Aug. 24, 1965 J. GRECZIN 3,201,954

METHOD AND APPARATUS FOR REINFORCING FLEXIBLE HOSE

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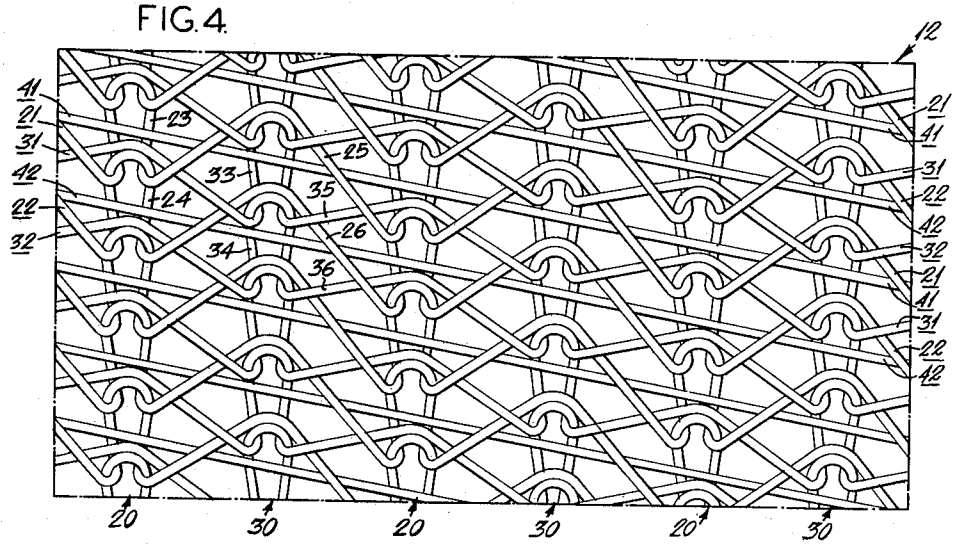
FIG. 4.



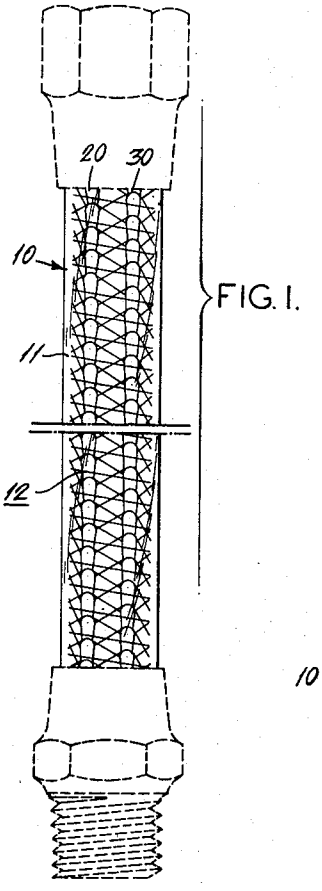
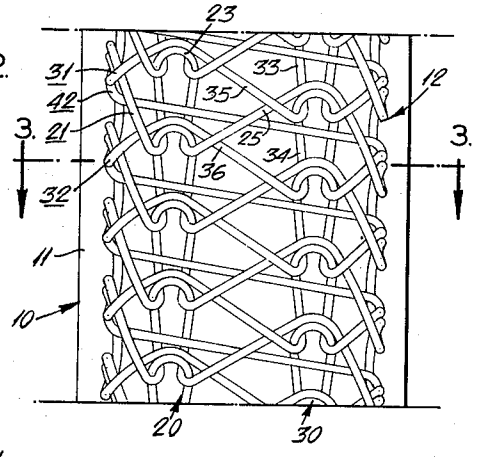


FIG. 1.

FIG. 2.



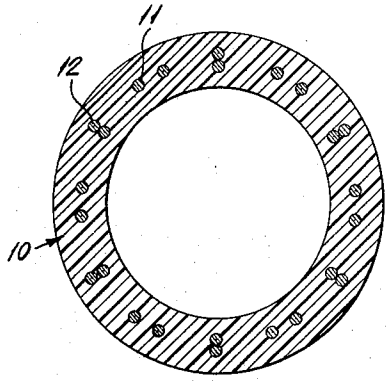


FIG. 3.

