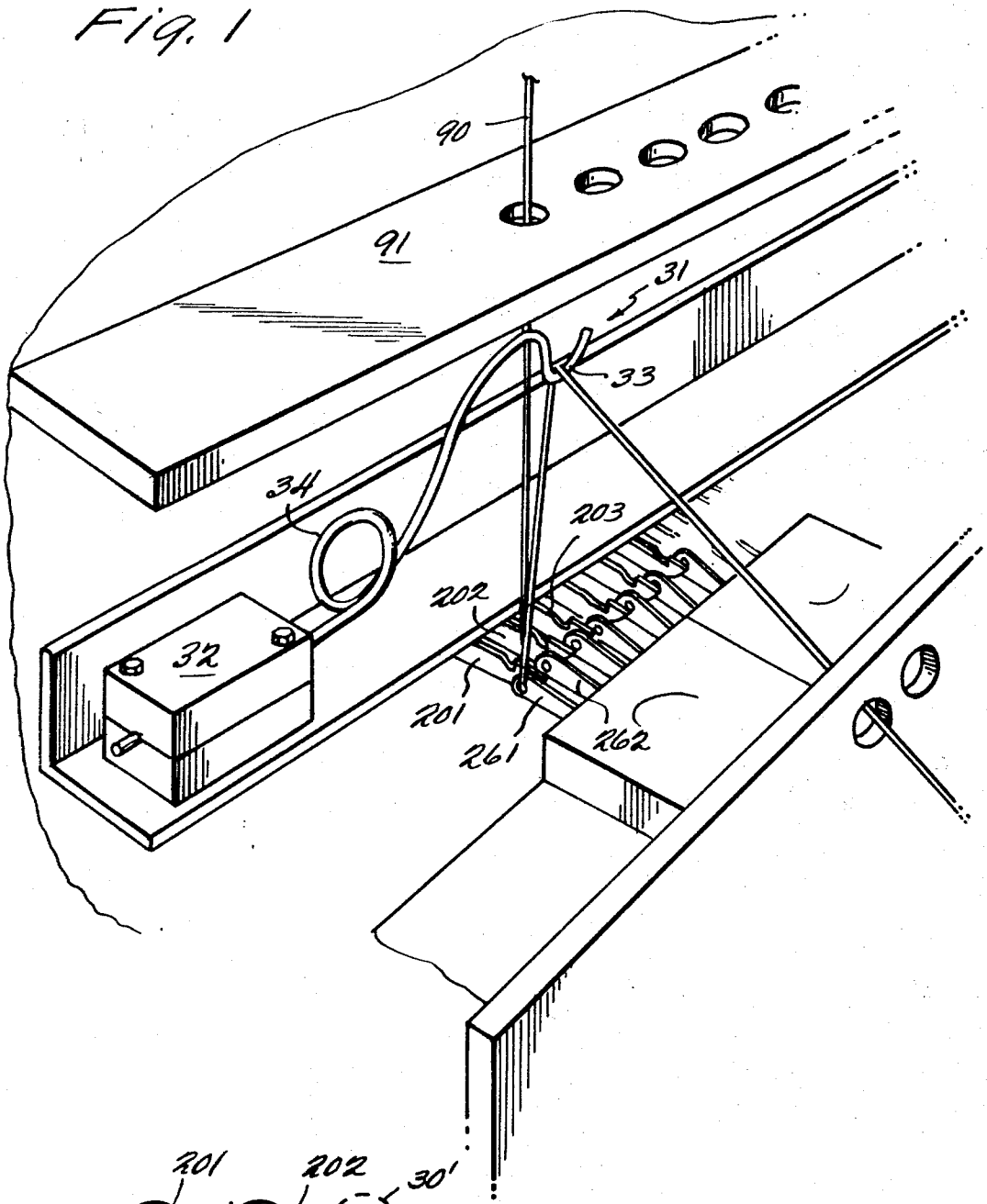
May 20, 1969 N. K. SHARPE 3,444,707

WARP KNIT FABRIC CONTAINING LOOSE FILLING AND HAVING UNFRAYED SELVAGE

Filed Sept. 7, 1967 Sheet 1 of 5

Fig. 1



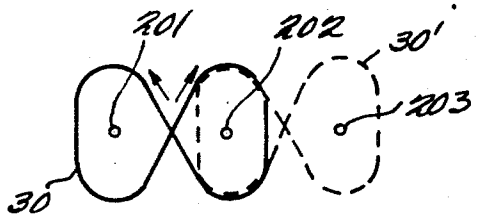


Fig. 5

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WARP KNIT FABRIC CONTAINING LOOSE FILLING AND HAVING UNFRAYED SELVAGE

