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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

Original Filed March 2, 1959 16 Sheets-Sheet 1

Fig. 1.

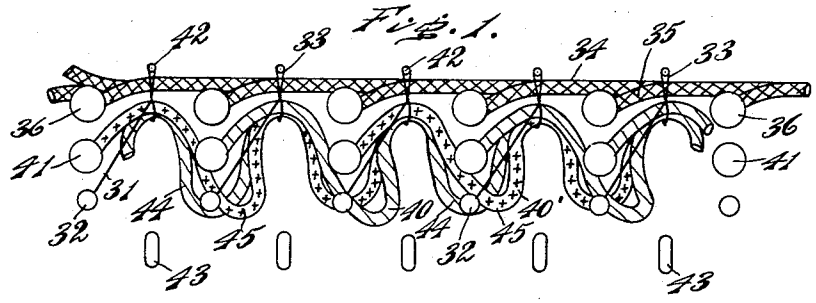


Fig. 2.

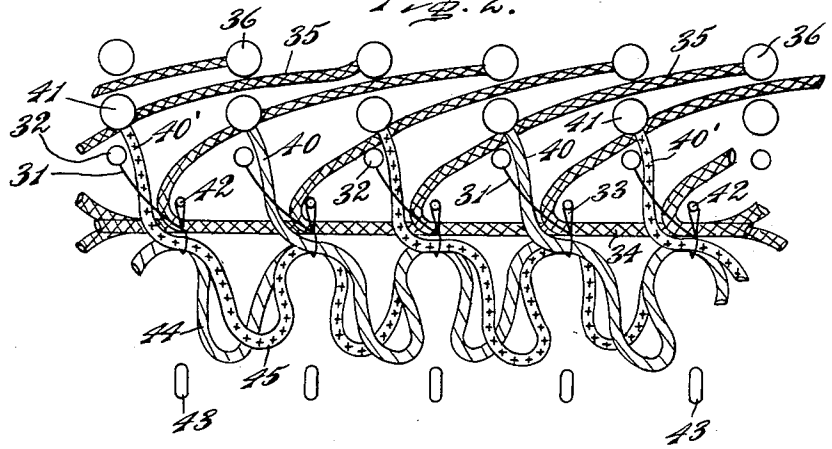
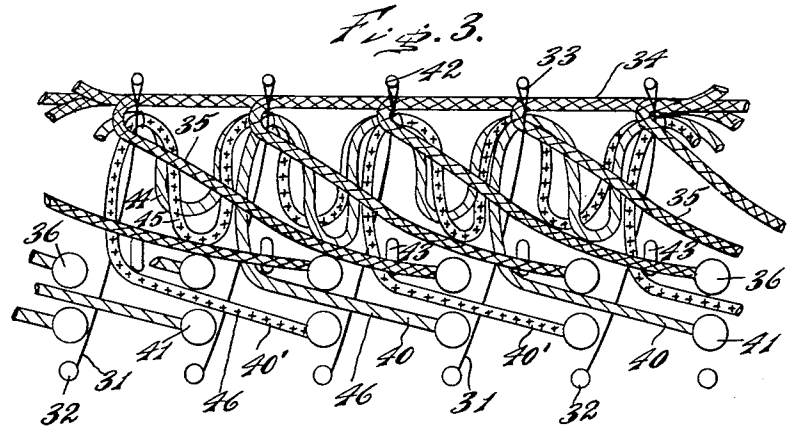


Fig. 3.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 4.

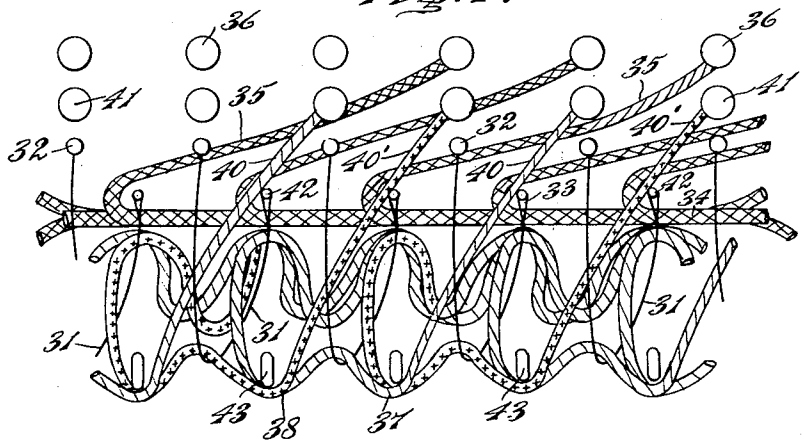


Fig. 5.

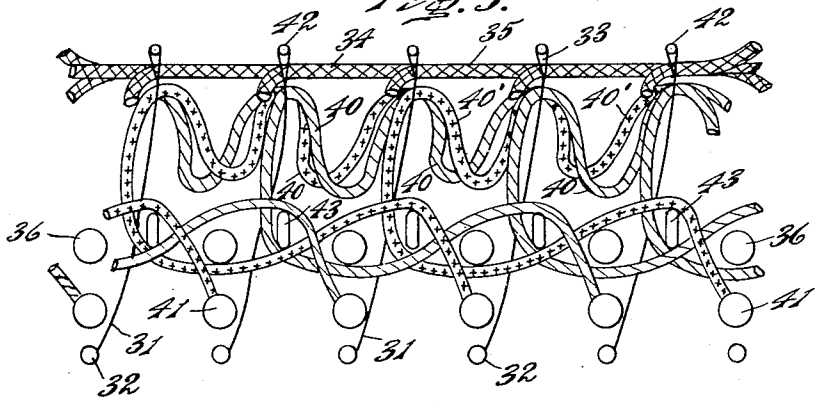
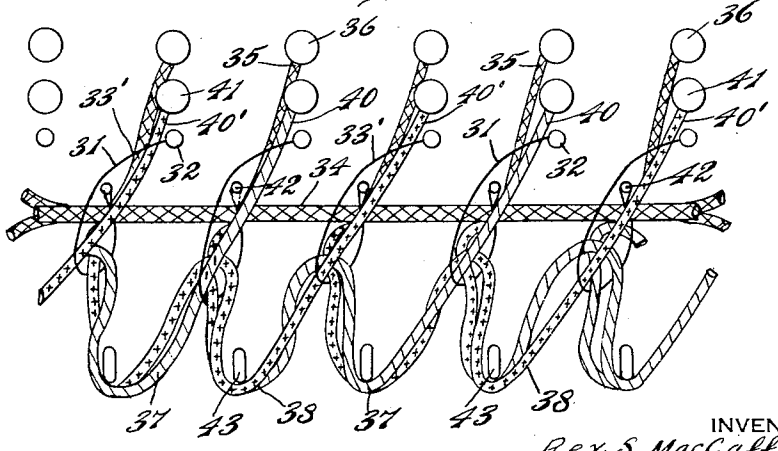


Fig. 6.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 7.

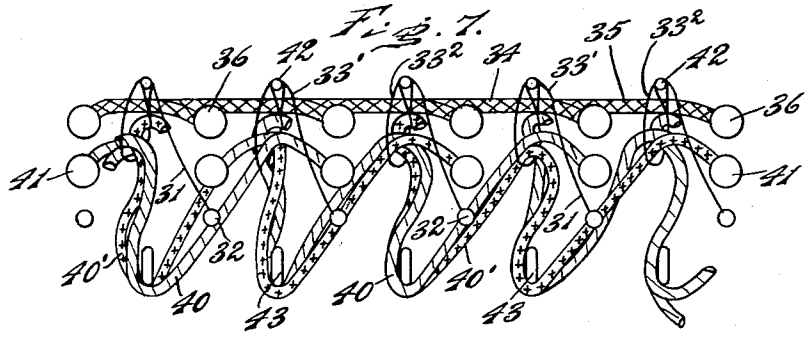


Fig. 8.

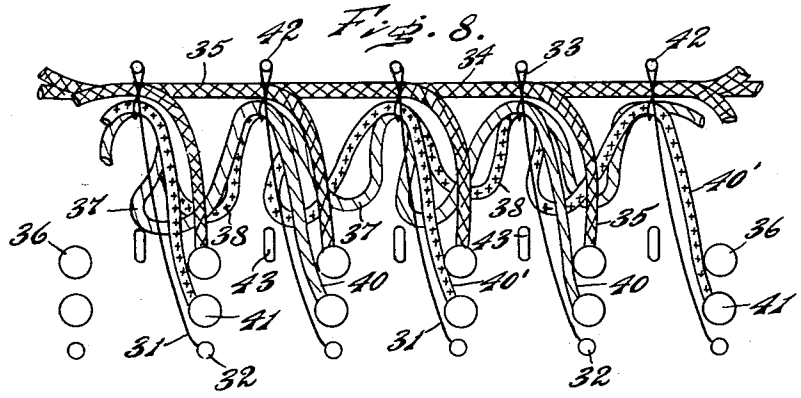
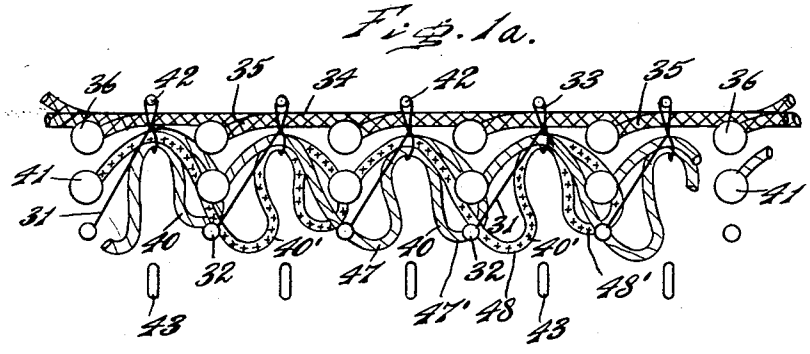


Fig. 1a.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 2a.

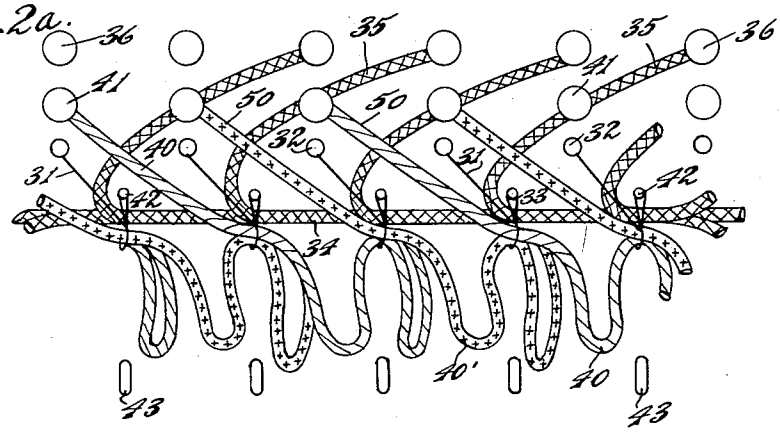


Fig. 3a.