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FIG. 5.

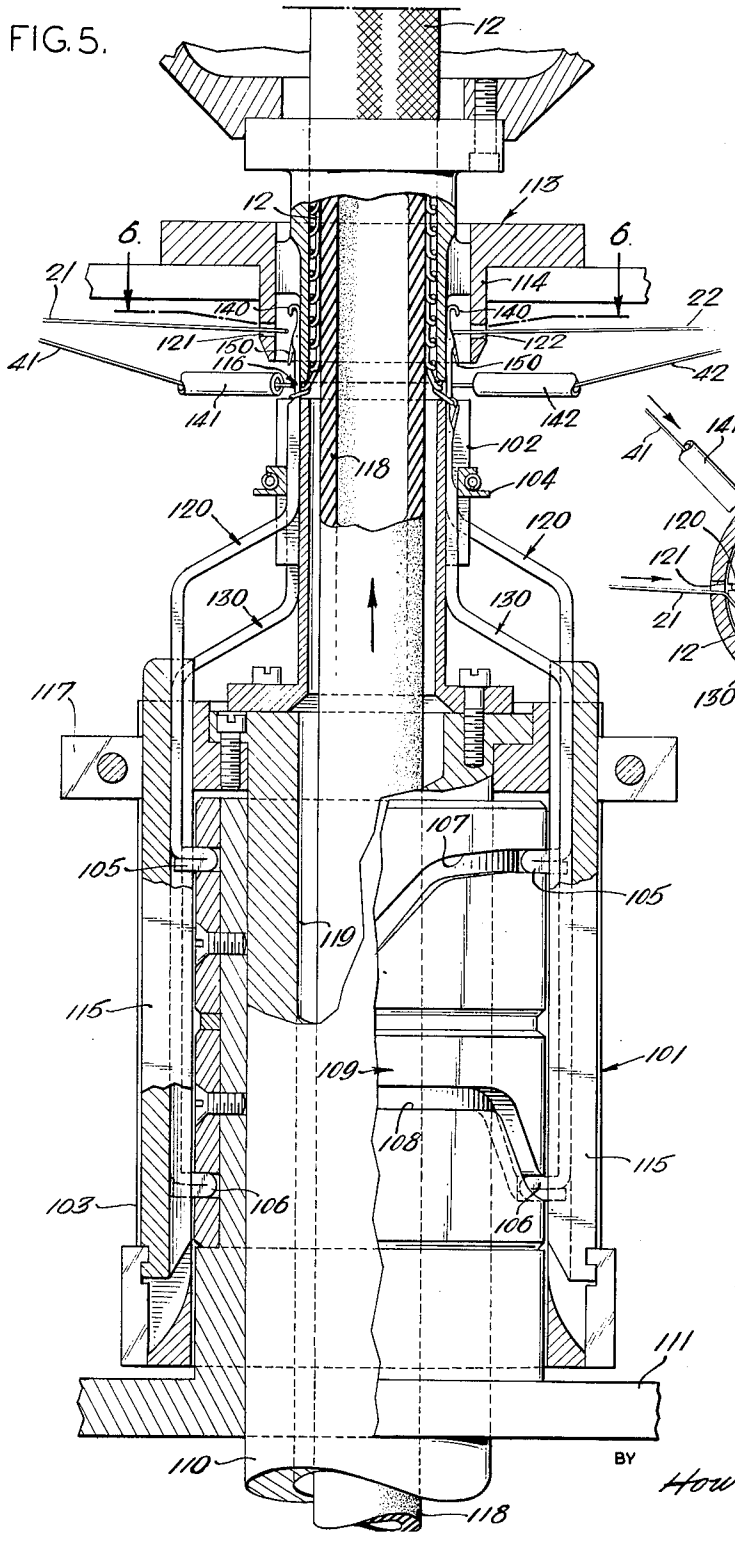

FIG. 6.

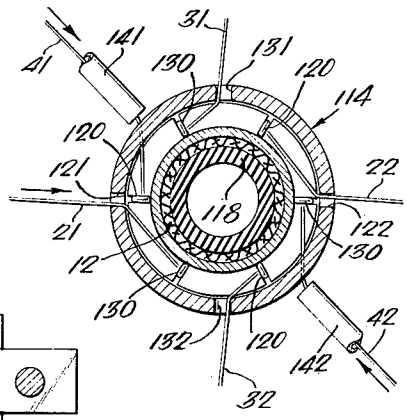

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FIG. 7.

