

July 11, 1961

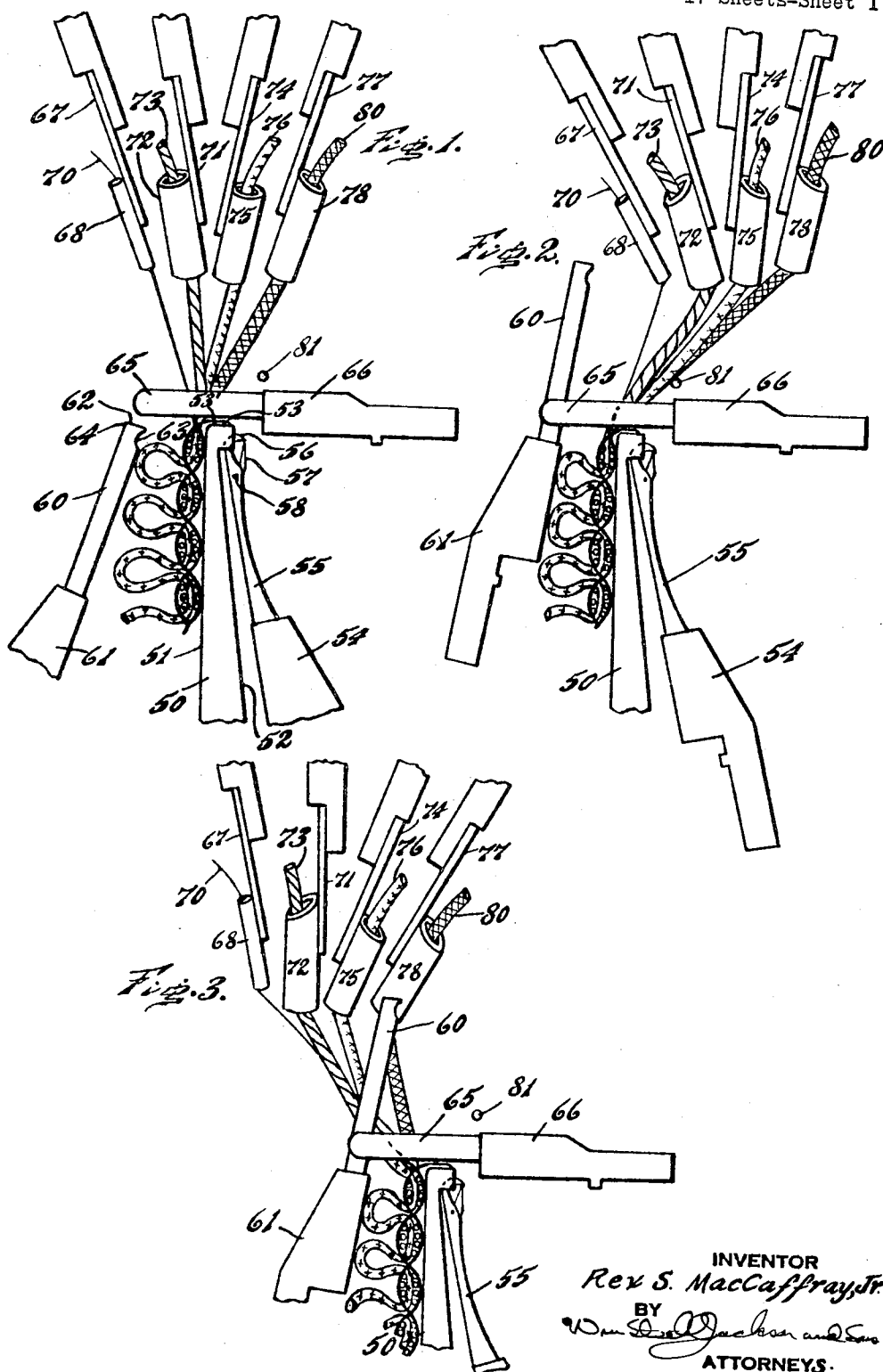
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 1



INVENTOR
Rex S. MacCaffray, Jr.
BY
Wm. D. Jackson and Son
ATTORNEYS.

July 11, 1961

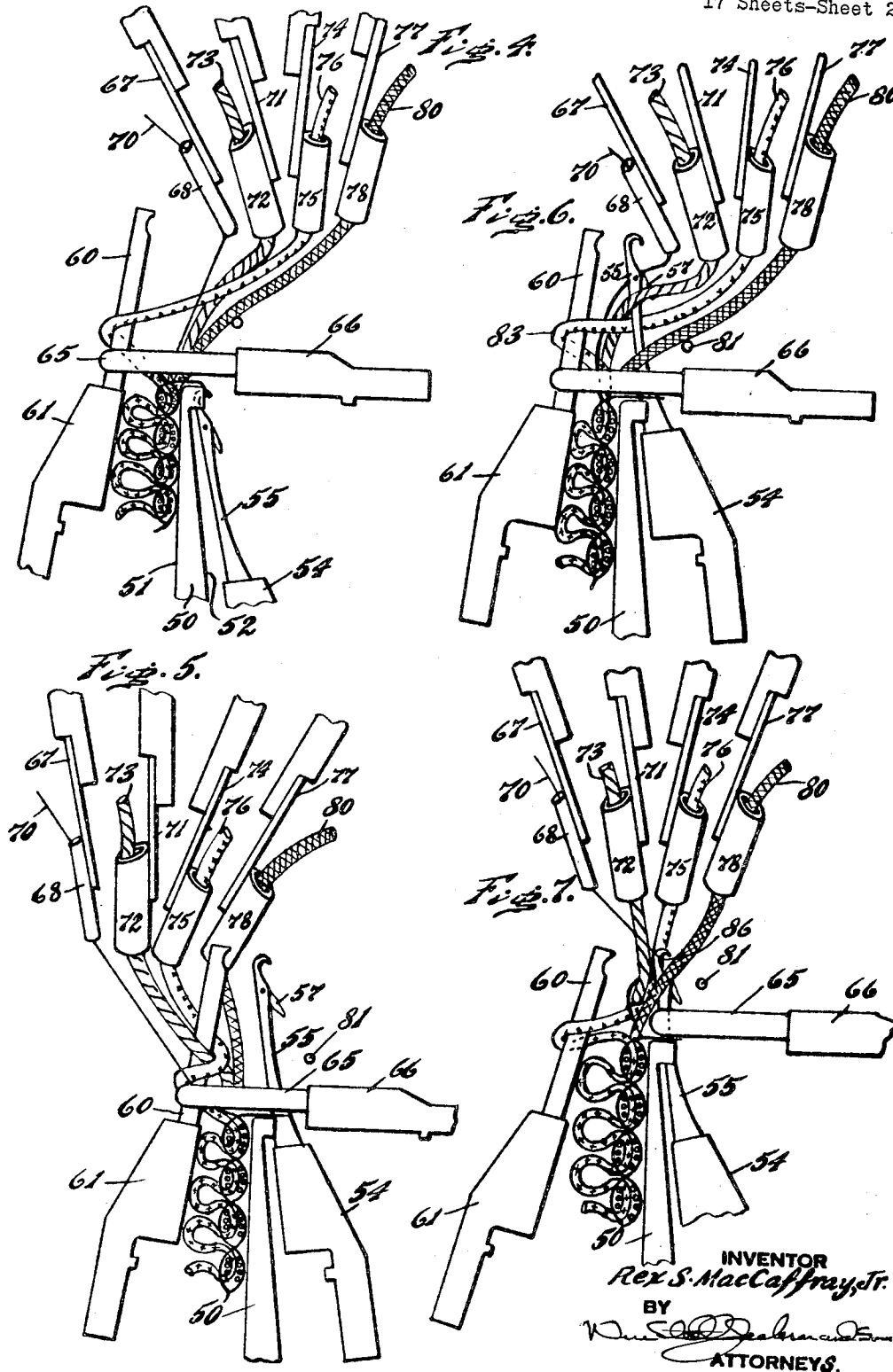
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 2



July 11, 1961

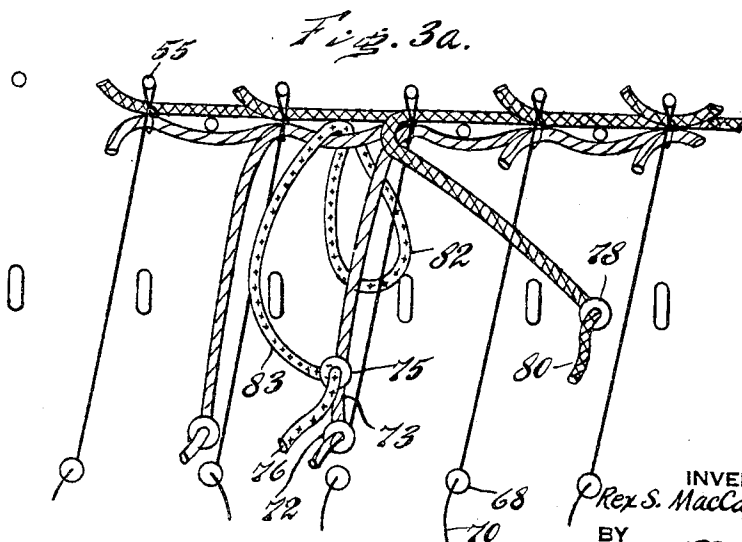
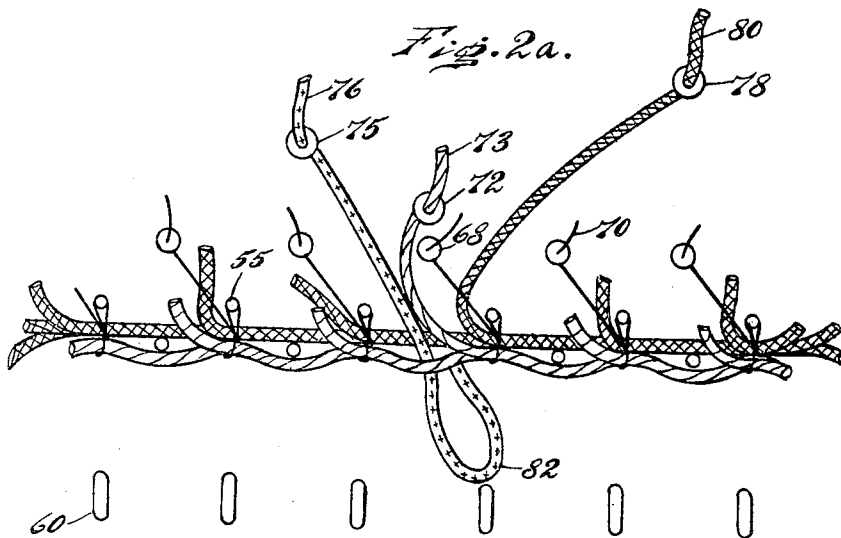
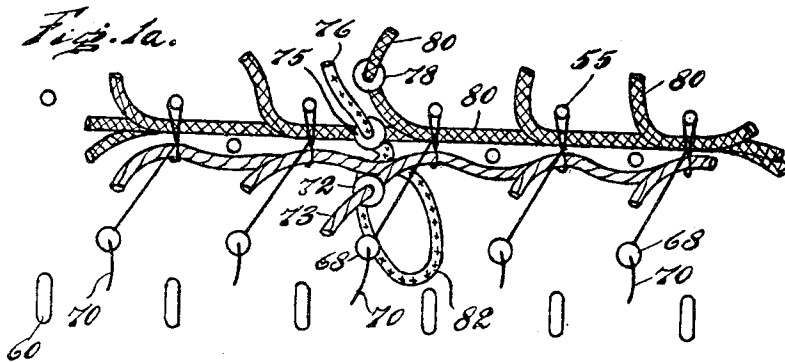
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 3



INVENTOR
Rex S. MacCaffray, Jr.
BY
[Signature]
ATTORNEYS.