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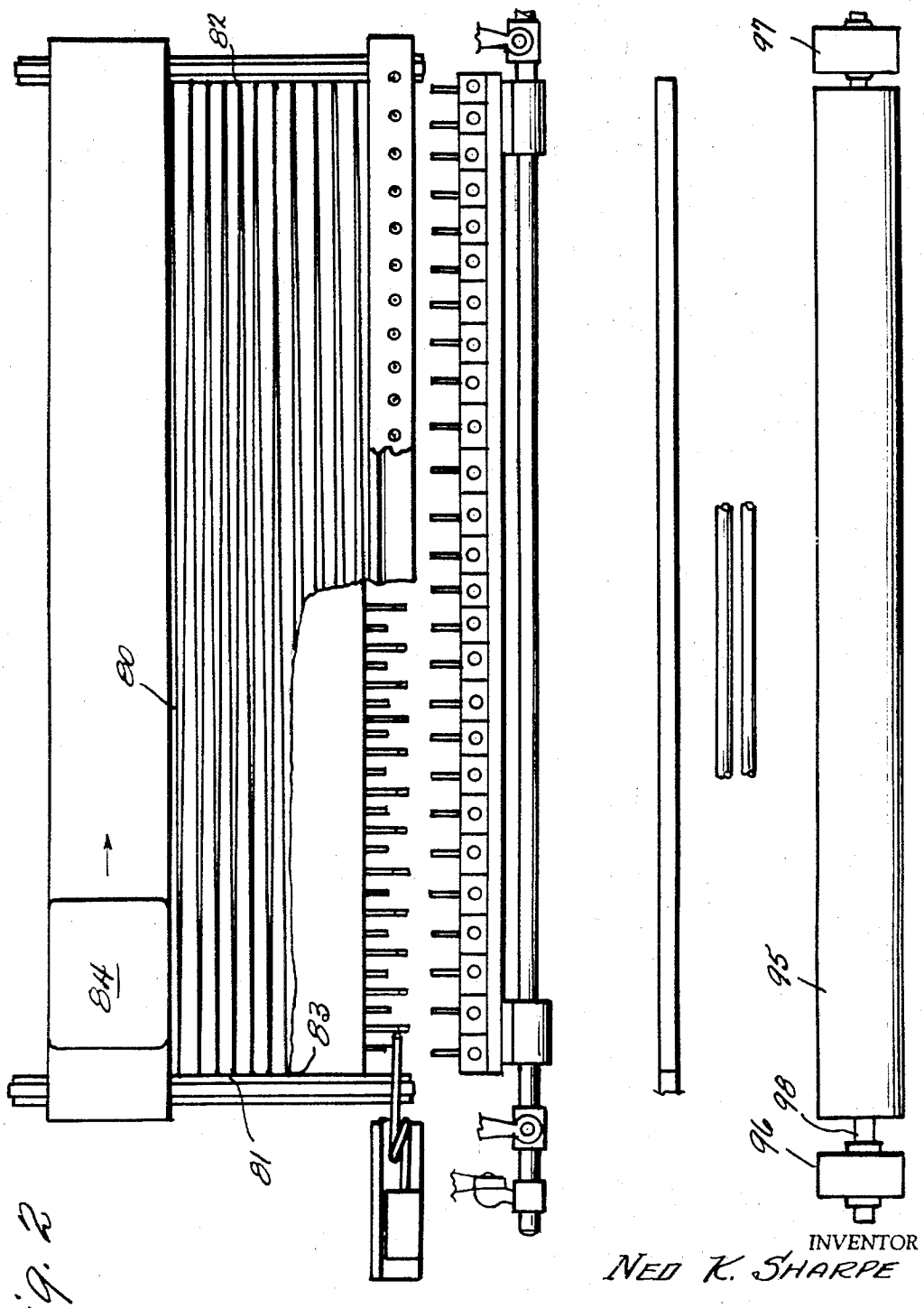


Fig. 2

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Filed Sept. 7, 1967 Sheet 3 of 5

