

[54] **METHOD AND APPARATUS FOR FORMING A RIB FABRIC HAVING A TWO-PLY SECTION**

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 [51] Int. Cl. .... **D04b 9/06, D04b 15/54**  
 [58] Field of Search .... **66/131, 141, 22, 196, 197, 66/19, 125 R, 25**

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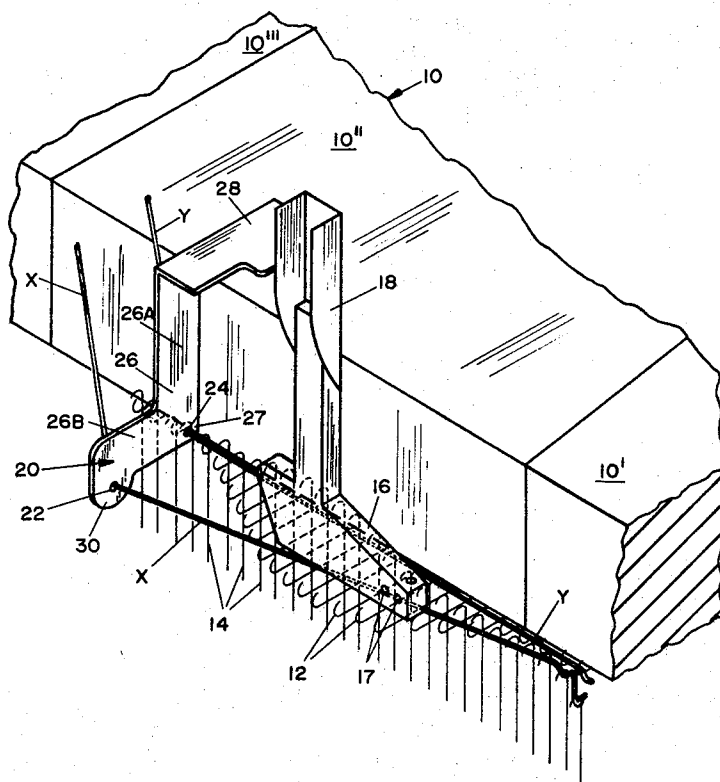
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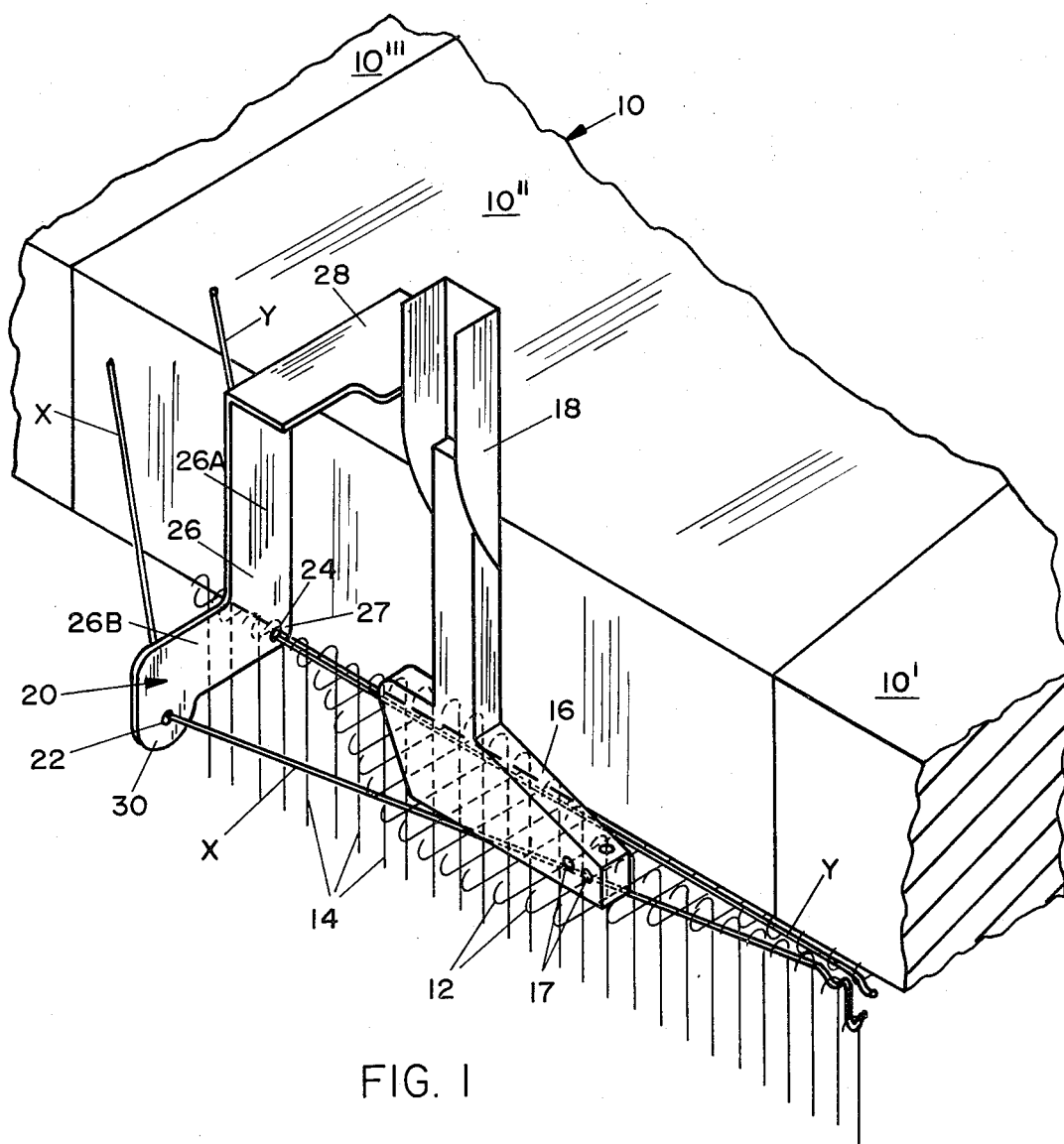
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[57] **ABSTRACT**

