

Oct. 16, 1962

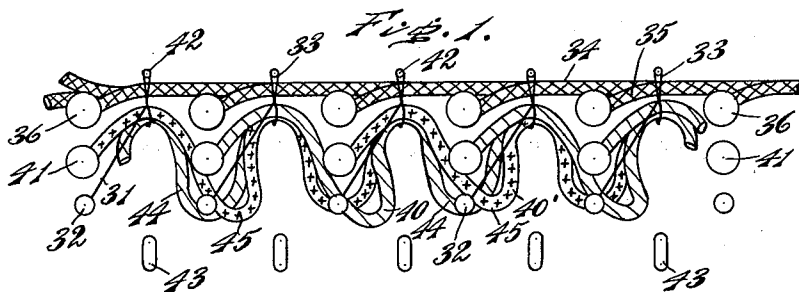
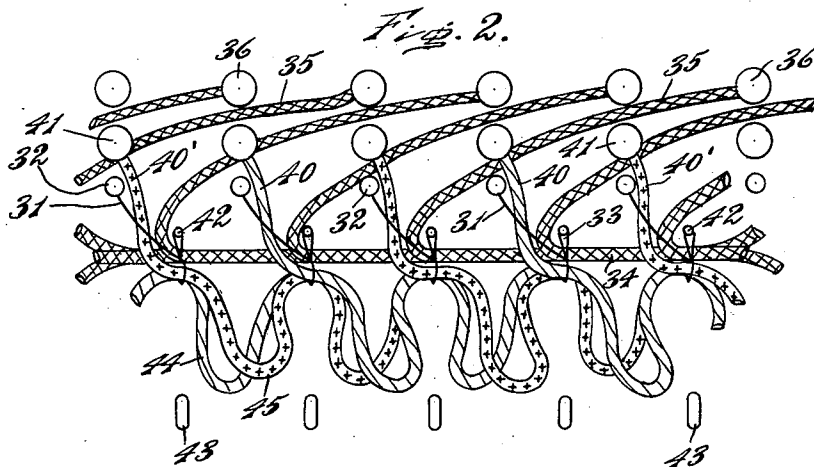
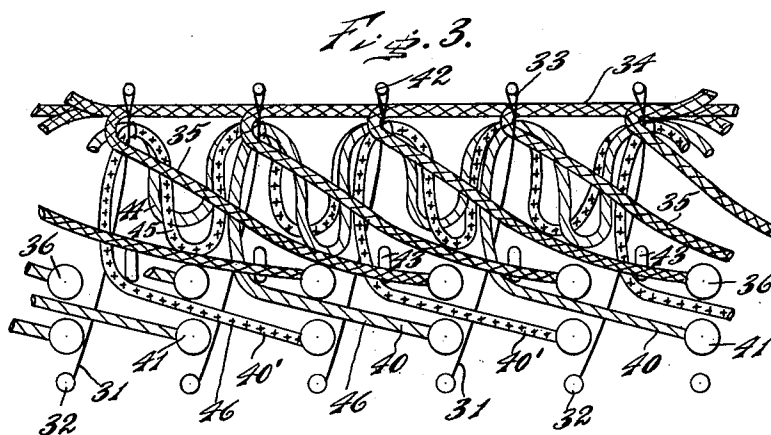
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3,058,326

MULTIPLE PILE PROJECTIONS

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16 Sheets-Sheet 1



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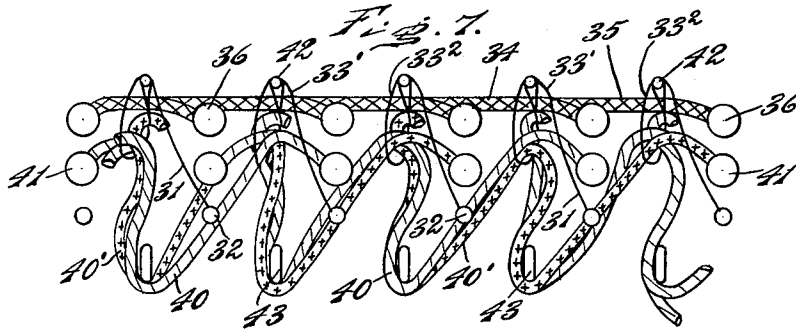
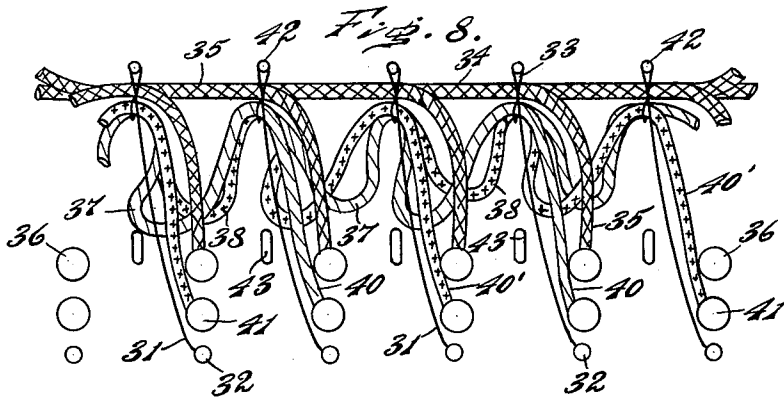
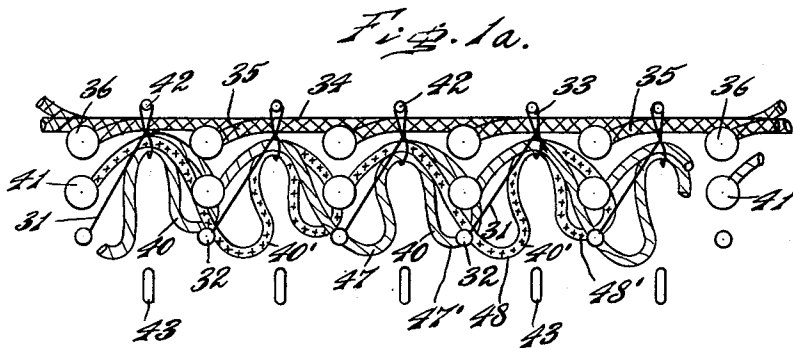
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16 Sheets-Sheet 2