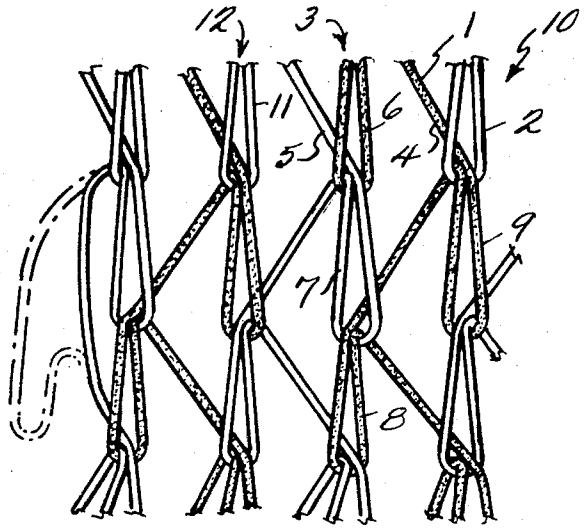


Fig. 6

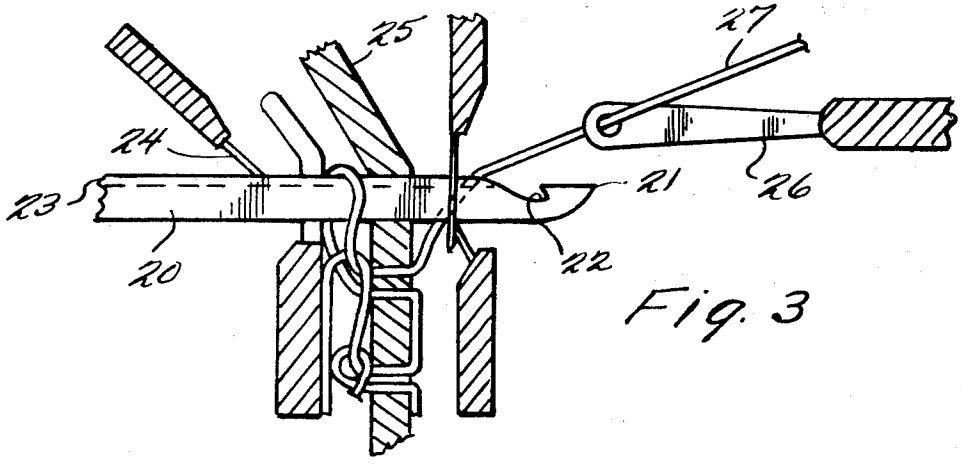


Fig. 3

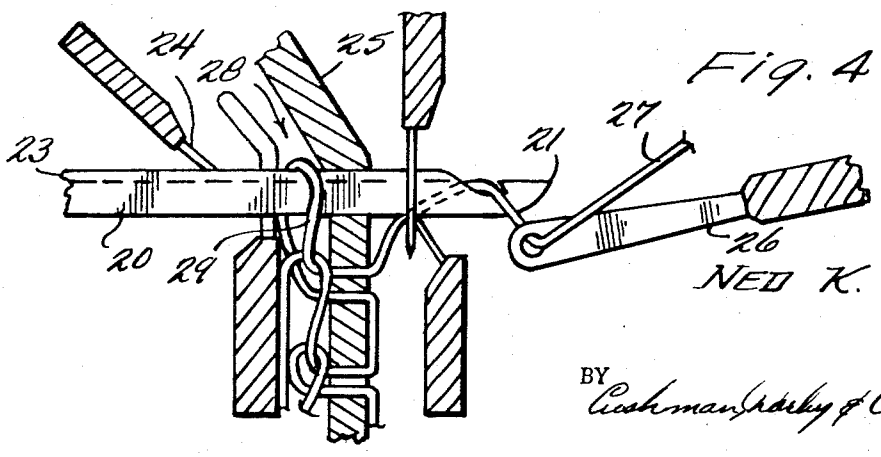


Fig. 4

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WARP KNIT FABRIC CONTAINING LOOSE FILLING AND HAVING UNFRAYED SELVAGE

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Fig. 7

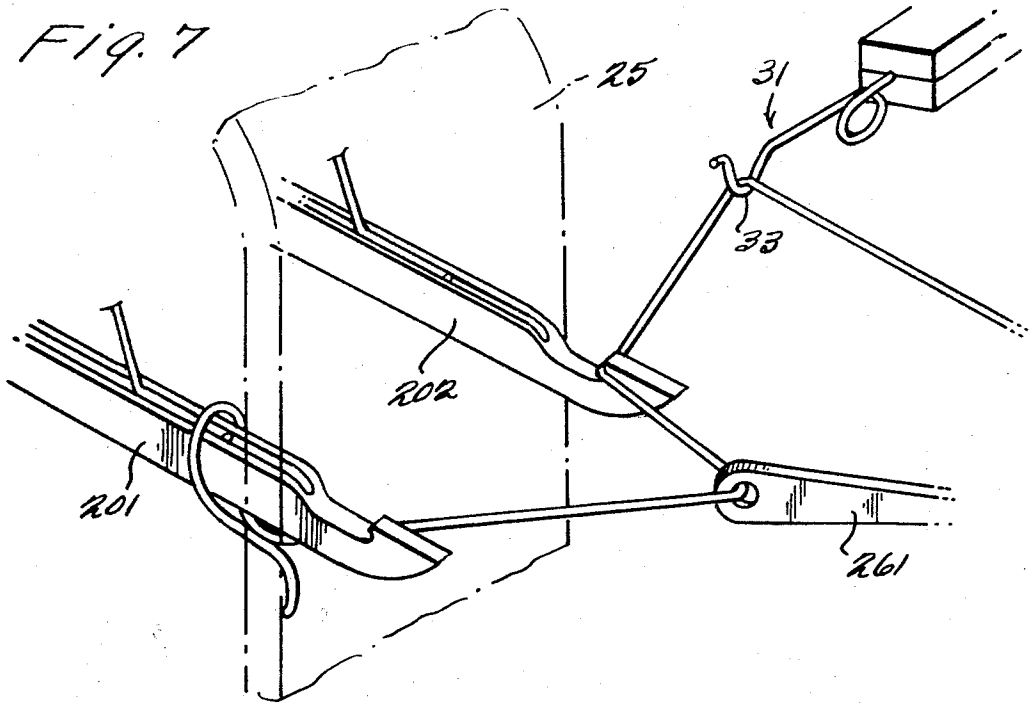
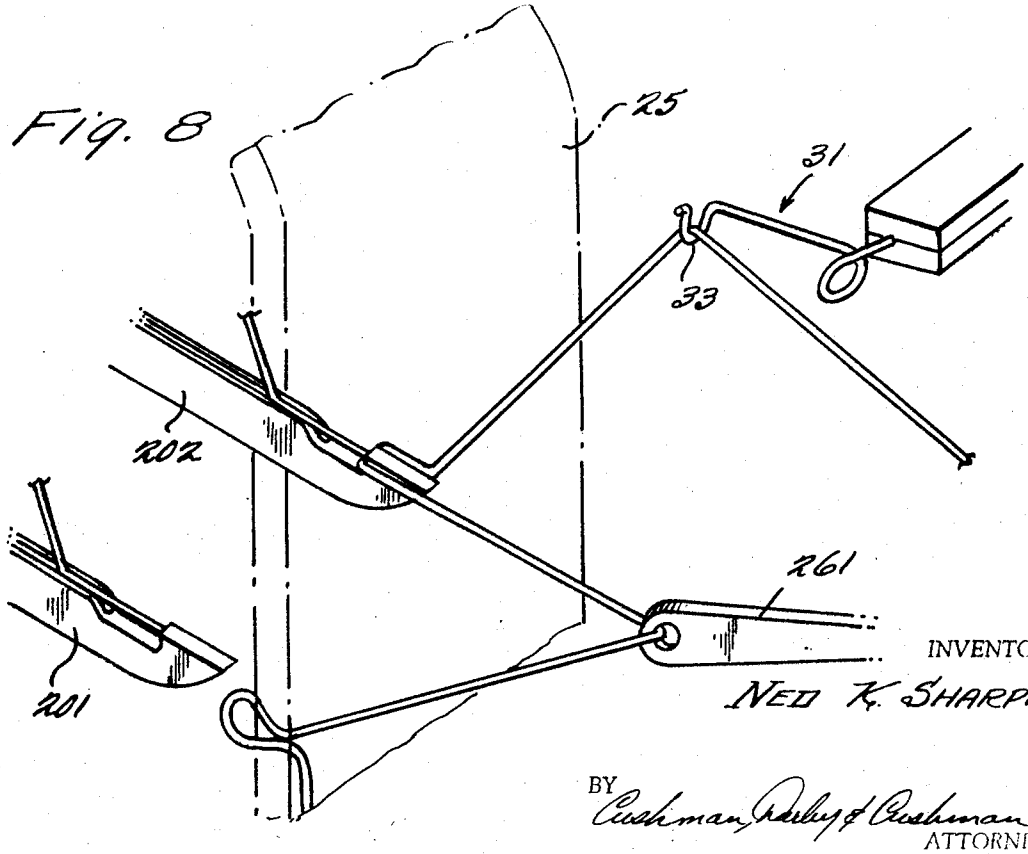