The method of knitting two-ply segments extending coursewise of a rib fabric on a knitting machine of the type having two sets of needles, for example cylinder and dial needles, a plurality of feeds, and means at a selected feed for guiding the yarn forming each ply into the path of the hooks of the needles on which it is being knit and into the hook-opposite side of the other set of needles. The feeding of the yarns to their respective sets of needles is carried on at a single yarn feed without reliance on any special cams or delayed timing.

**5 Claims, 15 Drawing Figures**





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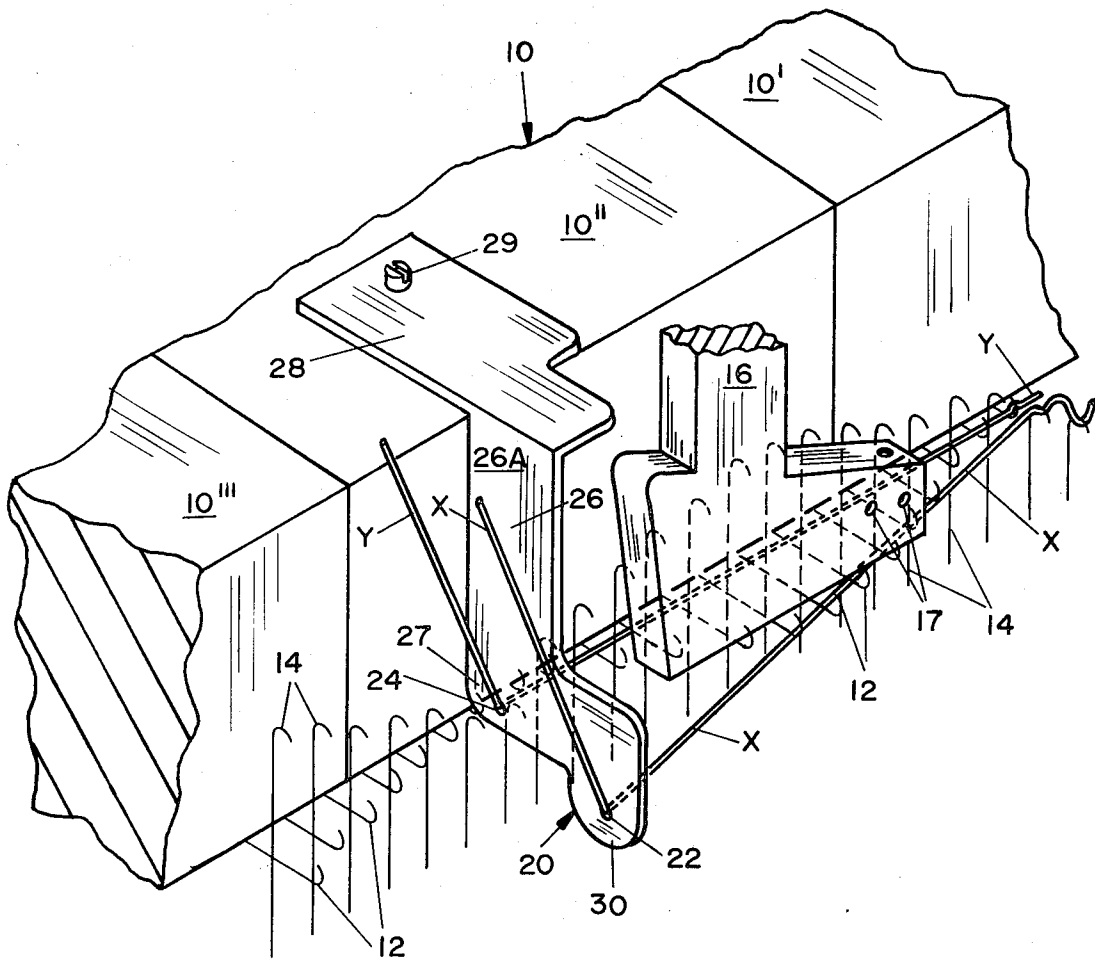


FIG. 2

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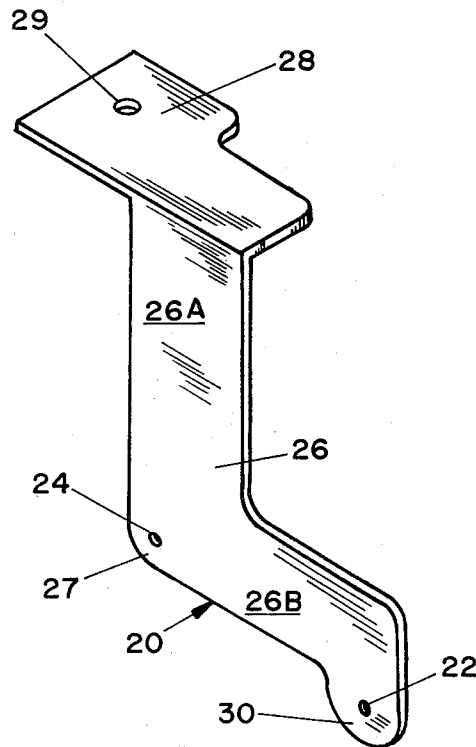