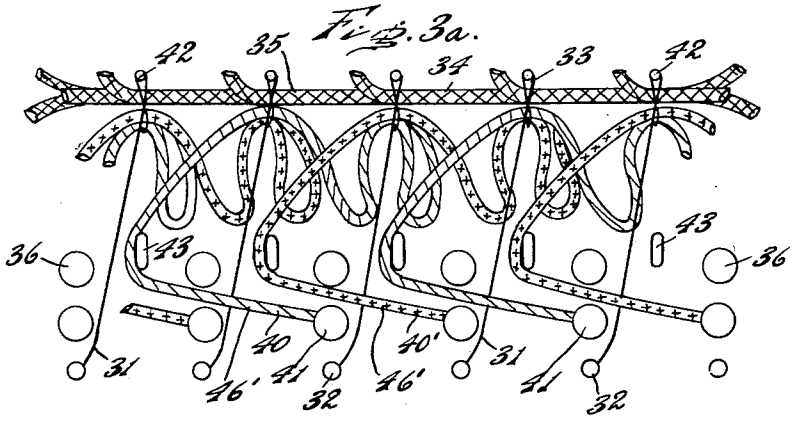
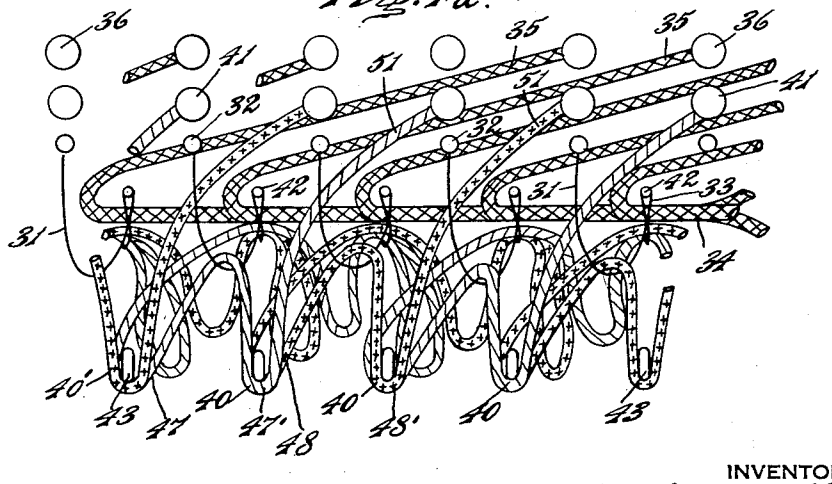


Fig. 4a.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 5a.

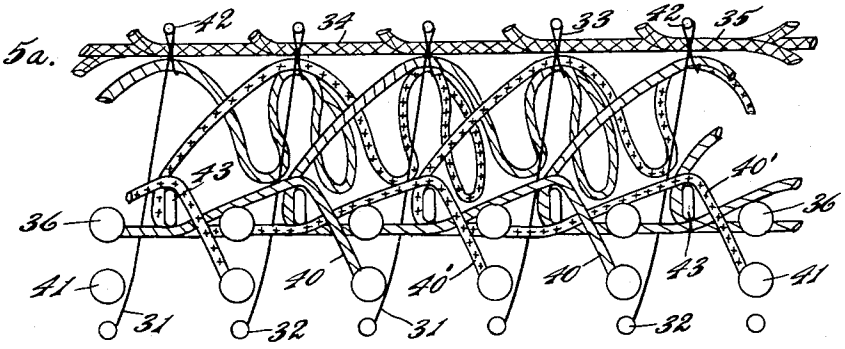


Fig. 6a.

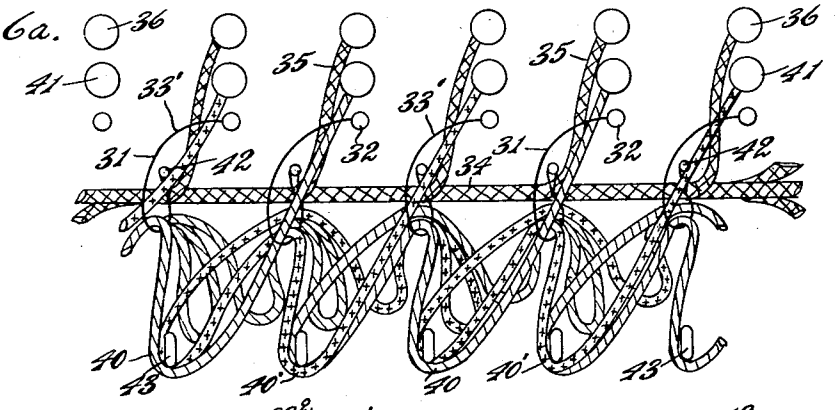


Fig. 7a.

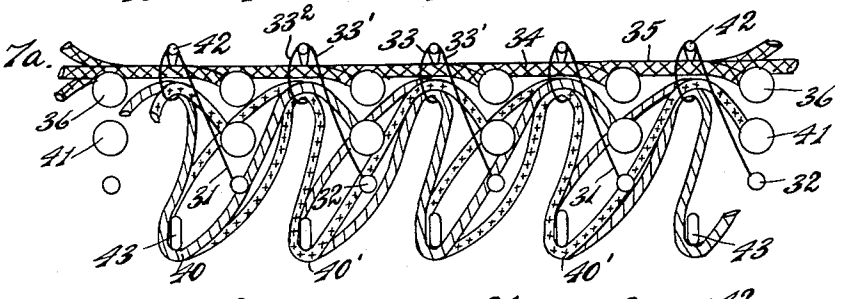
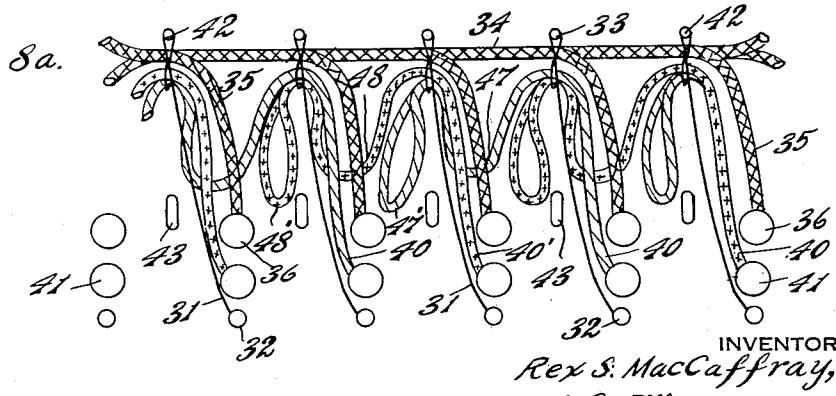


Fig. 8a.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 1b.

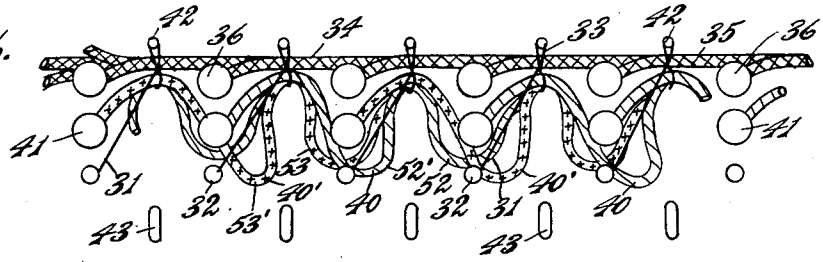


Fig. 2b.

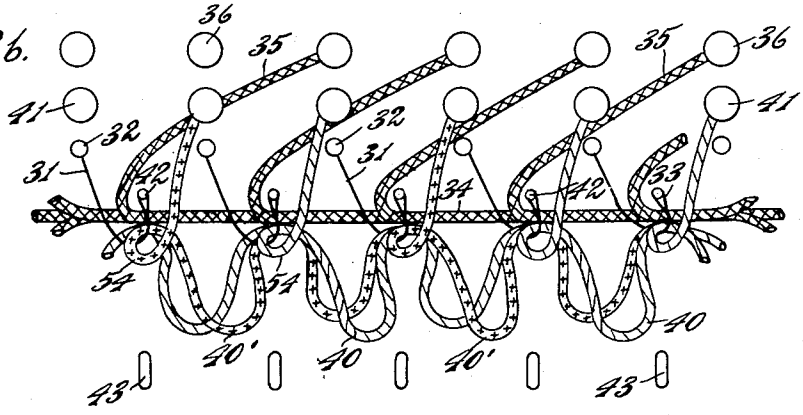


Fig. 3b.

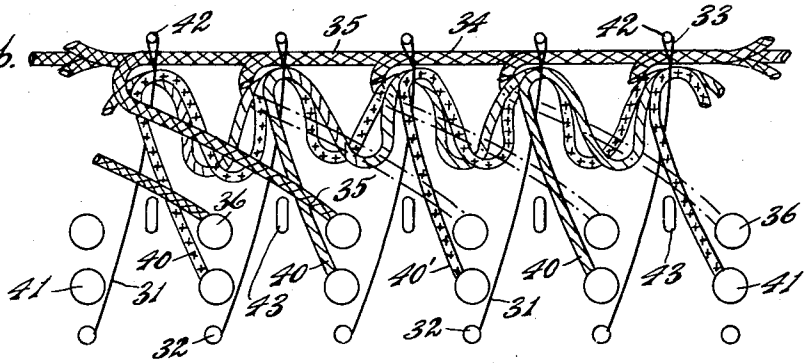
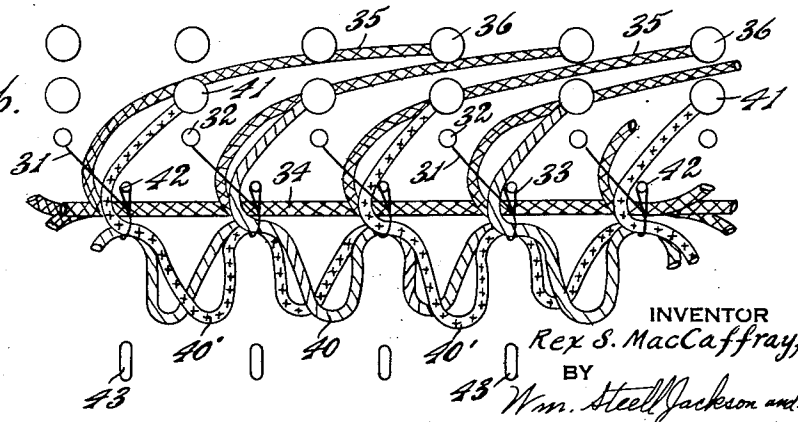


Fig. 4b.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 5b.

