Jan. 2, 1968 H. P. LANDGRAF 3,360,964

WARP-KNITTING MACHINE AND WARP KNITTING MADE THEREBY

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Fig. 1.

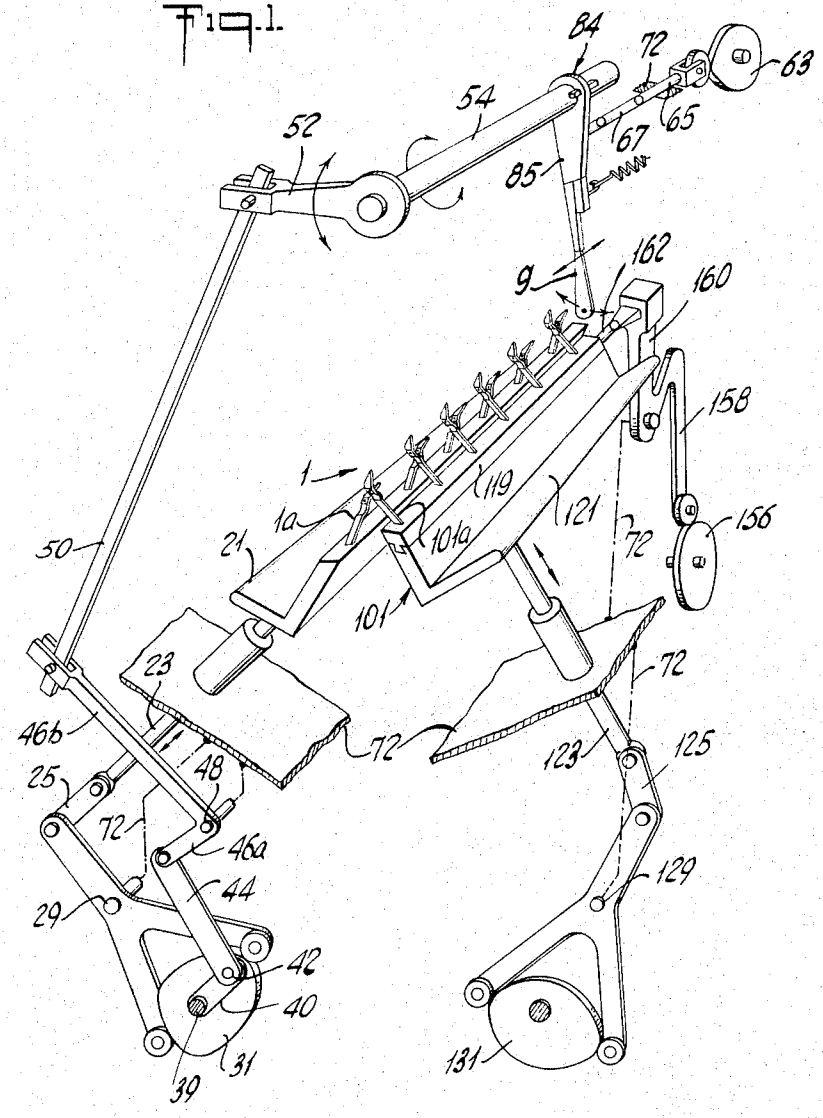
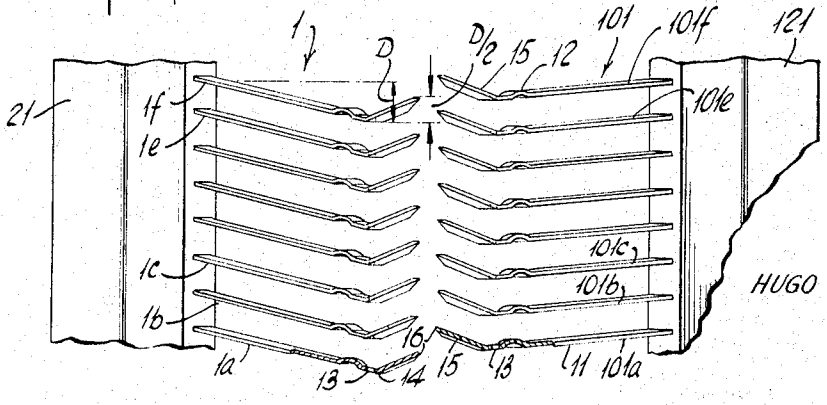


Fig. 2.



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Fig. 3a.

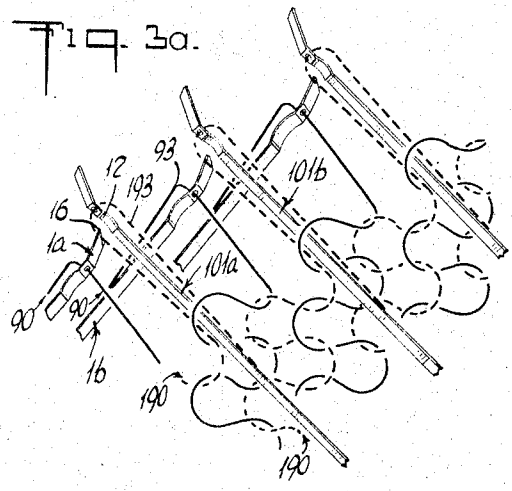


Fig. 3b.