July 11, 1961

R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 4

Fig. 4a.

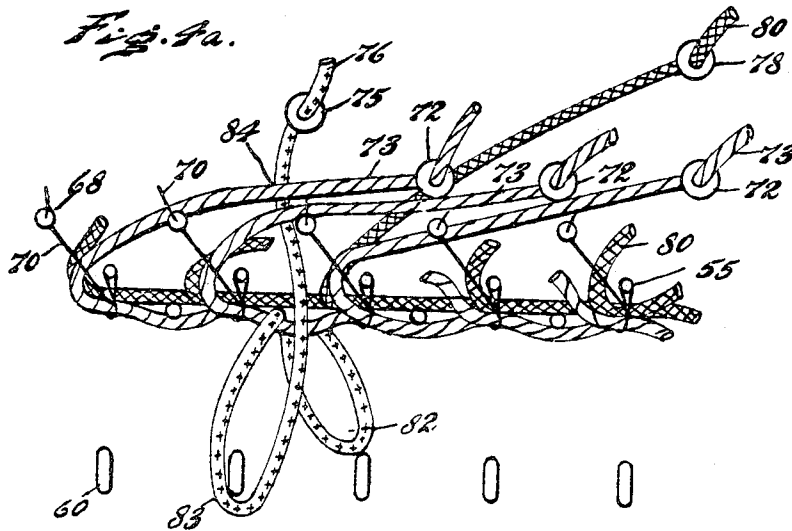


Fig. 5a.

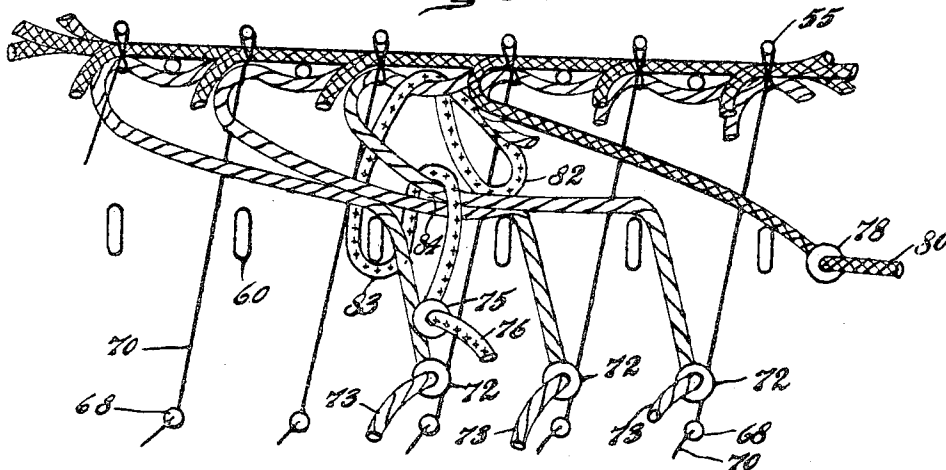
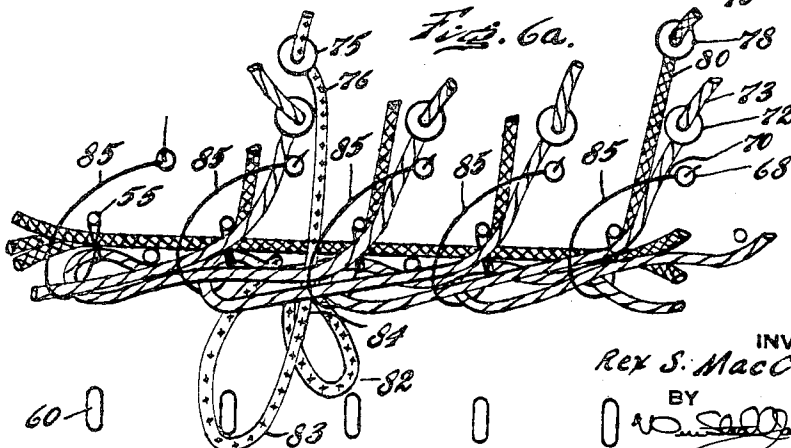


Fig. 6a.



INVENTOR
Rex S. MacCaffray, Jr.
BY
W. S. MacCaffray, Jr.
ATTORNEYS

July 11, 1961

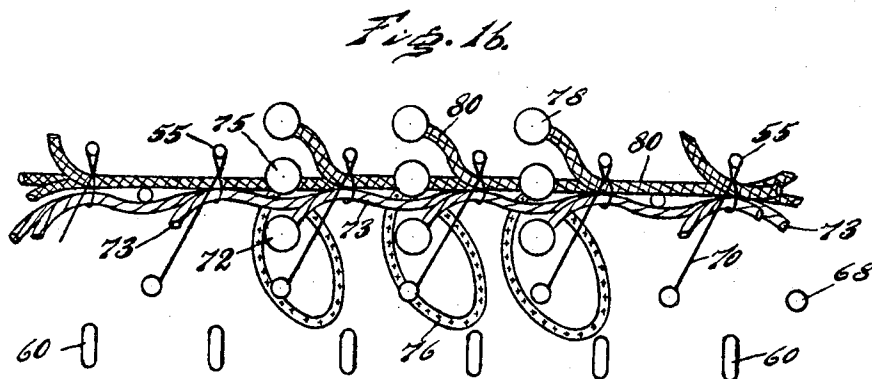
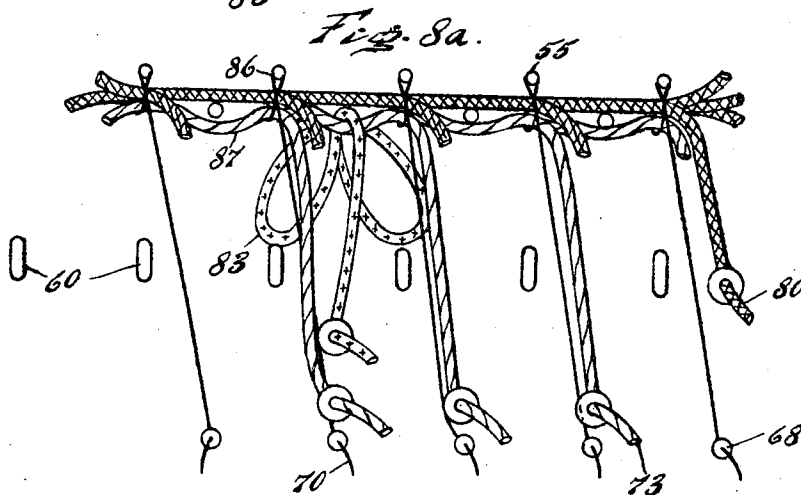
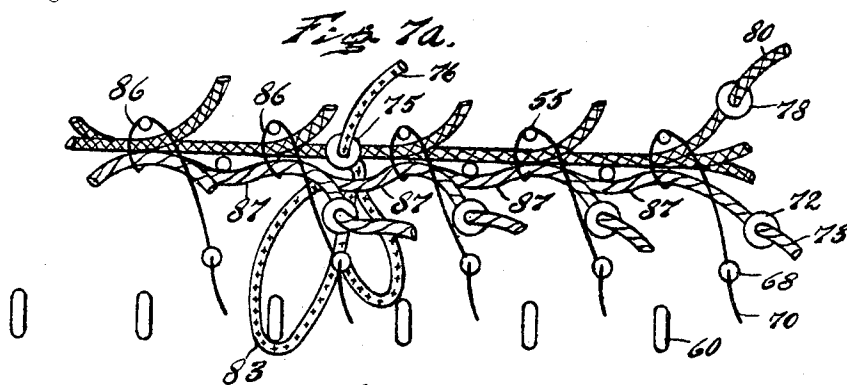
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 5



INVENTOR
Rex S. MacCaffray, Jr.
BY
[Signature]
ATTORNEYS.

July 11, 1961

R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 6

Fig. 2b.

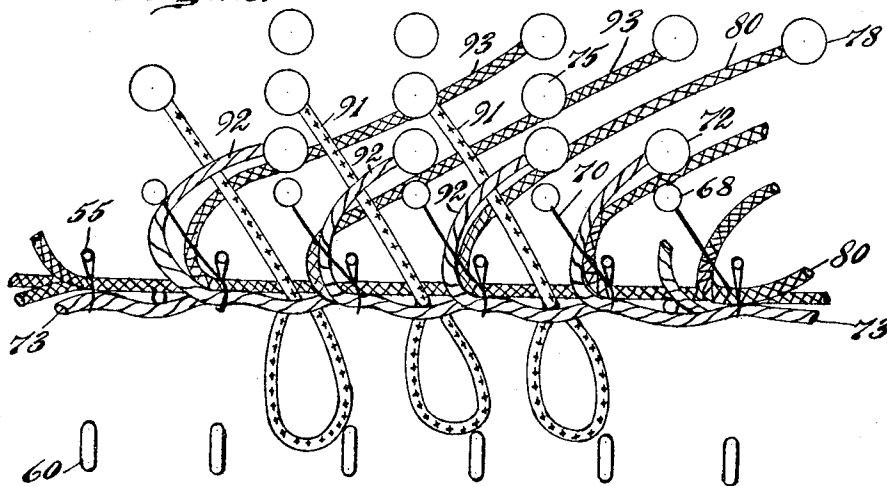


Fig. 3b.

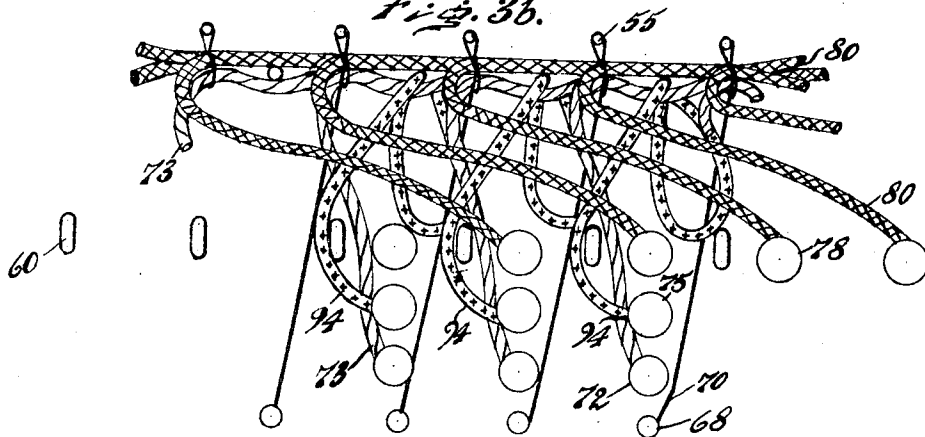
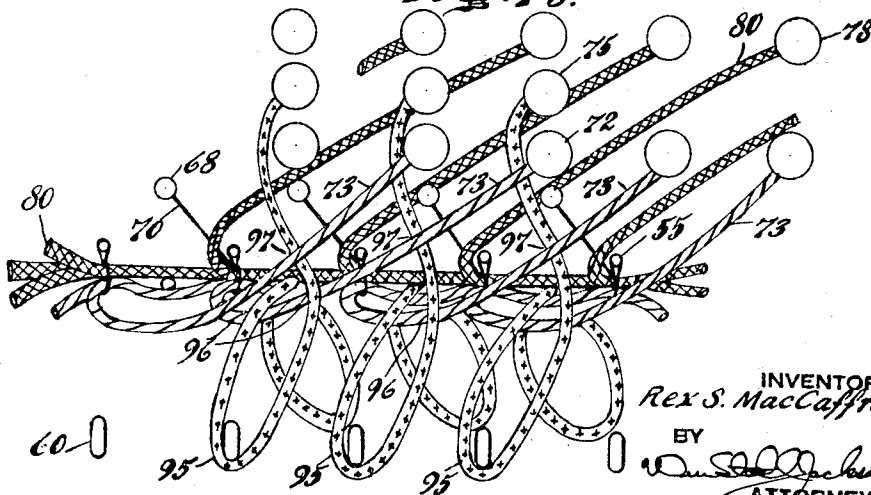



Fig. 4b.



