

[54] **METHOD OF KNITTING RUNPROOF COURSES**

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**FOREIGN PATENTS OR APPLICATIONS**

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[51] Int. Cl. .... **D04b 9/10, D04b 15/06**

[58] Field of Search ..... **66/172, 14, 104, 66/107, 198, 169 A, 178 R**

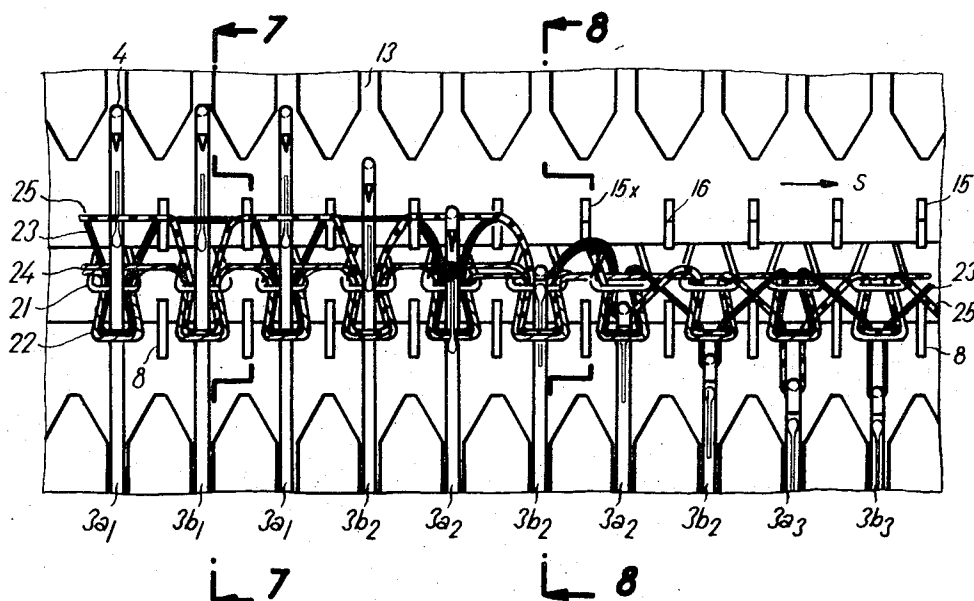
[57] **ABSTRACT**

Runproof courses are formed by providing alternate needles of a circular knitting machine with doubled loops formed of independent yarns and thereafter pulling one of said yarns from said loop and crossing the pulled yarn over to an adjacent loop.

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**2 Claims, 10 Drawing Figures**



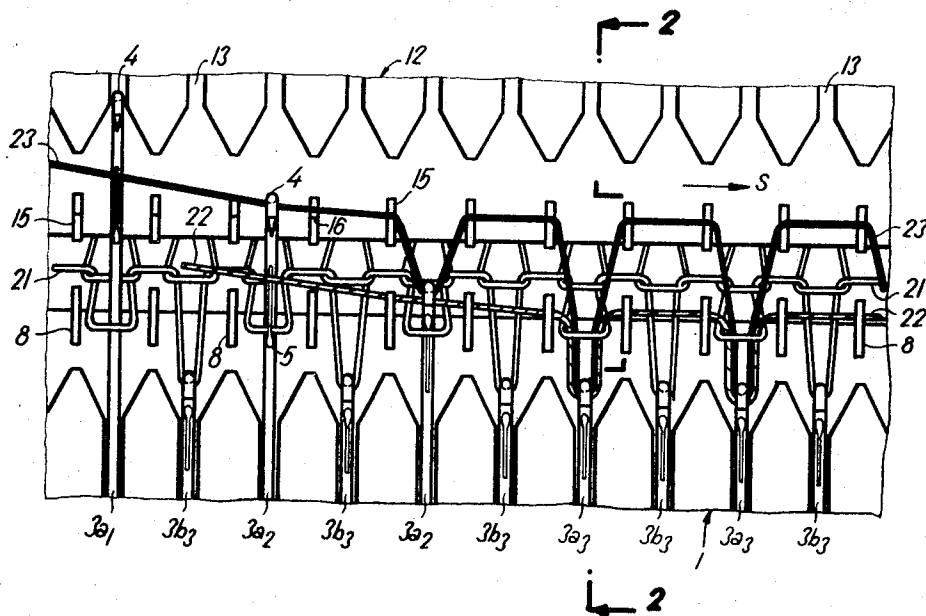


Fig. 1.

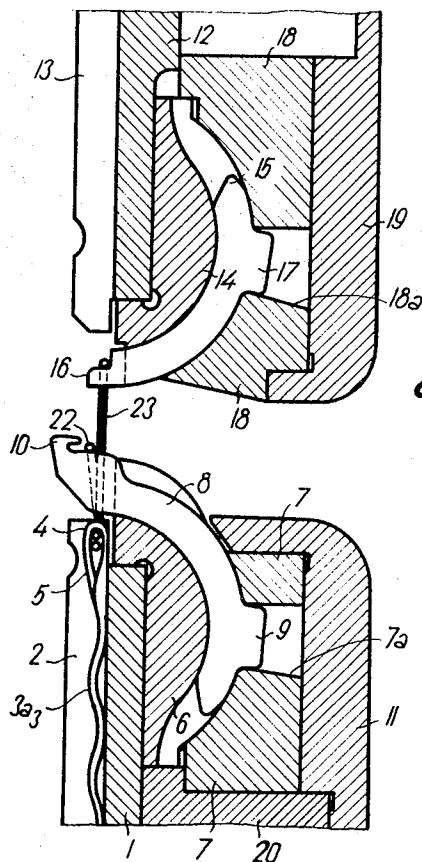


Fig. 2.