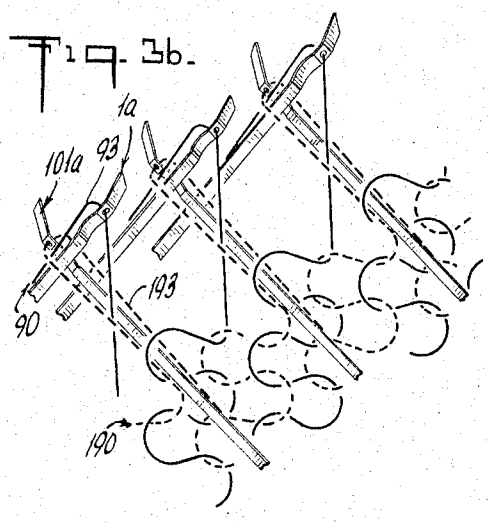


Fig. 3c.

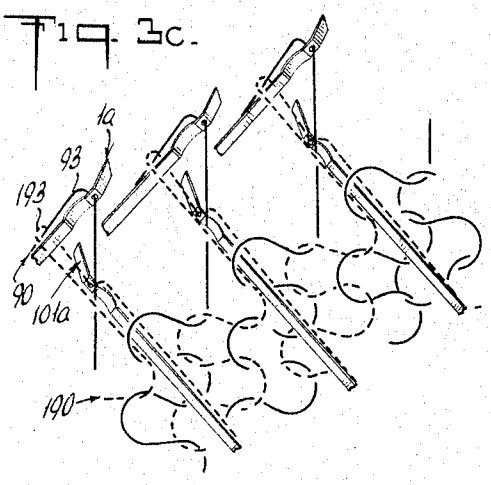


Fig. 3d.

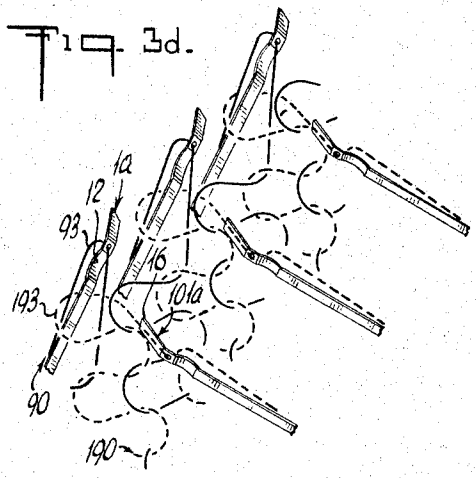
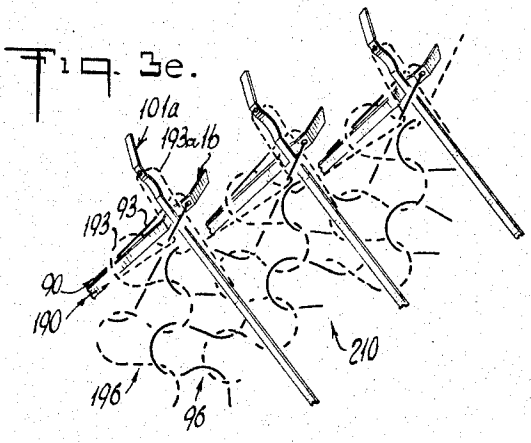


Fig. 3e.



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Fig. 4a.

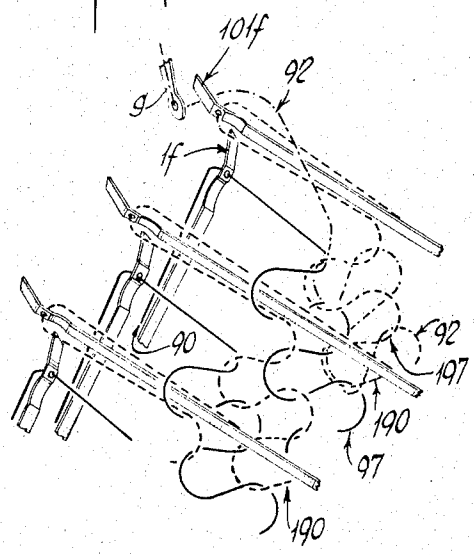


Fig. 4b.