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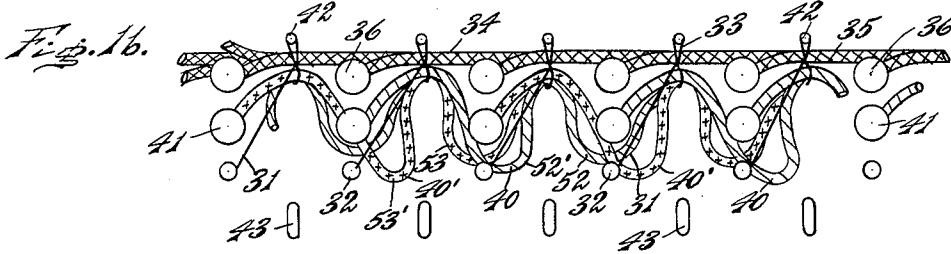
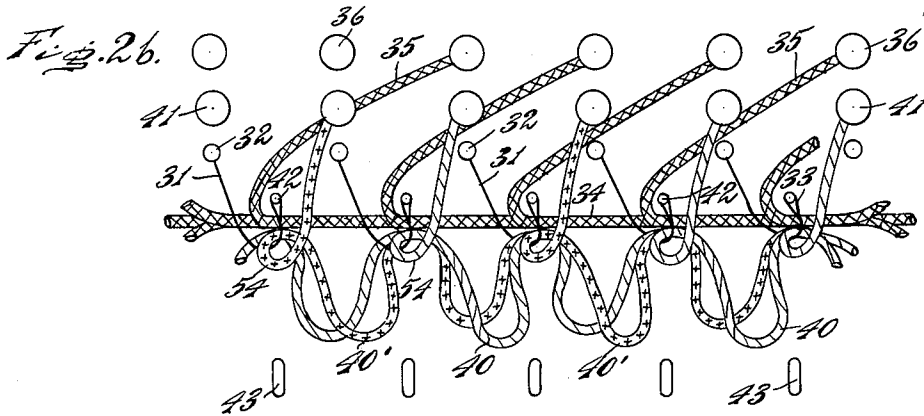
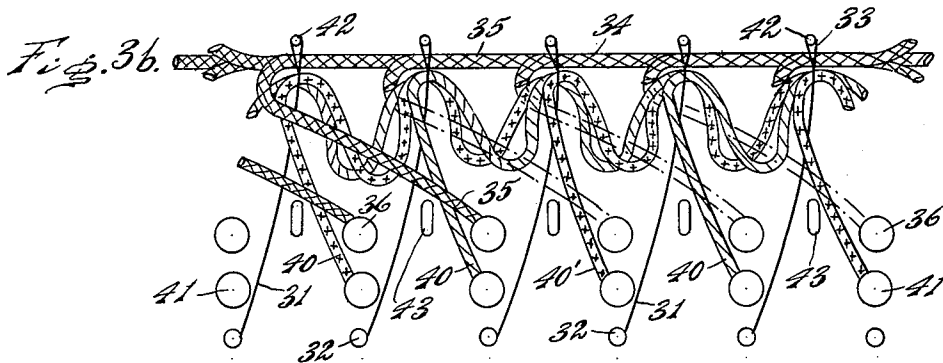
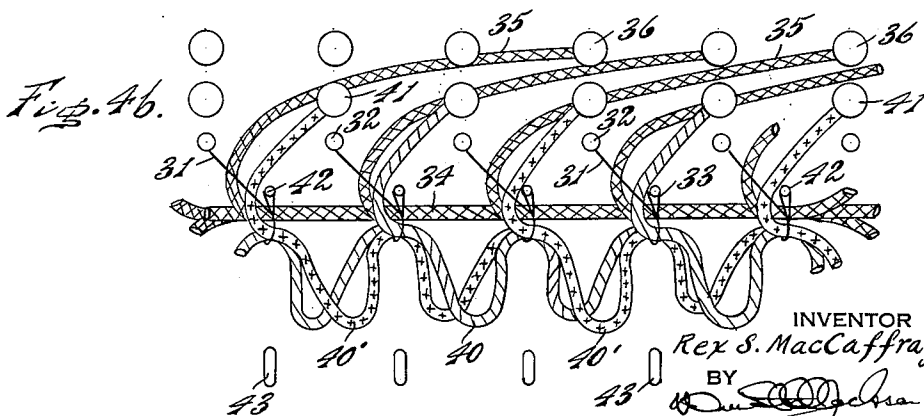
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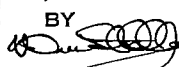
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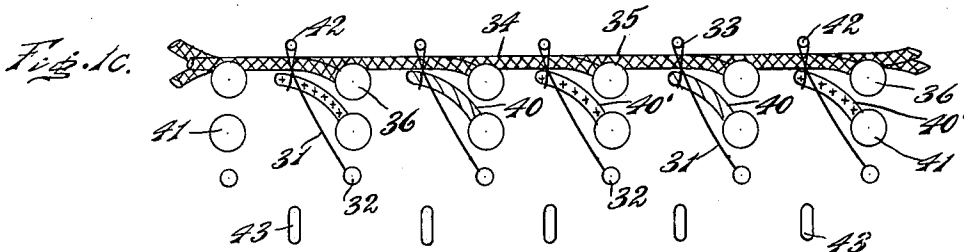
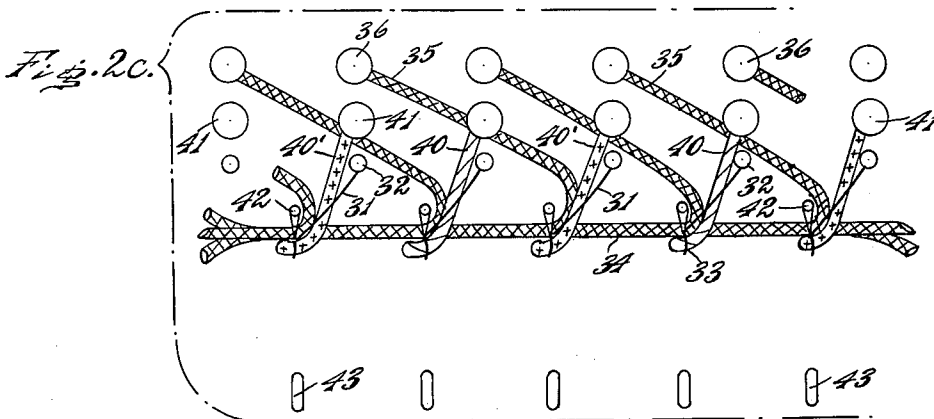
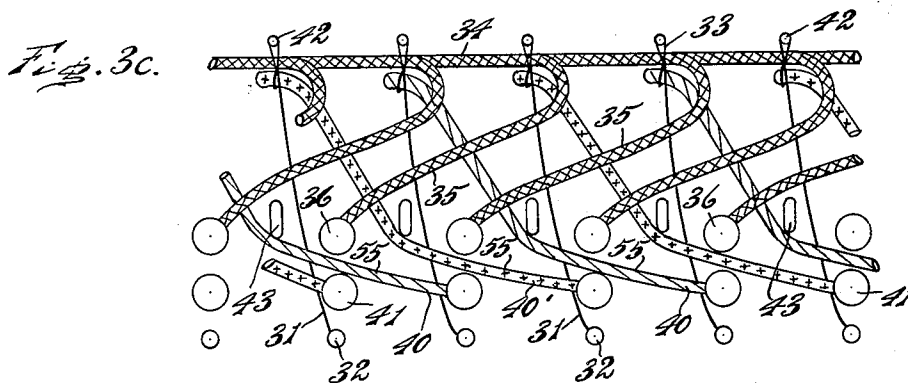
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Fig. 7c.

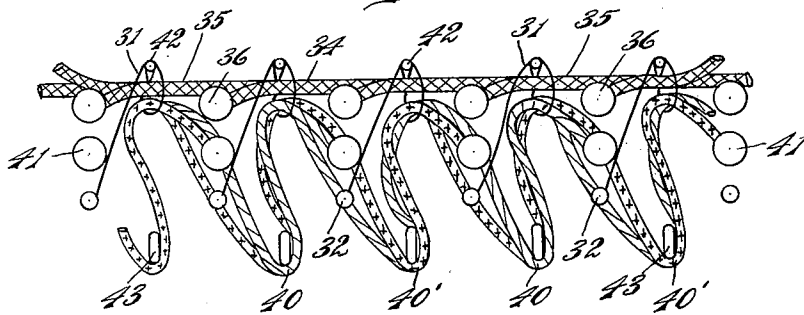


Fig. 8c.

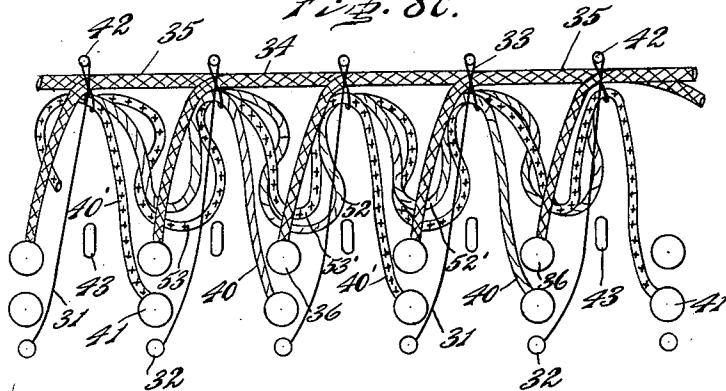
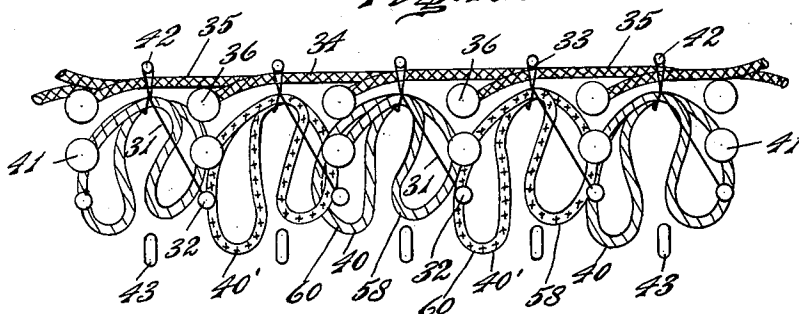


Fig. 1d.