Fig. 8



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WARP KNIT FABRIC CONTAINING LOOSE FILLING AND HAVING UNFRAYED SELVAGE

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Fig. 10

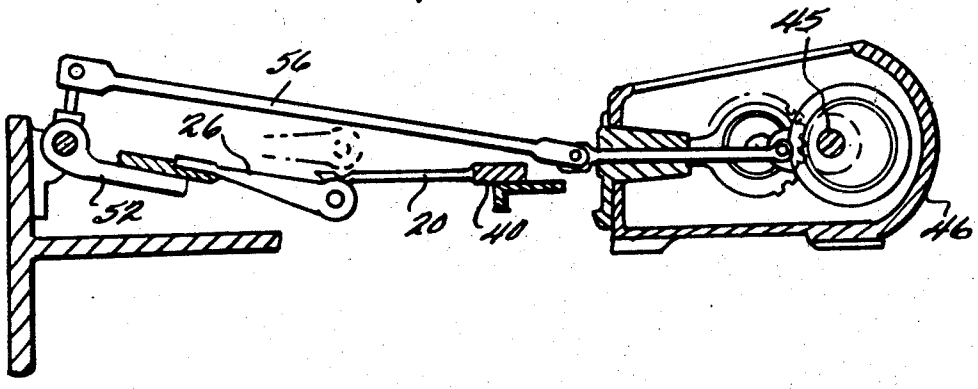
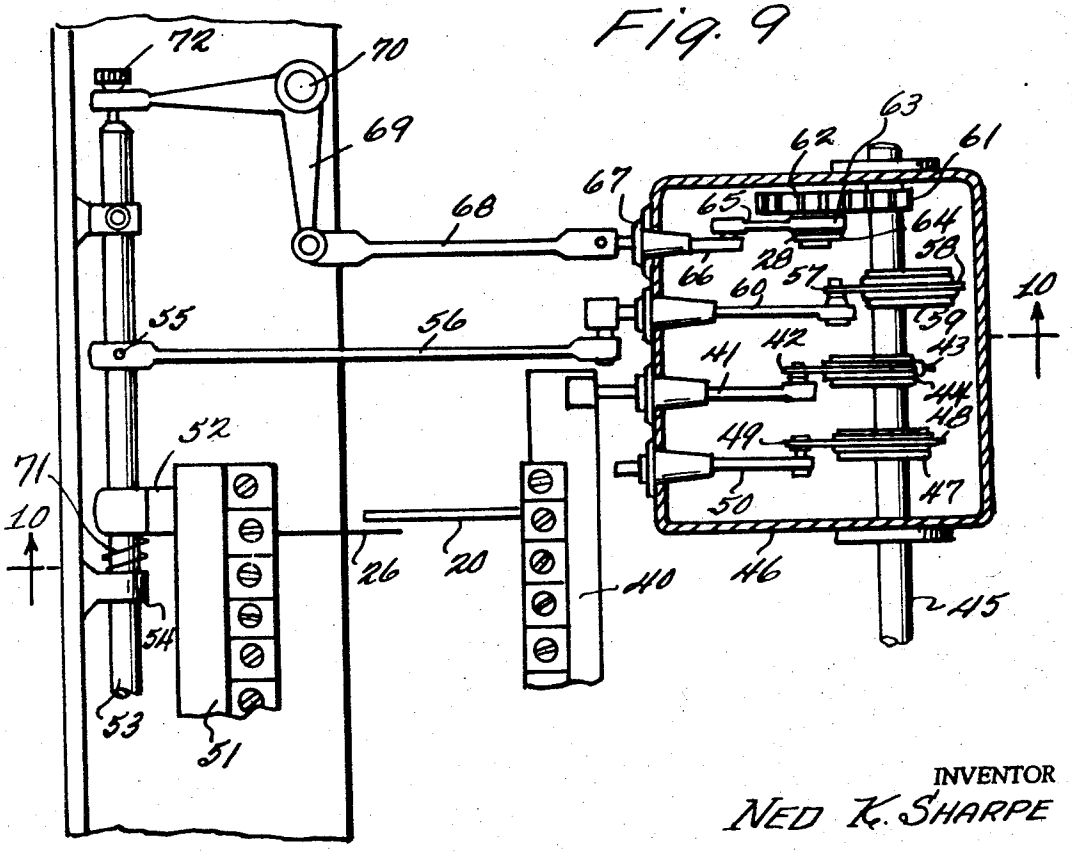