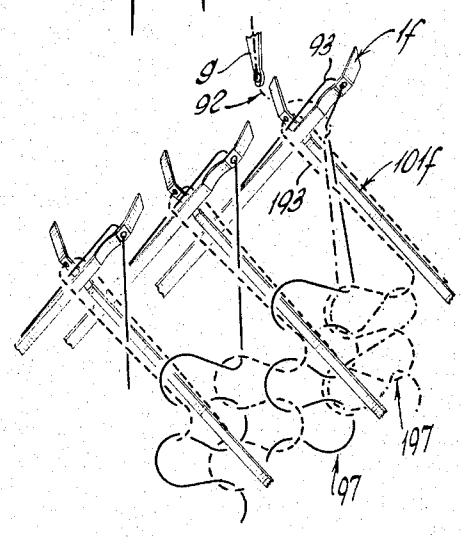


Fig. 4c.

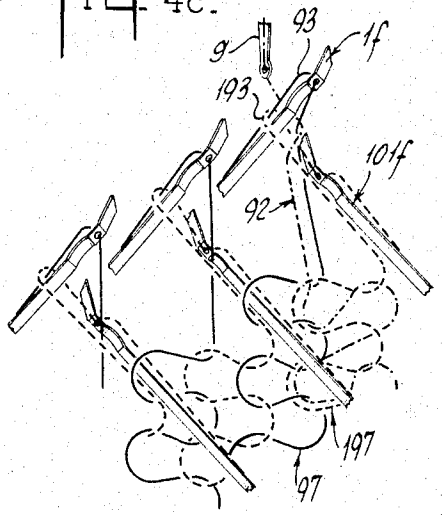
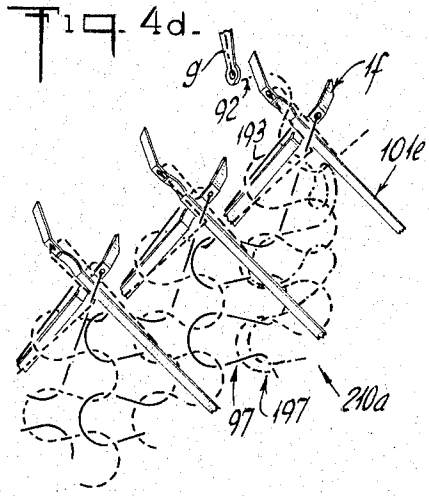


Fig. 4d.



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Fig. 5a.

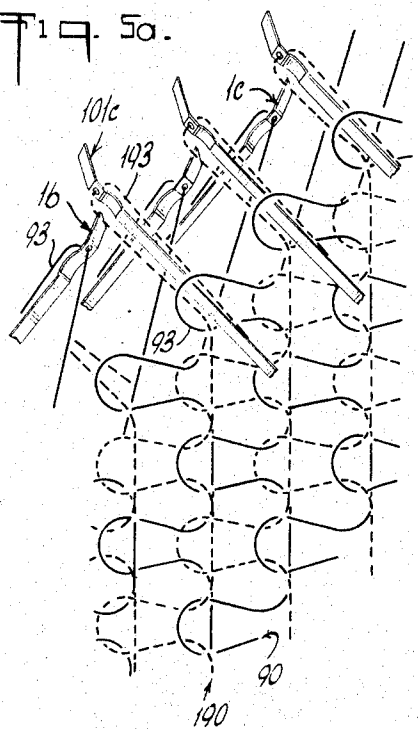


Fig. 5b.

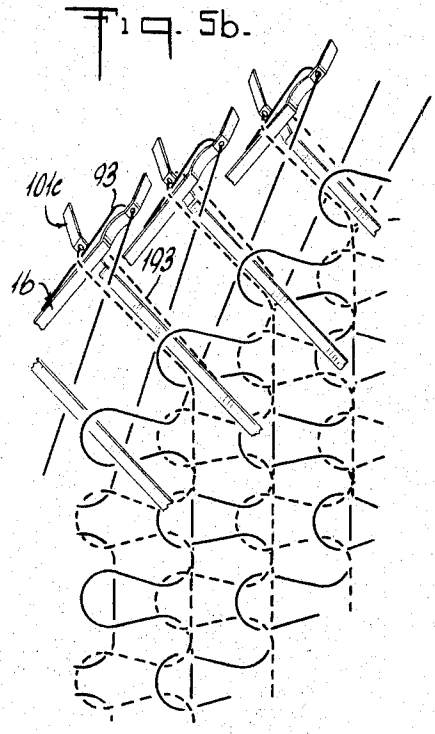
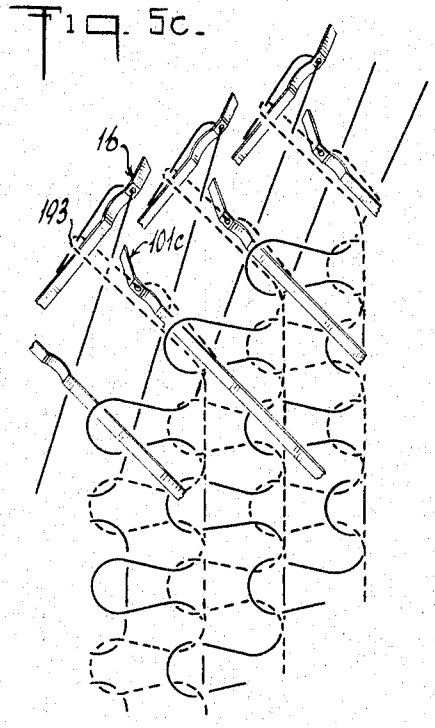


Fig. 5c.