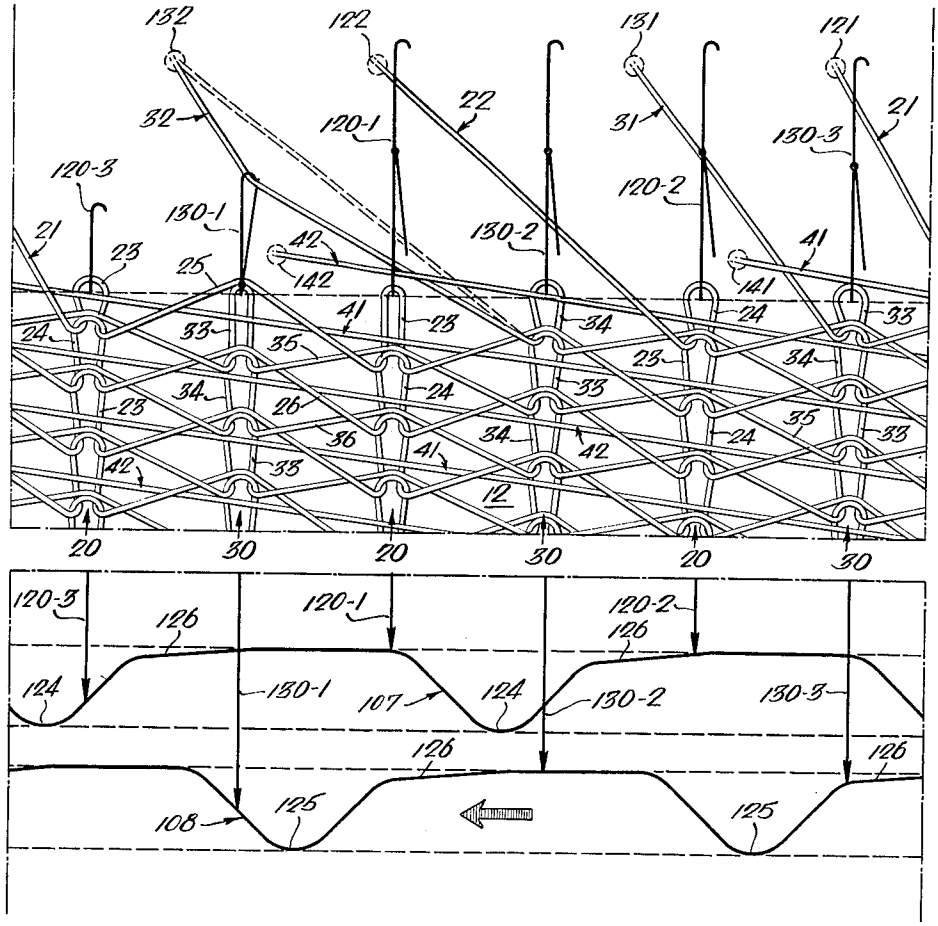

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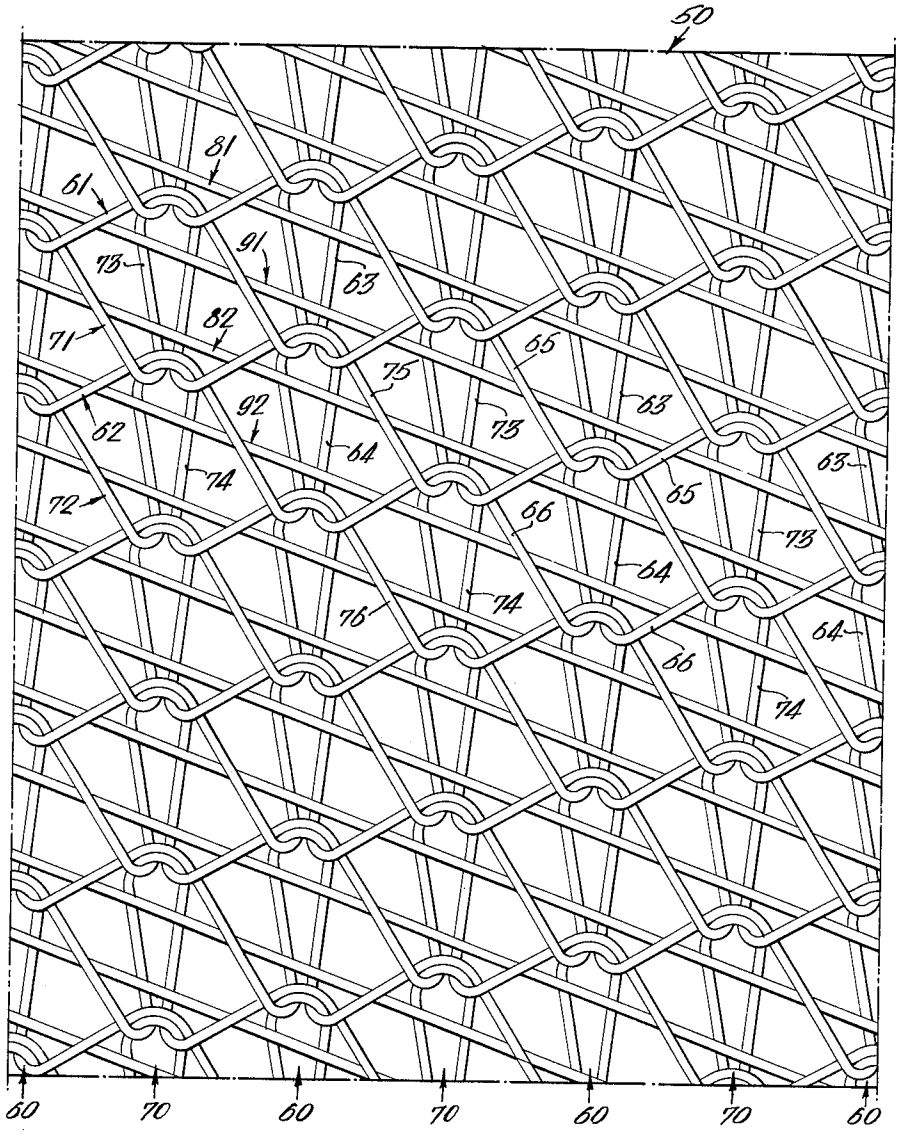
FIG.8.



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3,201,954

METHOD AND APPARATUS FOR REINFORCING FLEXIBLE HOSE

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Filed Feb. 19, 1962, Ser. No. 174,208
3 Claims. (Cl. 66—9)

The application is a continuation-in-part of my copending application Serial Number 19,403, filed April 1, 1960, now Patent No. 3,049,901.

The present invention relates to flexible hose of the type which is reinforced by tubular knitted fabrics, and is directed particularly to a method and apparatus for making a tubular knit reinforcing having one or more additional reinforcing elements incorporated into the knitted fabric.

The present invention provides a method and apparatus for producing a fabric having the improved burst strength without a substantial increase in production cost, and which prevents the hose from swelling.

The present invention also provides a method and apparatus which affords a wide variation in the character of the additional reinforcing element in the reinforcing fabric.

More specifically, the present invention produces a tubular knitted fabric composed of individual mutually-overlying knitted webs having incorporated therein a reinforcing strand interlaced with the webs to provide a smooth front and back face in the reinforcing fabric.

A primary object of the present invention is to provide a method and apparatus for knitting reinforcing over flexible hose, using a single cylinder machine which positions the reinforcing strands in front of the wale loops of the knitted web and behind the connecting runs intermediate the wale loops.

More specifically, another object of the present invention is to provide a knitting machine of highly simplified construction which is fully effective to produce the fabric by the method of the present invention.