Fig. 9



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3,444,707

WARP KNIT FABRIC CONTAINING LOOSE FILLING AND HAVING UNFRAYED SELVAGE

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Filed Sept. 7, 1967, Ser. No. 666,057
Int. Cl. D04b 23/10
U.S. Cl. 66—190 3 Claims

ABSTRACT OF THE DISCLOSURE

A warp knit fabric knitted through a base material forming chain stitches of two yarns, alternately forming stitches in adjacent wales. The end most chain having one yarn forming stitches alternately with the adjacent wale and another yarn forming stitches alternately in the same chain.

The present invention relates to a fabric and apparatus and method for making a fabric. More specifically, it pertains to a kind of fabric having loose fibers or filling yarn laid in and bound together with interlocking chain stitches produced by warp knitting. Each chain of stitches is made from yarn which alternately forms stitches in adjacent rows.

For purposes of simplicity, the term "sewing" will be used herein to refer to the warp knitting operation. This term has found use in the textile industry in connection with this kind of fabric and avoids confusion because the word "warp" is used to refer to another yarn sometimes used in this type of fabric, as will be explained below. Similarly, for convenience, the threads which form these loops are referred to as "sewing thread."

Fabrics of this type can be made by forming a plurality of chain stitched rows of loops of sewing thread along an array of loose fibers or loose filling yarn. The stitches pass through the material at spaced points along the machine direction of the fabric and gather the filling yarn, and to a certain extent the loose fibers, into a plurality of clusters separated by spaces corresponding to the stitch insertion points. A plurality of stitches are formed simultaneously across the material, so that the spaces tend to be essentially continuous across the fabric, especially where yarns are used as the filling.

The present invention is concerned with one kind of this class of fabrics, in which the stitches of adjacent chains are interlocked, that is a tricot stitch. This effect is obtained by the manner in which the sewing thread is supplied to loop forming needles. The thread passes through guides which oscillate between adjacent needles. Each sewing thread end is alternately supplied to adjacent sewing needles, and each chain contains loops alternately formed from two different threads.

This type of stitch has several advantages. First, the inter-knitting of the two sewing ends increases the durability of the fabric. If simple chain stitching is used, one break in a sewing thread may result in an entire chain of loops being pulled out. In the interlocking stitch described above, each sewing thread is interlocked with two others; therefore, a broken thread will be held by two others.

Another advantage of this type of stitch is that it facilitates the use of warp yarns. It is known that dimensional stability of the fabric can be improved by laying warp yarns against one side of the filling material and fastening them down with sewing thread. In the interlocking stitch, zigzagging of sewing thread between adjacent chains of loops provides a convenient means for holding the warp yarn in place. The warp yarn is simply laid against the fabric before the sewing thread is moved over it by the sewing thread guide.

However, the interlocking chain stitch has an important disadvantage. That is, it results in loose threads at the sides of the fabric and a rough or irregular edge. This can best be understood by first considering the simple chain stitch. With that type of stitch, the loose filling yarns are held in clusters by the sewing thread as explained above. On one side of the filling, there is a loop for each stitch, and, on the other side of the filling, there is the sewing thread connecting between adjacent loops. Whereas the connecting thread zigzags between adjacent chains in the interlocking chain stitch, in the simple chain stitch it follows the same line as the loops. Therefore, at the edge of the simple chain-stitched fabric, the clusters of loose filling yarns are held together between the loops on one side and the connecting threads on the other side. by cutting the filling close to the last chain of loops, a neat unfrayed edge can be produced.

This cannot be accomplished in the warp knitting machines which employ the interlocking stitch. In this type of machine, at the edge of the fabric, two sewing threads form loops in the last chain. The first of these also is formed into loops in the next to the last chain. The second is used in alternate loops in the last chain. However, when the first thread is transferred to the needle which produces the last chain of loops, the second thread is transferred to the needle which is beyond the last chain. The second thread is formed into a loop by the needle, and then transferred back to the needle which forms the last chain, in time for the next stitch. Since this "next needle" is not supplied with sewing thread to form a "next stitch," the loop that it has just formed remains loose. Ultimately, it will pull out, leaving loose thread in the last chain of stitches.

This construction has several disadvantages. First, the loose thread in the last chain can result in loosening the entire chain, and is easily snagged. Second, the loose filling fibers or yarn are not properly held in clusters and give the edge a frayed appearance. Any attempt to trim the fabric close to the last chain of stitches will still leave the filling loose in each cluster.

It might seem possible to simply remove the "next needle" so that loose loops will not be formed. However, this is not convenient. For example, needles usually are supplied in sets of, say, ten, mounted on a single "lead." It would be very difficult to provide independent mounting of the needles unless they are spaced too far apart. Since a machine is used to produce a variety of widths of fabrics, it is supplied with needle sets across its full width, and the width of the fabric produced is determined by the number of sewing threads supplied. Therefore, removing the "next needle" would require limiting the variety of fabric widths to that corresponding to a number of needle sets, or modifying needle sets by removing individual needles. Neither is satisfactory.