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Fig. 5d.

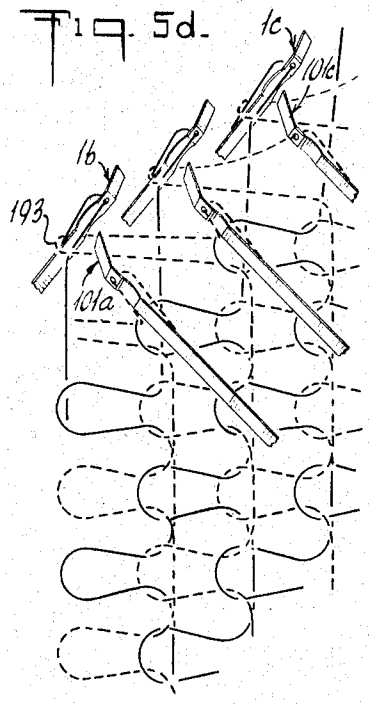


Fig. 5e.

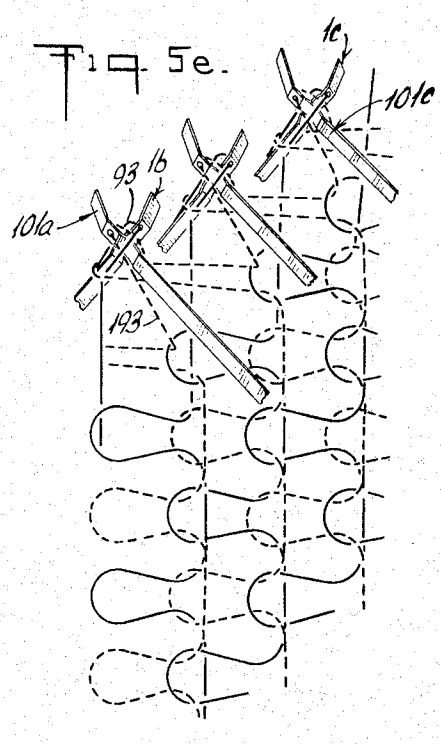
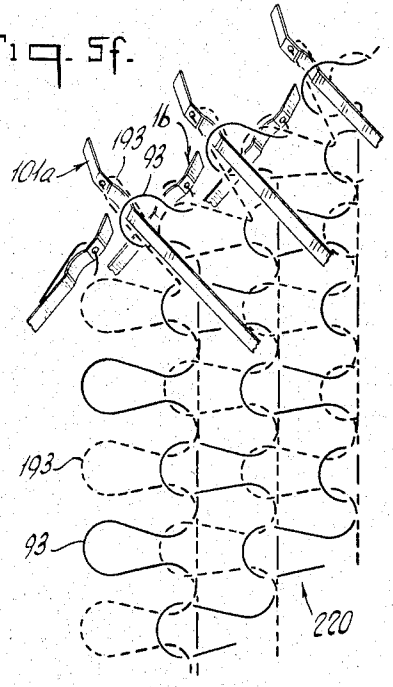


Fig. 5f.



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HUGO PAUL LANDGRAF

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3,360,964

WARP-KNITTING MACHINE AND WARP KNITTING MADE THEREBY

Hugo Paul Landgraf, Limbach-Oberfrohna, Germany, assignor to Veb Werkmaschinenbau Limbach-Oberfrohna, Limbach-Oberfrohna, Germany

Filed Jan. 6, 1965, Ser. No. 423,687
12 Claims. (Cl. 66—88)

The present invention relates to a warp-knitting machine and to a warp knitting produced by said machine. In particular, the warp-knitting machine is equipped with two rows of eye needles by means of which a warp kitting is formed by mutual loop transfer, with courses extending parallel to the longitudinal axis thereof. The front portions of all the eye needles are bent obliquely toward one side.

A known machine for the production of such warp knits is equipped with pointed eye needles which are straight. In order to interconnect on this machine the vertical courses, formed by the eye needles, into a continuous knit, one of the two rows of eye needles is set off with respect to the other row by one needle division or gauge after each loop transfer. The resulting warp knit has generally crossed stitches, that is, it is a twist warp knit, namely in left-left (purl-purl) fashion.

Another machine of the kind here entering into consideration has eye needles which are obliquely bent off to the side in front, by about one half needle division. The bend is located between the shank and the front end of these eye needles, the front end being parallel to the shank and presenting a hole. The eye needles are thus somewhat Z-shaped. The arrangement is such that the eye needles of one row are all bent to one side, e.g. to the left, while the needles of the other row are bent to the other side, namely to the right.