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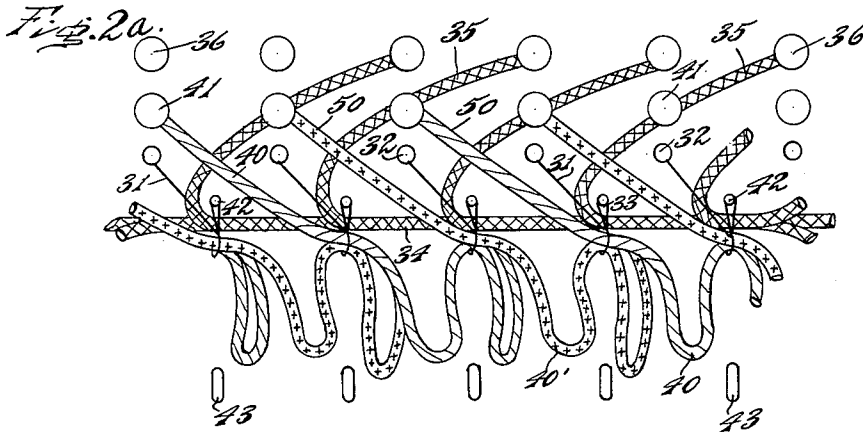
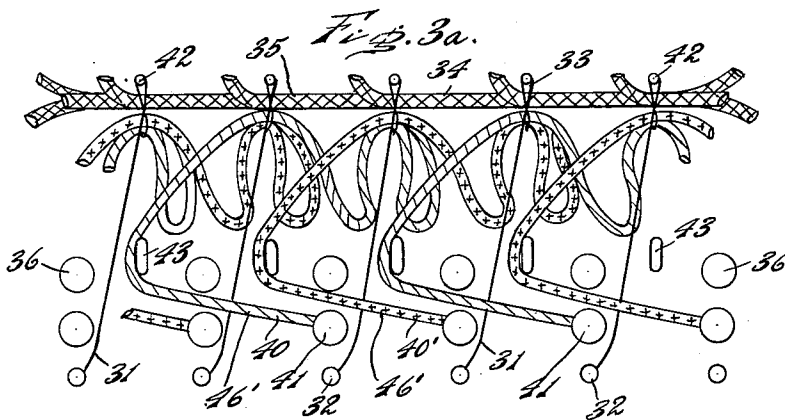
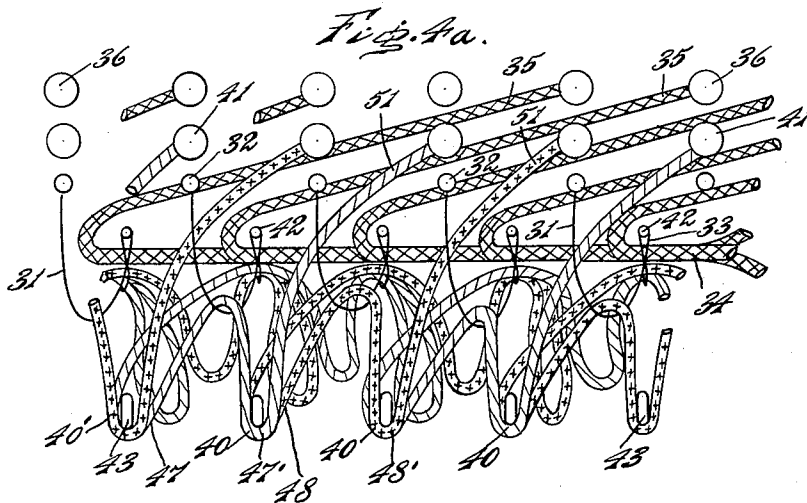
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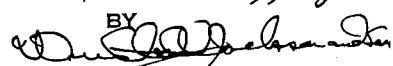
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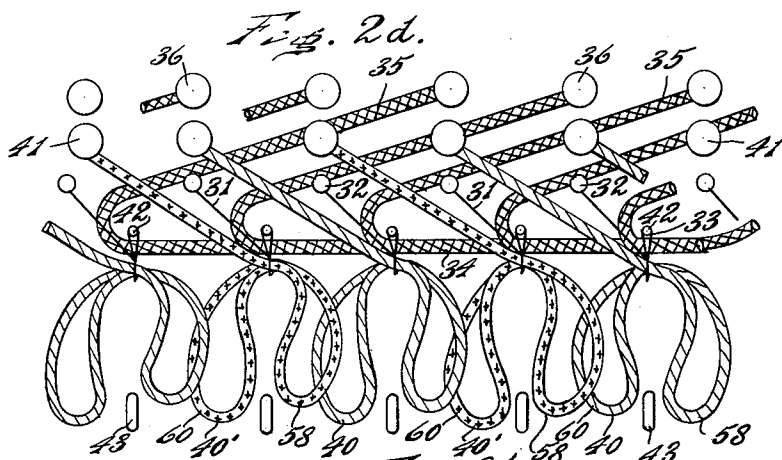
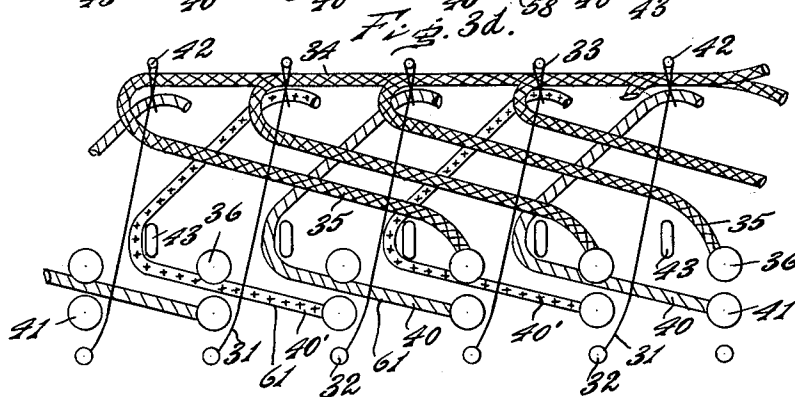
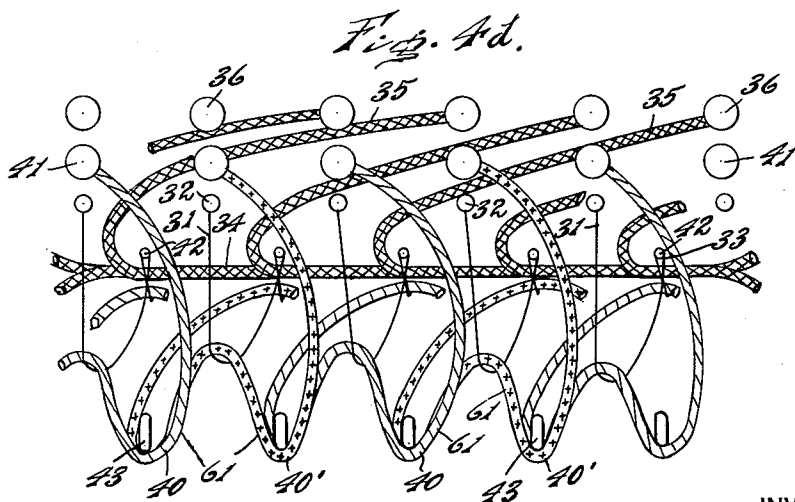
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MULTIPLE FILE PROJECTIONS