INVENTOR
Rex S. MacCaffray, Jr.
BY

ATTORNEYS.

July 11, 1961

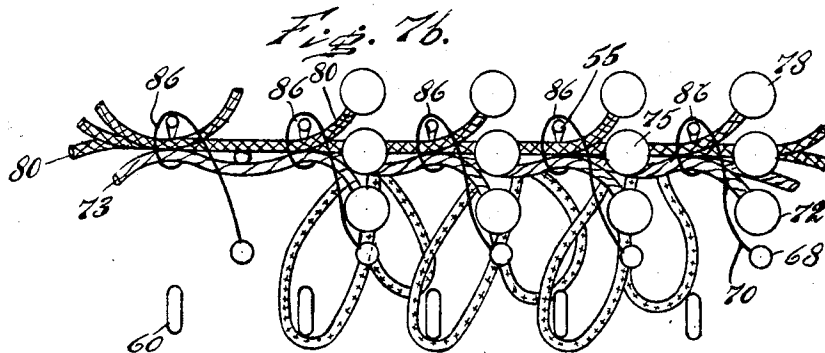
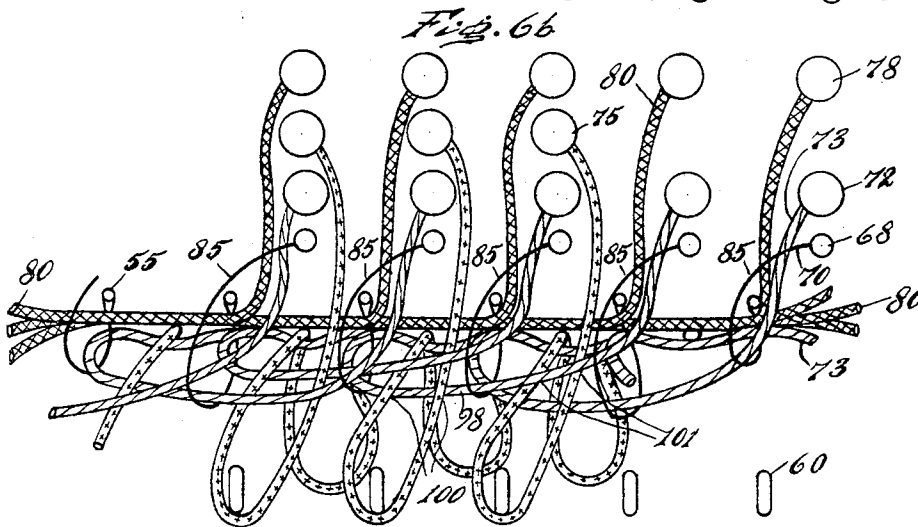
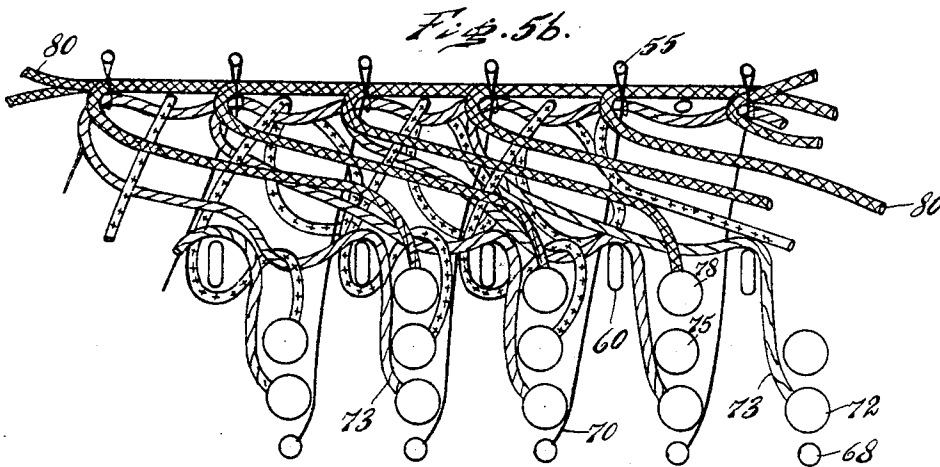
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEST BIND

Original Filed June 27, 1958

17 Sheets-Sheet 7



INVENTOR
Rex S. MacCaffray, Jr.
BY
[Signature]
ATTORNEYS.

July 11, 1961

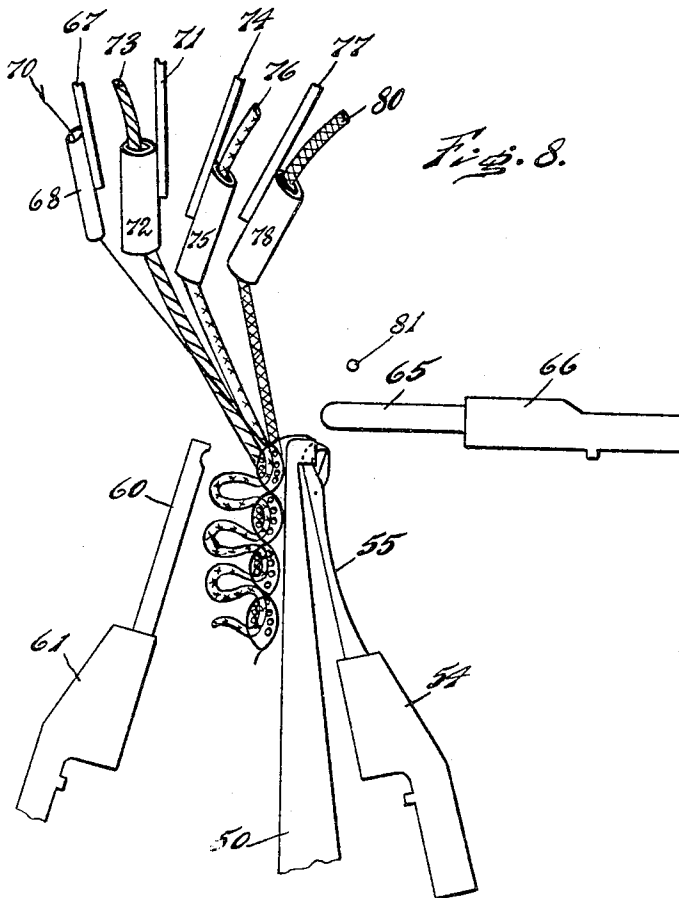
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 8



INVENTOR
Rex S. MacCaffray, Jr.
BY
Donald S. Jackson and Sons
ATTORNEYS.

July 11, 1961

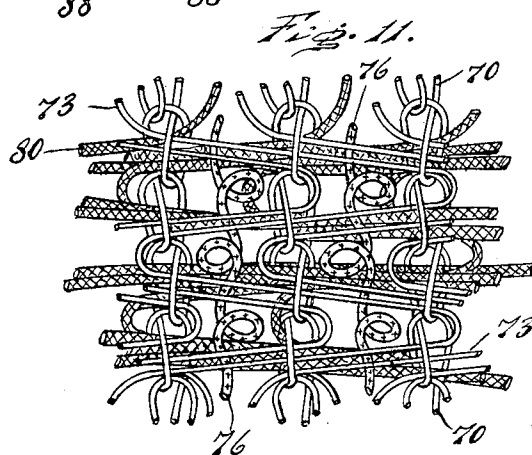
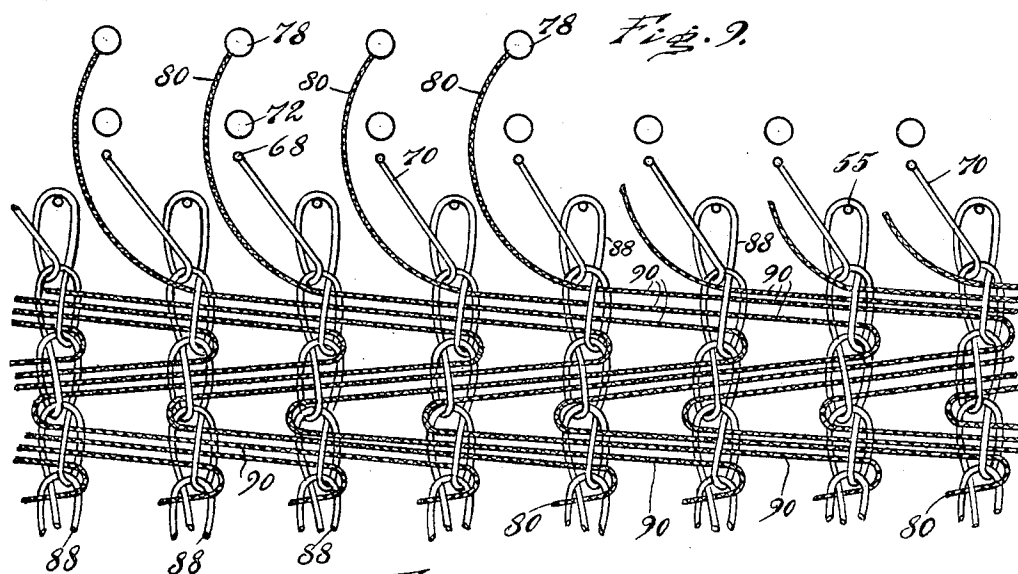
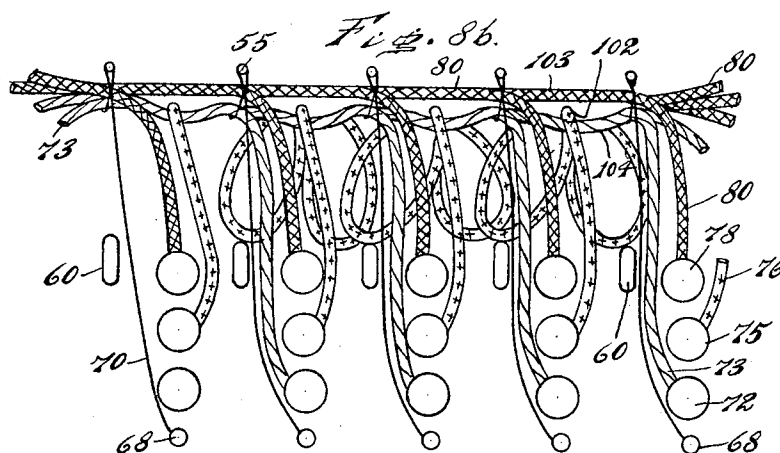
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 9



INVENTOR
Rex S. MacCaffray, Jr.
BY *[Signature]*
ATTORNEYS.

July 11, 1961

R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 10

Fig. 10.