FIG. 3

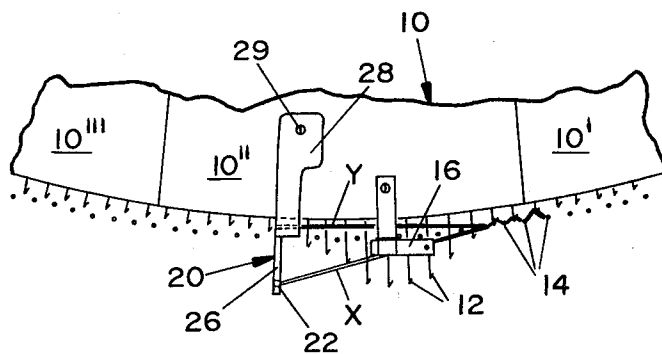


FIG. 4

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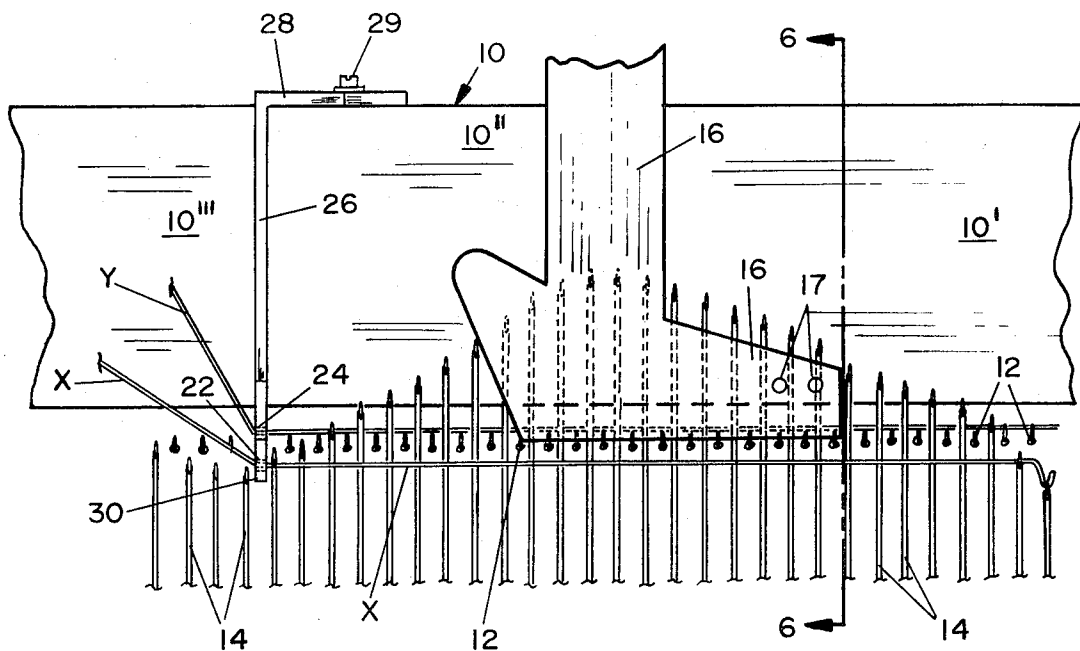