A principal object of the present invention is to provide a fabric which avoids the above-described difficulty. Other objects are to provide a method of producing such a fabric and apparatus for carrying out the method.

In accordance with the present invention, the loose loops described above are pulled out before the sewing thread which forms them completes formation of another loop. Therefore, this sewing thread forms alternate loops in the last chain; the portion of that thread connecting between loops follows the chain of loops similar to the thread in simple chain stitching. This thread, then, tightly binds the clusters of loose filling along a straight line. If the fabric is sheared close to this line, it will have a neat, unfrayed edge.

Briefly stated, in accordance with a preferred embodiment, the above-described loose loop is pulled out by a resilient thread guide whose resilience is overcome by

yarn tension when the loose loop is formed, but which recovers as soon as the loop is cast off a needle, thereby pulling the loop open.

As used herein, the term "resilient" is intended to describe a member possessing resilience. The term "resilience," for present purposes, refers to the ability of a body to recover its size and shape after being deformed, by stretching, compression or the like. Therefore, the term "resilient thread guide" refers to a member in contact with the thread which is displaced when a loop is formed in that thread but which resumes its original position when the loop is cast off.

Various types of material can be formed into a fabric by sewing in accordance with the present invention. One preferred form of material is described in U.S. Patent 2,890,579. A plurality of loose filling yarns are provided from continuous yarns which are wound back and forth across a kind of tenter frame by a carriage, and around heddle hooks on moving conveyor belts at either side of the frame. The conveyors are moving while the carriage traverses the space between them, so that the filling threads are more or less oblique to the machine direction and in two sets which are oblique to each other. That is after a set of parallel threads are caught on the hooks of one of the conveyors, the carriage moves directly across to the other conveyor. While the carriage moves across, the conveyors are moving perpendicularly to the carriage and, by the time the carriage reaches the other conveyor, that other conveyor has moved a short distance. Therefore the heddle hooks on which the threads are caught on the second conveyor are not directly opposite the hooks used on the first conveyor, and the threads are oblique to the machine direction. When the carriage returns to the first conveyor, an opposite effect is observed, and the threads laid down are oblique to the machine direction and to the threads laid down in the previous traverse.

Subsantially any textile fibers can be used for the warp, filling and/or sewing thread. These include natural fibers such as cotton, wool, sisal, linen, jute and silk, man-made fibers and filaments such as regenerated cellulose rayon, polynosic rayon, cellulose esters, e.g. cellulose acetate, cellulose acetate/butyrate and cellulose triacetate and synthetic fibers and filaments such as acrylics, e.g. polyacrylonitrile, modacrylics such as acrylonitrile-vinyl chloride copolymers, polyamides e.g. polyhexamethylene adipamide (nylon 66), polycaproamide (nylon 6) and polyundecanoamide (nylon 11), polyolefin, e.g. polyethylene and polypropylene, polyester, e.g. polyethylene terephthalate, rubber and synthetic rubber, saran, glass, and the like. Sewing yarn sizes ordinarily are 15 to 1100 denier and filling yarns 15 to 3300 denier. When warp yarns are used, they may be, e.g. 15 to 6600 denier. Normally, stitches will be 0.4 to 4 mm. apart along the warp and about 1.13 to 3.57 mm. apart across the fabric. Typically, the sewn fabric weighs 2 to 35 ounces per square yard.

The filling threads mentioned above are cast off the heddle hooks after they are caught up by loops of sewing threads which gather them into clusters, separated by spaces where the sewing thread passes through the fabric. At the edges of the fabric, the filling threads reverse direction and form loops extending beyond the last chain of stitches. Alternately, these edge loops are severed from the body of the fabric, in the hope of producing a neat edge. Prior to the present invention, when interlocking chain stitching was used, a neat edge was not possible because of the loose sewing thread in the last stitch chain, as described above.

Another type of loose filling material which can be used in this type of fabric is a batting or non-woven fiber web. This is a web of loosely arrayed fibers of any of the types previously mentioned, extending more or less randomly in various directions. Webs of this type may be formed by depositing atmospherically suspended fibers onto a moving screen, for example by suction applied through the screen. Webs also can be produced by carding a picker lap, and thickness can be increased by cross-laying a web in known manner. Strictly speaking, a batting or the like cannot be described as loose filling because the fibers are arranged more or less randomly in all directions. However, since a portion of the fibers will be more or less transverse or oblique to the loop chains, especially when derived from a cross-layed carded web, it can be considered to comprise loose filling for purposes of the present invention. Depending upon the relationship between the fibers, fabrics of this type may exhibit a tendency for the filling to be gathered into clusters by the sewing thread.

The invention will be better understood from the following detailed description of preferred embodiments, reference being made to the drawing, in which:

FIGURE 1 is a perspective view of the portion of the apparatus where loop chains are formed;

FIGURE 2 is a plan view of the apparatus, some parts being omitted for clarity;

FIGURE 3 is a cross-section of a portion of the apparatus;

FIGURE 4 is a cross-section similar to FIG. 3 but showing the parts after they have moved in the next step of operation;

FIGURE 5 is a schematic drawing showing the path of movement of a thread guide about adjacent sewing needles;

FIGURE 6 is a view of the fabric on greatly enlarged scale, the filling material being omitted for clarity;

FIGURE 7 is a perspective view, on greatly enlarged scale, of a portion of the apparatus but with some parts omitted for clarity showing sewing thread being layed into the sewing needles;

FIGURE 8 is a view similar to FIG. 7, but at a subsequent stage in the operation;

FIGURE 9 is a plan view, partially in section, of a portion of the apparatus showing the means for operating the needles and thread guides; and

FIGURE 10 is a cross-section along lines **10—10** of FIG. 9.