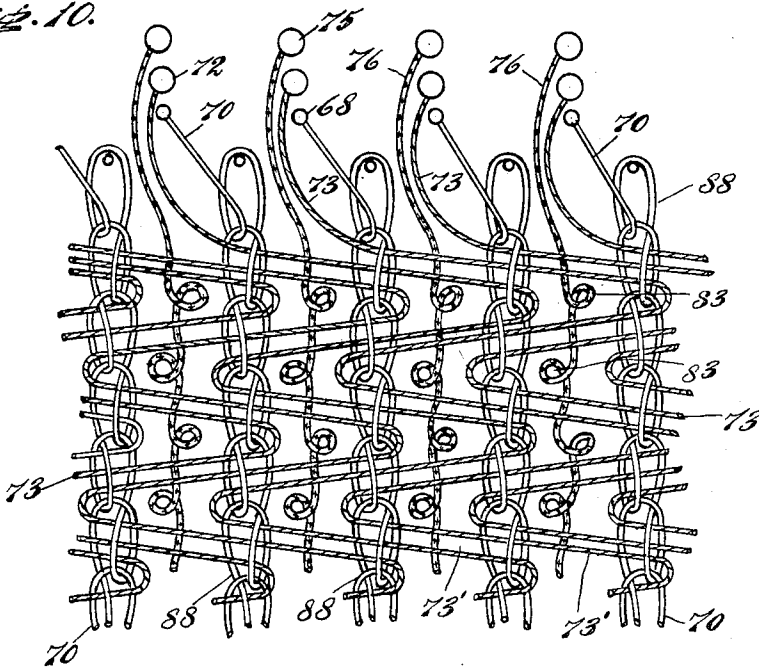
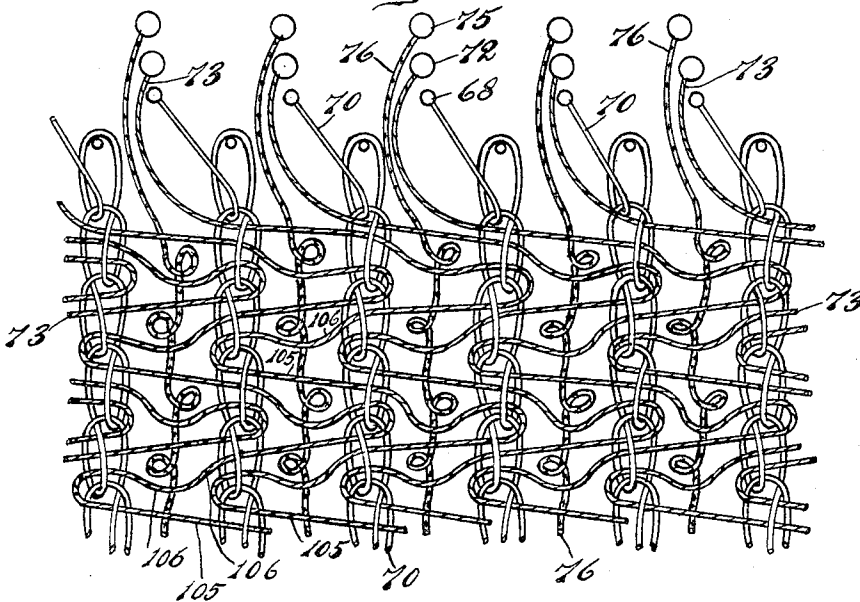


Fig. 12.



INVENTOR
Rex S. MacCaffray, Jr.
BY *[Signature]*
ATTORNEYS.

July 11, 1961

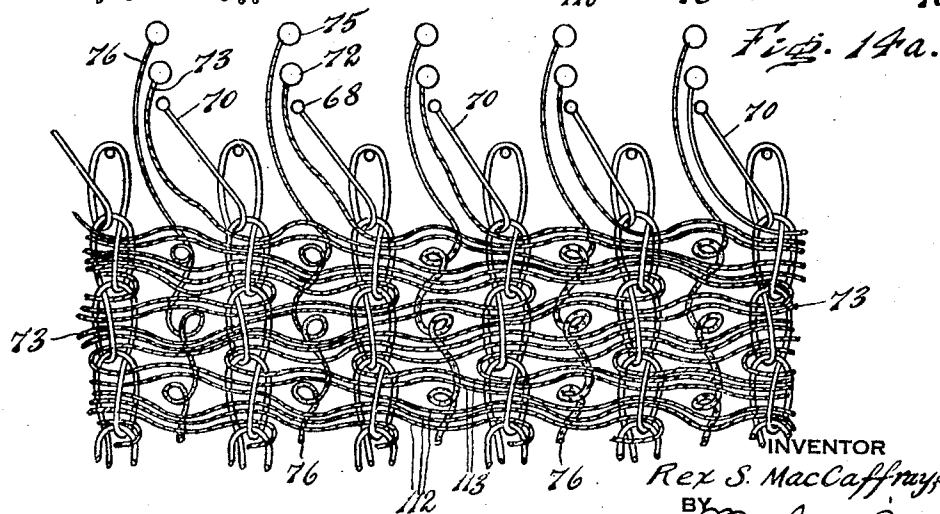
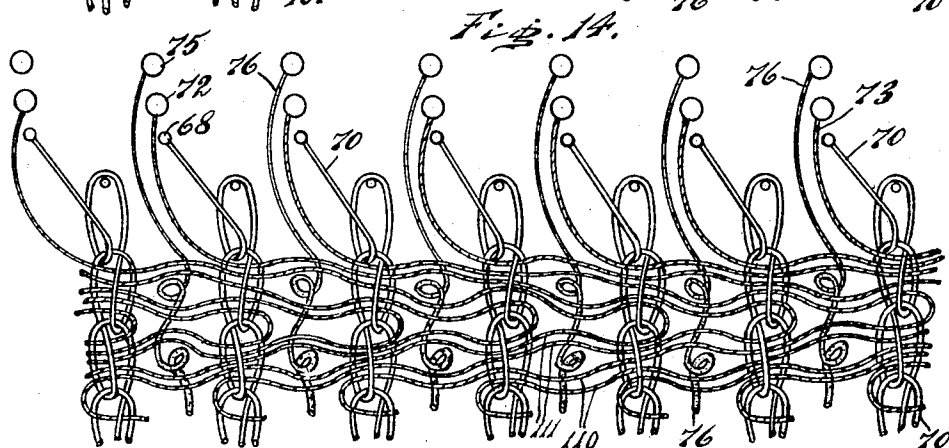
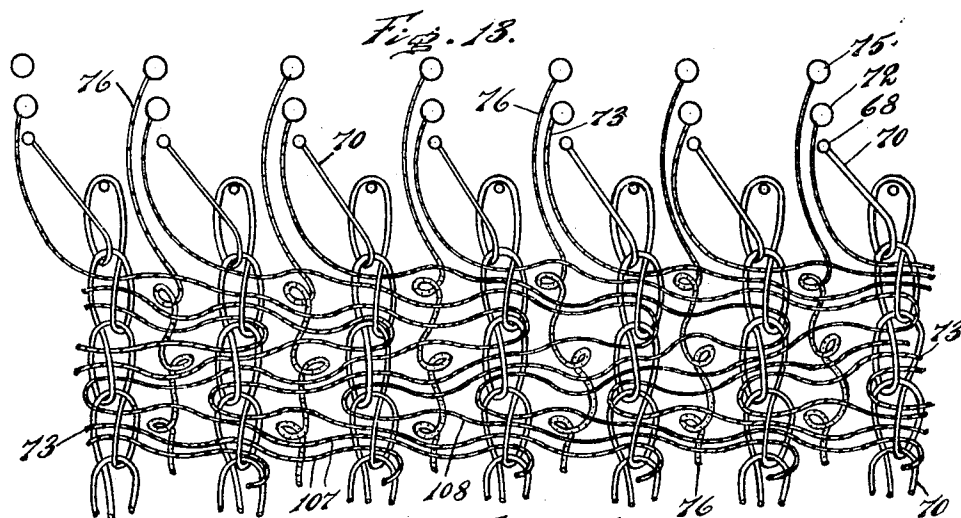
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 11



INVENTOR
Rex S. MacCaffray, Jr.
BY
[Signature]
ATTORNEYS.

July 11, 1961

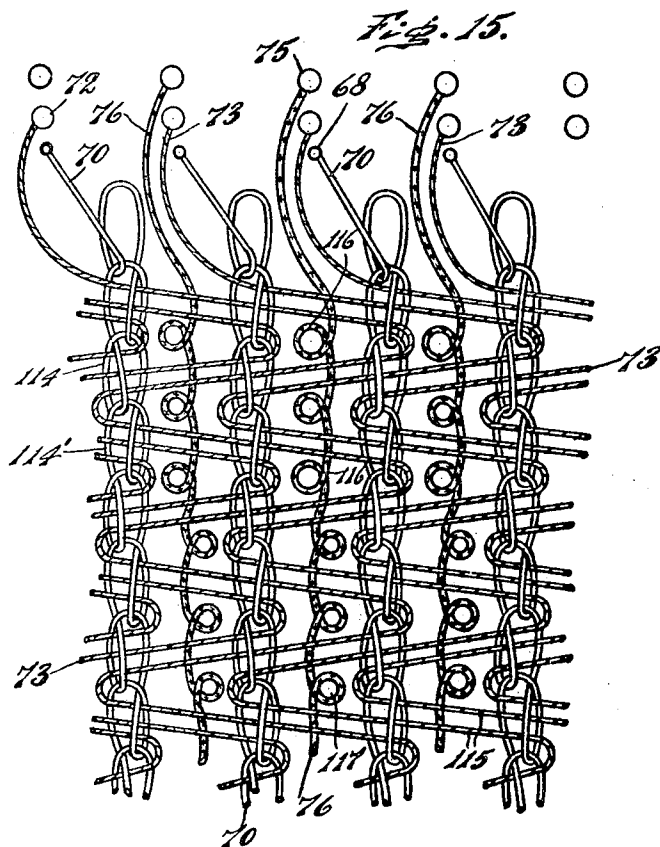
R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 12



INVENTOR

Rex S. MacCaffray, Jr.

BY

W. S. Jackson
ATTORNEYS.

July 11, 1961

R. S. MacCAFFRAY, JR

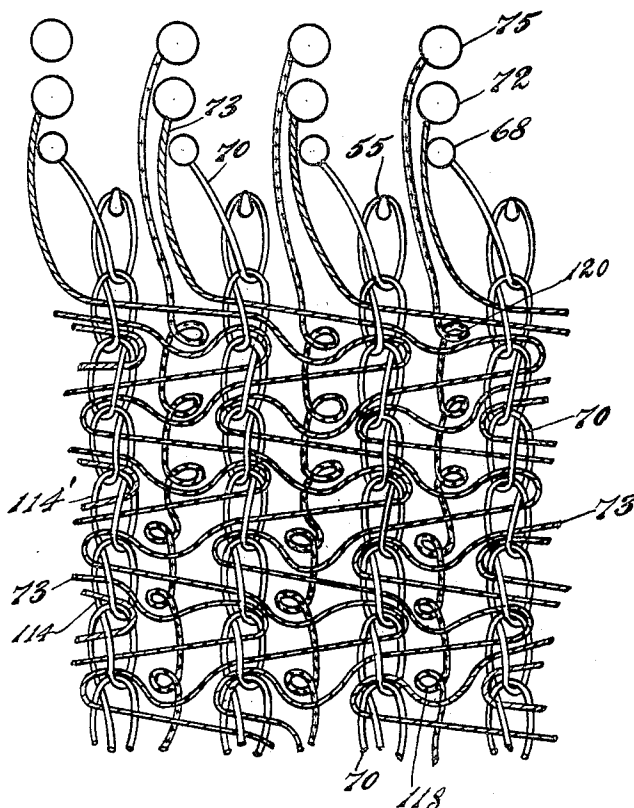
2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 13

Fig. 16.