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16 Sheets-Sheet 7



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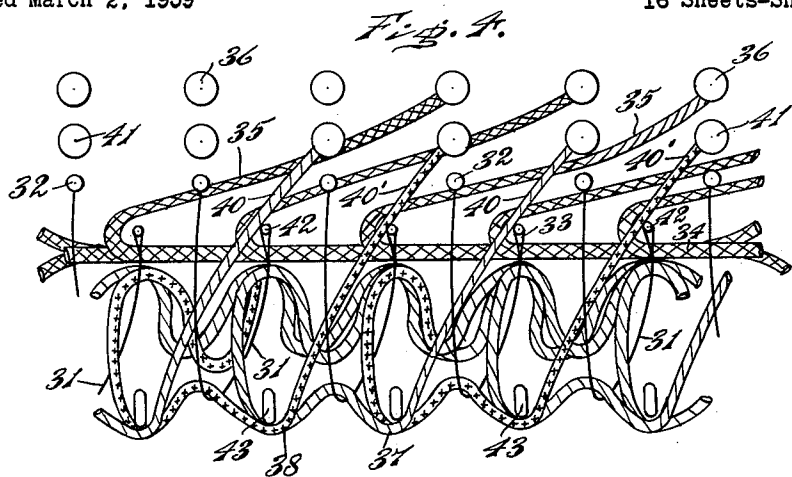
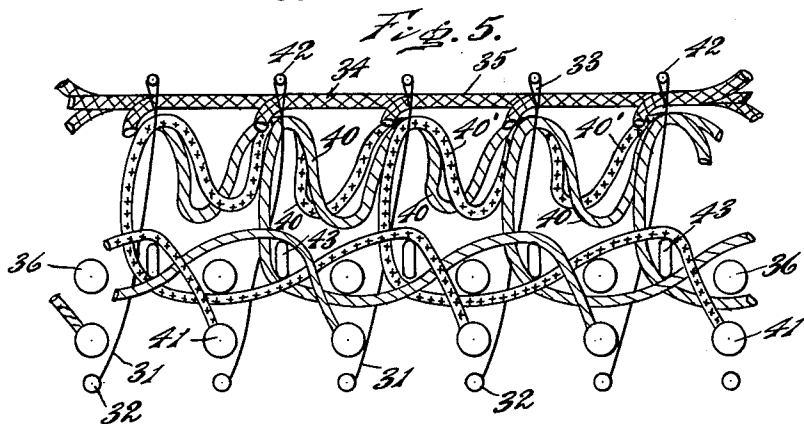
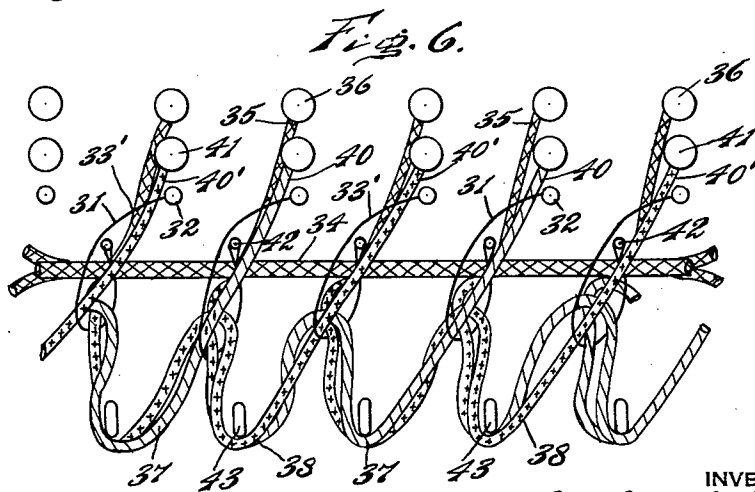
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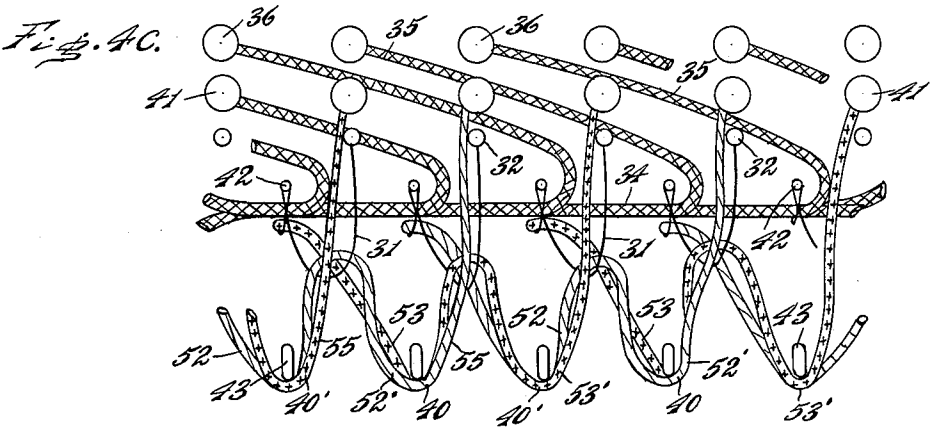
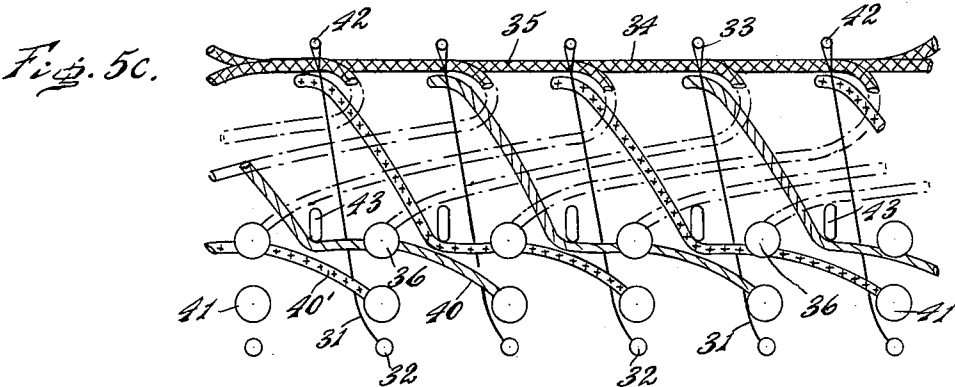
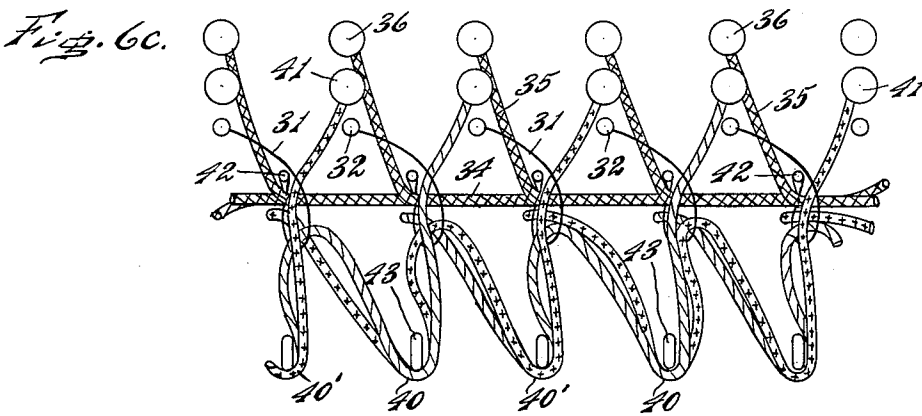
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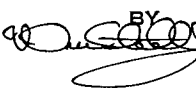
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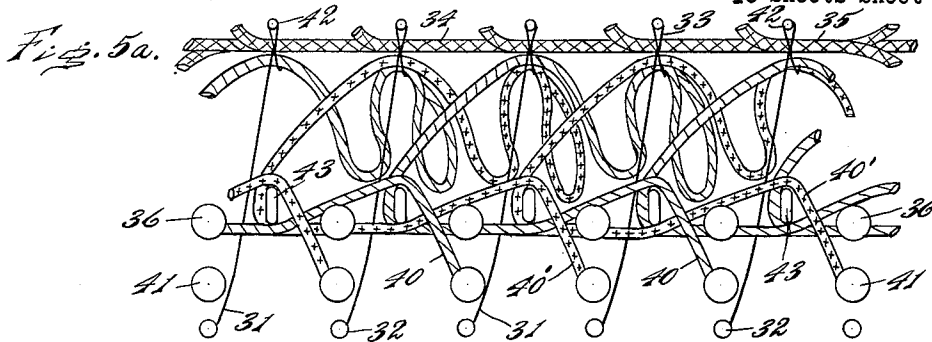
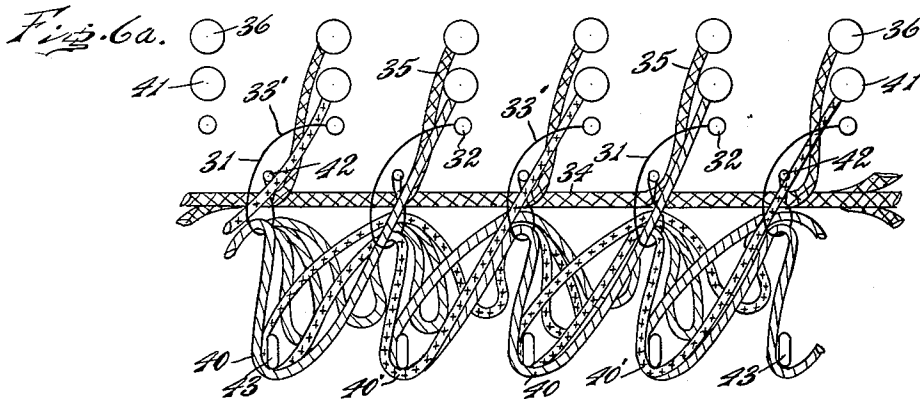
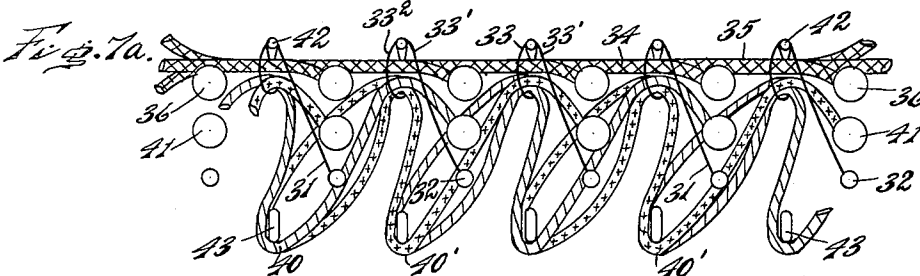
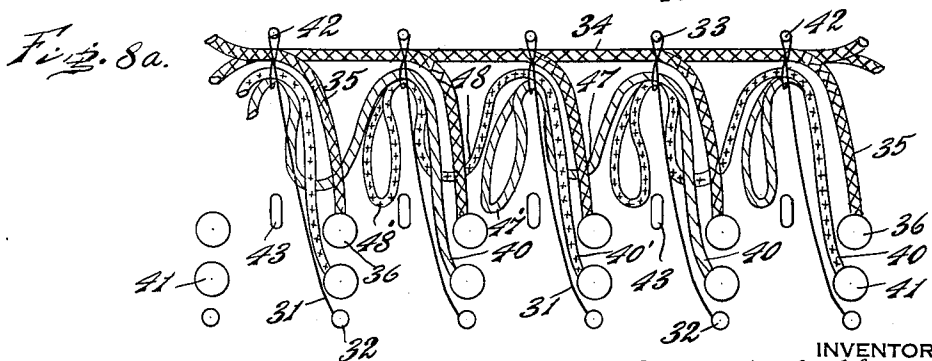
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Fig. 5b.