FIG. 5

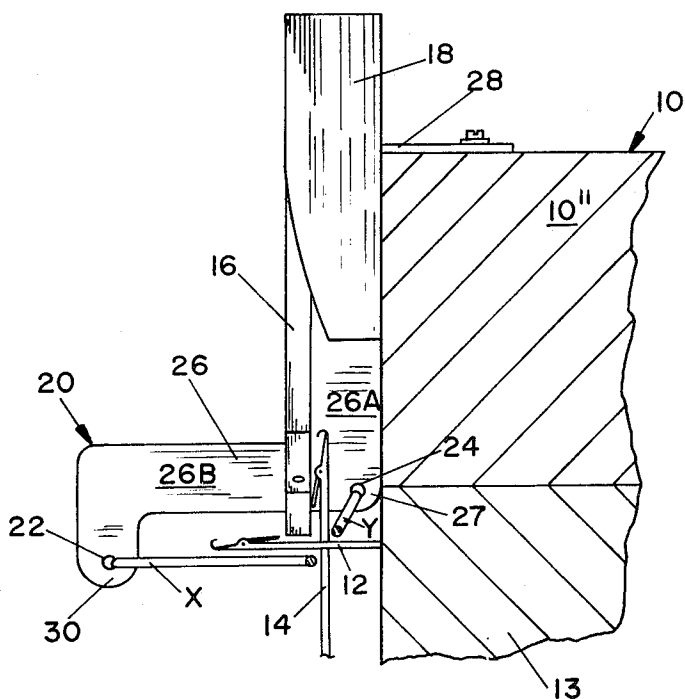


FIG. 6

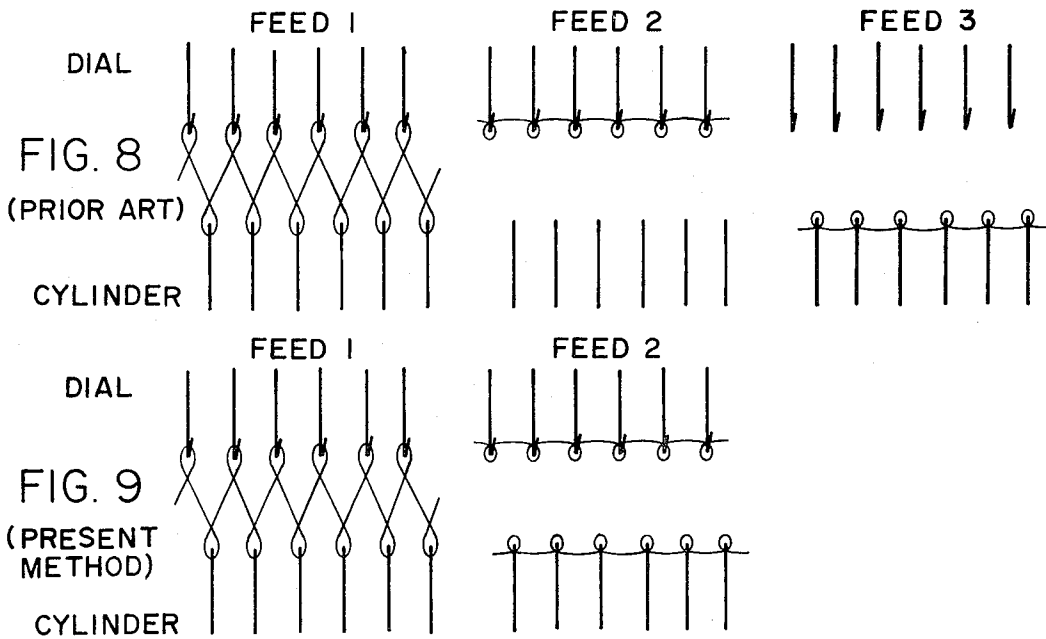
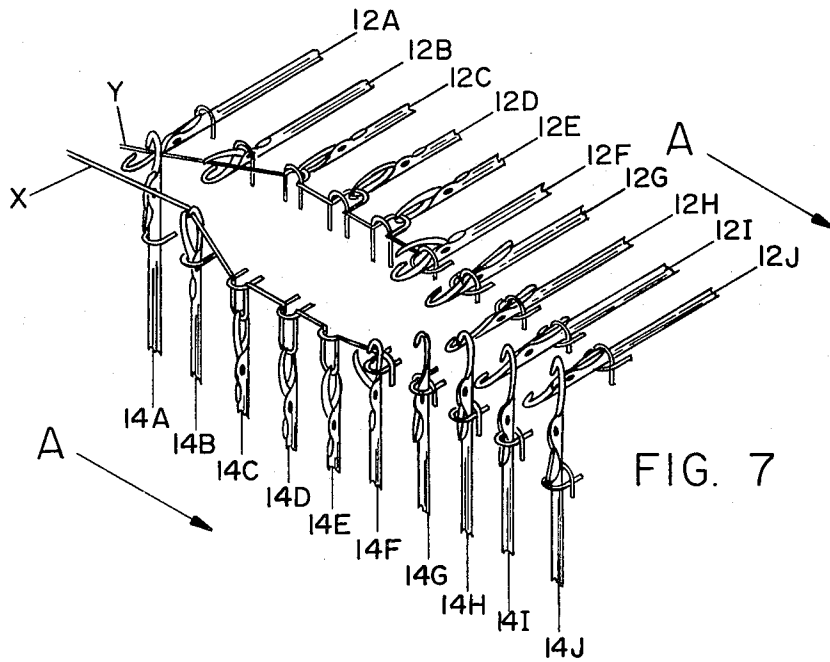
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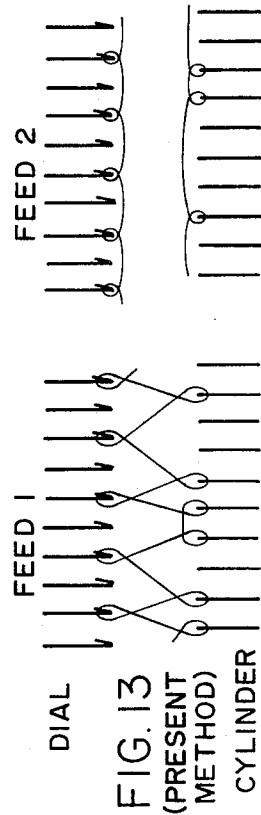
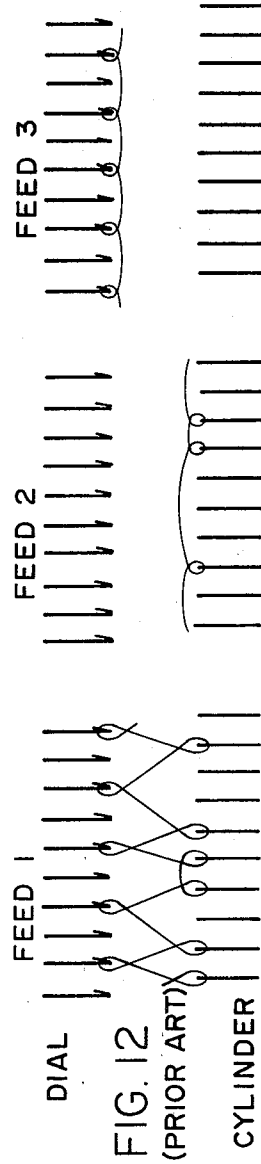
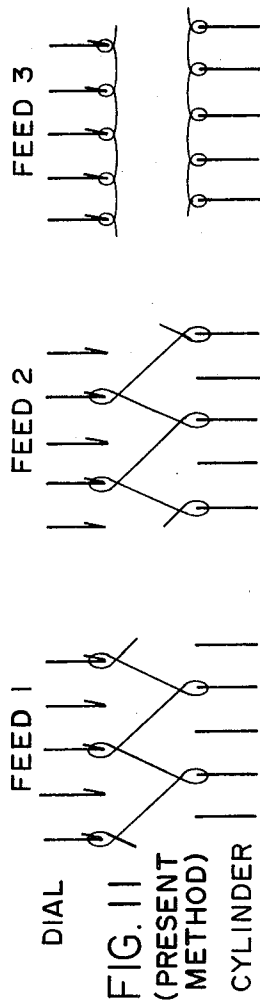
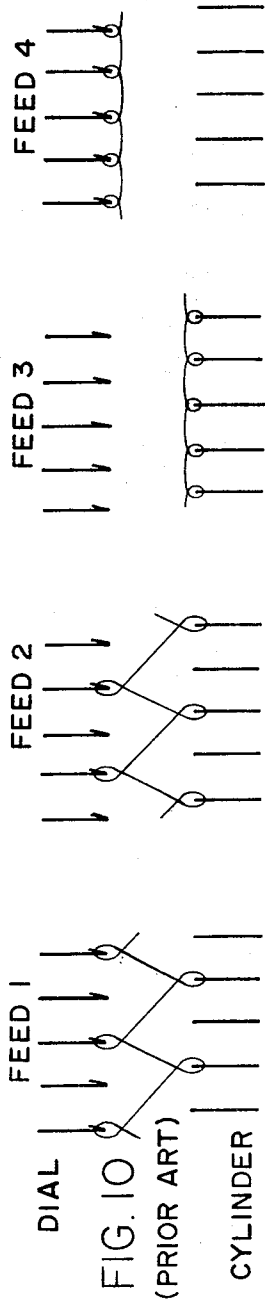
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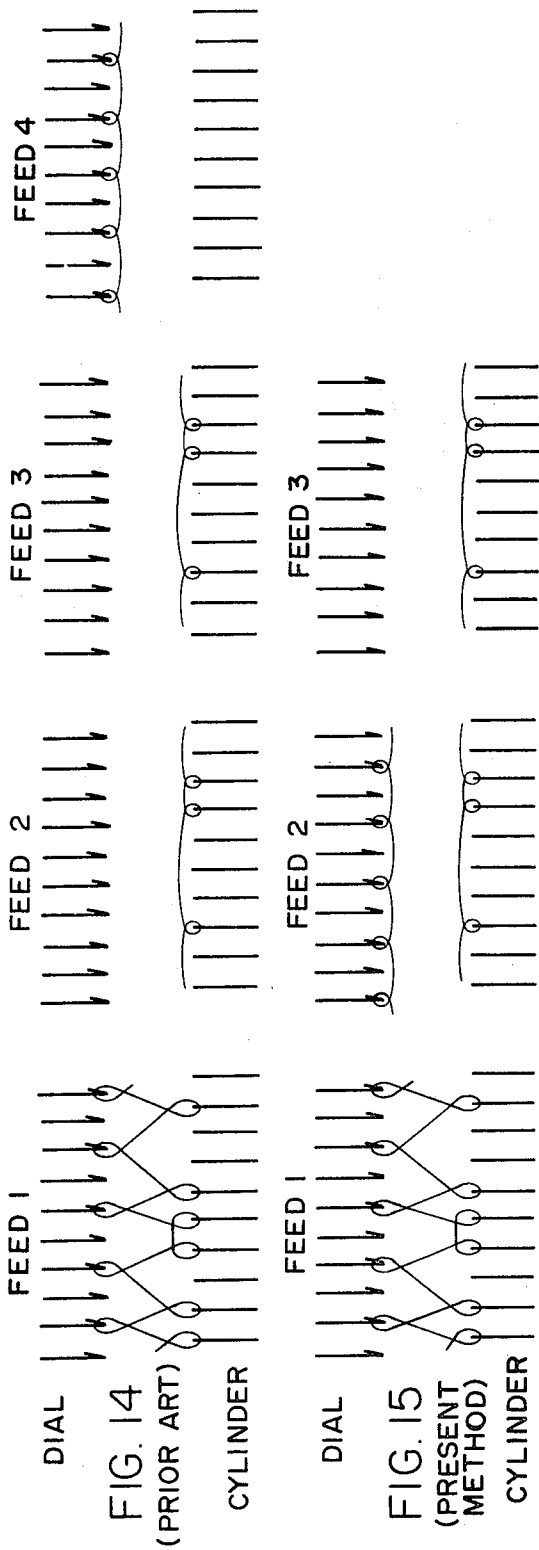
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## METHOD AND APPARATUS FOR FORMING A RIB FABRIC HAVING A TWO-PLY SECTION