All of the objects of the invention are more fully set forth hereinafter with reference to the accompanying drawings wherein:

FIG. 1 is a view showing a section of transparent plastic hose containing a tubular knitted fabric made according to the present invention;

FIG. 2 is an enlarged view in elevation more clearly illustrating the construction of the reinforcing fabric in the hose;

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 2;

FIG. 4 is a developed view of the fabric separated from the hose and split longitudinally to lie flat;

FIG. 5 is a vertical sectional view through a knitting machine made in accordance with the present invention with portions broken away to more clearly illustrate its construction;

FIG. 6 is a transverse sectional view taken on the line 6—6 of FIG. 5;

FIG. 7 is a diagrammatic representation illustrating the operation of the machine of the present invention, showing at the upper portion of the figure the movement of the needles and feeds as seen from the inside of the needle circle, showing in the mid portion of the figure the fabric formed thereby inverted and as seen from the outside of the upwardly moving web, and showing at the lower portion of the figure the cam tracks controlling the movement of the needles at a reduced scale to enable correlation with the needles shown in the upper portion of the figure; and

FIG. 8 is a view similar to FIG. 4 of a modified fabric made on apparatus embodying the present invention.

With reference to the drawings, and particularly FIGS. 1 to 4 thereof, the hose **10** illustrated therein comprises a plastic body **11** having a reinforcing fabric **12** embedded therein. The fabric **12** is composite of two tubular webs knitted from separate yarns and on separate sets of needles. In the cylinder, the needles are arranged so that those of one set alternate with those of the other set. Consequently, the wales **20** of one web alternate with the wales **30** of the other web about the circumference of the composite fabric.

In the present instance, each web of the composite fabric is formed on two feeds so that in each wale, there are wale loops formed of alternate yarns. The web having the wales **20** is formed of two yarns **21** and **22** which are formed into wale loops **23** and **24** respectively. The connecting runs **25** and **26** respectively between the wale loops in the web engage in the wales **30** of the other web as more fully set forth hereinafter. The web having the wales **30** is formed of two yarns **31** and **32** respectively forming wale loops **33** and **34** and connecting runs **35** and **36** respectively.

In the present instance, the webs are knit with the wale loops disposed on the rear face of the fabric and the connecting runs on the front face of the fabric. As shown in the drawings, the connecting runs of each adjoining pair of wales of each web in any one course, follow a path passing in front of the wale loop of the intervening wale of the other web and are knit in a manner to intersect the connecting runs of the other web diagonal to the coursewise direction of the respective webs.

In accordance with the invention, additional reinforcing strands are incorporated into the composite fabric to provide additional burst strength to the fabric without disturbing the smooth contour provided on the back and the front face of the fabric composed of the two interknit webs. To this end, in the fabric shown in FIG. 4, reinforcing strands **41** and **42** are laid into the composite fabric between the front and back faces thereof. The strands **41** and **42** pass in front of each wale loop it traverses, and behind the connecting yarn runs. The strand **41** passes in front of the wale loops **33** of the web having wales **30** and follows a path coursewise of said web coincident with the paths of the connecting runs **35** in said course so that it passes in front of the wale loops **23** of the other web and behind the diagonal connecting runs **25** of the other web throughout the fabric. The reinforcing strand **42** passes in front of the wale loops **34** in one course of the web having wales **30** and follows the paths of the connecting yarn runs **36** of said course to thereby pass in front of the wale loops **24** of the other web and behind the diagonal connecting runs **26** of the other web.

When the construction of FIGS. 1 to 4 embodies an open knit as shown, the reinforcing strands **41** and **42** may follow a straight helical path throughout the hose. Since the path of the reinforcing strands **41** and **42** are devoid of kinks, loops, and the like, this construction enables the use of metallic reinforcing strands such as wire or other strands which may be strong in tension but weak in shear. The use of such strands may also be desirable for other purposes than increasing the burst strength of the hose. For example, metallic strands may be desired to be incorporated in the hose for shielding effects, and the present invention therefore enables the shielding wire to be incorporated in the reinforcing fabric concurrently with the knitting thereof to eliminate the necessity for an additional operation of applying the shielding material to the hose.