As seen in FIG. 6, the sewing thread in the fabric is formed into interlocked chain stitching substantially along the warp or machine direction. Each sewing thread **1** is formed into a plurality of loops **2** spaced along the length of the fabric, each loop passing through the fabric. The loops are formed into parallel chains, but each chain is formed from two threads which alternately are formed into stitches of adjacent chains. For example, one chain of loops, designated **3** in the drawing, is formed from two threads **4** and **5**. A first loop **6** is formed from thread **4**, the next loop **7** is formed from thread **5** and the next loop **8** is formed again from thread **4**, etc. Thread **4** also is formed into loops **9** in the chain **10** on one side of chain **3**, alongside loop **7** and other loops in chain **3** which are formed from thread **5**. Similarly, thread **5** also is formed into loops **11** in a chain **12** on the other side of chain **3**, alongside loops **6** and **8** in chain **3**. The arrangement is such that each sewing thread is interlocked with two others in adjacent stitch lines so that, if a thread breaks, it will not pull out a succession of stitches as it would if each chain were formed from a single thread.

The formation of this chain stitching is illustrated in FIGS. 3 and 4. A needle **20** is provided which has a point **21** at one end and a hook **22** adjacent the end. There is a groove **23** in the upper surface of the needle in which slides part of a bent wire latch **24**. The needle is mounted for horizontal reciprocating motion.

A web **25** moves downwardly across the path of the needle, and as the needle reciprocates it alternately pierces and is withdrawn from the web, the web being advanced downwardly while the needle is withdrawn.

A thread guide **26** is provided to insert the sewing thread **27** into the hook **22** when the needle extends

through the web. As can be seen by comparing FIGS. 3 and 4, the thread guide moves up alongside the needle, across it and down on the opposite side, laying the thread in the hook **22** as it moves across. Then the needle is retracted and the latch **24** moves across the hook. At the same time, the web **25** moves down past the needle. As the needle moves forward to receive sewing thread again, the thread previously placed in the hook slides back onto the shank of the needle as seen at **28** to form a loop **29**. When the needle retracts again and the latch **24** closes, the loop **29** slides forward toward the tip of the needle, pushed if necessary by the upright portion of latch **24**. Since the hook **22** is closed by the latch, the loop **29** slides over the hook and is cast off the point **21** of the needle. At the same time, the thread in the hook is pulled through loop **29**.

The thread guide **26** is mounted to alternately move up and across two needles, designated **201** and **202** in FIG. 5. Therefore, it describes a figure eight path **30**.

The problem which the present invention avoids can best be understood from FIG. 5. Assuming that a needle **201** is the needle at the edge of the fabric being manufactured, one thread guide designated **261** (see FIG. 1) describes the path **30** and alternately lays thread into needles **201** and **202**. An adjacent thread guide **262** alternately lays thread in needle **202** and the needle **203** which is adjacent to needle **202**. Thus, when the thread guide **261** is laying thread into needle **201**, thread guide **262** is laying thread into needle **202**. When the next stitch is formed, thread guides **261** and **262** lay thread into needles **202** and **203**, respectively. But no thread is laid into needle **201**. Therefore, when needle **201** is retracted, the loop on its shank is cast off, but there is no thread in its hook to pull through the loop. Therefore, that loop is left loose.

The present invention provides means for pulling out that loop before another loop is formed by needle **201**, so that the thread is pulled tight behind the line of loops formed by needle **202**. As seen in FIGS. 1, 7 and 8, this is accomplished by a resilient thread guide **31** over which passes the thread supplied to the thread guide **261**. The resilient thread guide **31** is a piece of spring steel, firmly mounted at one end to the frame of the apparatus, for example by a block **32**. The free end of the resilient thread guide **31** is bent to form a kind of hook **33** over which the sewing thread passes. There also is a single loop **34** formed in the wire between its ends, to give it controlled resilience. The resilience of the guide **31** is sufficiently weak to be overcome by thread tension when a loop is formed by needle **201**, but sufficiently strong to pull out a loose loop of thread after it is cast off the needle **201**. Thus, when a loop is formed on needle **201**, the thread pulls the guide **31** down, and when the loop is cast off and is loose, the guide **31** elevates and pulls out the loose loop. This sequence is illustrated diagrammatically in FIGURES 7 and 8.

For rapid machine operation, it is advisable to use circular eccentric cams for actuating the needles and the thread guides. As shown in FIG. 9, a needle bar **40** carrying the needles **20** is actuated by a connecting rod **41** extending from an eccentric rod **42** linked by a strap **43** of an eccentric cam **44** which is rotated by the motor-driven shaft **45** supported by a housing **46**. Similarly, the reciprocating movement of the latches **24** required for closing the hooks of the needles is obtained by means of an eccentric cam **47** cooperating with a strap **48** actuating, through an eccentric rod **49**, a connecting rod **50** that actuates the brackets to which the latches **24** are attached through a cam. The holders of the thread guides **26** are fastened to a guide bar **51** which, by means of suitably attached lever arms **52**, is fixedly mounted on a shaft **53**. This shaft, being rotatably mounted within bearings **54**, is adapted to slide longitudinally back and forth and carries a short lever **55**.