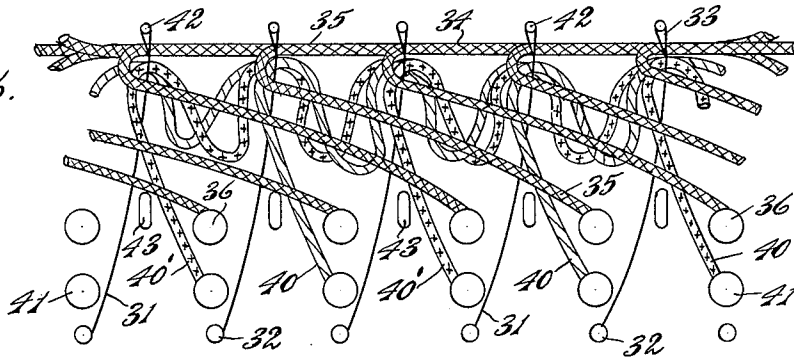


Fig. 6b.

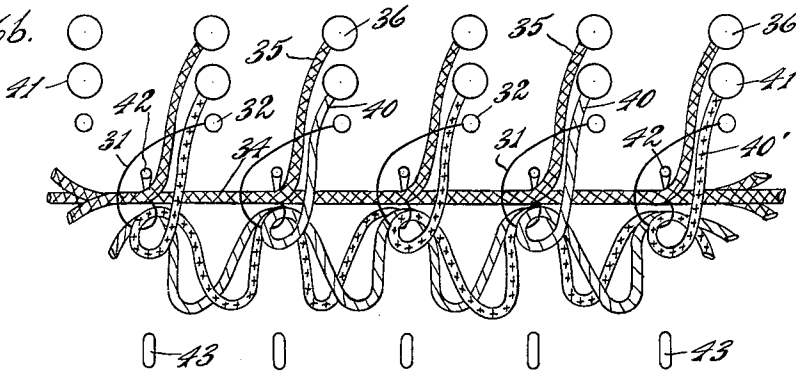


Fig. 7b.

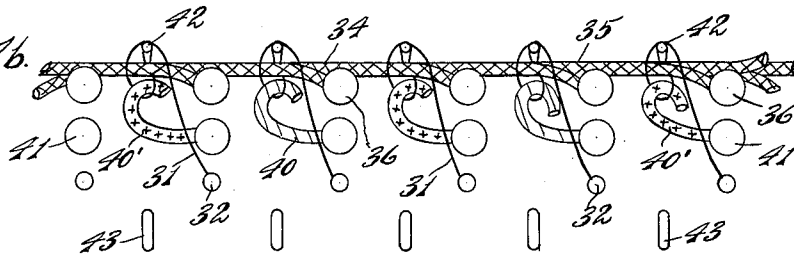
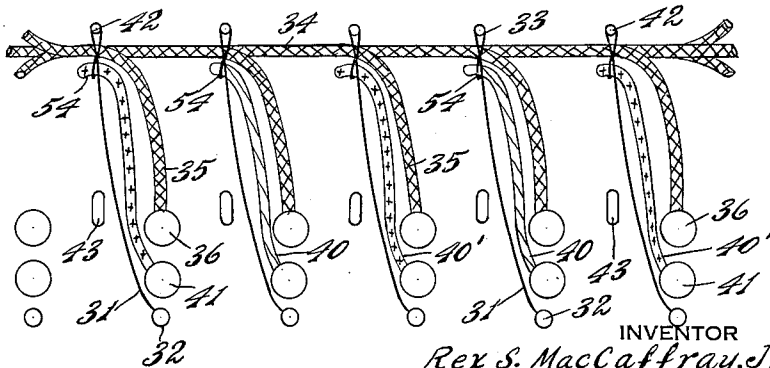
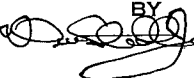


Fig. 8b.