INVENTOR
Rex S. MacCaffray, Jr.

BY
[Signature]
ATTORNEYS.

July 11, 1961

R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 14

Fig. 17.

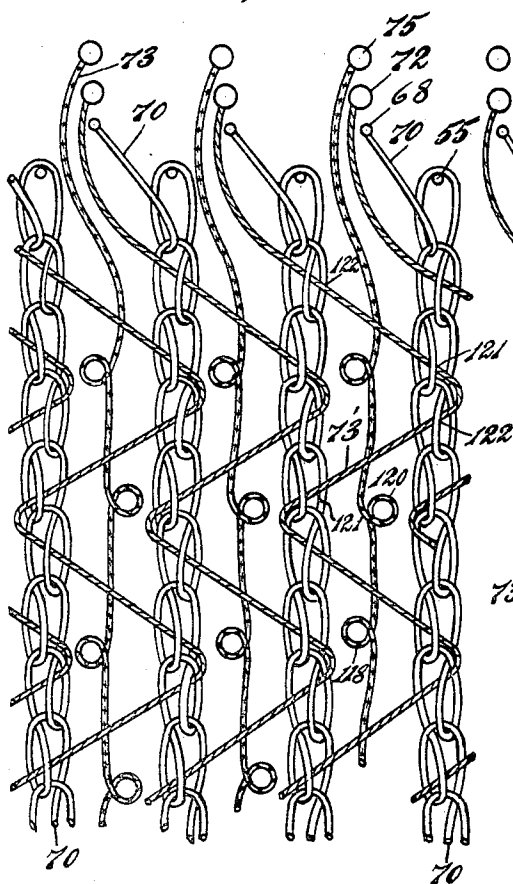
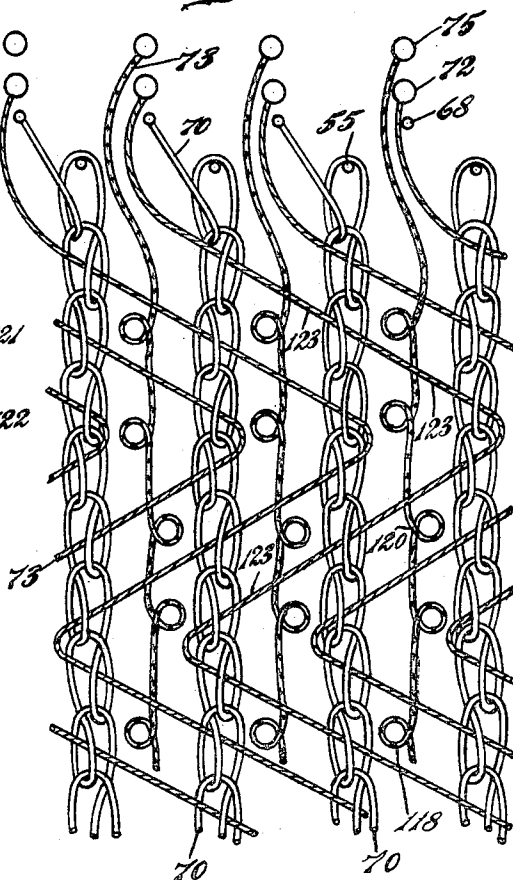


Fig. 18.



INVENTOR
Rex S. MacCaffray, Jr.

BY
Dunlop MacCaffray, Jr.
ATTORNEYS

July 11, 1961

R. S. MacCAFFRAY, JR

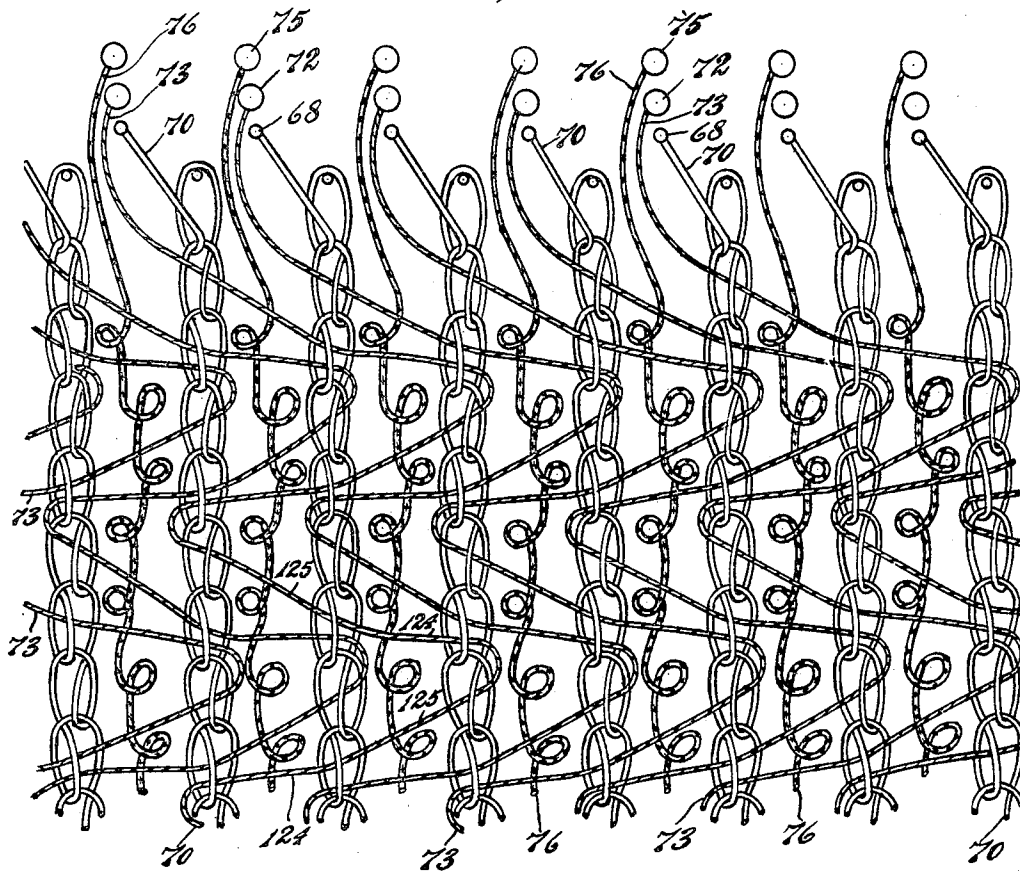
2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 15

Fig. 19.



INVENTOR
Rex S. MacCaffray, Jr.

BY
[Signature]
ATTORNEYS

July 11, 1961

R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 16

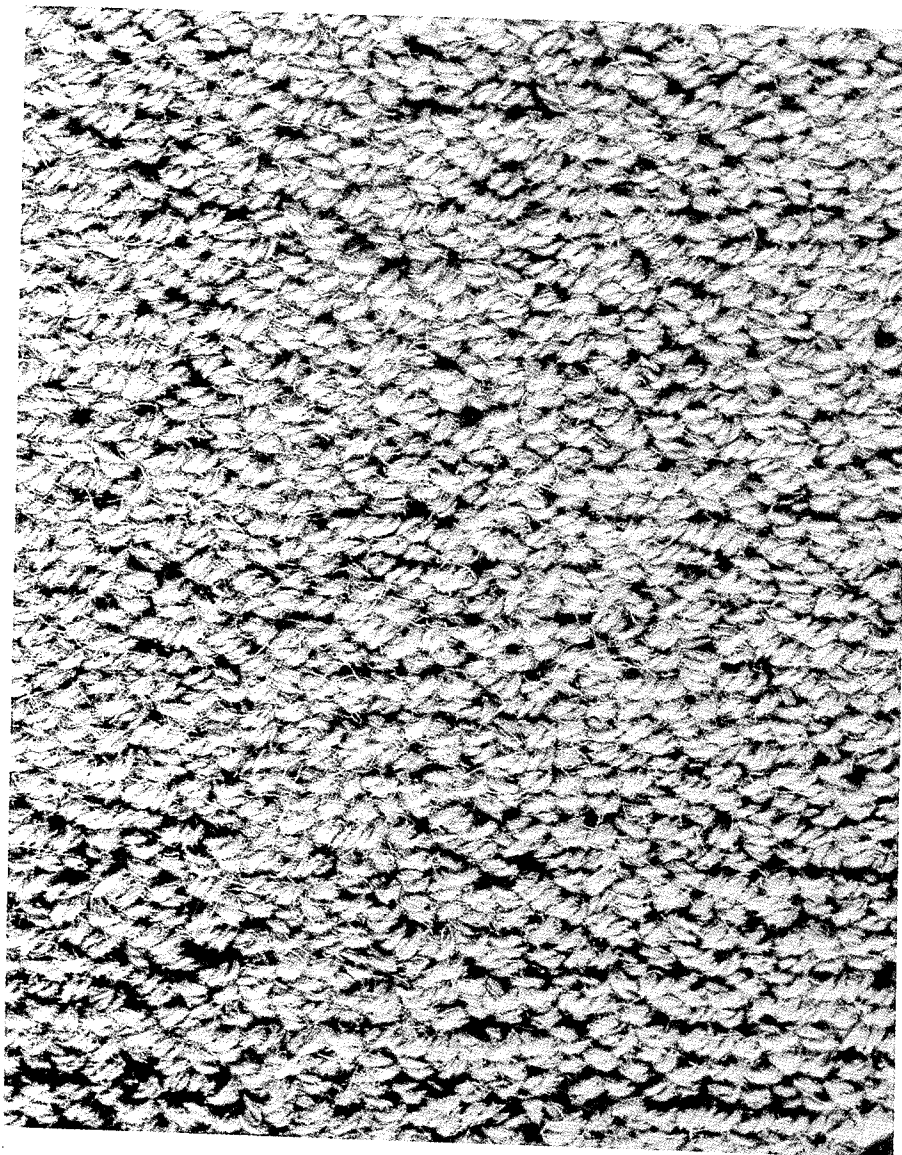


Fig. 20.