Lever **55** is connected with a coupling rod **56** linked to an eccentric rod **57**. Rod **57** with its strap **58** encloses the eccentric cam **59** which, by means of an intermediate connecting rod **60**, moves the thread guides up and down. Aside from this reciprocating movement, the thread guides must undergo an axially transverse back and forth movement in order to insert threads into the hooks of the needles and to alternate between needles. For this purpose, the thread guides **26** and the shaft **53** carrying the same are operated to perform one complete back and forth movement while the needles are moved twice in and out. To accomplish this, a pinion **61** keyed to the shaft **45** engages a spur wheel **62** of twice its size. Consequently, the spur wheel rotates at half of the speed of the shaft **45**.

Spur wheel **62** is fixedly connected with an eccentric cam **63** whose strap member **64** is linked by an eccentric rod **65** to a connecting rod **66** axially slidable in a bearing **67**. When in operation, the rod **66** and its linkage **68** impart axial reciprocation to the shaft **53** by actuating an angle lever **69** rotatably mounted to a pivot **70**. The tension spring **71** fastened about the shaft **53**, between one of the bearings **54** and the adjacent lever arm **52** of the guide bar **51** aids the axially oscillating movement by forcing the shaft against an adjusting screw **72** connecting the free end of angle lever **69** to that of the shaft **53**.

The filling yarn supply is illustrated in FIG. 2. For simplicity, a single yarn is shown, indicated by the numeral **80**. At opposite sides of the apparatus, there are chains **81** and **82**, each trained around sprocket wheels and driven by a motor, not shown. On each of the chains **81** and **82** there are a plurality of upright heddle hooks **83** around which the yarn is wound. Filling yarn is laid in place by a yarn guide mounted on a mobile carriage **84** which is traversed back and forth above the chains **81** and **82**. The arrangement is such that as the carriage moves a bit past the hooks on one side of the chains, the chain moves and the yarn is turned around one or more hooks. Then the carriage moves in the opposite direction across to the other chain and past that chain so that the procedure is repeated.

In actual practice, the carriage **84** carries several yarn guides and a plurality of yarn ends is laid down as superimposed layers, each layer being at an angle to the layer next to it. The filling yarn remains in this position until loops are formed by the sewing operation, and the filling is cast off the chains **81** and **82**. Then the filling takes the forms of generally parallel clusters of yarn separated by spaces at sewing thread stitch insertion points.

In lieu of this type of filling yarns, various types of non-woven materials may be used. They may be supplied from a beam and carried to the sewing needles by the chains **81** and **82**.

In some cases, the fabric may use warp yarn which is simply laid under the sewing thread and against the filling. The warp yarn **90** is supplied downwardly against the filling through a yarn guide **91** as seen in FIG. 1.

A special arrangement must be provided for supplying the sewing thread. In the conventional machine described previously, a single sewing yarn package supplies a plurality of ends, one for each thread guide. However, in using the present invention, this is not possible because the outermost sewing thread forms only one half as many loops as threads forming loops at the interior of the fabric. To maintain proper tension, it is necessary that the outermost sewing thread not unwind from the package at the same rate as other threads. Therefore, in accordance with the present invention, the outermost sewing thread is supplied from a separate package, capable of unwinding at a different speed from thread used at the interior of the package. The arrangement is illustrated in FIG. 2 in which three sewing yarn packages are indicated by the numerals **95**, **96** and **97** on a beam **98**. Sewing thread ends are supplied from these packages through appropriate thread guides and tensioning devices, not shown, to the thread guides **26** which lay them into the sewing needles **20**. The packages **96** and **97** each supply one end to the

outermost thread guides **20** while the package **95** supplies a plurality of ends to the other thread guides **20**. All three packages are mounted on the beam **98** to be capable of rotation at separate speeds. If the package **95** is mounted to the beam and the beam is rotatable, the packages **96** and **97** must be mounted on the beam with bearings to rotate independently. If the packages are unwound by a power drive, rather than through thread tension, obviously packages **96** and **97** must be driven at slower speed than the package **95**, i.e. at about half speed.

Various changes may be made in details of construction and mode of operation without departing from the scope of the invention, as defined in the appended claims.

What is claimed is:

1. In a fabric having a filling comprising a plurality of loose filling yarns or fibers and a plurality of chains of loops of sewing threads along one side of said filling generally perpendicular to said loose filling yarns or fibers with sewing thread connected between loops extending through said filling and along the other side of said filling,

the sewing threads in said fabric alternately forming loops in adjacent chains and each chain containing loops alternately formed of two different sewing threads;

the improvement in which a laterally outermost chain of loops is formed of (a) a first sewing thread which alternately forms loops in said outermost chain and

in the chain next to it and (b) a second sewing thread which only forms loops in said outermost chain alternately with loops formed from said first sewing thread and

the portions of said second sewing thread connecting between loops being substantially taut against said other side of said filling and substantially in line with said outermost chain of loops.

2. A fabric as set forth in claim **1** in which said filling comprises loose filling yarns gathered into substantially parallel clusters separated by spaces where said sewing thread passes through said filling.

3. A fabric as set forth in claim **1** in which said filling comprises a carded non-woven fiber web.

References Cited

UNITED STATES PATENTS

2,442,796	6/1948	Young	66—86
3,262,287	7/1966	Woodcock	66—90
3,274,805	9/1966	Duhl	66—84
3,365,918	1/1968	Hughes	66—85

RONALD FELDBAUM, *Primary Examiner.*

U.S. Cl. X.R.

66—193