### BACKGROUND OF THE INVENTION

The present invention is herein described with respect to circular knitting machines comprising two sets of needles, one set in the cylinder and the other in the dial, although the basic principle of the invention is also applicable to V-bed flat knitting machines. A machine of the circular design will conventionally include a number of knitting feeds or feed stations evenly distributed about its circumference, the number of feeds, all other variables being constant, determining the rate of production of the machine. Each feed station includes a conventional yarn carrier which performs the dual function of feeding the yarn into the path of both the cylinder and dial needles, as well as guarding the latches of both sets of needles from inadvertent closing. The cylinder needles are reciprocated in a vertical direction, while the dial needles are radially reciprocable at specified yarn feeds to accomplish the knitting of the fabric.

In knitting some fabric patterns, it is desirable at specified feeds, that only one set of needles be brought into action. Thus only the cylinder needles might be raised and lowered while the cams in the dial plate, controlling the dial needles, hold them in a retracted position out of action, with the attendant result that knitting occurs only on the cylinder needles. Conversely, it is possible to activate only the dial needles, holding the cylinder needles out of action, so that knitting occurs on the dial needles only. Where it is desired to produce a fabric including a two-ply segment in which each ply is separate from the other, hereinafter referred to as a "two-ply" segment, as in the forming of a Milano rib, one ply is knit on the cylinder needles, the other ply being knit on the dial needles, and it is universally accepted as conventional practice to use consecutive yarn feeds, one feeding the cylinder needles while the dial needles are out of action and the next feeding the dial needles while the cylinder needles are out of action. Such use of consecutive feeds, although satisfactory as far as attaining the desired pattern, is severely limiting on the productivity of a machine.