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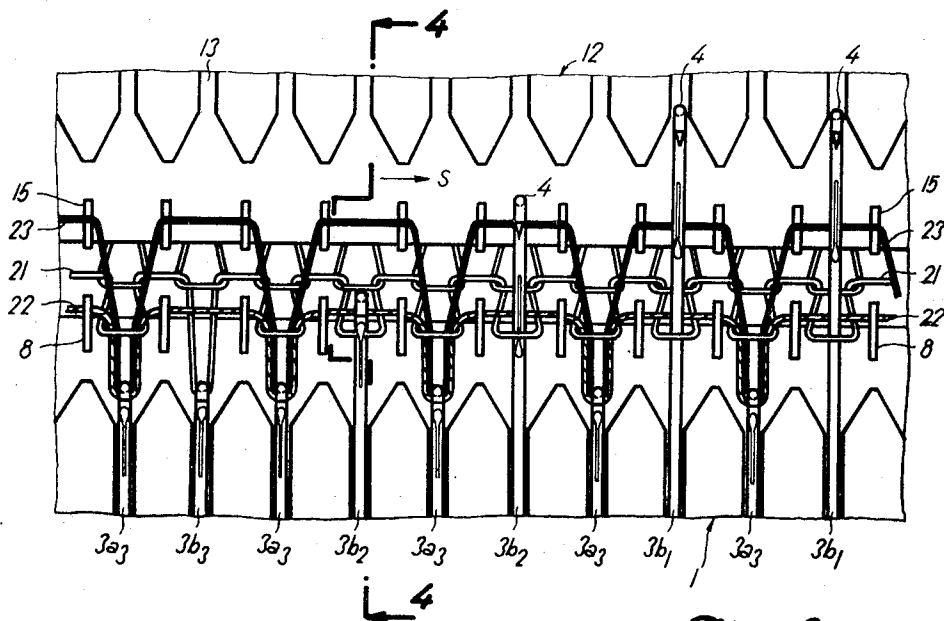


Fig. 3.

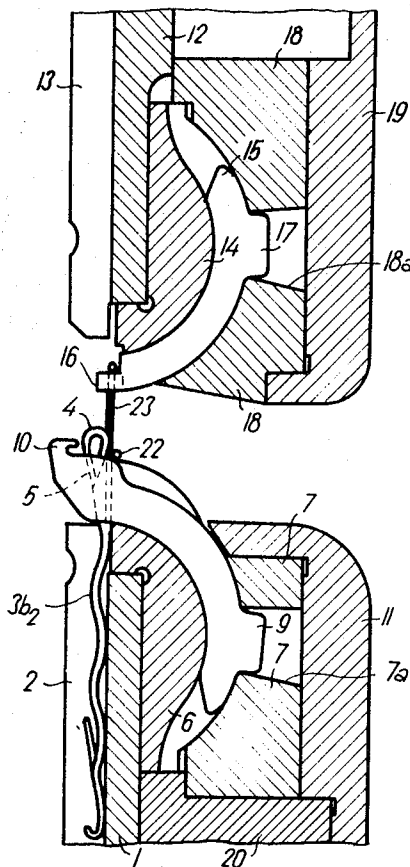


Fig. 4.

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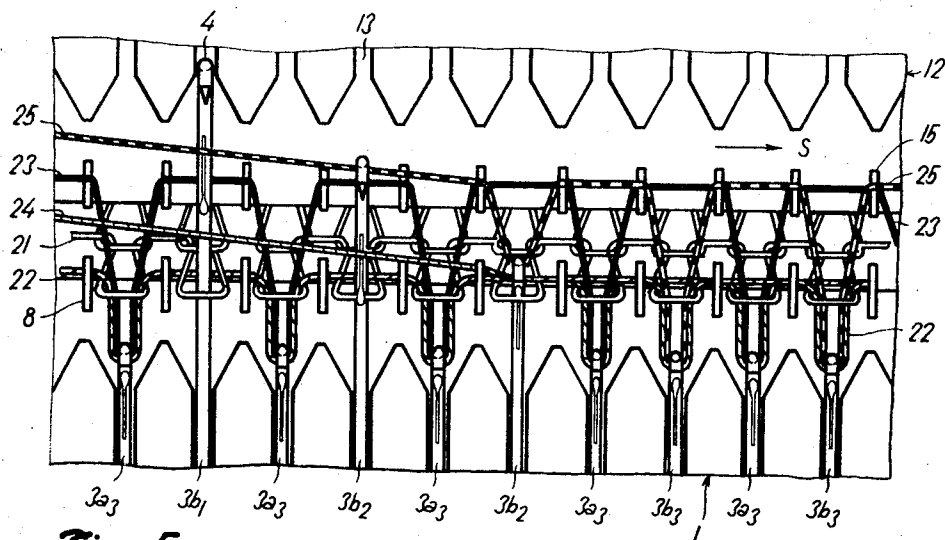


Fig. 5.

