bar	Backing Yarn Guide Bar
1	1-1-1-0	0-1-1-1	3-2-1-1	2-2-0-0
2	0-0-0-1	1-0-0-0	0-1-2-2	2-2-4-4

In some cases it will be preferred to make a cut fabric or a cut and uncut fabric, in which case at the point where the pile loops are to be cut, a plush point **51'** (Figure 16) has a wedge knife **136** on the side remote from the needle, sloping progressively away from the needle in the direction from the top toward the bottom. The plush point has at the upper end a flat top **137** and at the side toward the needle has a hook end **138**, as best described in my copending application Serial No. 666,312, filed June 18, 1957, for Cutting Plush Point for Carpet Knitting. This hook end prevents the lay-in backing yarn from going in front of the plush point during the cycles of the swing bar. There is also at the upper end remote from the needle a hook end **141** which prevents casting off when the push point is retracted.

As will be seen in Figure 16, the heel of the plush point at **141** is shaped so that it is generally parallel to the near side of the trick plate and engages the fabric, exerting a holding function as explained in my application above referred to.

The operations performed where cutting plush points are used are similar to those described in connection with Figures 1 to 8 for noncutting plush points, except that Figure 16 (corresponding to Figure 7) illustrates that one or more loops **142** remain around the cutting plush point when it retracts, and when the cutting plush point rises on the next cycle a previous loop which is tightly engaging the knife by pulling down along the blade as the take-up of the fabric progresses, is cut, forming cut pile tufts **143** as shown.

In some cases, using multiple frames, instead of intermediate thread-in, as previously described, I prefer to use a complete thread-in of an end of pile frame A and of pile frame B in each trick. An uncut pile of this character is shown in Figures 17 and 18, where the pile ends of frame A form one zigzag **144** at each chain and the opposite frame B forms an opposite zigzag **145** at each chain, so that each stitch binds two loops projecting in opposite directions from the same knitting chain. In this case, therefore, there are opposed mutually adjoining pairs of pile projections **146** and **147** in each trick or wale of each course, whereas in the fabric of Figure 9 these mutually supporting loops occur only in each alternate trick or wale of each course. The result is that the fabric of Figures 17 and 18 is much denser than that of Figures 9 and 10, and tends to give still better pile support and assures greater resilience and greater resistance against flattening.

The principles of the invention as explained in connection with Figures 9 and 10, and 17 and 18 apply also with any desired thread-in of the character previously discussed where cut pile is used rather than uncut pile,

as shown in Figure 19. Here each of the knitting chains **76** binds a U-shaped pile yarn element **148** which is bound at the middle at **150** in the stitch and forms two projecting tufts **151** and **152** which are upstanding in the pile. It will be evident that when viewed in course-wise section there is a tendency of these same tufts to mutually support one another in pairs. The tufts have been drawn in noninterfering position in Figure 19 for convenience in illustration, but in fact they laterally support one another.

Figure 20 illustrates the face of warp knitted pile fabric of the invention conforming to Figure 9. It will be evident that the loops in this fabric are arranged in mutually supporting pairs.

It will be evident that in accordance with the present invention, relatively inexpensive fabrics can be produced which nevertheless have high appeal since all of the pile yarn is effectively used in the face of the fabric, and burying of pile in the back of the fabric is avoided.

It will be evident that alternate pile projections tend to be slightly shadowed by the other pile projections of the pile and this lends itself particularly to creating a moresque effect even where the pile yarn of frame A and frame B, although of different solid colors, is alternately slightly masked. This is very desirable to break up lining and row effects and to conceal defects in knitting. The moresque effect is due to the fact that the face yarn bar running with the knitting chain tends to be dominant over the face yarn bar running opposite to the knitting chain in any course, because the yarn on this bar running with the knitting chain travels a longer path in the knitting operation.

It will be evident, of course, that where it is desired to avoid the dominance of one pile frame over another this can be avoided by regulating the tension of the pile yarn frame that would otherwise be dominant, to increase the tension on this pile yarn on that cycle, using equipment as described in my copending application Serial No. 689,113, filed October 9, 1957, for Knitted Pile Fabric Having High and Low Pile In The Same Course.

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 fabric 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. A warp knitted pile fabric comprising walewise extending parallel chains of knitted stitches, in-laid backing weft yarn ends extending walewise but each undulating sinuously across and bound into the stitches of at least three of the knitted chains, and pile warp ends extending walewise, each undulating sinuously across and anchored in successive stitches of only one of the said knitted chains so as to form pile loops projecting outwardly from the fabric and leaning alternately rightwardly and leftwardly from its anchoring chain, the pile loops anchored in successive chains along any particular course leaning alternately rightwardly and leftwardly from their anchoring chains into mutual supporting engagement so that each rightwardly leaning loop receives support from a leftwardly leaning loop and vice versa.

2. A pile fabric of claim 1, in which at the same wale and course anchored in the same chain there are both leftwardly and rightwardly leaning loops.

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