### SUMMARY OF THE PRESENT INVENTION

The present invention, on the other hand, combines the "cylinder-only" and "dial-only" knitting functions at a single feed thereby substantially increasing machine productivity. The improved method for forming the two-ply segment of a course comprises introducing the yarn forming one ply only to the cylinder needles at a position beneath or on the hook-opposite side of the dial needle shanks, so that the yarn is only picked up by the hooks of the cylinder needles. Simultaneously, and at the same feed, the yarn forming the other ply and being fed only to the dial needles is introduced at a position behind or on the hook-opposite side of the cylinder needle shanks, so that the yarn is picked up by the dial needles only.

Although the embodiment illustrated and described herein refers to a fabric having a two-ply segment with one yarn forming one ply and a second yarn forming the other ply, it is to be realized that additional yarns could be added in either ply. Also, additional yarns could be knit into both plies in a conventional manner by feeding such yarn into the hook sides of both the dial and cylinder needles.

In carrying out the invention, the conventional yarn carrier is used only for its latch guarding function, both yarn ends being fed through an auxiliary yarn guide attached to the machine at a prescribed position adjacent and slightly spaced in a circumferential direction from the conventional yarn guide. The auxiliary guide includes a first opening therein at a point below the level of the dial needles and a second opening at a point radially inward from the cylinder needles.

The utilization of such an apparatus and process eliminates at least one feed in each repeat. For example a Milano rib, previously requiring three feeds, now requires only two feeds in a repeat. It therefore follows that considerable savings may

be realized. For example, in a 48-feed machine, production is increased from 32 courses per revolution to 48 courses per revolution, an increase of 50 percent.

It is therefore an object of the present invention to provide an improved method and apparatus for forming a knit fabric having a two-ply section therein.

It is another object of the present invention to provide an improved method and apparatus for forming a knit fabric having a two-ply segment, wherein the yarn forming each ply is introduced at the same feed station and wherein the timing of the dial and cylinder needles is synchronous.

It is yet a further object of the present invention to provide an improved method of the type described for forming a knit fabric, having a two-ply section therein, in which one ply is knit on the cylinder needles only as the other is being knit on the dial needles only, wherein the yarn forming each ply is fed into the path of the hooks of the needles on which it is being knit and into the hook-opposite side of the other set of needles.

Other objects and advantages of the present invention will become apparent upon reading the specification and claims in light of the accompanying drawings, in which:

FIG. 1 is a fragmentary perspective view, with parts broken away, of a cylinder and dial type of knitting machine to which the improved attachments have been applied;

FIG. 2 is a view similar to FIG. 1, except looking from the opposite side of the yarn guides;

FIG. 3 is a perspective view of the auxiliary yarn guide illustrated in FIGS. 1 and 2 removed from the knitting machine;

FIG. 4 is a reduced fragmentary plan view of the knitting machine illustrated in FIGS. 1 and 2;

FIG. 5 is an enlarged elevation view of the apparatus illustrated in FIG. 4;

FIG. 6 is a vertical sectional view, partially in elevation, taken substantially along the line 6—6 in FIG. 5;

FIG. 7 is a diagrammatic view showing the relationship between the yarn ends forming the two plies and the cylinder and dial needles of a circular knitting machine having rib gating, and the operational sequence of these needles as the yarns are supplied according to the present improved method;

FIG. 8 is a schematic view of the needles and yarn relationship employed at consecutive feeds when knitting a first fabric having a two-ply segment according to the prior art;

FIG. 9 is a schematic view of the needle and yarn relationship employed at consecutive feeds when knitting said first fabric according to the present invention;

FIG. 10 is a schematic view of the needle and yarn relationship employed at consecutive feeds when knitting a second fabric having a two-ply segment according to the prior art;

FIG. 11 is a schematic view of the needle and yarn relationship employed at consecutive feeds when knitting said second fabric according to the present invention;

FIG. 12 is a schematic view of the needle and yarn relationship employed at consecutive feeds when knitting a third fabric having a two-ply segment according to the prior art;

FIG. 13 is a schematic view of the needle and yarn relationship employed at consecutive feeds when knitting said third fabric according to the present invention;

FIG. 14 is a schematic view of the needle and yarn relationship employed at consecutive feeds when knitting a fourth fabric having a two-ply segment according to the prior art; and

FIG. 15 is a schematic view of the needle and yarn relationship employed at consecutive feeds when knitting said fourth fabric according to the present invention.

Referring now to the drawings and particularly to FIGS. 1 and 2, the present invention is illustrated in connection with a circular knitting machine of the type having a set of dial needles 12 and a set of cylinder needles 14, the two sets operating synchronously. It should be recognized, however, that the invention might also be utilized with a V-bed flat machine.

A plate 10 is divided into a plurality of segments including 10', 10'', and 10''', each of the segments covering a plurality of dial needles and being removable to provide access thereto.

The dial needles 12 are mounted in the dial 13 beneath plate 10 for radial reciprocatory movement, and the cylinder needles 14 are mounted in a needle cylinder (not shown) for vertical reciprocatory movement, the paths of the respective needles intersecting. As illustrated in FIG. 1, the dial needles 12 are oriented in a position with the hooks thereof above the shank, and the cylinder needles are so oriented that the hooks face the outside of the shank or toward the outside of the cylinder formed by the cylinder needles 14. The cylinder and dial needles are arranged alternately around the periphery of the knitting machine in what is referred to as rib gating. An adjacent cylinder needle and dial needle, as used hereinafter in this specification is described as a cylinder/dial needle pair.