Referring to the apparatus shown in FIGS. 5 and 6, the knitting machine comprises a stationary needle cylin-

der **101** having a reduced upper section **102** and an enlarged lower section **103**. The needles are mounted in interiorly grooved vertical needle bars **115** which are retained in the lower section **103** by a clamp **117**. Similar needle grooves are provided on the exterior of the upper section **102** in accordance with the conventional practice, needles **120** and **130**, in the present instance three of each, being retained in the needle grooves by suitable retaining means **104**. The needles **120** and **130** are conventional in form including the usual hook **140** and latch **150**. The needles **120** and **130** are mounted for vertical reciprocation in the needle grooves and to this end, are provided with inwardly projecting butts **105** and **106** respectively which engage in cam tracks **107** and **108** formed in a rotary barrel cam **109** slidable on the stationary central post **110** of the needle cylinder. Means (not shown) is provided to cooperate with the lower portion **111** of the barrel cam **109** to rotate the same and effect vertical reciprocation of the needle in the stationary cylinder.

A rotary knitting head **113** is provided to cooperate with the vertically reciprocating needles **120** and **130** to form the knitted web. The head **113** is rotated in synchronism with the barrel cam **109** by conventional drive mechanism (not shown) and includes a tubular member **114** embracing the needles **120** and **130** when in their upper portion of their reciprocatory movement. Body yarn feed apertures **121**, **122**, **131** and **132** are provided in the tubular portion **114** to feed the body yarns **21**, **22**, **31** and **32** respectively as shown in FIG. 6. The tubular portion **114** terminates in spaced relation to the upper edge of the cylinder **101** to provide an annular slot **116** through which the knitted web may be drawn. In registry with the slot **116**, reinforcing yarn feeds **141** and **142** are provided for simultaneous rotation with the knitting head **113**. It should be noted that the reinforcing strand feeds **142** are positioned in registry with the work slot **116** defined between the tubular portion **114** and the upper end of the cylinder **101** so that it is possible to utilize a relatively stiff reinforcing strand, such as wire, inasmuch as the strand may be fed directly into overlying relation with the hose core **118** as it is advanced upwardly concurrently with the knitting of the composite fabric. In this manner, the reinforcing strand is wrapped about the hose core **118** in a tight helix devoid of kinks or turns, as best shown in FIGS. 2 and 4.

Rotation of the knitting head **113** and reinforcing yarn feeds **141** and **142**, in cooperation with the vertical reciprocation of the needles **120** and **130**, produces a cylindrical composite web which is formed about a hose core **118** which is advanced upwardly through a bore **119** in the cylinder **101** so that the upward withdrawal of the core **118** draws the knitted web upwardly within the bore of the tubular portion **114** of the knitting head. The reinforcing fabric **12** is composite of the two tubular webs having wales **20** and **30** respectively formed on the needles **120** and **130** respectively.

With reference to FIG. 7, the diagrammatic showing therein clearly illustrates the operation of the machine to produce the fabric **12**. It should be noted that the cam tracks shown diagrammatically at **107** and **108** in FIG. 7 are true developments of the cam tracks on the barrel cam, but are at a reduced scale relative to the needles by reason of the enlarged circumference of the cam with respect to the reduced circumference of the needle circle in the upper section **102** of the cylinder. Each of the cam tracks **107** and **108** comprises a relatively straight portion over the major part of the circumference thereof which retains the needles in their upper position within the tubular portion **114**. At points spaced by 180 degrees, the cam tracks dip downwardly as indicated at **124** and **125** to displace the needles downwardly to draw the wale loops. The dips **124** in the cam track **107** are in general registry with the yarn feeds **131** and **132** whereas the dips **125** in the cam track

108 are in general registry with the yarn feeds **121** and **122**. In this manner, the needle associated with a particular cam, is displaced downwardly to draw a stitch concurrently with the passage of the yarn feed associated with that needle. It should be particularly noted that the cam track **107** for the needles **120** is offset from the cam track **108** for the needles **130** by less than 90 degrees in order to insure proper cooperation of the needles with the yarn feeds to produce the desired composite fabric with the reinforcing strands positioned in front of each wale loop. The terminal part of the stitch draw portion of each cam which returns the needles to the upper position, is shaved as indicated at **126** to insure proper operation of the needles.