For the production of a continuous knit also on this machine one eye-needle row must be staggered or set off after each loop transfer in relation to the other row, namely by one needle division, so that the result is a left-left twist warp knit.

This known machine also provides to bring about the staggering by mutual displacement of both needle rows by one half division each, the two rows being staggered in the same direction in several stitch-forming processes stepwise to one side and then back again by the same distance. In this way likewise a left-left twist warp knit is formed, but with atlas character.

Further, one eye-needle row in this machine may be stationary in longitudinal direction and only the other row is progressively staggered or displaced (in one and the same direction) by one half needle division each, in order then to return again. The result is a left-left warp knit with atlas character, but in which one course with open stitches alternates with one whose stitches are crossed.

It is the object of the present invention to provide a warp-knitting machine on which warp knits with exclusively open stitches can be produced, and a knitted fabric made thereby.

It is also the object of the invention to provide a novel knitting machine wherein specially arranged eye needles are used for producing a new type of knitted product.

It is a further object of the invention to provide a warp knitting wherein the courses extend parallel to the longitudinal axis of the product, the courses being formed by mutual loop transfer. The knitting corresponds, with respect to the stitch pattern, to simple hoisery goods and is therefore desirable for various purposes. Moreover, such a product has the advantage of better stretchability in the direction of the stitch courses as compared with twist knits.

According to one of the important features of the warp-knitting machine of this invention, the front portions of the eye needles are obliquely bent to the same side in both needle rows, forming obtuse angles with the respective needle shafts.

Another feature relates to the fact that said eye needles have protrusions on their sides toward which the front portions are bent, and that the two eye-needle rows are so arranged in relation to each other that the free needle ends or points in one row are approximately opposite the summit or outermost points of the needles in the other row.

It is yet another feature of the inventive machine that the eye needles used therein have an inclination in their front portions which, as compared to the summit of the protrusions, corresponds to approximately one-half needle division or gauge.

As far as the fabric is concerned which is made by the warp-knitting mentioned above, it is an important feature of one of the possible fabrics that a smooth left-left warp knit is produced where all stitches of all courses are open.

According to another feature, a different fabric may be made which is a warp knit, left-left crossed, where in the courses as well as in the wales a stitch formed by one warp yarn alternates with a stitch consisting of the other warp yarn, all stitches of all courses being again open.

Other objects and advantages of the invention will be appreciated and more fully understood with reference to the following detailed description, when considered with the accompanying drawings, wherein

FIG. 1 is a somewhat schematic, perspective illustration of the major operating elements in the warp-knitting machine according to the invention, some co-operating elements being omitted for the sake of clarity;

FIG. 2 is a planar arrangement of a number of eye needles of both needle rows, seen from above, with the operating elements of FIG. 1 omitted for the sake of clarity;

FIGS. 3*a* through 3*e* are illustrations of the production of a left-left warp knit having open stitches exclusively, in five successive stages;

FIGS. 4*a* through 4*d* show the provision of the warp knit made according to FIGS. 3*a*–3*e* with a solid longitudinal edge or selvedge at both end courses, in four stages; and

FIGS. 5*a* through 5*f* are illustrations of the production of a left-left crossed warp knit, in six stages.

It should be noted that FIG. 3*e* includes the partial illustration of one fabric embodiment while FIG. 4*d* is a variant thereof; finally, FIG. 5*f* shows a different fabric made by the warp-knitting machine according to the invention.

The warp-knitting machine illustrated in FIG. 1 is equipped with two opposite rows **1**, **101** of eye needles **1***a*, **101***a*, for example, secured to respective needle bars **21**, **121** in a conventional way, and arranged approximately at right angles to each other (see also FIGS. 3*a*–3*e*, etc.). Each of the needles has the following parts, as illustrated in FIG. 2: a shaft portion **11**, followed by a protruding portion **12**, an eye **13** for a warp yarn, the outermost or summit point of the needle being denoted **14**, a front-end portion **15** and a needle tip or point **16**. The shafts **11** and the front ends **15** form an obtuse angle.

The needles of both rows extend obliquely to opposite sides with respect to the needle bars. The direction of inclination amounts to about one needle division or gauge between the needle bases and the outermost points **14**, as shown in FIG. 2 by letter D. The deflection of the front portions **15** with respect to the points **14** amounts to about one-half needle gauge, marked *D*/2.

It should be noted that the slant of the needle shaft **11** between the summit point **14** and the needle base avoids that the eye needles interfere with one another during their operation, and especially that the needles shear off the warp yarns during loop transfer.

The needles of both rows are bent to the same side, i.e., the summit points **14** of all needles **1***a*, **1***b*, **1***c*, or **101***a*, **101***b*, **101***c*, etc., point to the same side (that is, downwards when viewed in FIG. 2), just as the tips **16** of all needles point to the other side (upward in FIG. 2). The two eye-needle rows **1**, **101** are so arranged in relation to each other that the tips **16** in one row are located approximately opposite the summit points **14** in the other row. The protrusions **12** are on the sides to which the needle tips point. The cooperation of these needle pairs will be described in full detail somewhat later in the specification.