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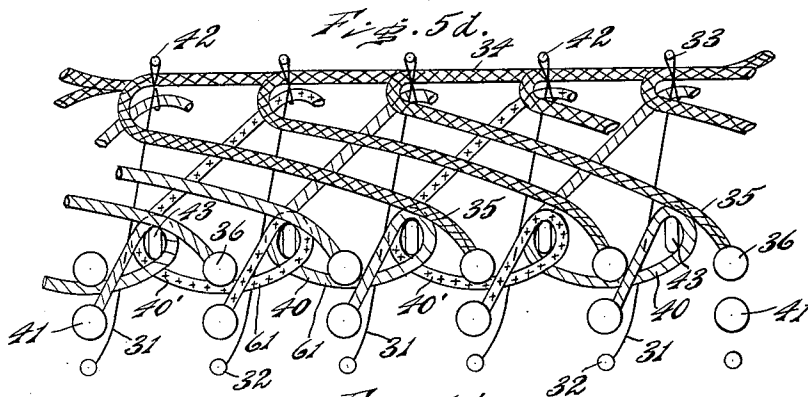
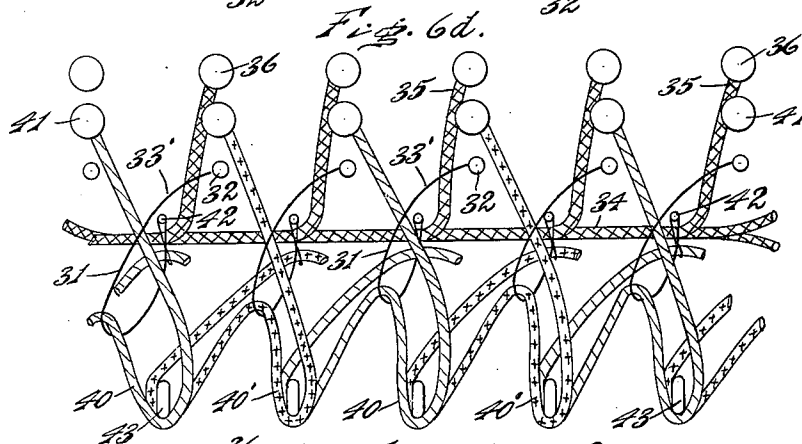
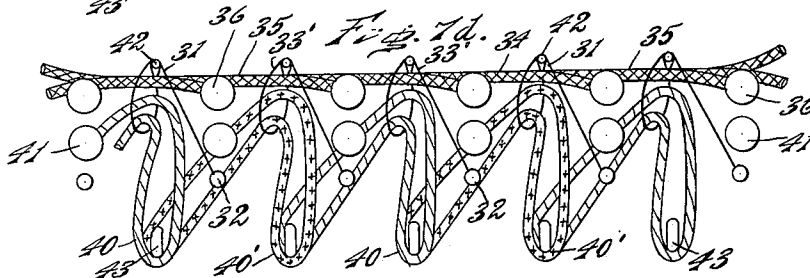
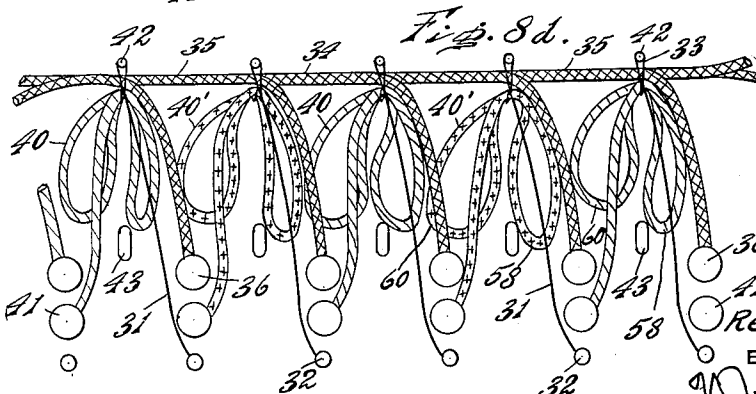
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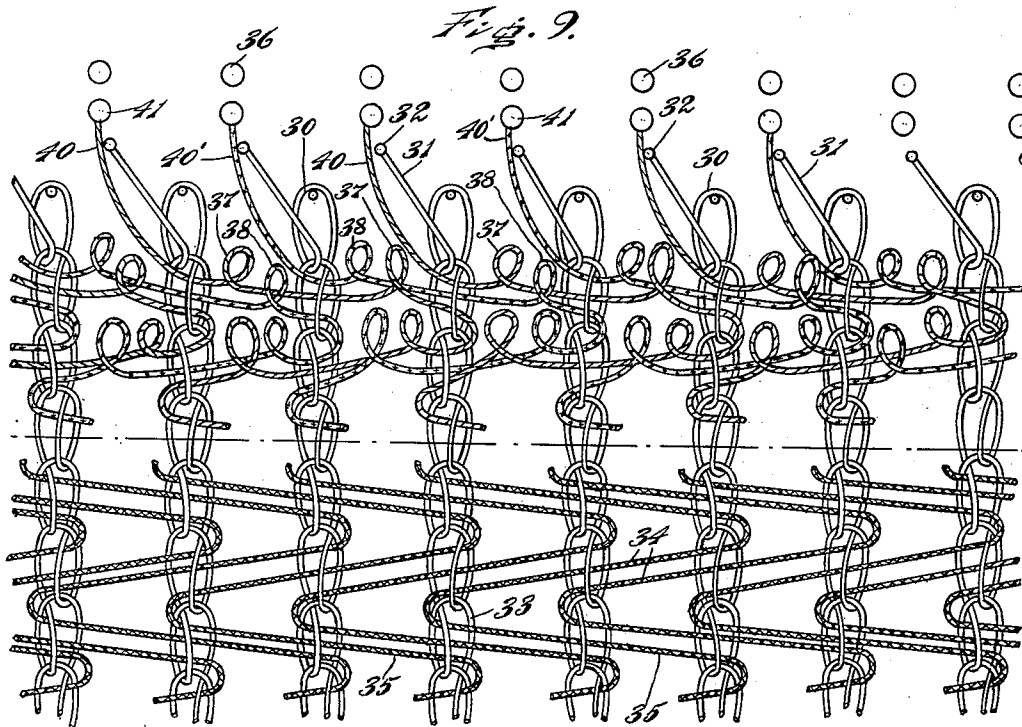
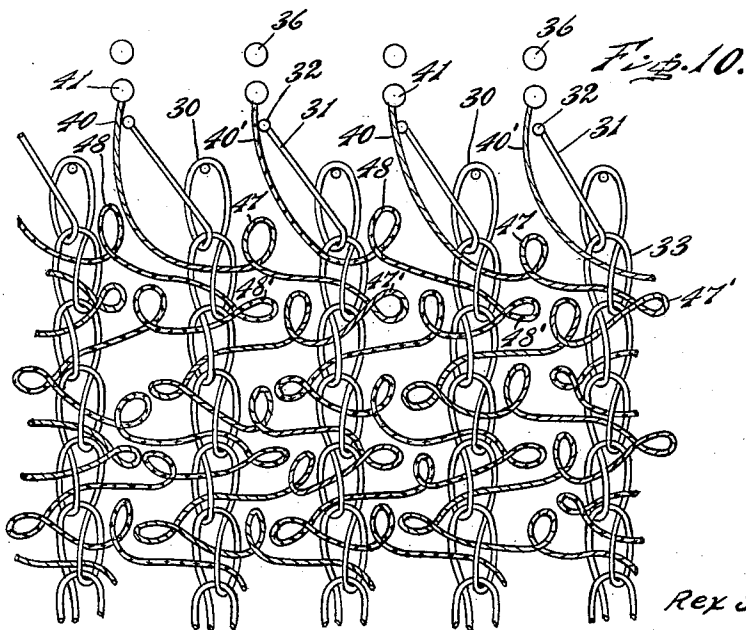
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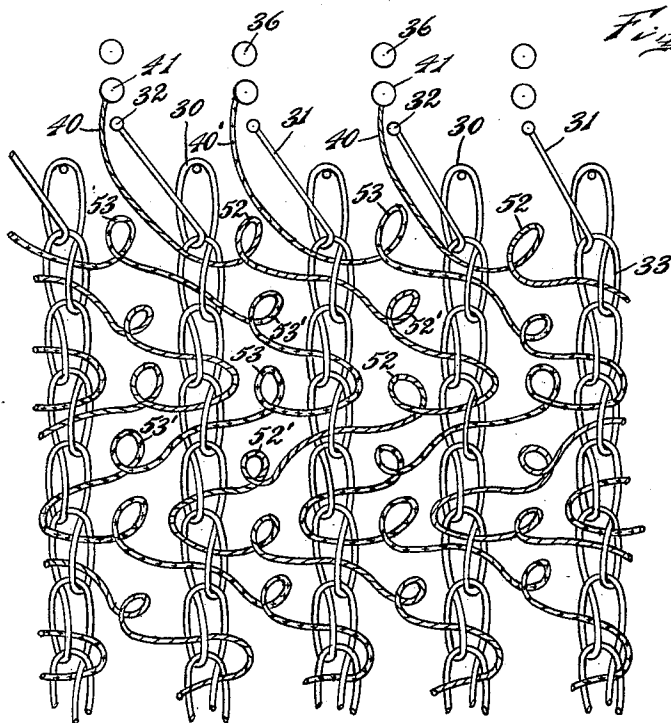
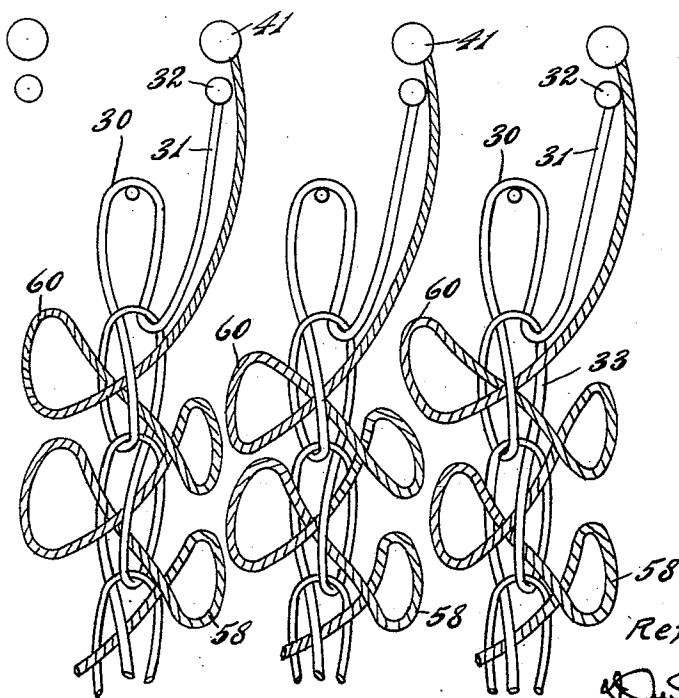
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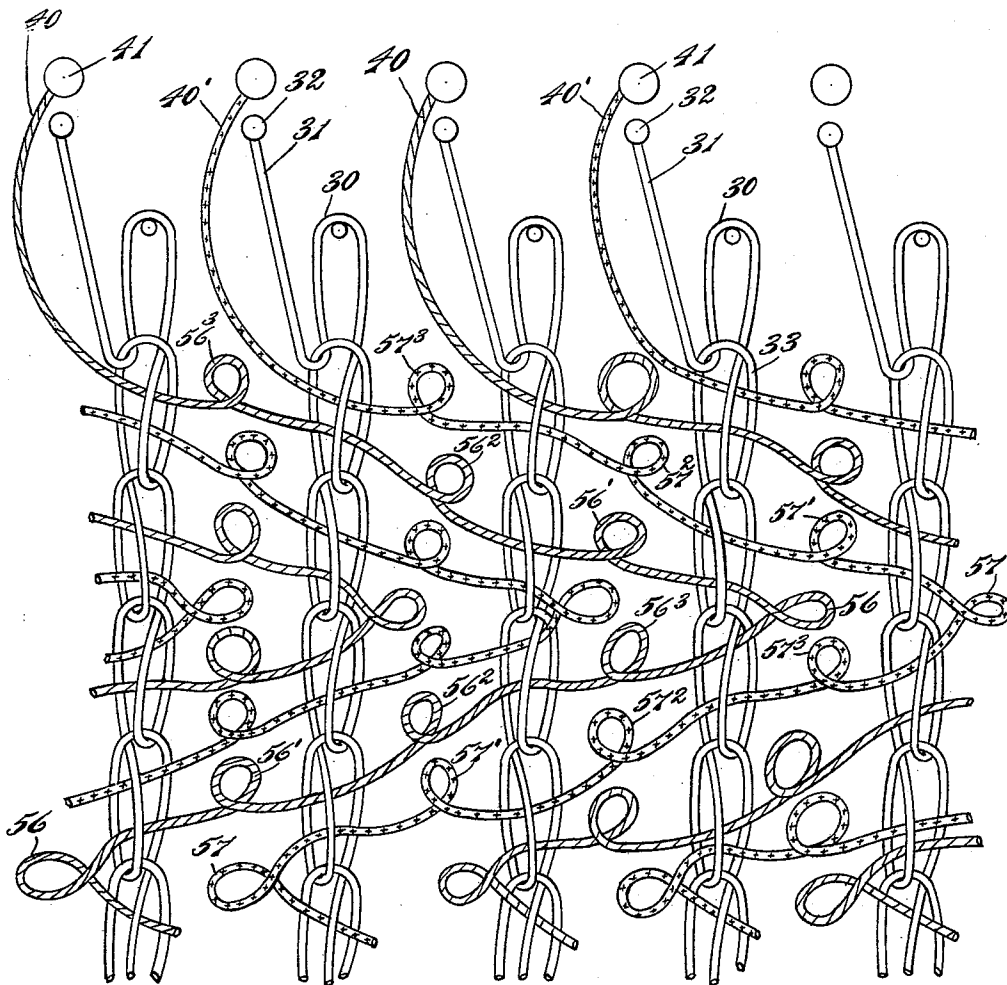
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Fig. 12.