With reference to FIG. 7, the needles **120** are designated **120–1**, **120–2**, and **120–3** for the purpose of identification, each of the needles acting similarly as it is traversed by the rotary knitting head. The needles **130** are similarly designated **130–1**, **130–2**, and **130–3**. With reference to the needle **120–1**, it is in the position to be lowered by the cam track **107** as the feed **122** passes toward the left. The yarn **22** from the feed **122** is engaged in the hook of the needle **120–1** and the needle draws the yarn **22** to form a wale loop. As the loop is drawn, the adjacent body yarn **32** passes between the latch and the shank of the needle, and the yarn **32** is cast off with the previously-formed loop knit on the needle **120–1** with the yarn **21**. In this way, the yarn **32** and the reinforcing strand **42** pass in front of the wale loop as seen in FIG. 7, when the needle is elevated by the cam track **107**.

The needle **130–1** is displaced downwardly concurrently with the needle **120–1**, but by reason of the cam track **108** being offset from the cam track **107** by less than 90 degrees, the needle **130–1** is displaced downwardly slightly in advance of the downward displacement of the needle **120–1**. This advance displacement of the needle **130–1** insures that the yarn **32** engaged in the hook of the needle **130–1** is displaced downwardly below the latch of the needle **120–1**, so that it is positioned intermediate the latch and the shank whereby the yarn **32** is not plated or interknit with the yarn **22** within the hook of the needle **120–1**.

With reference to FIG. 4, the loop formed in the yarn **22** by the needle **120–1**, is the loop **24**. The yarn loop formed by the needle **130–1** in the yarn **32** is the loop **34**. The previously formed loop on the needle **120–1** is the loop **23** and it should be noted that the connecting run **35** between the adjoining loops **33** of the yarn **31** passes in front of the loop **23**, as does the reinforcing strand **41**. By the same token, the loop **33** previously formed on the needle **130–1** is positioned behind the reinforcing strand **41** and the connecting run **26** of the loops **24** so that the composite fabric shown in FIG. 4 is formed by the advance of the rotary knitting head **113** around the needles which are reciprocated by the barrel cam **109**.

Thus, the two webs which make up the composite fabric are knitted concurrently on two sets of needles which needles are interdigitated in alternating relationship. Adjacent needles of the two sets are displaced generally concurrently, with the leading needles of the two being drawn down slightly in advance of the trailing needle so as to insure displacement of the yarn in the hook of the first needle to a latch-clearing position below the latch of the adjacent needle of the other set, whereby the connecting run from the loop knitted on the first needle is cast off the second needle without being interknitted with the yarn in the hook of the second needle.

Where it is desired to have a more compact reinforcing fabric, the fabric shown in FIG. 8 may be made with only slight modification of the apparatus of the present invention. The fabric **50** illustrated therein is similar to the fabric **12** in that it is a composite of two separate webs each formed on two feeds. In this fabric, four reinforcing strands are embodied in the fabric. The wales

60 of the first web alternate with the wales 70 of the second web. The yarns 61 and 62 of the first web are formed into wale loops 63 and 64 and connecting runs 65 and 66 respectively. The yarns 71 and 72 of the second web are formed into wale loops 73 and 74 and connecting runs 75 and 76 respectively. The two webs are interknit as described above in connection with the fabric 12 so that the connecting runs of the webs intersect each other on lines diagonal to the course-wide direction thereof.

The fabric 50 embodies reinforcing strands 81, 82, 91 and 92. The strand 81 passes in front of the wale loops 63 in one course of the first web and follows the paths of the connecting yarn runs 65 of said course to pass in front of the wale loops 74 of the second web and behind the diagonal connecting runs 76. The reinforcing strand 82 passes in front of the wale loops 64 of the first web, and follows the paths of the connecting yarn runs 66 to thereby pass in front of the wale loops 73 of the second web and behind the diagonal connecting runs 75 of said second web. In a similar manner, the reinforcing strand 91 passes in front of the wale loops 73 in one course of the second web and follows the paths of the connecting yarn runs 75 of said course to thereby pass in front of the wale loops 63 and behind the diagonal connecting runs 65 of the first web. The reinforcing strand 92 passes in front of the wale loops 74 in one course of the second web and follows the paths of the connecting yarn runs 76 of said course to pass in front of the wale loops 64 of the first web and behind the diagonal connecting runs 66 of said first web. It is noted that the loops 63, 64, 73 and 74 are drawn to a length which is sufficient to permit the strands 81, 82, 91 and 92 to remain straight and parallel to one another without kinks.