Each needle bar **21**, **121** has respective rods or bolts **23**, **123** secured thereto for moving the needle rows **1**, **101** up and down, perpendicularly to the longitudinal axis of these rows, so as to perform a mutual transfer of loops between respective needle pairs, as will be explained later. For the sake of clarity, only one bolt is shown for each needle bar. The bolts **23**, **123** are axially guided in a machine frame portion, the frame being generally designated **72** in FIG. 1 of the drawing. By way of guide rods **25**, **125** the bolts **23**, **123** are connected to three-armed levers **27**, **127** which, in turn, are supported by the machine frame **72**, as shown at **29**, **129**, respectively. These levers **27**, **127** are actuated by cam disks **31**, **131**.

The cam disks **31**, **131** thus impart to the needle bars **21**, **121** and the needles attached thereto an ascending and descending motion. The shafts carrying the cam disks **31**, **131** are coordinated in their rotation so as to provide the needle movements required for the particular knitting operation to which the machine is set up.

For the sake of clarity, weft guides and supporting rails therefore have not been shown in FIG. 1. Also, the mechanism (e.g. cam-operated roller slide) for imparting a reciprocating movement to the guide rails has been omitted.

A machine is described and claimed therein which has features common with the present application, but includes eye needles which are bent, in their entirety, toward one side in one row and toward the other side in the other row (rather than having front portions which are bent obliquely to one side, as in the present disclosure).

Both machines, that of the present and that of the copending application, also feature operational elements specific to and co-operating with the particular type of needles for producing the respective fabrics made by the machines.

Reverting now to the machine illustrated in FIG. 1, it will be seen that needle row **101** is not attached directly to bar **121** but is arranged on an auxiliary bar **119** which is guided in bar **121** for longitudinal displacement. The actuating mechanism comprises a control shaft, coordinated with the afore-mentioned shafts of the cam disks **31**, **131**, which carries a cam disk **156** serving to impart a reciprocating movement to the auxiliary bar **119**. The cam disk **156** is associated with a roller lever **158** pivotally journaled in a portion of machine frame **72**. Lever **158** is connected with bar **119** by way of an angle lever **160** which is coupled to the auxiliary bar **119** by means of rod **162**.

An auxiliary eye needle or yarn guide **9** is likewise shown in FIG. 1. This needle is movable both in longitudinal direction of the eye-needle rows **1**, **101** and also at right angles thereto, as indicated by the arrows. The operation of this needle or guide **9** will be described in more detail with reference to FIGS. 4*a* through 4*d*.

For the execution of the first-named movement another cam disk **63** is carried by a control shaft. The disk **63** is associated with a roller slide **65** guided for axial movement in a portion of the machine frame **72**. A shaft **54**, to be described somewhat later, carries a support **85** for the auxiliary needle **9**, the support being connected with the slide **65** by way of a coupling rod **67**. A tension spring serves to hold the support **85** and the outer end of slide **65** against the cam disk **63**.

The connection between the shaft **54** and the support **85** is by conventional means, schematically shown at **84**, which may consist of a key and a groove, for axial displacement of support **85** with respect to shaft **54** while pivoting therewith.

The shaft **54** has the purpose of performing the second-named movement of needle or guide **9**, namely its lateral pivoting. For this purpose, the shaft **39** which carries the cam disk **31** has a crank **40** rigidly connected therewith. A crank pin **42** on the crank **40** has a coupling rod **44** connected thereto which is articulated on a first arm **46***a* of a bell-crank lever; its journal **48** is stationary (e.g., by being rigid with the frame **72**) while a second arm is identified by **46***b*.

The bell-crank arm **46***b* is connected, by way of a coupling rod **50**, with a lever **52** which is fixedly connected to the afore-mentioned shaft **54**.

Each needle row **1**, **101** carries a yarn chain (not shown in FIG. 1). Each pair of oppositely arranged needles (e.g. **1***a*, **101***a*) cooperates in producing various warp knits, as will be explained and shown with reference to the successive operation stages shown in FIGS. 3*a*–3*b*, 4*a*–4*b* and 5*a*–5*f*, to be described hereafter in detail.

With the machine according to the invention it is possible to produce warp knits in various stitch constructions, whose courses extend parallel to the longitudinal direction of the fabric in the usual manner, but whose stitches are all open. This will be explained somewhat later with reference to two specific examples of products that can be produced with the machine.

In one case, the machine can be used so that both eye-needle rows are stationary in longitudinal direction during the production of the knit, so that each eye needle of one row, which during the preceding stitch-forming step has transferred its loop to an eye needle of the other row, takes up during the next step the loop of the adjacent needle of the afore-mentioned other row.