INVENTOR
Rex S. MacCaffray, Jr.
BY

ATTORNEYS

July 11, 1961

R. S. MacCAFFRAY, JR

2,991,640

WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

Original Filed June 27, 1958

17 Sheets-Sheet 17

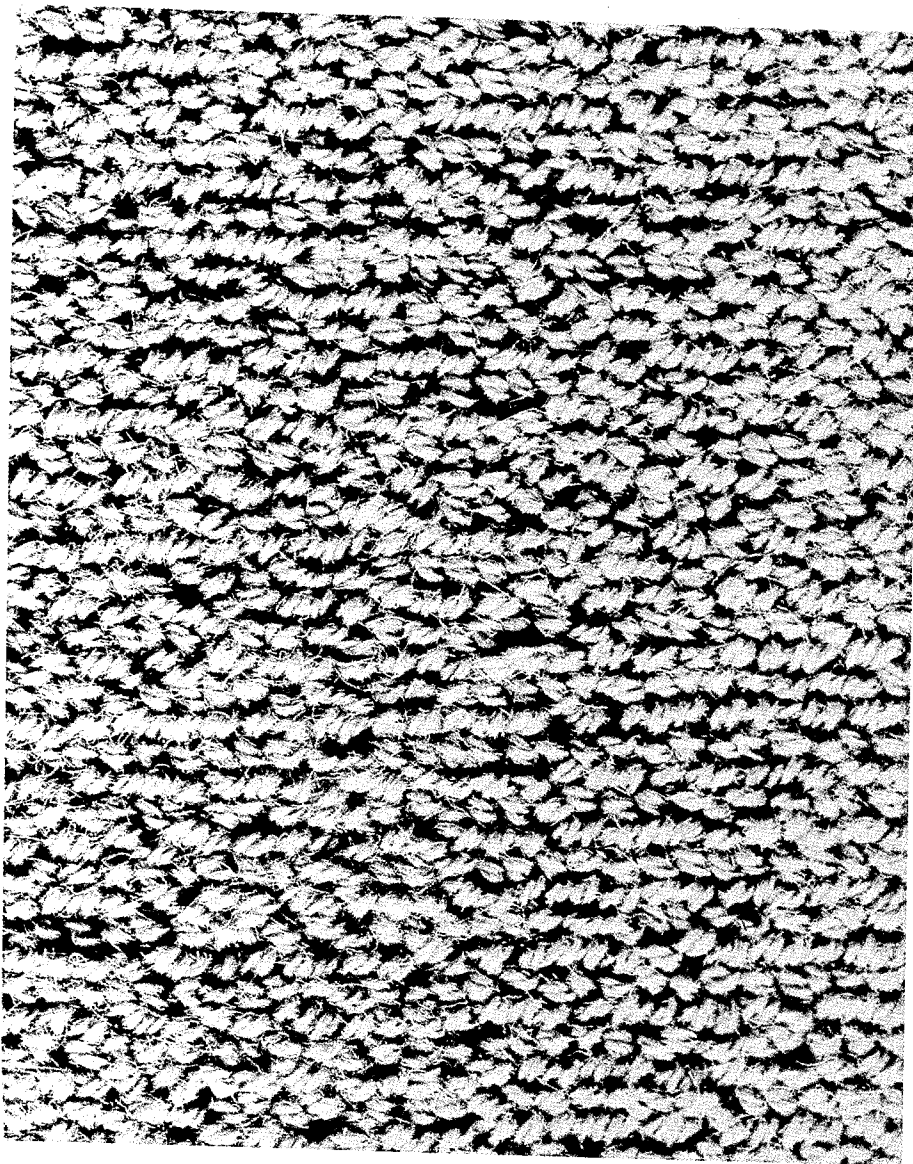


Fig. 21.

INVENTOR
Rex S. MacCaffray, Jr.
BY

ATTORNEYS

2,991,640 WARP KNITTED PILE FABRIC WITH MULTIPLE LAID-IN WEFT BIND

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

Original application June 27, 1958, Ser. No. 745,178.
Divided and this application Aug. 24, 1959, Ser. No.
835,611

8 Claims. (Cl. 66—191)

The present invention relates to warp knitted pile fabric, particularly of the character of carpets and rugs.

The present application is a division of my copending application Serial No. 745,178, filed June 27, 1958, for Warp Knitted Pile Fabric With Multiple Laid-In Weft Bind and Method, which in turn is a continuation-in-part of my copending application Serial No. 682,926, now abandoned, filed September 9, 1957, for Knitting Fabric Having Lay-In Binding Weft, with respect to claim 13 thereof.

A purpose of the invention is to bind pile projections formed from pile yarn located between knitting chains by a plurality of binding wefts extending above the pile yarn ends in the same course between adjoining pile projections walewise.

A further purpose is to bind pile projections in a warp knitted pile fabric by a plurality of adjoining binding wefts in the same course extending between adjoining pile projections walewise.

A further purpose is to bind projections of pile yarn ends between knitting chains by a plurality of binding wefts in the same course which are respectively on opposite sides of the pile projections.

A further purpose is to lay in backing weft, form pile by wrapping pile yarn ends around plush points, lay in a plurality of binding wefts over each pile yarn end per course, and form knitted stitches which grip the backing wefts and the plurality of binding wefts.

A further purpose is to form the laid-in binding wefts by shogging over at least two wales (three needles) in a single step executed after wrapping the pile yarn ends around the plush points.

A further purpose is to form the laid-in binding wefts by shogging in two steps, each over at least one wale, one of the steps being executed before wrapping the pile yarn ends around the plush points and the other of the steps being performed after wrapping the pile yarn ends around the plush points.

A further purpose is to produce a warp knitted pile fabric having a face of intermediate density.

A further purpose is to form a warp knitted pile fabric having a face of concentrated density.

A further purpose is to obtain selective variation in orientation of pile projections by varying stitch direction according to a repeat, and thus influencing the position of the pile projections held by the multiple laid-in binding weft, whether in the adjoining multiple binding weft form or in the split multiple binding weft form. This may be employed using alternating right and left hand stitches, or using successions of two or more right hand stitches and two or more left hand stitches, or using uneven successions of left hand stitches and right hand stitches, according to a pattern repeat.

A further purpose is to lay in three or more binding wefts on a single course, laying in one binding weft before and two or more after forming a loop or laying in

two binding wefts before and one or more after, as desired.

A further purpose is to extend the laid-in binding weft diagonally over at least one or more wales in a plurality of courses, or to extend the laid-in binding weft diagonally over one or more wales in a plurality of courses and then coursewise over one or more wales.

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 stepwise vertical machine diagrams showing the steps of forming the fabric according to the invention.

FIGURES 1a to 8a are diagrammatic stepwise fragmentary plan views showing the formation of the fabric according to FIGURES 1 to 8 where double adjoining binding wefts are used.

FIGURES 1b to 8b are diagrammatic stepwise fragmentary plan views showing the formation of the fabric of FIGURES 1 to 8 where split multiple binding wefts are used.

FIGURE 9 is a diagrammatic view of the fabric according to the invention showing only the laid-in backing wefts, the knitted chains and the tubes of the guide bars incident to forming the portions of the fabric shown.

FIGURE 10 is a diagrammatic face view of a multiple binding weft fabric according to the invention where the binding wefts in a particular course are adjoining, the backing being omitted.

FIGURE 11 is a face view of a completed fabric according to FIGURES 9 and 10, including both the multiple adjoining laid-in binding wefts and the backing.

FIGURE 12 is a diagrammatic face view according to the invention of a multiple binding weft fabric in which the binding wefts are split or on opposite sides of the pile projections, omitting the backing.

FIGURE 13 is a diagrammatic face view of a split binding weft fabric, omitting the backing, in which there are three binding wefts on each course, two put in before the pile loop is formed and one afterward.

FIGURE 14 is a view similar to FIGURE 13, showing a variation in which split binding wefts are inserted, two before and two after the loops are formed.

FIGURE 14a is a view similar to FIGURE 13 showing a variation in which split binding wefts are inserted, three before and two after the loop is formed.

FIGURE 15 is a diagrammatic face view of a variant form of fabric according to the invention, using alternate left and righthand stitches with adjoining double binding wefts, and omitting the backing wefts for clarity of illustration.

FIGURE 16 is a diagrammatic face view according to the invention showing a repeat of left-hand and right-hand stitches, in this case three left-hand and three right-hand, with multiple binding wefts of the split type.

FIGURE 17 is a diagrammatic face view of a fabric according to the invention, showing diagonal laid-in binding weft shogged across two needles.

FIGURE 18 is a view similar to FIGURE 17, in which the laid-in binding weft is shogged across three needles and extends diagonally across three wales and three succeeding courses.

FIGURE 19 is a view similar to FIGURE 17, in which the laid-in binding weft in one course is shogged across two needles and in the next course is shogged across one needle in the same direction.

FIGURE 20 is a photographic view of the face of a

pile carpet which is warp knitted according to FIGURES 1 to 8 and 1a to 8a.

FIGURE 21 is a photographic view of the face of a pile carpet which is warp knitted according to FIGURES 1 to 8 and 1b to 8b.

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

In my application Serial No. 682,926, filed September 9, 1957, for Knitting Fabric Having Laid-In Weft, I disclose a pile fabric and the method of making it in which the pile projections are bound by laid-in binding wefts and are not bound in the stitches directly.

In many cases it is desirable to obtain a firmer bind of the pile than is possible by using single laid-in binding wefts, and in the present invention I accomplish the bind by multiple aid-in binding wefts in many cases.

The single laid-in binding weft produces a pile of relatively very low density, other things being equal, due to the fact that the legs of the loops or tufts are relatively widely spaced.

In some cases it is desirable to produce pile of intermediate or high density for a given gauge and a given number of courses per inch.

I find that by employing a plurality, say two or more adjoining binding wefts in the same course to bind the pile projections, I can obtain an intermediate density. By using a plurality, suitably two or more binding wefts in the same course which are split, or placed on opposite sides of the pile projections, I can obtain a still higher density. Thus, for a given gauge and number of stitches per inch I obtain a lower and denser pile where there are multiple binding wefts put in together, and a still lower and still denser pile where there are multiple binding wefts put in split relation.

The present invention offers the advantage of improved utilization of face yarn as compared to warp knitted pile fabric in which the pile projection is bound in by the warp chain.

The invention also gives a warp knitted pile fabric which is very firm and resistant to distortion as compared to previous warp knitted pile fabrics.

It will further be noted that by using a multiple bind of binding wefts supplied together, the straight line pile projection orientation normally secured from a single binding weft is greatly changed, and when a multiple bind is used, with binding wefts split, the orientation of the pile is even more markedly changed as compared with a single laid-in bind. This not only gives a highly unusual texture for the multiple adjoining bind and another unusual texture for the multiple split bind, but it also assures that the effect of the yarn variation is obscured. Furthermore, the multiple adjoining laid-in bind gives more level pile than the single laid-in bind and the multiple split laid-in bind gives still more level pile than the multiple adjoining laid-in bind, at the expense of slightly higher face yarn consumption for a particular yarn height. Even more pronounced texturing differences can be produced by deliberately imparting a rotational bias to the pile projections, particularly where they are uncut. This is accomplished by using left-hand and right-hand stitches in a repeat. Where the pile yarn has a particular twist (right-hand or left-hand in the last twisting operation, which may be the ply if the yarn is merely plied or may be the cable if the yarn is cabled), a left-hand stitch in a particular course will give a certain orientation to the multiple binding wefts which will give rotational bias to the pile projection, and a right-hand stitch will give a different orientation to the multiple winding wefts which imparts another rotational bias to the pile projections. These biases are not truly opposite because the yarn is always twisted in a particular direction.

In some cases it is preferable to obtain a greater coverage for a given amount of pile yarn by opening up the binding points for the two sides of the loop, either

throughout the fabric or in certain areas. In this case it is very desirable to extend the laid-in binding weft diagonally across the wales, either throughout the entire fabric, or in certain areas, in which case the laid-in binding weft can extend coursewise in the same wale in other areas.

Considering now the fabric and method in detail and referring to my patent application Serial No. 682,926, filed September 9, 1957, for Knitted Fabric Having Laid-In Weft, for other aspects including the mechanism, considering this in connection with the warp knitting loom as shown in D. R. Paling, Warp Knitting Technology (1952) Chapter 11, Raschel Warp Looms and Chapter 12, Raschel Warp Loom Mechanism, and considering the drawings in detail:

Considering first FIGURES 1 to 8 inclusive, in connection with FIGURES 1a to 8a inclusive, for the multiple binding weft form in which a plurality of binding wefts are put in by a single shogging step, in connection with FIGURES 9, 10 and 11, which show the resulting fabric, the procedure is as follows:

A stationary vertically extending trick plate 50 as well known in the art in looms of this character is generally of tapered cross section with a side 51 extending generally vertically and supporting the fabric being formed and removed by a take-off mechanism and the side 52 suitably slightly converging and adjoining the needles. The trick plate at the top has a comb portion 53 and a blunt top 53' shown in FIGURE 1.

The warp knitting loom employed is suitably of the double needle bar type, one needle bar mounting supports 54 for a series of latch needles 55, as well known, which extend generally at a slight angle to the trick plate. The latch needles as shown in FIGURE 1 have hook ends 56 at the top directed away from the trick plate and latches 57 pivoted at 58 and in one position closed against the back ends. The other needle bar in the device of the invention at the opposite side of the trick plate is equipped with plush points instead of needles.