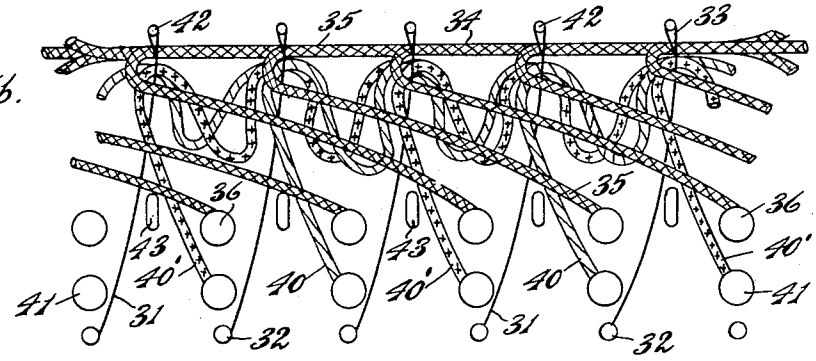


Fig. 6b.

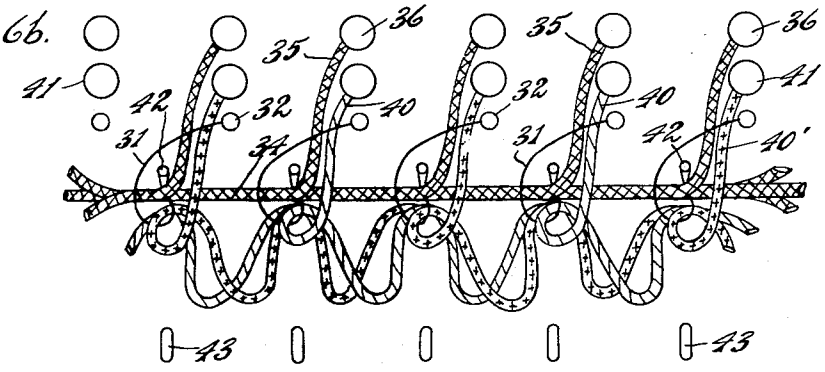


Fig. 7b.

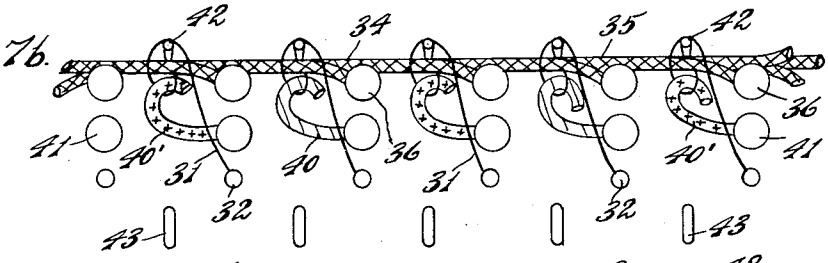
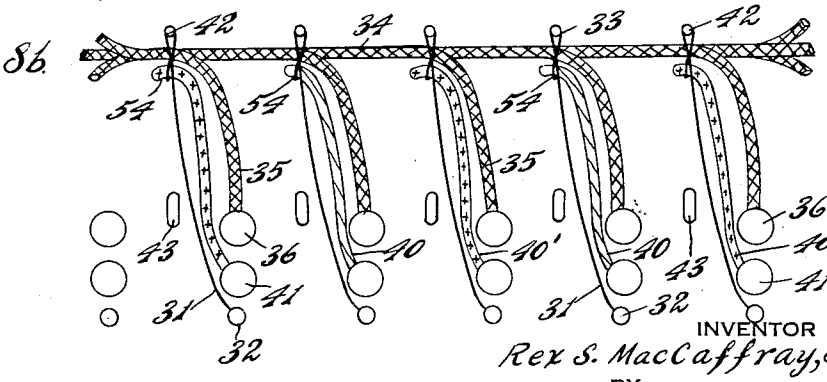


Fig. 8b.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 1C.

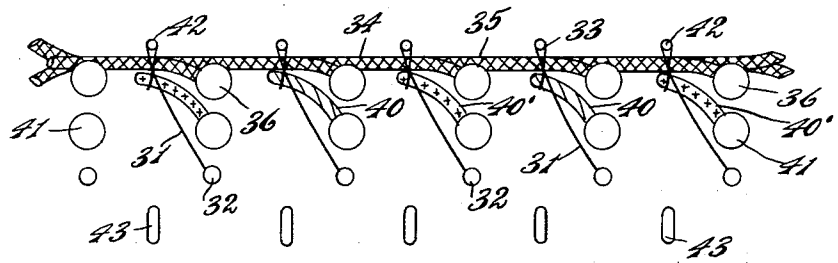


Fig. 2C.

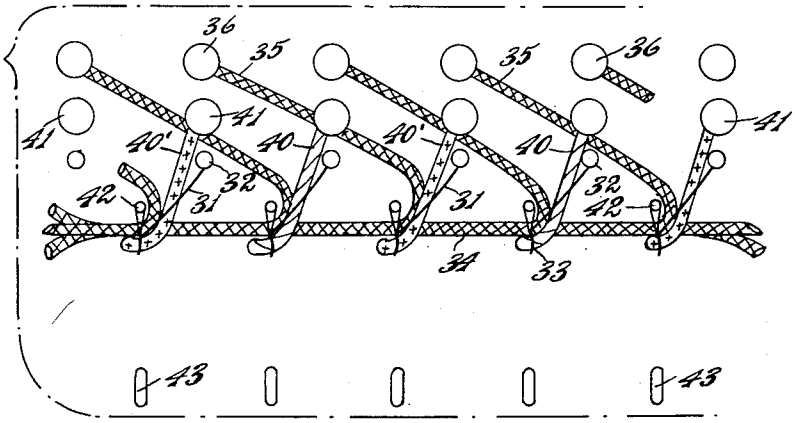
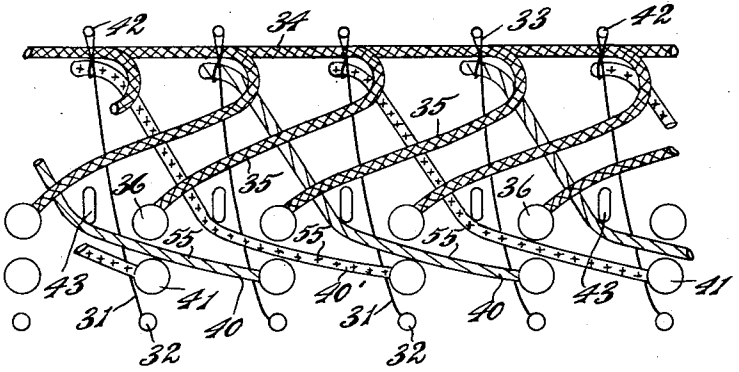


Fig. 3C.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 4C.

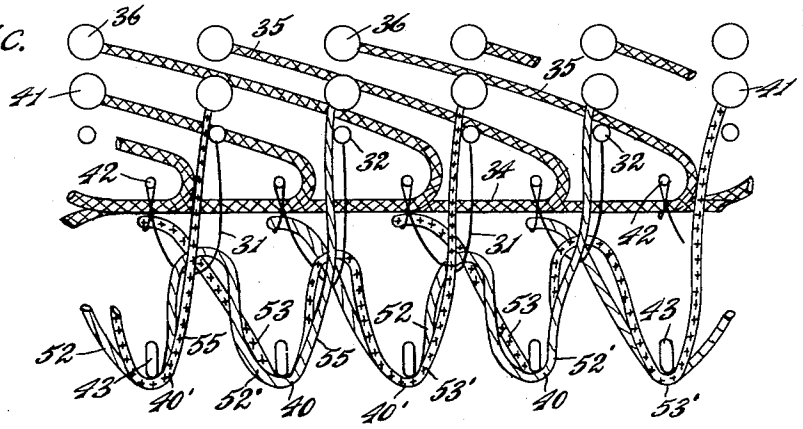


Fig. 5C.

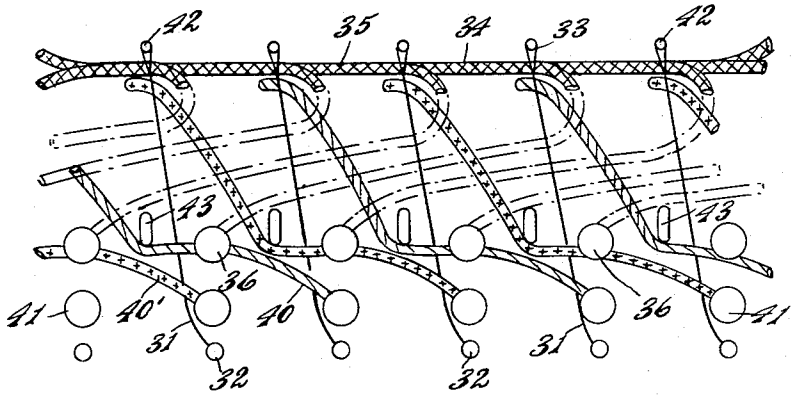
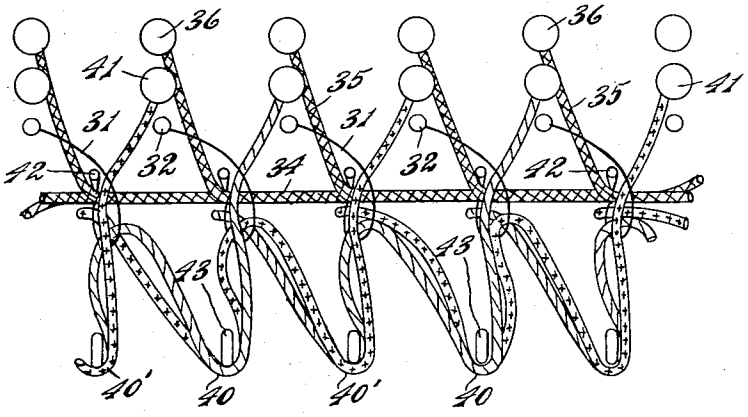


Fig. 6C.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 7c.