Another possibility of use of the warp-knitting machine according to the invention is that one of the two eye-needle rows, after it has taken up the loops of the other row, can be shifted and moved back by one needle division or gauge to the side to which the needle summits point, before it is again made operative for the take-up of the loops of the other needle row. Thus each eye needle of one row, which has taken up a loop of the needle of the other row, offers its loop to the second next needle of this other row, and this latter needle in turn presents its loop to the second next needle of the first-named row.

Example 1

For the purpose of producing a warp knitting generally denoted **210** (see FIG. 3*c*), the two eye-needle rows **1**, **101** are held fixed in their longitudinal direction during the production of the knit, namely in the mutual arrangement shown in FIG. 2. According to FIG. 3*a*, the needles in row **101** are close to their raised position. These needles carry loops **193** consisting of warp yarns **190** shown in broken lines, which are offered to the needles in row **1** for uptake.

The needles of row **1** now move upward so that their tips **16** are inserted into the loops **193** of row **101** in the zone of the protrusions **12**. Together with FIG. 2 it can be visualized that, for example, the needle **1***a* enters into a loop **193** which is carried by the needle **101***a* of the opposite row.

According to FIG. 3*b*, needle row **1** is in its raised position; therefore the loops **193** are now traversed by the

needles of row **101***a* and into them is inserted a loop **93** of the needle row **1**, consisting of warp yarn **90**. Now the needles of row **101** withdraw, while the needles of row **1** remain in the position of FIG. 3*b*. Owing to this expedient the loops **193** of row **101***a* get to hang on the needles of row **1**, as shown in FIG. 3*c*.

As per FIG. 3*d*, the needles for row **101***a* are in their lowered position. These needles are thereafter brought back to the raised position for the next stitch-forming stage in order to take up the loops **93** of row **1**. Now the needles of row **1** withdraw a little so as to have their protrusions **12** opposite the tips **16** of the corresponding needles of row **101***a*.

It is visible from FIG. 3*e* how the needles of row **101**, brought into the raised position, now pass through the loops **93** of the needles in row **1**. Now the needles in row **101***a* each draw a new loop **193***a* into the loop **193**. Thereafter row **1** is pulled back to the lowered position so that the loops **93** now hang on the needles of row **101**, as did in the preceding cycle or step the loops **193** on the needles of row **1**.

It should be noted here that the eye needle **101***a* does not take up the loop **93** of needle **1***a* but that of the adjacent needle **1***b*, as is clear from the planar arrangement appearing in FIG. 2. In FIG. 3*e*, the eye needle **1***a* is omitted for greater clarity.

Owing to the particular configuration of the eye needles, courses **196** (shown in broken lines) and courses **96** (shown in solid lines), FIG. 3*e*, are mutually interconnected in a continuous smooth left-left warp knit **210** without requiring the shifting or staggering of one or the other of the eye-needle rows **1** or **101**. Moreover, all stitches of all courses **96**, **196** are open. The afore-mentioned courses are directed in the finished product parallel to the longitudinal direction of the knit, that is, vertically; the wales are consequently disposed at right angles thereto, that is, horizontally.

It is preferable to assign the auxiliary eye needle or yarn guide **9** to the three eye needles **1***f*, **101***f* and **101***e* participating in the formation of the end courses, as illustrated in FIG. 1 and also in FIGS. 4*a* through 4*d*. The auxiliary eye needle **9** carries a special yarn **92** which serves to make two end courses **97**, **197** into a firm longitudinal edge or selvedge. The needle **9** covers the needle **101***f* when the needles have a position corresponding to FIG. 3*a*.

As FIG. 4*a* shows, the special yarn **92** is placed over the shank of the needle **101***f* and then under the free end thereof. When needle **1***f* then passes through loop **193** of needle **101***f*, needle **1***f* engages over the yarn **92** so that the latter at the same time grips loop **93** of needle **1***f* from behind, as FIG. 4*b* shows.

When the needles of row **101** are pulled back for the transfer of their loops **193** to the needles in row **1**, the yarn **92** lies above the respective loop **193** and behind loop **93** of needle **1***f* (FIG. 4*c*). Thereafter, the loops **93** in the needle row **1** must be taken up by needle row **101**. The auxiliary needle **9** now lays its special yarn **92** over and then under the needle **101***e*, when the latter has passed through loop **93** (FIGS. 3*a* and 4*d*). In the finished knit, identified as **210***a*, the yarn **92** traverses the sinker stitches of the courses **97**, **197** so that they are locked. In FIG. 4*d*, the eye needle **101***f* is omitted for greater clarity.

Example 2

As has been explained with reference to FIG. 1, one of the eye-needle rows, namely row **101**, is laterally displaceable by one needle division or gauge. The movement is toward the side in which the summits **14** point (that is, downward in FIG. 2), and back again, to produce a warp knit left-left crossed. The product resulting thereby is generally identified in FIG. 5*f* as **220**.