At the yarn feed which forms the two-ply segment of the fabric a conventional yarn carrier 16 is adjustably attached to a mounting bracket 18 in a well-known manner, which, in turn, is suitably secured to the knitting machine. The conventional carrier 16 is useful in the practice of the present invention only in its latch guarding function (except when a third yarn or additional yarns are utilized in both plies), because neither yarn end *x* or *y* actually passes through the openings 17 which normally feed the yarn to the needles in forming the standard rib fabric. Where additional yarns are used in both plies, they may of course be fed through an opening 17 in conventional carrier 16 if they are to be knit into both plies. Moreover at the feeds which form the remainder of the fabric, (those feeds attached to plate segments 10' and 10'') yarn carrier 16 is used in its normal manner, while the yarn feeding is accomplished at the feed illustrated in FIGS. 1 and 2 by an auxiliary yarn guide 20.

Yarn guide 20 is suitably attached to the knitting machine at a position circumferentially preceding yarn carrier 16, atop the point where both sets of needles are in their retracted positions. The auxiliary guide 20 includes a first yarn feeding passageway 22 receiving and guiding yarn end *x* and a second yarn feeding passageway 24 receiving and guiding yarn *y*. The respective yarns are fed into a position beneath (in the case of yarn end *x*) and behind (in the case of yarn end *y*) conventional guide 16, whereby the yarn *x* to be knit on the cylinder needles only is laid in beneath the shank (hook-opposite side) of the dial needles and the yarn *y* to be knit on the dial needles only is laid in behind the shank (hook-opposite side) of the cylinder needles.

As illustrated in FIGS. 1-3, auxiliary yarn guide 20 comprises a generally L-shaped plate 26 vertically arranged and having a horizontal flange 28 extending adjacent the upper surface of plate segment 10' from the upper end of upright leg 26a and a depending tab 30 protruding downwardly from the outer end of the horizontal leg 26b. An opening 29 in the upper horizontal flange 28 provides a means for securing yarn guide 20 to the stationary plate segment 10'. Opening 22 in tab 30 lies below the horizontal plane defined by the dial needles 12, while a second opening 24 in the heel portion 27 of L-shaped plate 26 lies behind or radially inward of the cylinder formed by the cylinder needles 14.

As better illustrated in FIGS. 5 and 6, the yarn strand *x* extends through opening 22 in auxiliary yarn guide 20 and is fed beneath the shanks of dial needles 12 to a position beneath conventional yarn guide 16 into the path of the hooks of successive cylinder needles 14. The path of yarn *x* intersects the downward path of cylinder needles 14 at a point circumferentially succeeding conventional yarn guide 16 and at a knitting point immediately prior to the closing of the latch. The above described yarn path defines a critical angle exceeding the tangent to the cylinder formed by the cylinder needles taken at the point where the yarn is first engaged by the cylinder needles, in that if the angle is too small, the yarn is subject to the scissors effect of the needle latch which can snag or rupture the yarn. In such a situation, by way of explanation, the scissors effect is likely to occur in the present invention because the feeding point of the yarn taken by the cylinder needles is below the level of the dial needles, a point lower than normal with respect to each cylinder needle latch.

If the angle of feed is too small, as the latch closes, the lower portion of the latch will engage the yarn and may pinch the yarn between the latch and the needle shank. Increasing the feed angle ensures that the upper portion of the latch engages the yarn and properly moves it into knitting position.

At the same time the second yarn strand *y* extends through opening 24 in the heel 27 of yarn guide 20 and is fed behind the shanks of cylinder needles 14 to a position in the inward path of the hooks of dial needles 12 (note particularly FIGS. 4 and 6).

Referring now to FIG. 7, cylinder needles 14 are arranged in the usual manner so that they reciprocate vertically and parallel to each other, while the dial needles 12 are arranged so that they reciprocate to and fro along the radii which diverge from a common center. While FIG. 7 shows the dial needles 12 parallel to each other, this is merely for convenience of illustration, although the set-up on a V-bed flat machine would be quite similar to FIG. 7.

In the described embodiment the needles have latches of the usual type, and the needles are assumed to turn counterclockwise when viewed from above, this being indicated by the arrows A in FIG. 7.

As illustrated in FIGS. 1-6 and as more specifically illustrated in FIG. 7, each cylinder/dial needle pair operates synchronously or simultaneously, and yarn ends *x* and *y* are first engaged by the needles of each cylinder/dial needle pair at approximately the same time. In the drawing (FIG. 7) needles 12 have been designated 12a-12j and needles 14 have been lettered 14a-14j for clarity. As illustrated by the first needle pair 12a and 14a, both needles are in their extended position beyond the yarn ends *x* and *y*, while needles 12b and 14b have begun to retract and are grasping their respective yarn ends *y* and *x*. The formation of the loop is completed by needles 12c-e and needles 14c-e. Needles 12f-j and 14f-j are returning to their extended position while their latches open to receive yarn from a subsequent feed, and with the newly formed loops being held on the shanks of the needle. It is emphasized that at yarn feeds utilizing auxiliary guide 20, only yarn end *y* is formed into loops, as successive dial needles 12 are withdrawn, yarn *x* being laid into the system on the hook-opposite side of the dial needle shanks. The reverse is true with yarn end *x* in that only the cylinder needles 14 grasp yarn *x* since it is laid in on the hook-opposite side of the dial needle shanks.