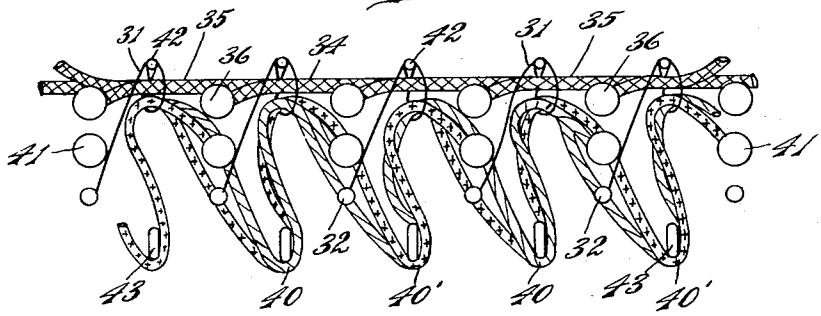


Fig. 8c.

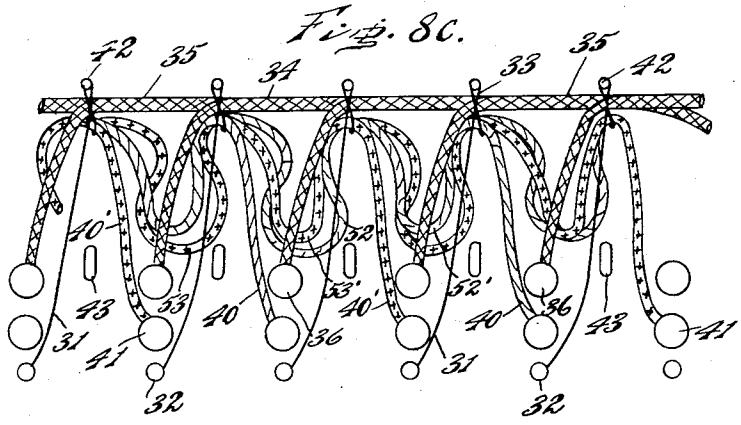
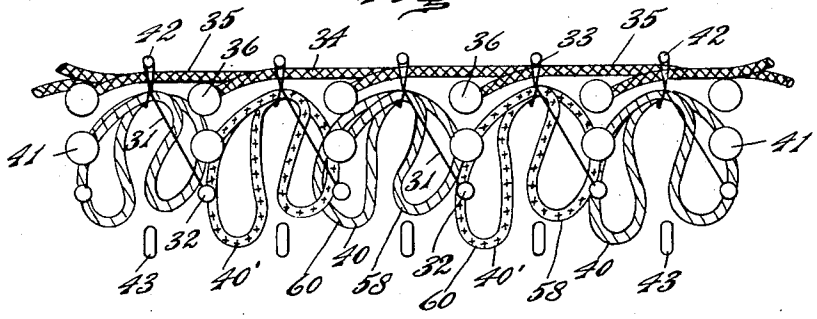


Fig. 1d.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 2d.

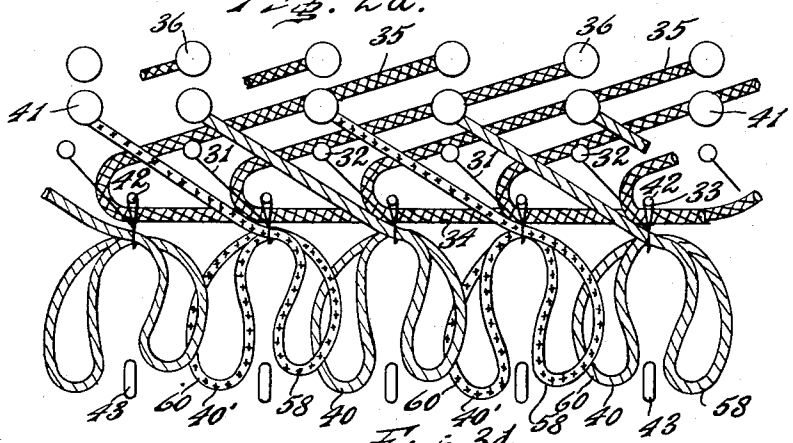

Fig. 3d.

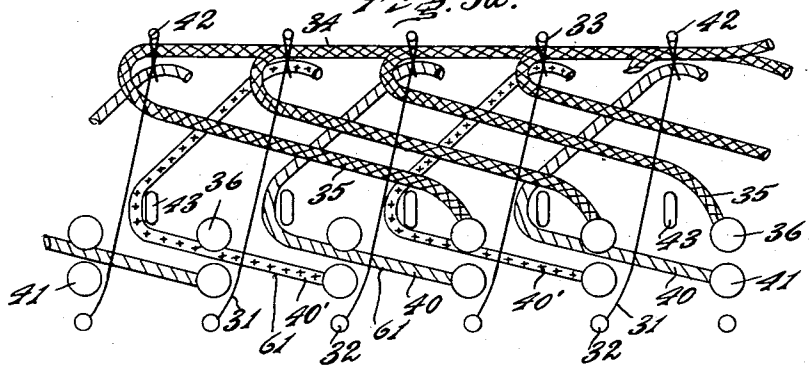

Fig. 4d.

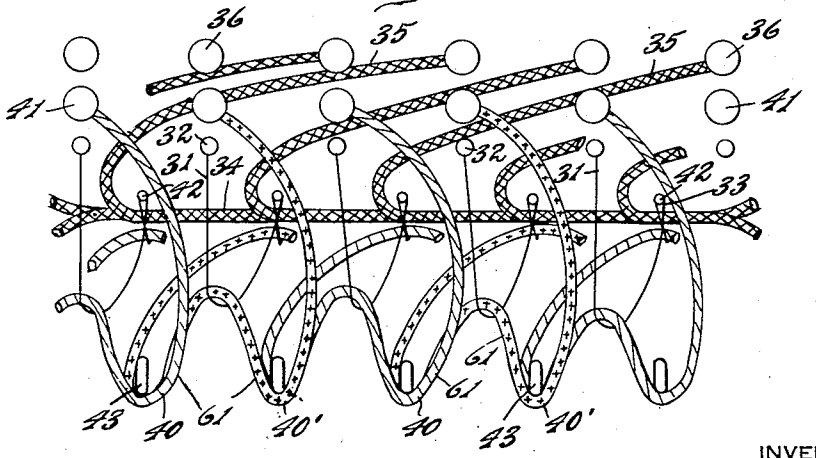

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Fig. 5d.

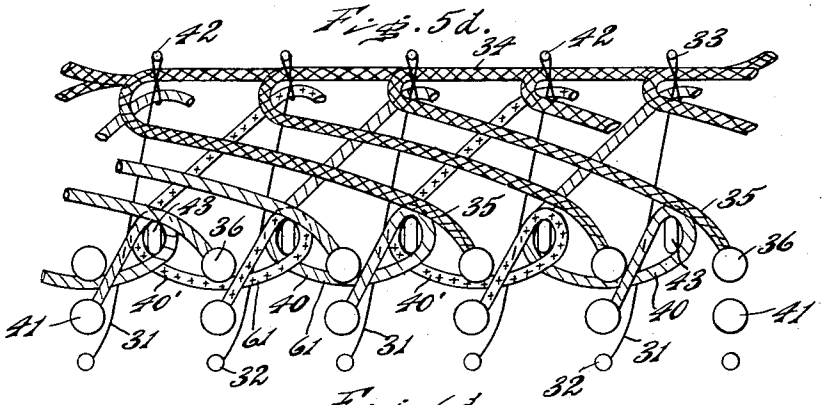

Fig. 6d.

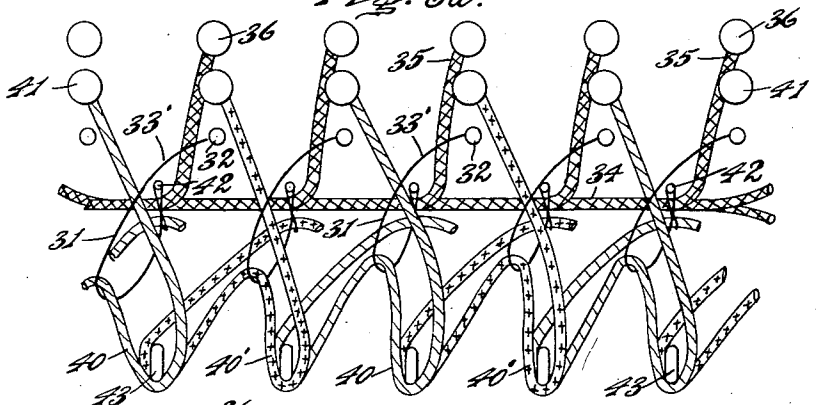

Fig. 7d.

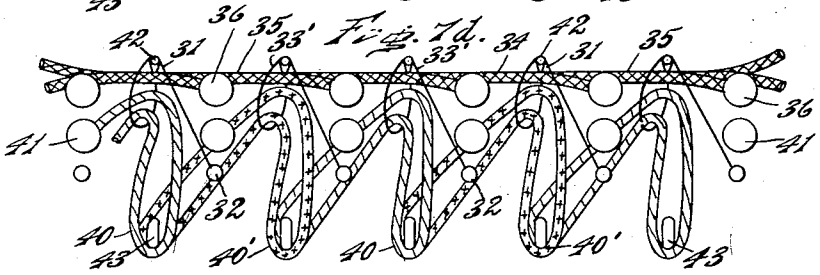

Fig. 8d.

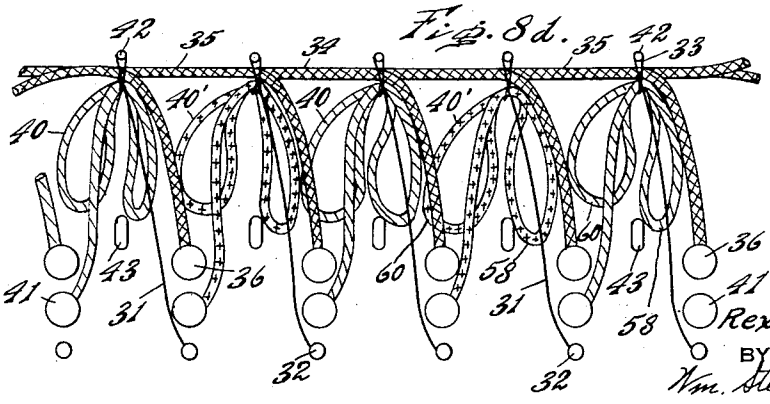

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Fig. 9.