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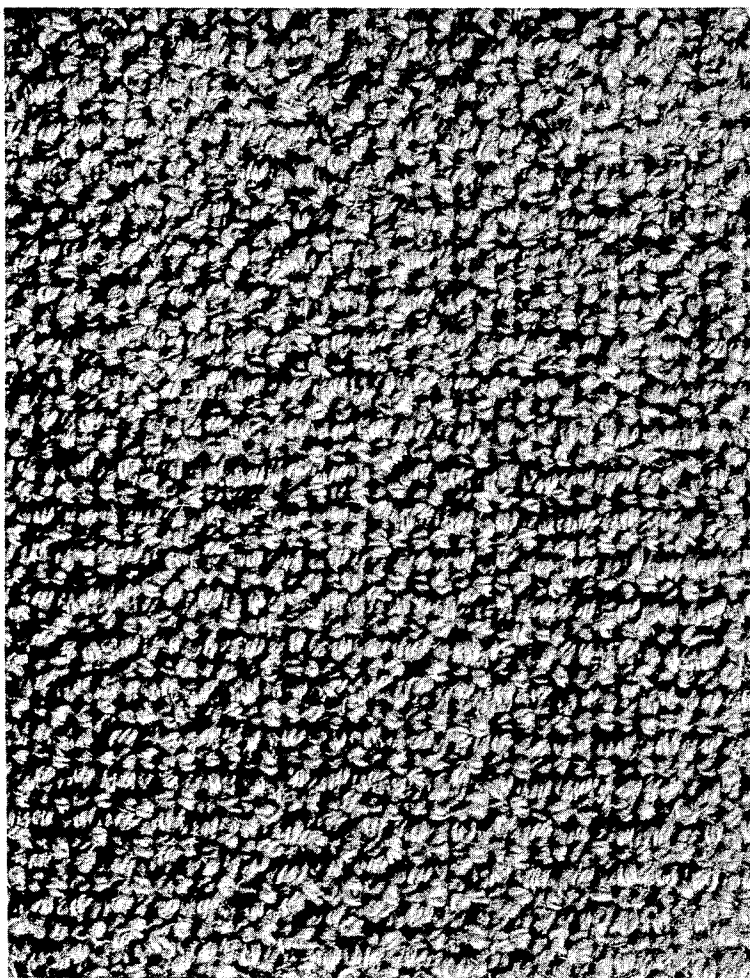


Fig. 14.