In making uncut or loop pile fabric, noncutting plush points 60 are mounted on mounting 61 and the noncutting plush points are in effect metallic strips having suitably blunt ends 62, notched at the side toward the needles at 63 and filleted slightly at the upper corner 64 remote from the needles.

Positioned immediately above the trick plate, and attached to move across it is a sinker comb 65 mounted on sinker support 66 on a sinker bar as well known.

Suitably positioned above the sinkers and extending clear across the machine is a swing bar which carries suitably positioned thereon in order from front to back, a horizontally slidable mounting which supports a knitting yarn guide bar 67 which carries a series of eyes or tubes 68 which guide knitting yarn 70, then a horizontally slidable mounting for a binding weft yarn guide bar 71 which carries a series of eyes or tubes 72, one for each binding binding weft yarn end 73; next toward the back there is a horizontally slidable support which supports in slidable relation the face yarn guide bar 74 which carries eyes or tubes 75, one for each face yarn end 76, and finally at the rear, there is a horizontally slidable support which mounts in sliding relation a backing yarn guide bar 77 which carries a series of eyes or tubes 78, one for each backing yarn end 80. A latch wire 81 extends across the back of the machine.

In FIGURES 1 and 1a, the machine is at zero degrees or 360 degrees and is taking the first step after completion of the last stitch. The needles 55 and the plush point 60 are down or retracted, the sinker comb is advanced or forward, and the sinker bar with the guide bars 67, 71, 74 and 77 is in midposition and moving back. When desired in fabric design, the guide bars can shog in either direction any reasonable distance at different positions. The condition encountered in FIGURE 1 is shown in FIGURE 1a where knitting yarn 70, fed by tubes 68 is locking

5

in the stitch backing yarn 80 and binding weft yarn 73 fed by tubes 78 and 72 respectively. One complete face yarn end 76 is shown having pile loop 82, the remaining face yarn ends 76 being broken away.

FIGURE 2 corresponds to 30 degrees advance in the cycle. The position of the needles and of the sinkers is the same as that of FIGURE 1. The guide bars are all the way back out of line with the needles and plush points and the plush points 60 have just completed their advance or upward motion preparatory to the formation of pile projections.

As shown in FIGURE 2a, the position of the fabric components is substantially that of FIGURE 1a, except that the feed tubes have changed their position by shogging pile yarn 76 and backing yarn 80 to the positions as shown.

FIGURES 3 and 3a correspond to the position at 90 degrees in the cycle. The swing bars and the guide bars with it move to the front past the plush points and the face yarn guide bars are now shogged in the preferred embodiment of the invention in either direction so that in the next succeeding step loops will be formed around the plush points to produce pile. The formation of such a loop by shogging is shown at 83 in FIGURE 3a.

In the steps illustrated in FIGURES 4 and 4a at 150 degrees in the cycle, the swing bar has moved back, carrying with it the guide bars, while the needles, plush points and sinker comb remain in the same position as they were previously. The backward swing of the swing bar completes the formation of a loop shown at 83 in FIGURE 4a around one of the plush points, while similar loops (not shown) are formed around other plush points. As soon as the guide bars have cleared the plush points 60, binding weft 73 shogs by moving eyes or tubes 72, for example to the right, as shown in FIGURE 4a, and preferably also backing yarn 80 shogs, suitably in the same direction (or in the opposite direction if desired) by moving guide bar tube 78 as shown in FIGURE 4a.

It will be evident that binding weft yarn is laid in at the position of FIGURES 4 and 4a to form the bind for one leg of the loop being formed at 83, as indicated by the crossing at 84 in FIGURE 4a. It will be evident that backing yarn 80 is laid in to form the backing in FIGURES 4 and 4a, although backing yarn is desirably also laid in in FIGURES 1 and 1a.

The position of FIGURES 5 and 5a at 210 degrees in the cycle corresponds to the completion of the shogging except for the knitting yarn. The guide bars have all moved forward past the needle position at the plush point side, the needles 55 having advanced or raised, and the latches 57 have been opened by the previous knitting stitches as shown in FIGURE 5, while the previous knitting stitches have moved down on the needles below the latches, leaving the hooks of the needles open as shown. FIGURE 5a shows the arrangement of the needles in the position of FIGURE 5 as the needles come up.

The position of FIGURES 6 and 6a corresponds to 270 degrees in the cycle. The position shows all guide bars moved back of the plush points and needles, with the new stitch ready to be formed when it enters the hooks of the needles in the next step. The face yarn ends are now formed in loops 83 around the plush points as shown in FIGURE 6a. The knitting yarn guide bar now shogs, forming loops of knitting yarn 85 which are about to enter the hooks of the needles and wrap around the needles above the latches and below the hooks.

FIGURE 7 at 300 degrees in the cycle shows the guide bars moving to the front, and midway in their swing. The sinker comb 65, which has been in position across the fell and across the end of the trick plate among the needles, now retracts to clear the ends of the needles. The needles, having engaged the knitting yarn in their hooks, are beginning to retract and the latches are closed by the previous stitch, while the plush points are also retracting.

6

The previous stitches are now allowed to be cast off as the needles retract. Actually the casting off takes place between the step of FIGURE 7 and FIGURE 8, and once the stitches are cast off, the previous face yarn loops are bound by being gripped by the weftwise stretch of binding weft.

By observation of FIGURES 7 and 7a, it will be evident that loops 85 of knitting yarn previously formed have now entered the hooks of the needles at 86 to form a stitch which grips together in a bundle the binding weft ends and the backing weft ends, forming a binding stretch 87 of binding weft yarn which grips and anchors one side of the projections of pile yarn 76.

FIGURES 8 and 8a correspond to 330 degrees to the cycle and show the stitch completed and locked. The sinker comb 65 is fully retracted and is now about to advance again to the position of zero or 360 degrees (FIGURE 1), the face yarn loops have been cast off by the plush points and a new completed pile loop 83 is shown in FIGURES 8 and 8a.

FIGURE 9 illustrates the resulting backing of the fabric which is formed, consisting of knitting chains 88 extending walewise, and anchoring backing yarn 80 in bundles 90. It will be noted that the backing wefts in this case shog over four needles or four tricks, but the feature of how many needles the backing yarn shogs across is unimportant in the present invention, and a wide variety of backing yarn arrangements may be used.

FIGURE 10 illustrates the face of the fabric of FIGURES 1 to 8 and 1a to 8a, showing as it does the same knitting chains 88, omitting the backing, but illustrating pile yarn ends 76 running walewise intermediate between the knitting chains, and not directly locked in the chains, the pile yarn ends being bound by laid-in binding wefts 73 which are shogged across three needles or three tricks. A distinctive feature of the fabric of the present invention is that between each pair of pile loops 83 walewise there are two binding wefts seen for example at 73' which extend across over the pile and bind the pile projections.

In the form of FIGURES 1 to 10 inclusive, the multiple (two) binding wefts which bind each end of each pile projection are in the same course and lie between adjoining pile projections. It will be evident of course that the question of whether two such multiple binding wefts form a bundle binding together, or whether three or some other number is used is a matter of choice within the principles of the invention.

The arrangement shown in FIGURE 10 gives a somewhat higher density of pile, other things being equal, than is obtained using single laid-in binding wefts. In this sense it gives a texture which is different from that obtained by the single laid-in binding wefts.

In some cases it is preferable to obtain a still denser texture for the same construction dimensions. In FIGURES 1b to 8b inclusive, and 12, I illustrate a multiple laid-in binding split weft construction, which gives such a high density texture.

FIGURE 1b at 0 or 360 degrees shows essentially the same features as FIGURE 1a, and the knitting step is the same as that of FIGURE 1.

FIGURE 2b at 30 degrees in the cycle shows the position of the needles and the sinkers the same as in FIGURE 2a, the guide bars all the way back out of line with the needles and plush points, and the plush points 60 have just completed their advance or upward motion, preparatory to the formation of pile projections. The face yarn has shogged one needle to the left forming stretches 91. The laid-in binding wefts have shogged one needle to the right, forming stretches 92. The backing yarn has in this case optionally shogged three needles to the right forming stretches 93. Otherwise, FIGURE 2b is the same as FIGURE 2a.

FIGURE 3b corresponds to the position at 90 degrees in the cycle. As in FIGURES 3 and 3a, the swing bar and the guide bars with it have moved to the front past the plush points and the face yarn guide bars 74 have in this

case shogged one needle to the right (back to the position of FIGURE 1b) in the preferred embodiment so that in the next stop loops will be formed around plush points. The stretches formed by the face yarn are designated 94.

In the next step as shown in FIGURE 4b at 150 degrees in the cycle, the swing bar has moved back carrying with it the guide bars, while the needles, plush points and sinker combs remain in the previous position. The backward movement of the swing bar completes the formation of loops 95 of face yarn around plush points. Laid-in binding wefts 73 have shogged two needles to the right, (they formerly had shogged one needle) completing the second step of shogging. Backing yarn 80 also optionally shogs to the right in this position.

It will be noted that on stretch 92 of the laid-in backing weft, only crossings 96 are under the newly formed pile loop 95, and other crossings 97 are on top of the newly formed pile loop 95, thus creating the split laid-in binding weft effect.

FIGURE 4b completes the lay-in of the binding weft for the cycle. It also completes all other shogging except the shogging of the knitting yarn.

The position of FIGURE 5b at 210 degrees in the cycle shows all the guide bars moved forward past the needle position on the plush point side, the needles advancing and the needle latches opened by the previous knitting stitches as shown in FIGURE 5, while the previous knitting stitches have moved down on the needles below the latches leaving the hook ends of the needles open.

FIGURE 8b corresponds to the position at 270 degrees in the cycle. All guide bars have moved back of the plush points and needles, and the new stitch is ready to be formed when it enters the hook of the needles at the next step. Binding weft stretches are plainly visible at 98, and it will be seen that the binding weft stretches 98 are under the loops 100, and over the next pile loops 101.

The knitting yarn guide bar now shogs, forming loops of knitting yarn 85 which are about to enter the hooks of the needles, and wrap around the needles at a position above the latches and below the hooks.

FIGURE 7b at 300 degrees in the cycle shows the position at which the guide bars have moved to the front and are midway in their swing. The sinker comb 65 which has been in position across the fell and across the end of the trick plate among the needles is now retracted to clear the ends of the needles, the needles have engaged the knitting yarn loops 86 in their hooks and are beginning to retract and the latches are being closed by the previous stitches while the plush points are retracting. The previous stitches are now cast off as the needles retract, the casting off taking place between the step of FIGURE 7b and the step of FIGURE 8b, and once the stitches are cast off, the previous pile loops are bound by binding the ends of the weftwise stretches of binding weft as shown in FIGURE 8.

The stitches bind together the binding weft ends and the backing ends into a bundle.

FIGURE 8b at 330 degrees in the cycle shows the stitch completed and locked. It will be noted that the bind of the pile at 102 is between the backing yarn which forms the back half of the clamp at 103 and the binding wefts which form the front half of the clamp at 104.

The resulting fabric with the split laid-in binding wefts is shown in FIGURE 12, where it will be noted that between each pair of pile projections extending walewise there is above the pile end a binding weft 105 from the previous course and a binding weft 106 from the next course. Thus it will be evident that the laid-in binding wefts in this case shog over three needles and the stretches of binding weft for a particular course are partly on one side and partly on the other side of the pile projection. This has the effect of forming a dense pile for the particular controlling dimensions.