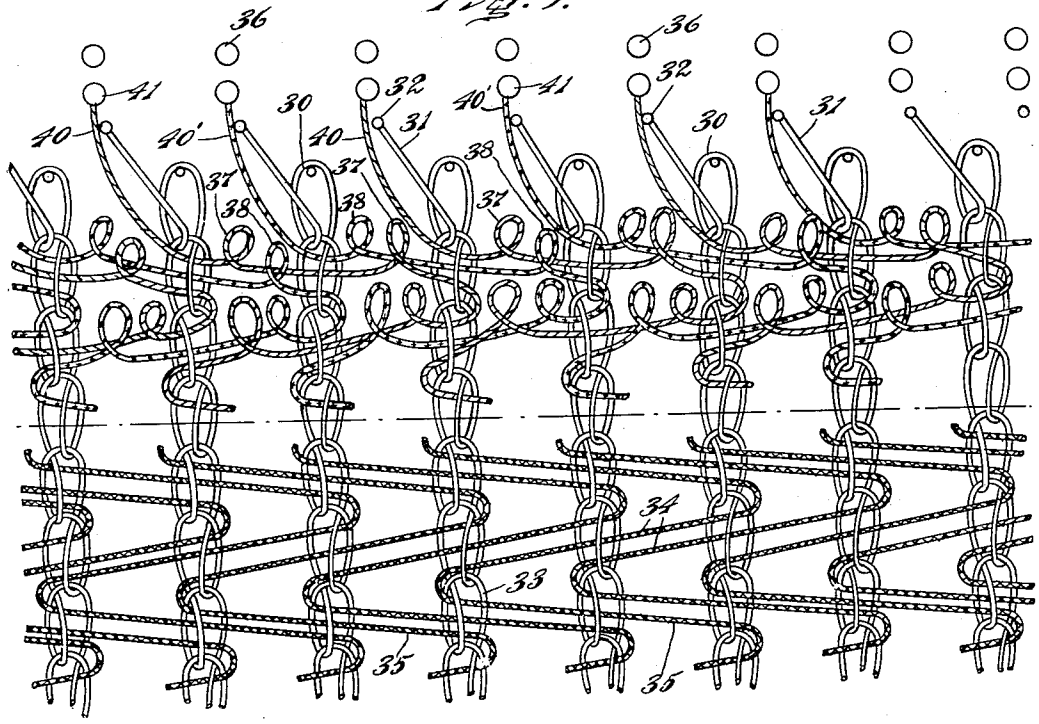
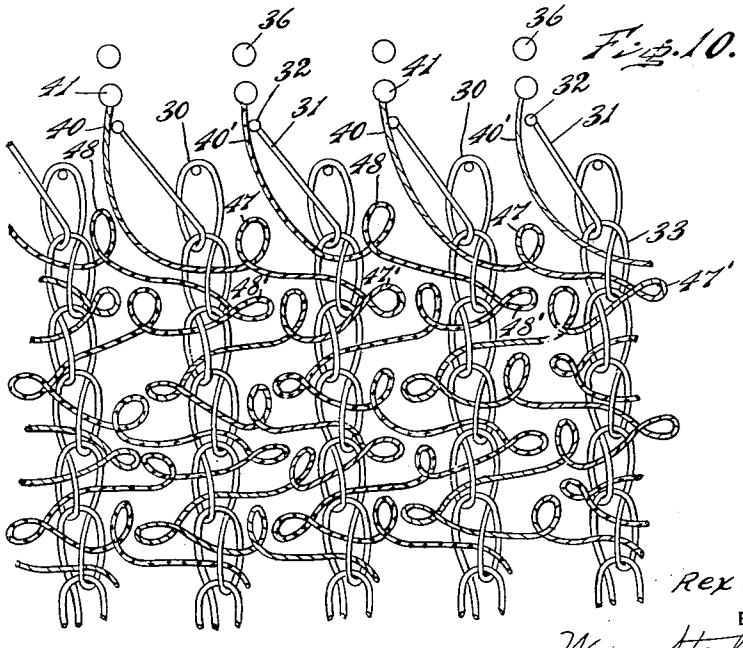


Fig. 10.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Fig. 11.

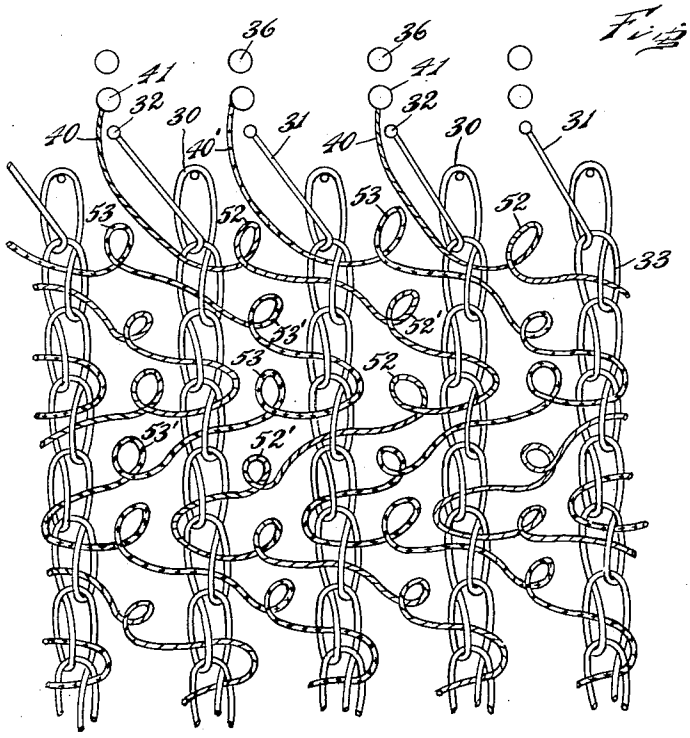
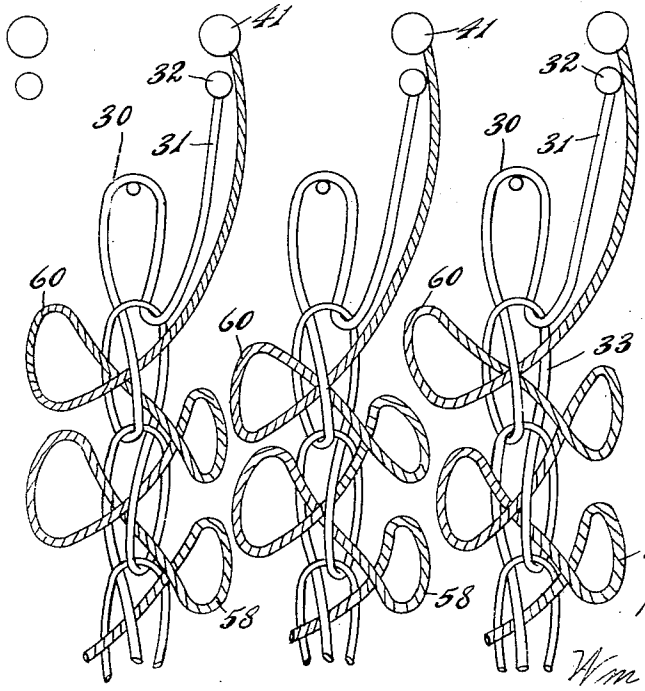


Fig. 13.



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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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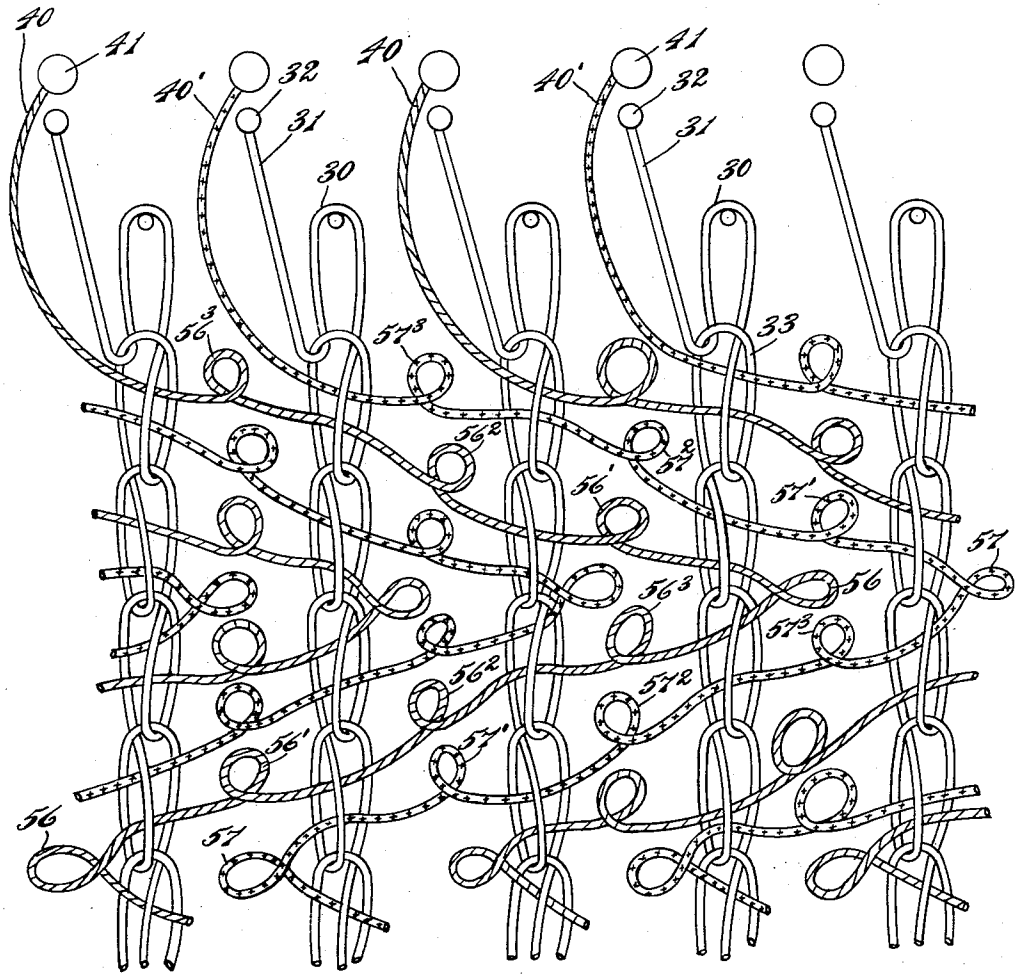
Fig. 12.