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MULTIPLE PILE PROJECTIONS

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Filed Mar. 2, 1959, Ser. No. 796,364

16 Claims. (Cl. 66-191)

The present invention relates to warp knitted pile fabrics.

This application has been divided, and the subject matter of the method has been embodied in United States patent application Serial No. 9,460, filed February 18, 1960, for Method of Warp Knitting Pile Fabric With Multiple Pile Projections, now United States Patent No. 2,989,858.

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 projections 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 en-

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

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

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

FIGURES 1c to 8c 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).

The FIGURES 1d to 8d are diagrammatic fragmentary enlarged top plan views showing the formation of a fabric having pile loops or other pile projections which are all bound in the same chain, but with double loop formation of the present invention as shown in 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 1a to 8a, 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 1b to 8b and 1c to 8c 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 in 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 practice 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 theatre, 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 that 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 cases 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

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loops, it will be evident that they can be formed as cut pile tufts following the principles of my copending patent application Serial No. 656,312, filed June 18, 1957, for Warp Knitting Machine Using Cutting Plush Point, now United States Patent No. 2,907,101.

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 projection 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 150 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

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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 36 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 33² 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 of 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 1a to 8a illustrate the method of knitting the fabric of FIGURE 10. FIGURE 1a 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 2a 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 3a. Backing yarn tubes 36 are shogging to the right to form laid-in stretches of backing yarn 35 for the new stitch.

In FIGURE 3a 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 4a 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 3a 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 4a 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 5a 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 6a at 270 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 7a 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 8a, 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 1a to 8a 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 layin 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 1b to 8b and FIGURES 1c to 8c. 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 1b to 8b.

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

The needles and plush points are down in FIGURE 1b, and 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 2b.

In FIGURE 2b 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 3b 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 4b at 150 degrees in the cycle, the guide tubes have moved all the way back to the needle side.

In FIGURE 5b 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 6b 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 7b 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 8b 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 4b.

By FIGURE 8b 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 1c to 8c.

FIGURE 1c at zero degrees in the cycle is the first step in the method of constructing the pile loops of FIGURE 11. In FIGURE 1c 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 2c 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.

On FIGURE 3c 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 4c 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 5c 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 6c 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 7c 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 8c 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 57² which are bound in successive stitches of adjoining chains and loops 57³ which are bound in corresponding stitches of adjoining chains.

The technique of knitting the form of FIGURE 12 follows the form of FIGURES 1a to 8a 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 1d to 8d. 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 1c to 8c. 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 1d to 8d inclusive.

In FIGURE 1d 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 1b to 8b is ready to start shogging for the next stitch.

In FIGURE 2d 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 3d 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 3d to avoid confusion.

In FIGURE 4d 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 FIGURES 5d 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 needles hooks for the knitting yarn.

In FIGURE 6d at 270 degrees in the cycle, the yarn guide tubes have moved back past 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 7d 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 8d 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.

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 laid-in backing wefts in sinuous form, pile yarn ends moving sinuously back and forth across wales and having a plurality of pile projections on each pile yarn end in each course, and knitting chains binding together the laid-in backing wefts and the pile yarn ends, there being a knitting stitch binding the lines of pile projections between each pair of pile projections in the same course.

2. A pile fabric of claim 1, in which the pile projections on the same course and the same pile yarn end are anchored at opposite ends in different chains.

3. A pile fabric of claim 1, in which the pile projections produced on the same pile yarn end and in the same course are in one case anchored between stitches in adjoining chains and in another case anchored in adjoining stitches in the same chain.

4. A pile fabric of claim 1, in which the pile projections formed on the same course and on the same pile yarn end are in all cases anchored in corresponding stitches in adjoining chains.

5. A pile fabric of claim 1, in which on each pile yarn end in one course there is a pile projection whose legs are bound in adjoining stitches of the same chain and a pile projection whose legs are bound in corresponding stitches of adjoining chains, and on each pile yarn end in the next course there is a pile projection whose legs are bound in successive stitches of adjoining chains and a pile projection whose legs are bound in corresponding stitches of adjoining chains.

6. A pile fabric of claim 1, in which the legs of one pile projection on each pile yarn end in each course are bound in adjoining stitches in the same chain and the legs of one pile projection on each pile yarn end in each course are bound in the same stitch of the same chain.

7. A warp knitted pile fabric having backing yarn extending weftwise, pile yarn extending in successive shogged stretches weftwise, each pile yarn end forming a plurality of pile projections in the same course, the backing wefts and the legs of the pile yarn ends which form the pile projections being bound in the stitches of knitting chains.

8. A pile fabric of claim 7, in which the pile projections formed on the same end and in the same course are oriented alike.

9. A pile fabric of claim 7, in which one of the pile projections formed on the same pile yarn end and in the same course is oriented weftwise and another is oriented walewise.

10. A pile fabric of claim 7, in which one of the pile projections formed on the same pile yarn end and in the same course is oriented weftwise and another is oriented diagonally.

11. A warp knitted pile fabric having laid-in binding wefts, pile yarn ends each of which includes on the same pile yarn end and in the same course two pile loops, some of which are weftwise, some of which are walewise, and some of which are diagonal.

12. A warp knitted pile fabric comprising laid-in backing wefts in sinuous form, pile yarn ends moving sinuous-

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ly back and forth across wales and having a plurality of pile projections on the same pile end in a particular course, the knitting chains binding together the laid-in backing wefts and the pile yarn ends, there being a knitting stitch binding the lines of pile projections between each pair of pile projections on the same course, the pile projections formed on the same course on the same pile yarn and being in one case anchored in corresponding stitches on adjoining chains and in another case anchored in successive stitches on adjoining chains.

13. A warp knitted pile fabric, comprising a series of knitted chains extending warpwise, backing yarn extending sinuously back and forth and united in the knitted chains, and pile yarn extending sinuously and united in the knitted chain, there being on the same pile yarn end pile projections of different orientations, one orientation being coursewise and one orientation being walewise.

14. A warp knitted pile fabric, comprising a series of knitted chains extending warpwise, backing yarn extending sinuously back and forth and united in the knitted chains, and pile yarn extending sinuously and united in the knitted chain, there being on the same pile yarn pile projections of different orientations, certain pile projections being oriented coursewise and certain pile projections being oriented diagonally.

15. A warp knitted pile fabric, comprising a series of knitted chains extending warpwise, backing yarn extending

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sinuously back and forth and united in the knitted chains, and pile yarn extending sinuously and united in the knitted chain, there being on the same pile yarn end pile projections of different orientations, one orientation being coursewise, one orientation being walewise, and one orientation being diagonal.

16. A warp knitted pile fabric, comprising a series of knitted chains extending warpwise, backing yarn extending sinuously back and forth and united in the knitted chains, and pile yarn extending sinuously and united in the knitted chain, there being on the same pile yarn end pile projections of different orientations, the pile projections of one orientation having their legs anchored in successive stitches of the same chain, and the pile projections of the other orientation having their legs anchored in the same chain stitch.

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