In operation, it is therefore apparent that at a single yarn feed incorporating the present invention and utilizing auxiliary feed guide 20, there may be formed a two-ply segment of a fabric by a method eliminating the requirement of any delayed feeding arrangement, cam arrangement or delayed timing system. The needles may operate simultaneously or synchronously at a single feed with the result that the fabric may be formed much more economically and in a more simplified manner than by devices previously known.

Such patterns as Milano rib may therefore be produced without the use of successive yarn feeds to form the two-ply section, the reduction of a yarn feed per pattern repeat leading to a considerable increase in the productivity of the machine. Other popular patterns including Ponti di Roma may also be formed with similar production increases. The invention makes possible a variety of patterns not otherwise economically feasible, and thereby increases the versatility of the machine.

The first fabric pattern illustrated schematically in FIGS. 8 and 9 is popularly known as Milano rib and comprises alternating sections of single ply ribs with an intermediate section of double ply fabric therebetween in which the plies are completely separate and can be formed by the apparatus and method of this invention. Whereas such a fabric produced by prior techniques necessitated the use of three feeds per repeat, as illustrated in FIG. 8, it is now possible to form the fabric utilizing a two feed repeat (FIG. 9), a resulting productivity of 50 percent.

The second fabric illustrated in FIGS. 10 and 11 is popularly known as Ponte di Roma which, like the first fabric, has two-ply segments spaced walewise from each other throughout the fabric. As shown in FIG. 11, the two-ply segments can be formed at the same feed with a consequent increase in production and economy.

FIGS. 12 and 13 illustrate a third type of fabric construction comprising a single welt pattern having two-ply segments spaced walewise from each other. Here again, the two-ply segments are advantageously formed at a single feed according to the present invention.

The foregoing examples are illustrative only and it will be apparent to those skilled in the art that the present invention can be used in connection with the manufacture of other types of knit fabrics formed on circular machines of the type having two sets of needles, including double knit machines, conventional rib machines, interlock machines, sweater machines and the like. In addition, the present invention is also applicable to the V-bed flat knitting machines. The method according to the invention can be employed for the production of underwear, outerwear, swimwear, footwear and the like.

FIGS. 14 and 15 compare the prior art method and the present method of knitting a double welt variation of said third fabric.

I claim:

1. A method of knitting a two-ply segment of a fabric wherein each ply of said fabric is independent of the other ply on a rib gated knitting machine of the dial and cylinder type having dial needles and cylinder needles and at least a yarn feed station for each two-ply segment of fabric, said method comprising:

- a. guiding the yarn to form one of said plies into knitting position on the hook-side of the shanks of certain of said cylinder needles at said yarn feed station, at least two of said certain cylinder needles being immediately adjacent one another, and said yarn extending on the hook-opposite side of the shanks of said dial needles, said yarn being fed into knitting position along a path which defines an angle exceeding the tangent to the cylinder formed by the cylinder needles taken at the point where the yarn is first engaged by the cylinder needles;
- b. simultaneously guiding a second yarn to form the other ply in said two-ply segment into knitting position on the hook-side of the shanks of certain of said dial needles at least two of said certain dial needles being immediately adjacent one another, and said yarn extending on the hook-opposite side of the shanks of said cylinder needles; and
- c. synchronously moving said certain dial and cylinder needles at said yarn feed station into knitting position to form both plies of said two-ply segment at the same feed.

2. A method of knitting a two-ply segment of a fabric, wherein each ply of said fabric is independent of the other ply, on a rib gated knitting machine of the type having dial needles

and cylinder needles and also having a yarn feed station, said method comprising the steps of:

- a. guiding a first yarn for one of said plies into knitting position on the hook-side of the shanks of all said cylinder needles, but on the hook-opposite side of the shanks of said dial needles, said first yarn being fed into knitting position along a path which defines an angle exceeding the tangent to the cylinder formed by the cylinder needles taken at the point where the yarn is first engaged by the cylinder needles;
- b. simultaneously guiding a second yarn for the other ply into knitting position on the hook-side of the shanks of all of said dial needles, but on the hook-opposite side of the shanks of said cylinder needles; and
- c. synchronously operating all of said dial and cylinder needles into knitting position to form both plies of said two-ply segment at the same feed.

3. In a knitting machine of the type having dial needles and cylinder needles arranged in rib gated relationship and operated synchronously, a yarn guide means positioned in operative relationship with a yarn feed of the knitting machine, said guide means including a first opening therein for receiving a first yarn from a supply source and directing said first yarn into knitting position on the hook-side of the shanks of all dial needles, but on the hook-opposite side of the shanks of the cylinder needles, said guide means also including a second opening therein for simultaneously receiving a second yarn from a supply source and directing said second yarn into knitting position on the hook-side of the shanks of all the cylinder needles, but on the hook-opposite side of the shanks of said dial needles, the yarn from said second opening being fed along a path which defines an angle exceeding the tangent to the cylinder formed by the cylinder needles taken at the point where the yarn is first engaged by the cylinder needles.

4. The improvement according to claim 3, wherein said guide means comprises a plate having said first and second openings therein, said plate being attached to a portion of said machine and being disposed in a vertical plane, said first opening in the plates positioned at a point below the horizontal plane defined by the dial needles and on the hook-side of said cylinder needle shanks, said second opening being inwardly disposed in a radial direction from the cylinder formed by the cylinder needles and on the hook-side of said dial needle shanks.

5. The improvement according to claim 4, wherein said first opening is radially spaced from said cylinder needles and circumferentially spaced from a prescribed point on the cylinder where said first yarn is initially engaged by the cylinder needles, said radial and circumferential spacing being such that said first yarn is fed to said point at an angle exceeding a tangent to the cylinder formed by said cylinder needles at said point.

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