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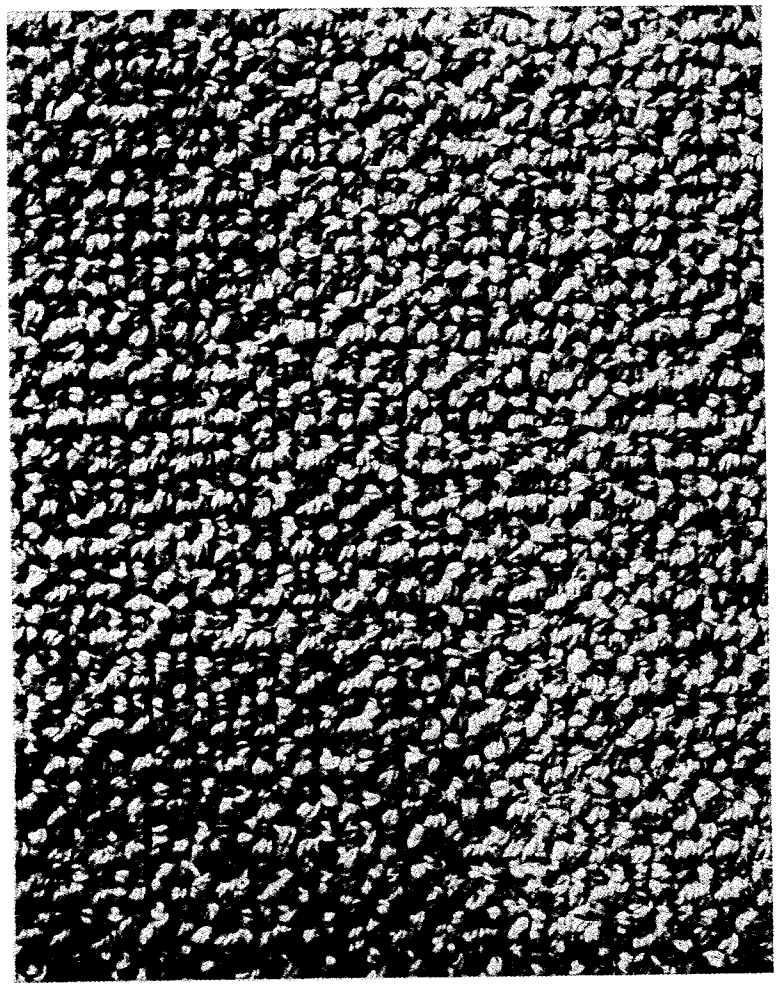

Fig. 14.

United States Patent Office 2,989,858 Patented June 27, 1961

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METHOD OF WARP KNITTING PILE FABRIC WITH MULTIPLE PILE PROJECTIONS

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Original application Mar. 2, 1959, Ser. No. 796,364. Divided and this application Feb. 18, 1960, Ser. No. 9,460

3 Claims. (Cl. 66—85)

The present invention relates to methods of warp knitting pile fabrics having multiple pile projections.

The parent application has been divided, and this application is a division of my copending application Serial No. 796,364, filed March 2, 1959, for Multiple Pile Projections.

A purpose of the invention is to increase the density of pile without corresponding increase in the backing stitch density.

A further purpose is to improve the utilization of pile yarn in a warp knitted pile fabric.

A further purpose is to increase the yardage production without increasing the speed by forming twice the number of pile projections per course as in the prior art, thus allowing the stitch length to be increased to such an extent that for a given pile density the production will be doubled.

A further purpose is to produce a more wear resistant warp knitted pile fabric.

A further purpose is to increase the yarn utilization in moresque type warp knitted pile fabrics.

A further purpose is to form straight warp lines of knitting chains, to lay in backing yarn alternating weftwise in the loops of the chain stitches, to form pile loops with legs of the pile loops bound in the stitches of the chains, each pile loop being formed so that it will be split by a knitting chain into two complete loops, both of which loops having a binding point in one stitch, but the opposite legs of the loops having binding points in different chains.

A further purpose is to form two pile loops or other pile projections from the same pile yarn ends in warp knitting in the same course with the same orientation.

A further purpose is to produce two pile projections formed on the same course from the same pile yarn end in warp knitting, one of the pile projections being oriented weftwise and the other pile projection being oriented diagonally with respect to the weft.

A further purpose is to produce on each course a loop or pile projection both of whose legs are bound in the same stitch of the same chain of stitches, and also a loop of pile projection one leg of which is bound in that stitch and that chain and the other leg of which is bound in the next stitch.

A further purpose is to form high and low pile loops or other pile projections in broken or staggered rows rather than continuous rows in the face of a carpet or rug so as to diversify the texturing.

A further purpose is to produce two pile loops or other pile projections on the same pile yarn end in the same course of a warp knitted pile fabric, one of which loops is oriented weftwise and the other of which is oriented walewise.

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 the 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 fragmentary enlarged top plan views showing the steps of formation of a fabric of the invention according to FIGURE 9.

FIGURES 1*a* to 8*a* are diagrammatic fragmentary enlarged top plan views showing the steps of formation of a fabric of the invention according to FIGURE 10.

FIGURES 1*b* to 8*b* are diagrammatic fragmentary enlarged top plan views showing the steps of formation of the 1st, 3rd, 5th, etc. stitch only of the fabric of FIGURE 11 (in other words the odd numbered stitches).

FIGURES 1*c* to 8*c* are diagrammatic fragmentary enlarged top plan views of the steps of formation of the 2d, 4th, 6th, etc. stitches only of the fabric of FIGURE 11 (in other words the even numbered stitches).

FIGURES 1*d* to 8*d* are diagrammatic enlarged top plan views of the steps of formation of the fabric of FIGURE 13.

FIGURE 9 is a fragmentary top plan view of the fabric produced in accordance with FIGURES 1 to 8, illustrating the knitting chains and the face yarn only, with the backing yarn shown below separately for the sake of clarity. This view has been expanded in order to permit showing the double adjoining face loops formed from the same face yarn around adjacent plush points and across three lines of chain in the same course. The center legs of the two pile loops are bound under a common center chain, and the opposite legs of each loop are bound in the two adjacent chains to the right and left of the center chain and in the same course.

FIGURE 10 is an expanded top plan view of the face of a fabric of FIGURES 1 to 8, with the backing yarn removed for the sake of clarity, the backing yarn suitably being of the form of FIGURE 9. One binding point is common to both loops but the first leg of the first loop is bound in the stitch of the previous course of the same chain that forms a common binding point, while the second leg of the second loop is bound in the stitch of the adjoining chain in the same course as the common binding point.

FIGURE 11 is an expanded top plan view of the fabric of FIGURES 1*b* to 8*b* and 1*c* to 8*c* with the backing removed for the sake of clarity. The backing is suitably the same as in FIGURE 9. The pile loops are formed around two adjacent plush points. The pile loops have a common center binding point with the outside leg of the first loop bound in the previous stitch of an adjacent chain, while the second loop has the outside leg bound in the same course of another adjacent chain.

FIGURE 12 is an expanded top plan view with the backing yarn removed to better display the loop formation. The backing will suitably be as in FIGURE 9. The loops are formed in pairs around adjacent plush points and the sequence is a combination of the steps used to produce the fabrics of FIGURES 10 and 11.

FIGURE 13 is an expanded top plan view with backing removed, showing a fabric with double loops formed around adjacent plush points. The backing will suitably be as in FIGURE 9. The first leg of the first loop is bound in the previous stitch, and the second leg of the first loop and both legs of the second loop are bound in the next stitch of the same chain.

FIGURE 14 is a photographic view of the face of a fabric sample which conforms to FIGURES 1 to 8 and 9.

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

In warp knitting loop pile fabrics for use as carpets, rugs, upholstery and other heavy fabrics of that type, the pactice in the prior art has been to knit lines of chain stitches, form the back of the carpet by alternating heavy layin yarn weftwise which is secured in the loops of the chain stitches, and forming a projecting loop of face yarn

from each end of face yarn in each course, with the legs of the pile loop fastened in the chain stitches.

When very compact long wearing pile was required in the prior art, it was formed by shortening each stitch and increasing the number of stitches and courses per inch, or by the use of a finer gauge trick plate, or both, for the purpose of increasing the number of pile projections per square inch.

When the number of courses per inch is increased, this decreases the yardage produced in a given time, because the course or takeup is laid down.

On the other hand, if a finer gauge is used, this limits the size of the face yarn. The machine parts are more fragile. In addition the use of fine gauge parts increases the cost of setup and operation due to the increase in the number of parts for a given width and the more precise adjustments required on the knitting machine when fine gauge parts are used.

I have discovered that I can produce fabrics with a more compact and closer spaced pile face without employing close stitches and fine gauge, by forming two pile loops from each end of pile yarn in each stitch and wale.

This is accomplished by looping the pile yarn around two plush points at the same time instead of around one plush point as in the prior art. This forms one wide loop which in every case extends around two plush points and extends across an intermediate line of knitting chain. When the knitting stitch is formed, the intermediate end of knitting yarn must pass between the plush points which have been bridged by the wide loop. This splits or subdivides the loop into two adjoining loops with a common center binding point formed by the intermediate line of knitting chain.

When a cut pile is formed, cutting plush points may be used in the same way as noncutting except that the pile loops are not cast off but instead are cut, producing four cut pile projections in each course from each running end of pile yarn.

The results which have been described above are accomplished by one pile yarn guide bar or frame, and, of course, they can be multiplied by using two or more frames.

One of the great advantages of the present invention is that there is no layin of pile yarn which does not produce a pile projection, and therefore, each stretch of pile which in the prior art produced a single loop, in the present case produces two loops or other pile projections. Accordingly pile utilization is greatly improved.

The principles of the invention can be applied to produce an extremely compact pile with a normal openness of stitch, thus greatly improving the wear resistance, or it can be applied to fabric having a very open stitch which still employs a pile of normal compactness.

In some cases, it is desirable to apply the principles of the invention to warp knitted pile fabrics having the moresque effect, using pile yarn ends of different colors in different tubes of the same pile yarn guide bar. In the prior art, there has been difficulty in warp knitting moresque pile carpets and rugs because of the introduction of lining effects through variation in yarn of particular colors in different parts of a carpet of large area, as in a lobby of a hotel or theater, or, in fact in any broadloom. By the present invention, however, the loops formed from a single pile yarn end are distributed laterally in broader weftwise bands, and therefore the likelihood that lines will be visible is correspondingly decreased. While this principle is believed to find its widest use in moresque carpets, it is also useful in plain colored face yarn applied on a particular frame which may be the only frame used or one of several.

The invention is also applicable to carpets or rugs having high and low pile projections in the face. In prior experiments with carpets having high and low loops, I have found there are difficulties through the tendency to limit the variation obtainable because of long narrow rows of pile produced from the same pile end. By the present invention, it is possible to distribute the pile projections from the same pile yarn end in broader bands weftwise, breaking up the rows and adding greatly to the interest in fabrics having high and low pile.

The present invention produces two adjoining pile projections from the same pile end and in the same course, and these two pile projections can be oriented in different ways, in some cases both extending weftwise, and in some cases one extending weftwise and one diagonally of the weft, and in still other case both pile projections extending walewise.