In some cases, instead of using merely one laid-in

binding weft from each of two courses on each side of the pile projection, it will be preferable to employ two or more laid-in binding wefts from one course and one from the next course, or vice versa, in making up the tuft bind. FIGURE 13 illustrates a split binding weft arrangement having two binding wefts 107 laid-in before the formation of the pile projection and one binding weft 108 from the same course laid in after the formation of the pile projection. The construction of FIGURE 13 gives a more solid back and also a firmer integration of the pile projection into the back. It also gives a different texture from that of FIGURE 12.

FIGURE 14 illustrates a multiple split binding weft in which there are two laid-in binding wefts 110 preceding the formation of the loop and two laid-in binding wefts 111 following the formation of the loop from each course. Whereas in FIGURE 12 the laid-in binding weft shogs over three needles, and in FIGURE 13 it shogs over four needles, in FIGURE 14 the laid-in binding weft shogs over five needles.

This gives an even firmer back and a tighter tuft bind than FIGURE 13.

In other cases, using the split binding weft, it is desirable to employ binding wefts from the same course, some put in ahead and some after the pile projection, and to have at least three binding wefts in one group and at least two binding wefts in the other group. FIGURE 14a illustrates a form having three laid-in binding wefts 112, put in ahead of each pile projection and two laid-in binding wefts 113, put in afterward, the laid-in binding wefts shogging across at least six needles.

In some cases it is desirable to give a variable orientation to pile projections by using left-hand and right-hand stitches in the knitting chain according to a pattern repeat, with the laid-in binding weft, which in some cases may be single and in other cases multiple.

In FIGURE 15 I illustrate a sequence of alternate right-hand stitches 114, and left-hand stitches 114'. There are in this case two binding wefts in the same course between each pair of walewise pile projections illustrated at 115. The pile is wrapped around plush points to the left and plush points to the right in a pattern repeat sequence, in this case three plush points to the right and then three plush points to the left on successive courses. This gives opposite pile loops 116 in a sequence, and then loops 117 in a sequence according to a pattern repeat.

It will of course be evident that any other desired sequence of left-hand and right-hand stitches, and right-hand and left-hand loops according to a pattern repeat can be used as desired in FIGURE 15.

The arrangement of left-hand and right-hand stitches according to a pattern repeat as shown in FIGURE 15 for a multiple adjoining laid-in binding weft tuft bind, can also be applied as in FIGURE 16 in a multiple split laid-in binding weft tuft bind. Here the knitting chains involve a succession of right-hand stitches 114 and then a succession of left-hand stitches 114' according to a pattern repeat (here three right-hand, then three left-hand) and the loops are arranged in a sequence of loops 118 (left-hand) and 120 (right-hand), left-hand loops being formed around left-hand plush points when forming right-hand stitches, or vice versa when forming left-hand stitches in the preferred embodiment. In this case the split laid-in binding weft is as shown in FIGURE 12, with one laid-in binding weft of each course placed before and one after the pile loop formation.

In some cases it is preferable to position the laid-in binding weft diagonally rather than strictly coursewise. This gives a much opener fabric which is desirable for use with heavy face yarn or in production of low-cost fabric, since the coverage is better.

As shown in this example, FIGURE 17, the binding weft for each bind anchors at one end in the previous

course at 121 and at the other end in the next course at 122. This means that the laid-in binding wefts, which in this case shog over one needle, in each course form generally diagonal stretches 73'. It will be evident that this fabric as in all other cases has laid-in backing wefts not shown.

In some cases it is desirable to have the laid-in binding weft extend diagonally but also shog over one needle in each of three successive courses as shown in FIGURE 18. This produces a laid-in binding weft stretch 123, which forms a single weft tuft bind between each pair of walewise pile projections.

The fact that the knitting stitches are successively left-hand and right-hand according to a pattern repeat in FIGURES 17 and 18 and the loops 120 and 118 are formed right-hand and left-hand in these figures, and with the pile tuft or loop bind alternately extending in opposite diagonals, tends to give several different loop orientations which assures a wide diversity of loop angles and necessarily tends to make the fabric free from lining effects.

In some cases it is preferable to use a combination of straight weftwise and diagonal tuft bind, with a view to imparting a variety of loop orientations and creating a very compact face.

In FIGURE 19 I illustrate a straight weftwise laid-in binding weft 124 which has shogged over two needles in the same course, and then a diagonal binding weft stretch 125 which has shogged over one needle in the next course. This gives a single laid-in binding weft over the pile yarn between each pair of walewise pile projections.

FIGURE 20 shows photographically the face of a pile carpet of intermediate pile density produced according to the invention, in accordance with the principles of FIGURES 1 to 8 and 1a to 8a, involving adjoining multiple laid-in binding wefts.

FIGURE 21 is a photographic view of the face of a pile carpet according to the invention, knitted in accordance with the principles of FIGURES 1 to 8 and 1b to 8b, showing a split multiple laid-in binding weft.

For the same pitch and number of stitches per inch, it will be evident that the pile density in FIGURE 20 is lower than that in FIGURE 21, and in FIGURE 21 there are more pronouncedly different pile orientations from the standpoints of rotation of the pile projections. On the other hand, other things being equal, the pile height is somewhat lower in FIGURE 21 than in FIGURE 20.

It will be evident of course that any of a wide variety of changes can be employed in the fabrics of the invention which are well known in the art, and which need not be illustrated in order to be understood. The question of whether the pile projections are cut as in my copending application, Serial No. 666,312 filed June 18, 1957, now Patent No. 2,907,191, for Cutting Plush Point for Carpet Knitting, or uncut, as shown throughout, is immaterial from the standpoint of the present invention.

Also, by reason of the complexity of the illustration and the desire to simplify as far as possible, I have shown only one pile yarn guide bar and one frame of pile yarn, but it will be understood of course that two or more pile yarn guide bars introducing two or more frames may be used as desired.

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

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

1. A warp knitted pile fabric, comprising walewise extending parallel chains of knitted stitches, inlaid backing weft yarn ends extending sinuously across the chains and bound into the stitches of the knitted chains, pile yarn ex-

tending walewise between the lines of knitted stitches and rising in pile loops in each course, and inlaid binding weft yarn undulating sinuously across and anchored in stitches of the chains, each said stretch of inlaid binding weft extending across three chains, each said stretch extending across and binding the leg of a loop in each of two wales, and there being two of said stretches of binding weft yarn anchored in each stitch.

2. A pile fabric of claim 1, in which the stitches of the knitted chains are grouped in a sequence of a first plurality of one character of stitch either right hand or left hand grouped together, then at least one stitch of the opposite character before repeating the first plurality of stitches, producing a repeat pattern of stitches in the fabric.

3. A pile fabric of claim 2, in which some of the pile loops are oriented left hand and right hand in accordance with a pattern repeat which conforms to the pattern repeat of the knitted stitches.

4. A warp knitted pile fabric, comprising walewise extending parallel chains of knitted stitches, inlaid backing weft yarn ends extending sinuously across the chains and bound into the stitches of the knitted chains, pile yarn extending walewise between the lines of knitted stitches and rising in pile loops in each course, and inlaid binding weft yarn undulating sinuously across and anchored in stitches of the chains, each said stretch of inlaid binding weft in each course being composed of two sections, the first section being inlaid across the first wale and bound in a first two-lines of chain stitches and across the second base leg of a first pile loop in said first wale, and binding the leg of the pile loop, the second section of inlaid binding weft being a continuation of the first section and inlaid across an additional adjacent line of chain stitches and bound in such stitches and across a second adjoining wale and across the base leg of a second pile loop in said second adjoining wale of the same course, each second section of the said inlaid binding weft acting to reenforce each of said first sections of inlaid binding weft, there being two inlaid binding weft yarns anchored in each stitch.

5. A wrap knitted pile fabric, comprising walewise extending parallel chains of knitted stitches, inlaid backing weft yarn ends extending sinuously across the chains and bound into the stitches of the knitted chains, pile yarn extending walewise between the lines of knitted stitches and rising in pile loops in each course, and inlaid binding weft yarn undulating sinuously across and anchored in stitches of the chains, in which each course is composed of two sections, the first section being inlaid across a first wale and anchored in a first two lines of chain stitches in the same course and over the pile yarn end in said first wale at the first base leg of a pile loop in said wale and course, the second section of the inlaid binding weft being a continuation of the first section, and being inlaid across an additional line of chain stitches and across a second adjoining wale and across the second base leg of a pile loop in this second adjoining wale of the same course, each pile loop in the fabric having each leg bound by both the first stretch of a first binding weft and the second stretch of a second binding weft, and there being two stretches of binding weft anchored in each stitch.

6. A warp knitted pile fabric, comprising walewise extending parallel chains of knitted stitches, inlaid backing weft yarn ends extending sinuously across the chains and bound into the stitches of the knitted chains, pile yarn extending walewise between the lines of knitted stitches and rising in pile loops in each course and inlaid binding weft yarn undulating sinuously across and anchored in stitches of the chains, each stretch of binding weft yarn in each course being composed of two sections, the first section being inlaid across a first wale and anchored in stitches of the same course of two lines of knitted chain stitches and extending over the first

11

leg of a pile yarn loop in this first wale, the second section of inlaid binding weft being a continuation of the first section and being inlaid across an additional line of chain stitches and anchored in the stitch of the same course and across a second adjoining wale and over the second leg of the pile yarn loop in said second wale, each pile loop of the fabric being bound by a first stretch of one binding weft and reenforced by a second stretch of a second binding weft, which double stretches of binding weft are inlaid across the first leg of one pile loop and the second leg of an adjoining pile loop in the same course of an adjoining wale, and there being two ends of binding weft yarn anchored in each chain stitch.

7. A warp knitted pile fabric, comprising walewise extending parallel chains of knitted stitches, inlaid backing weft yarn ends extending sinuously across the chains and bound into the stitches of the knitted chains, pile yarn stretch extending across and anchored in the stitches and rising in pile loops in each course, an inlaid binding weft yarn undulating sinuously across and anchored in stitches of the chains, each binding weft yarn stretch extending across and anchored in the stitches of three different knitted chains, and between knitted chains extending across the base leg of a pile loop in each wale, there being two binding weft ends anchored

12

in each stitch of the knitted chain and there being two stretches of binding weft across each leg of each pile loop.

8. A warp knitted pile fabric, comprising walewise extending parallel chains of knitted stitches, inlaid backing weft yarn ends extending sinuously across the chains and bound into the stitches of the knitted chains, pile yarn extending walewise between the lines of knitted stitches and rising in pile loops in each course, and inlaid binding weft yarn undulating sinuously across and anchored in stitches of the knitted chains, the inlaid binding weft stretches extending from the base legs of pile loops and between successive pile loops, being bound in one line of knitted stitches in a particular course, and being bound in the next two lines of knitted stitches in the next course, there being two stretches of binding weft anchored in each knitted stitch, and there being two stretches of binding weft extending across each leg of each pile loop.

References Cited in the file of this patent

UNITED STATES PATENTS

2,005,951	Morton	June 25, 1935
2,331,289	Amidon	Oct. 12, 1943

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,991,640

July 11, 1961

Rex S. MacCaffray, Jr.

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

Column 2, line 62, for "slogged" read -- shogged --;
column 3, line 16, for "multipl el aid-in" read -- multiple laid-in --; column 11, line 18, after "yarn" strike out "stretch extending across and anchored in the stitches" and insert instead -- extending walewise between the lines of knitted";
line 22, for "enchored" read -- anchored --.

Signed and sealed this 28th day of November 1961.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

DAVID L. LADD

Commissioner of Patents

USCOMM-DC