According to FIG. 5*a*, on the shanks of the needles in row **101** there hang the loops **93** which come from the needles in row **1**. Row **101** now offers its loops **193** to row

1, and for this purpose the former has first been moved by one needle gauge in the afore-mentioned direction. Compared with FIG. 2, therefore, eye needle **101***c*, for example, has taken over loop **93** of needle **1***c* and, in view of the lateral shift of needle row **101**, it now cooperates with needle **1***b*.

According to FIG. 5*b*, needle **1***b* passes through loop **193** of needle **101***c* and in so doing pulls a new loop **93** into loop **193** of needle **101***c*. As FIG. 5*c* shows, row **101** is now returned to its original position (the one shown in FIG. 2), so that loop **193** of needle **101***c* hangs on needle **1***b*. Thereafter, row **101** is displaced again by one needle division or gauge (in downward direction, as viewed in FIG. 2). Thus, needle **101***a* again cooperates with needle **1***b*, and needle **101***c* with needle **1***c* (FIG. 5*d*).

According to FIG. 5*e*, needle **101***a* enters loop **93** of needle **1***b* and in so doing again pulls a new loop **193** into the same. Thereafter row **1** goes back so that loop **93** of needle **1***b* now hangs on needle **101***a* (FIG. 5*f*). For the following stitch-forming step the row **101** must be displaced again, as described. In the left-left warp knit **220** thus produced, a stitch **193** formed by warp yarn **190** alternates, in the courses as well as in the wales, with a stitch **93** which consists of the other warp yarn **90**. In addition, it should be noted, all stitches are again open.

It may also be mentioned that the machine is also capable of working so that one of the two eye-needle rows, after it has taken up the loops of the other row, shifts and then moves back again by one needle division to that side to which the needle tips point (instead of the side having the summits), before it is again made operative for the take-over or transfer of loops of this other row. The result will be that each needle in one row which has taken up a loop of the needle in the other row again offers its loop to the same needle in said other row.

The result of this further operation, not described in detail, is a weft-chain knitting which consists, on the one hand, of fringes formed by pairs of double courses presenting upon stitches and, on the other, of weft yarns which interconnect the fringes, each weft yarn surrounding or embracing with its reversing points two needle stitches of the outer course of two double courses each; in addition, the weft yarns traverse the sinker stitches thereof.

The foregoing disclosure relates only to preferred embodiments of the invention, which is intended to include all changes and modifications of the examples described within the scope of the invention as set forth in the appended claims.

What I claim is:

1 A warp-knitting machine comprising, in combination, two rows of reciprocable eye needles adapted for mutual loop transfer, a needle bar for each row of said eye needles, means for independently reciprocating each needle bar substantially at right angles with respect to one another, wherein each needle has a shaft portion and a front portion obliquely bent to the same side in both eye-needle rows, there being an outermost summit point on each needle between said shaft and said front portions, the ends of the front portions in one eye-needle row being approximately opposite said summit points of the needles in the other eye-needle row, and means for guiding respective warp and weft yarns to said eye-needle rows.

2. A warp-knitting machine according to claim **1**, wherein said front portions of the eye needles are pointed.

3. A warp-knitting machine according to claim **1**, wherein the eyes of said needles are in close proximity to said summit points.

4. A warp-knitting machine according to claim **1**, wherein each needle has a protrusion between said shaft and said front portions, said protrusions being toward that side of said eye needles toward which said bent front portions are directed, the ends of the front portions in

one eye-needle row being approximately juxtaposed to said protrusions in the other eye-needle row.

5. A warp-knitting machine according to claim 1, wherein said shaft portions are obliquely bent off with respect to said needle bar of the respective row in a direction opposite to that in which said front portions are bent.

6. A warp-knitting machine according to claim 1, further comprising means for keeping said eye-needle rows stationary in longitudinal direction while reciprocated, whereby each needle of one row transfers a yarn loop formed thereon to a first needle of the opposite row while taking up a similar yarn loop in the next operational stage from a second needle of the opposite row adjacent said first needle.

7. A warp-knitting machine according to claim 1, further comprising means for longitudinally displacing at least one of said eye-needle rows between successive operational stages, whereby different adjacent needles of one row are made to cooperate with the same needle of the other row.

8. A warp-knitting machine according to claim 7, wherein said displacing means is operative to move said at least one row in the direction toward which said summit points are directed.

9. A warp-knitting machine according to claim 7, wherein said displacing means is operative to move said at least one row in the direction toward which said front portions are bent.

10. A warp-knitting machine according to claim 7,

wherein said displacing means is operative to move said at least one row substantially by one full needle division.

11. A warp-knitting machine according to claim 1, further comprising at least one auxiliary yarn guide and means for guiding a special yarn to at least some of said eye needle in both rows.

12. A warp-knitting machine according to claim 11, wherein said special yarn is led by said auxiliary yarn guide to at least one terminal eye needle in each row, said terminal needles forming outermost stitches which constitute a selvedge.

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MERVIN STEIN, *Primary Examiner.*

R. FELDBAUM, P. C. FAW, *Assistant Examiners.*