In some cases, in accordance with the present invention, three orientations of pile projections can be employed in the same fabric. Thus, in the same fabric on the same pile end, there can be pile projections which extend weftwise, those which extend walewise and those which extend diagonally with respect to the weft and to the wale, in any desired sequence of arrangement.

In one embodiment of the invention, the pile yarn ends are bound in a single row of stitches, and on each course one pile projection is formed, both of whose legs are bound in the same stitch, and another pile projection is formed with one leg bound in the same stitch and another leg bound in the next stitch.

The nature of the invention can best be understood by first considering FIGURE 9, with further reference to FIGURES 10, 11, 12 and 13, which represent expanded diagrammatic plan views of the faces of the fabrics of the invention.

These fabrics may be made in a standard Raschel warp knitting machine, as well known in the art, of the character described for example in D. F. Paling, Warp Knitting Technology (1952), particularly pages 132 to 192 inclusive. In this machine the knitting latch needles manipulated by a needle bar cam are operated to raise and fall within a trick plate which guides the needles. On the opposite side of the trick plate from the needle bar there is a second needle bar but in this case it is furnished with a gang of plush points instead of needles, and a suitable cam which causes the plush points to rise and fall. Above the needles and plush points there are swinging guide bar carriers for the pile yarn, backing yarn and knitting yarn, with a standard swinging motion for all bars, and an individual shogging motion for each bar separately, these motions cooperating with a letoff for yarn and a pickup for fabric as well known in the prior art.

Considering now FIGURE 9, the fabric consists of a series of warpwise knitting chains **30** formed of knitting yarn **31** fed through tubes **32** on the knitting yarn guide bar. The chains **30** have knitting stitches **33** including loops which bind together bundles **34** of backing yarn **35** fed by tubes **36** of a backing yarn guide bar. The backing yarn follows a serpentine course over a required number of needles, in this case shogging over three lines of chain stitches, but suitably shogging over more than three lines of chain stitches as desired. The face of the fabric is composed of pile yarn loops **37** and **38** in each course and wale, formed from pile yarn ends **40** and **40'** fed from adjoining pile yarn tubes **41** of the same pile yarn guide bar, but are indicated by different stippling to indicate that they are suitably of different color or of the same color as desired. The backing yarn is shown only in the lower section of the view for clarity.

It will be noted in FIGURE 9 that the knitted chains are alternately of left hand and right hand stitches, although the question of whether the stitches alternate or are always the same is not critical in the present invention.

The pile yarn ends in FIGURE 9 have shogged over three needles and form loops **37** and **38** extending weftwise. While the pile projections are shown as uncut pile loops, it will be evident that they can be formed as cut

pile tufts following the principles of my copending patent application Serial No. 666,312, filed June 18, 1957 for Warp Knitting Machine Using Cutting Plush Point, now United States No. 2,907,191.

Each pile yarn end forms two pile projections on each course in FIGURE 9. One of the pile projections is offset one wale from the other pile projection.

Thus in the same wale and course there is one pile projection **37** and one pile projection **38**. In an ordinary warp knitted pile fabric, there would be only one pile projection in the same wale and course, but FIGURE 9 has two such pile projections.

The double loop formation just described can be utilized in different ways as previously explained. It can be used to produce extremely dense and wear-resistant pile, or it can be used to increase the rate of production of a pile having more open stitches. Unlike prior art fabrics which in some cases shog across needles without forming pile, in the present invention pile projections are formed on each shog across a needle, and therefore there is high efficiency of the utilization of pile yarn.

It is of course evident that each of the pile yarn ends forms pile projections laterally in adjoining wales, and this tends to increase the width of the pile formed by particular pile yarn ends and in addition supplements each loop by an adjoining loop formed on the same course for mutual supporting purposes. This gives a fabric which is less likely to show lining effects, particularly where moresque pile yarn is used, and it also breaks up rows where high and low pile projections are used.

In the form of FIGURE 9 the pile projections formed from the same pile yarn end in the same course are all oriented in the same way, that is, all weftwise or coursewise. It will be evident as later explained, however, that the pile projections formed in the same course from the same pile end can be differently oriented if desired.

The steps in constructing the fabric of FIGURE 9 are shown in FIGURES 1 to 8 inclusive, which are diagrammatic expanded plan views of the main operating parts of a Raschel warp knitting machine and of the fabric being formed thereon according to the invention. In addition to the parts already described, there are shown in each view latch needles **42** and plush points **43** respectively on opposite sides of the fabric.

It will be evident that in FIGURE 1 the bundles **34** of backing yarn **35** are all bound by the previous stitch **33** which is on the needles **42**. At the beginning of the cycle, as in FIGURE 1, the loops of the previous course are shown at **44** and **45**. The needles and plush points are down, and the yarn guide tubes are moving back toward the needle side as shown.

In FIGURE 2 at 30 degrees in the cycle, the plush points **43** have just risen and the yarn guide tubes **32, 41** and **36** have moved all the way back on the needle side. The backing yarn guide tubes **36** are shogged three needles to the right to form the layin of the backing yarn **35**.

In FIGURE 3 at 90 degrees in the cycle, the yarn guide tubes **32, 41** and **36** have moved to the front of the plush points. The pile yarn guide tubes **41** have moved to the right past two plush points **43**, forming stretches **46** of pile yarn **40** and **40'** which will become the pile loops of the new course of stitches.

In FIGURE 4 at 115 degrees in the cycle, the yarn guide bars **32, 41** and **36** have moved all the way back to the needle side as shown.

The pile yarn guide bar tubes **41** shog one needle space to the right to be in position to form the second outside leg of the loops **37** and **38** being formed on the plush points **43**.

In FIGURE 5 at 210 degrees in the cycle, the yarn guide tubes **32, 41** and **36** have moved to the front in position to allow the needles to rise, and the needles have risen. Loops of the last knitting stitch **33** slide down the needles, opening their latches, and the now opened hooks of the needles are ready to form the new knitting stitch.

In FIGURE 6 at 270 degrees in the cycle, the yarn guide tubes **32, 41** and **35** have moved back past the needles **42**, and knitting yarn guide tubes **32** have shogged to the right one needle space so that the knitting yarn **31** is in position to form loops **33'** around the hook sides of the needles. The loops **37** and **38** of pile yarn for the new course are now fully formed and ready to be bound in by the new knitting stitches.

In FIGURE 7 at 300 degrees in the cycle, the yarn guide tubes are moving to the front, and needles **42** and plush points **43** are retracted to their lower position. Between the position of FIGURE 7 and the position of FIGURE 8 the new loops of knitting yarn **33'** are pulled down by the hook of the needle and the old stitch loops 33^2 are raised over the closing latches of the needles and the needle hook with its new loop to complete the stitches as shown in FIGURE 8 at 330 degrees in the cycle. In FIGURE 8 the plush points have just released the new pile loops **37** and **38** and the course is complete.

As already described, the construction of FIGURE 9 orients all the loops in the same way, but in FIGURE 10 loops are oriented differently. In FIGURE 10 the lines of stitches unite the bundles of backing yarn (like FIGURE 9, but not shown) and also unite pile yarn ends **40** and **40'**, which form loops **47** and **47'** from pile yarn ends **40** and loops **48** and **48'** from pile yarn ends **40'**, both of the loops **47** and **47'** or **48** and **48'** being formed from the same end in the same course.

Thus it will be seen that in FIGURE 10, a weftwise and a walewise loop is formed from each pile yarn end in the same course.

FIGURES 1*a* to 8*a* illustrate the method of knitting the fabric of FIGURE 10. FIGURE 1*a* shows the position at zero degrees in the cycle, the previous loops **47** and **47'** and **48** and **48'** being completed. The needles **42** and plush points **43** are down. The yarn guide tubes **32, 41** and **36** with the yarn on them are moved back toward the needle side.

FIGURE 2*a* at 30 degrees of the cycle shows the yarn guide tubes **32, 41** and **36** moved all the way back to the needle side. In this position the plush points are rising. Pile yarn guide tubes **41** are shogged one needle to the left, forming stretches **50** preparatory to forming these into loops in FIGURE 3*a*. Backing yarn tubes **36** are shogging to the right to form layed-in stretches of backing yarn **35** for the new stitch.

In FIGURE 3*a* the guide bars **32, 41** and **36** have moved all the way to the front and guide bar tubes **41** have shogged two needles to the right past two plush points **43** to form stretches of yarn **46'**, each of which will eventually form two loops of pile yarn.

In FIGURE 4*a* at 150 degrees in the cycle, yarn guide bar tubes **32, 41** and **36** have moved back to the needle side and the stretches of pile yarn **46'** shown in FIGURE 3*a* have formed the new loops **47, 47'** and **48, 48'**. These loops are separated by the knitting yarn **31**. The pile yarn guide bar in FIGURE 4*a* also shogs the pile yarn one needle to the right in order to form the second legs of the loop as illustrated at **51**.

In FIGURE 5*a* at 210 degrees in the cycle, the guide bar tubes **32, 41** and **36** are shown moved to the front or plush point side. No shogging is taking place and all yarn has been placed in position except the knitting yarn, and the needles are now rising. The pile yarn which will form the double loops is around the plush points. As the needles rise the loops of the previous knitted stitches will move down on the hooks of the needles, opening the latches and placing the open hooks of the needles in position to accept the knitting yarn.

In FIGURE 6*a*, at 210 degrees in the cycle, the guide bar tubes **32, 41** and **36** have moved back past the needles to the needle side. Knitting yarn guide bar tubes **32** now shog one needle to the right to form loops **33'** of knitting yarn which will enter the hooks of the needles **42**.

In FIGURE 7*a*, at 300 degrees in the cycle, the course

is fully formed but not yet locked in place. The needles **42** are dropping and the old loops **33²** are rising over the closed latches of the needles and will pass over the new loops of knitting yarn which have been put in the hooks of the needles, thus completing the knitting stitch as well known in the art. The guide bar tubes are now moving forward.

In FIGURE 8*a*, at 330 degrees in the cycle, the knitting stitch has been locked over and completed. The plush points **43** have just dropped and released the last formed loops, the guide bar tubes **32**, **41** and **36** are all the way forward, and are ready to start back toward the needle side to be in position to start the next course of stitches. The loops **47** and **48** are straight across chains of stitches and the loop **47'** or **48'** is tied in in the same stitch of the same chain of stitches.

In the form of FIGURES 1 to 8 and 9 both of the double loops are oriented coursewise and in the form of FIGURES 1*a* to 8*a* and 10 one of the double loops is oriented coursewise and the other walewise.

In the form of FIGURE 11, one of the double loops is oriented coursewise and the other is oriented diagonally. In this fabric, unlike the others, there is only one loop in the same course and wale, so that the feature of increased production is not present, but the difference in orientation which will break up lining effects without dead laying of pile yarn does exist.