The fabric of FIG. 8 may be formed by simply adding two additional reinforcing yarn feeds in the knitting head at points 90 degrees spaced from the reinforcing feeds 141 and 142. Of course, other modifications are possible within the scope of the invention; for example, it is possible to employ twelve needles rather than six to form a more dense fabric. In such a case, the needles alternate between the needles 120 and 130, but in other respects, the apparatus may be identical.

The use of four reinforcing strands in the reinforcing composite fabric may provide a much denser fabric, and when using relatively thick yarns, can produce the appearance of a braided fabric rather than a knitted fabric. In many cases, it may be desired to dispose the reinforcing fabric of FIG. 8 on the exterior of the hose to serve as a fabric covering for the hose, rather than embedding the fabric within the body portion of the hose as shown in FIGS. 1 and 3.

While the invention has been described in detail with reference to apparatus embodying two reinforcing strands, it is apparent that other embodiments of the invention are possible to satisfy any given requirements. For example, the main yarn feeds may be increased or decreased, as desired, and the travel of the knitted web within the cylinder may be either upwardly as shown or downwardly. The core 118 may also be omitted if desired. Other changes and modifications may be made in and to the apparatus and method illustrated and described herein without departure from the present invention as defined in the appended claims.

What is claimed is:

1. The method of knitting a composite fabric composed of two superimposed webs comprising the steps of providing two sets of needles arranged in interdigital relationship in a needle circle with the needles of one set alternating with the needles of the other set, knitting each web of the fabric on one of the sets of needles, feeding yarn

to said needles consecutively about the circumference thereof, and drawing-down said needles to form knit loops, one needle of each set being drawn down approximately concurrently with an adjacent needle of the other set, the leading needle with respect to the direction of yarn feed being drawn down slightly in advance of the subsequent needle to thereby position the yarn engaged in the hook of the leading needle below the latch of said subsequent needle so as to be cast off during the formation of a knitted loop by the subsequent needle.

2. Apparatus for reinforcing flexible hose comprising a circular knitting machine having a single hollow cylinder for receiving the hose core, two sets of knitting needles having hooks and latches mounted for longitudinal reciprocation in said cylinder between an extended limit position projecting beyond the end of said cylinder and a retracted limit position within the end of said cylinder, a knitting head mounted for rotation relative to said needles and cylinder including a tubular portion having a bore receiving said hose core and terminating in spaced relation to the end of said cylinder to define a work slot therebetween, yarn feed means in said head for each set of needles to introduce yarns into the hooks of the needles in the set, separate cam means for each set of needles mounted for rotary movement relative to said needles concurrently with said head, and reinforcing strand feed means in registry with said work slot to introduce reinforcing strands into the composite fabric formed by said two sets of needles, said cam means cooperating with said reinforcing strand feed means to position the reinforcing strand below the latches of the needles whereby upon displacement of said needles from their extended position, said reinforcing strand is cast off with the immediately preceding loop on said needles without engaging in the hook thereof and without being interknit with the yarn fed thereto, the reinforcing strand thereby being positioned at the same side of each wale loop formed by said needles.

3. Apparatus according to claim 2 wherein each of said cams has a stitch-draw portion in substantial registry with one of said yarn feeds for feeding yarn to the hook of the needles associated with said cams, the stitch-draw portions of said cams being positioned to displace a pair of adjoining needles of the two sets from the extended position to the retracted position substantially concurrently, the stitch draw portion of the cam for the leading needle of said pair being advanced to initiate retraction of said leading needle in advance of retraction of said adjoining needle to thereby insure positioning of the yarn in the hook of the leading needle and below the latch of the adjoining needle and avoid knitting of said yarn in the hook of the adjoining needle.

References Cited by the Examiner

UNITED STATES PATENTS

430,300	6/90	Rhome et al.	66—10
1,947,302	2/34	Meiwald	66—9 X
2,006,275	6/35	Meiwald	66—169
2,016,870	10/35	Meiwald	66—9
2,032,993	3/36	Larkin	66—9
2,066,408	1/37	Lombardi	66—190
2,201,905	5/40	Larkin	66—9 X
2,264,213	11/41	Larkin	66—190
2,870,619	1/59	Greczin	66—169

FOREIGN PATENTS

619,207	9/35	Germany.

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