In FIGURE 11 the lines of stitches hold the bundles of backing yarn (like FIGURE 9, but not shown) and also hold pile yarn loops or pile projections **52** and **53** which are oriented warpwise and pile yarn loops or pile projections **52'** and **53'** which are oriented diagonally. In each case the first loop of each pile yarn end is located diagonally between adjacent chain stitches in different courses, while the second loop of each pile yarn end is formed between adjacent chain stitches in the same course.

It is understood that in the method of forming the fabric of FIGURE 11, it is necessary to consider both FIGURES 1*b* to 8*b* and FIGURES 1*c* to 8*c*. To form the diagonal loops **52'** and **53'** and the weftwise loops **52** and **53**, it is necessary to establish a previous binding point which is illustrated in FIGURES 1*b* to 8*b*.

In FIGURE 1*b* at zero degrees in the cycle, the last stitch has just been completed, forming previous loops **52**, **52'** and **53**, **53'** around the plush points.

The needles and plush points are down in FIGURE 1*b*, the guide bar tubes **32**, **41** and **36** are moved to the rear to be in position to allow the plush points to rise in FIGURE 2*b*.

In FIGURE 2*b* the guide bar tubes **32**, **41**, and **36** have moved to the rear or needle side. Plush points **43** have risen and face yarn guide tubes **41** have shogged one needle to the right to move the face yarn into the binding position shown at **54**.

Backing yarn guide tubes **36** are shogging to the right to carry the backing yarn **35** across a sufficient number of needles to form a layin of backing yarn, suitably at least three needles.

Since no pile yarn loops are formed in this course, the remainder of the sequence is a standard Raschel warp knitting sequence. Thus in FIGURE 3*b* at 90 degrees in the cycle, the yarn guide tubes have moved front to the plush point side. No shogging of the pile yarn takes place at this point.

In FIGURE 4*b* at 150 degrees in the cycle, the guide tubes have moved all the way back to the needle side.

In FIGURE 5*b* at 210 degrees in the cycle, the yarn guide tubes have moved front in position to allow the needles to rise. Loops of the last knitting stitch slide down the needles, opening the latches and the now open hooks of the needles are ready for the new knitting stitch.

In FIGURE 6*b* at 270 degrees in the cycle, the yarn guide tubes have moved to the back past the needles and knitting yarn guide bar tubes **32** shog one needle space to the right to put knitting yarn **31** into the open hooks of the needles.

In FIGURE 7*b* at 300 degrees in the cycle, the yarn guide tubes are moved to the front and the needles and plush points are dropping. Between this and FIGURE 8*b* the new loop of the knitting yarn will be pulled down by the hook of the needle and the old stitch will rise over the closing latch and the needle hook with its new loop to complete the stitch at 330 degrees in the cycle of FIGURE 4*b*.

By FIGURE 8*b* at 330 degrees in the cycle, the binding point **54** has been completed.

The remainder of the steps of forming the fabric of FIGURE 11 will be understood by reference to FIGURES 1*c* to 8*c*.

FIGURE 1*c* at zero degrees in the cycle is the first step in the method of constructing the pile loops of FIGURE 11. In FIGURE 1*c* the needles and the plush points are bound, and the yarn guide tubes **32**, **41** and **36** are moving to the back or needle side.

In FIGURE 2*c* at 30 degrees in the cycle, the yarn guide tubes are moving all the way back to the needle side, and the plush points **43** have risen, and the yarn guide tubes **36** are shogging a sufficient distance to the left, at least three needles, to form the layin of backing yarn **35**.

In FIGURE 3*c* at 90 degrees in the cycle, the yarn guide tubes have moved all the way front to the plush point side.

Pile yarn guide tubes **41** have shogged two needles to the right, forming stretches **55** which will become new loops in the present course.

In FIGURE 4*c* at 150 degrees in the cycle, the guide bar tubes **32**, **41** and **36** have moved back to the needle side. The stretch of pile yarn **55** which was formed around two plush points has now been split into two loops **52** and **52'** and **53** and **53'** by the loop of knitting yarn.

FIGURE 5*c* at 210 degrees in the cycle, shows the guide bar tubes **32**, **41** and **36** moved forward to the plush point side. This is required to allow the needles **42** to rise. The loops of knitting yarn formed over the needles from the last stitch slide down the needles, opening the latches so that the hooks are open to receive the next knitted stitch.

In FIGURE 5*c* at 270 degrees in the cycle, the yarn guide tubes have moved back through the needles, and the knitting yarn guide tubes **32** have shogged one needle to the left to put knitting yarn **31** into the hooks of the needles **42**.

In FIGURE 7*c* at 300 degrees in the cycle, the yarn tubes **32**, **41** and **36** have moved forward toward the plush point side and the knitting yarn **31** which was placed in the hooks of the needles is being pulled down and the old loops of the previous stitch will slide over the closed latching of the needle and over the new loop to form a new knitting stitch.

In FIGURE 8*c* at 330 degrees in the cycle, the needles are dropping and forming a new knitting stitch, and the plush points have dropped and released the loops which correspond with the loops in FIGURE 11.

It is possible to combine the features of the various loops of the fabrics above referred to in a single fabric as shown in FIGURE 12. This fabric has loops which are bound in the same course of adjoining chains, loops which are diagonal and loops which are bound in successive stitches of the same chain.

Thus as shown there are on ends **40** loops **56** which are bound in successive stitches in the same chain, loops **56'** which are bound in corresponding stitches of adjoining chains, loops **56²** which are bound in successive stitches of adjoining chains and loops **56³** which are bound in corresponding stitches of adjoining chains. Similarly on the intermediate pile yarn ends **40'** there are loops **57** which are bound in successive stitches of the

same chain, loops 57' which are bound in corresponding stitches of adjoining chains, loops 57^2 which are bound in successive stitches of adjoining chains and loops 57^3 which are bound in corresponding stitches of adjoining chains.

The technique of knitting the form of FIGURE 12 follows the form of FIGURES 1*a* to 8*a* with the following changes:

In each step two loops are formed. In the first case the first loop is located warpwise in the fabric; the second loop weftwise in the fabric; in the second case the first loop is located diagonally in the fabric and the second loop weftwise. In the first case the warpwise loop is formed according to the technique of formation of the loop **58** in FIGURE 13, which follows FIGURES 1*d* to 8*d*. The second loop in the first case is formed according to FIGURES 1 to 8.

In the second case the diagonal loop is formed according to 1*c* to 8*c*. In the second case the weftwise loop is formed according to FIGURES 1 to 8.

In some cases it is desirable to form pile loops or other pile projections which are all bound in the same chain, but with double loop formation in accordance with the present invention as shown in FIGURE 13. Thus in FIGURE 13 there are loops **58** bound in successive stitches of the same chain and loops **60** bound in the same stitch of the same chain, alternating with one another walewise.

The method of construction is shown in detail in FIGURES 1*d* to 8*d* inclusive.

In FIGURE 1*d* at zero degrees in the cycle, the latch needles **42** and the plush points **43** are down, the yarn guide tubes **32**, **41** and **36** have moved to the rear or needle side, and no shogging has taken place as yet. The last course has formed loops **58** and **60** which are bound in by the last stitch of knitting yarn **31**, and the backing yarn **35** is formed in bundles **34** bound by the stitches. The pile yarn which may be of different colors in alternate tubes as shown in FIGURES 1*b* to 8*b* is ready to start shogging for the next stitch.

In FIGURE 2*d* which corresponds to 30 degrees in the cycle, the plush points **43** rise as the guide bar tubes move all the way back on the needle side. Backing yarn **35** is shogged to the right to form the layin of the backing yarn. The pile yarn ends **40** and **40'** are shogged to the left one needle to be in position to form loops around plush points in the next figure.

In FIGURE 3*d* at 90 degrees in the cycle, the yarn guide tubes move to the front past the plush points, and the pile yarn guide tubes **41** shog two needles to the right to form stretches **61** of pile yarn in front of two plush points. The loops formed in the previous course have been broken away in FIGURE 3*d* to avoid confusion.

In FIGURE 4*d* at 150 degrees in the cycle, the guide tubes **32**, **41** and **36** have moved back past the needles which are still down. The pile yarn guide tubes have shogged one needle to the left to form the second leg of the loop in position for the binding stitch. In this position the stretches **61** are split into two loops by the knitting yarn **31**.

In FIGURE 5*d* at 210 degrees in the cycle, the guide bar tubes **32**, **41** and **36** are in front past the plush points. The needles **42** rise, and the last stitch looped around the needles slide down, opening the latches and preparing the open needle hooks for the knitting yarn.

In FIGURE 6*d* at 270 degree in the cycle, the yarn guide tubes have moved back past the the raised needles. The knitting yarn guide tubes **32** have shogged to the right one needle, forming stretches **33'** to put loops of knitting yarn **31** into the hook of the needles.

In FIGURE 7*d* at 300 degrees in the cycle, the guide tubes are moving to the front, the needles are dropping and the knitting yarn loops **33'** are in the hooks of the needles.

In FIGURE 8*d* at 330 degrees in the cycle, the needles are down, and the knitting stitch has been completed by the new loop being pulled down inside the last loop as well known. The yarn guide tubes are in the front and the plush points have dropped, leaving loops **58** and **60** bound by the stitches.

FIGURE 14 shows in photographic view the face of the fabric sample which conforms to FIGURES 1 to 8, and 9.

It will be evident that when knitting stitches are referred to herein the preferred knitting stitch as shown is a so-called crochet.

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 making a warp knitted pile fabric, using plush points and using a guide bar carrying a plurality of pile yarn ends, which comprises forming walewise extending parallel chains of knitted crochet stitches, forming backing of warp yarn undulating sinuously and inlaid in the knitted stitches of the chains on successive courses, moving said guide bar carrying said pile yarn ends weftwise to form loops around two adjoining plush points, and forming knitted stitches around the extreme legs of said loops and between two adjoining plush points to split said loops into two pile projections and fasten the base legs of said loops to the backing to form two pile loops in each course from the same pile yarn end.

2. The method of claim 1, which comprises moving said guide bar carrying said pile yarn ends continuously weftwise across three plush points.

3. The method of claim 1, in which the plush points are raised on each course, which comprises moving said guide bar carrying said pile yarn ends weftwise in back of one plush point in the direction of previous movement at the end of the previous course and before raising the plush points for the next course, and then on the next course reversing and moving the warps of pile yarn ends across in front of two plush points and then back of a third plush point, thereby forming in each course one pile loop oriented walewise and one pile loop oriented weftwise.

References Cited in the file of this patent

UNITED STATES PATENTS

2,531,718 Rice ---------- Nov. 28, 1950