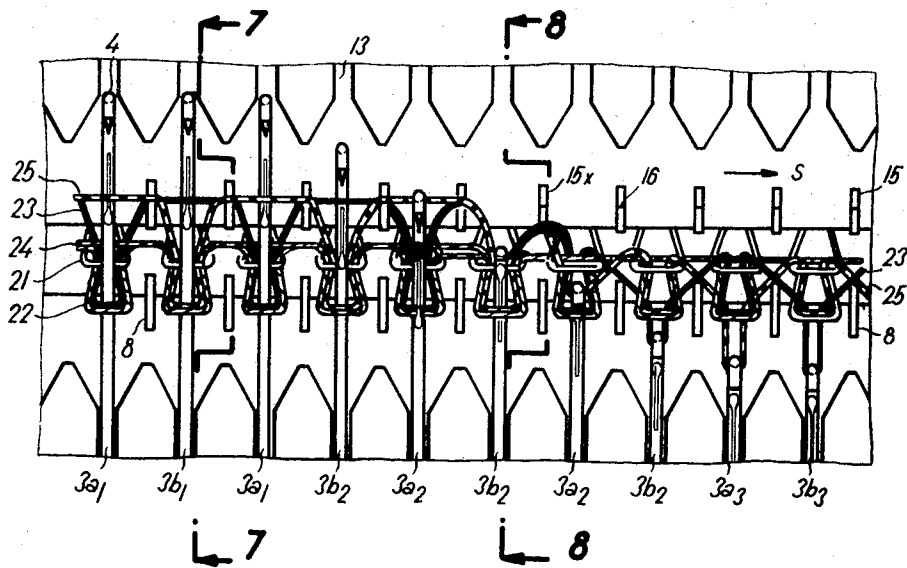


Fig. 6.

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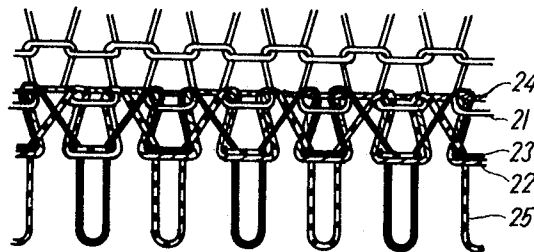
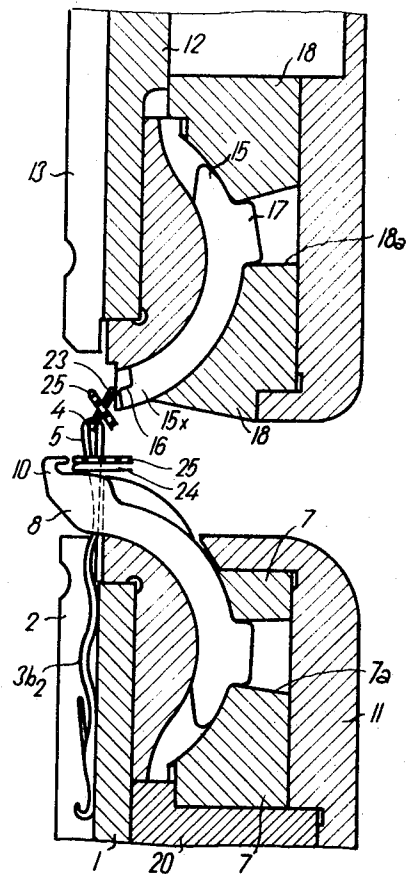
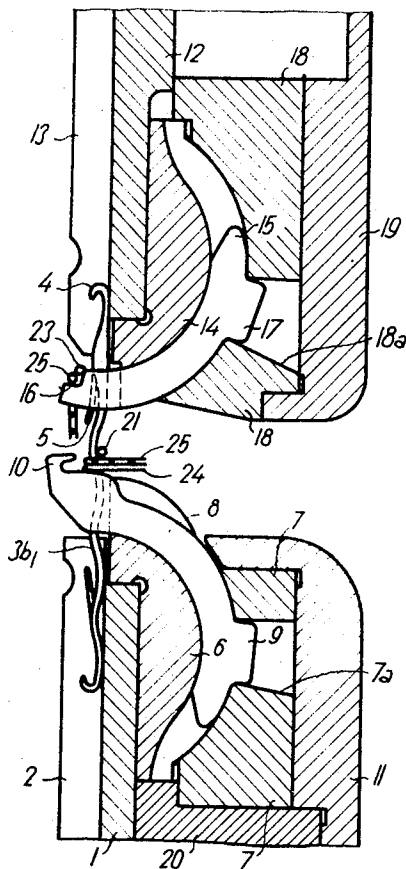


Fig. 9.

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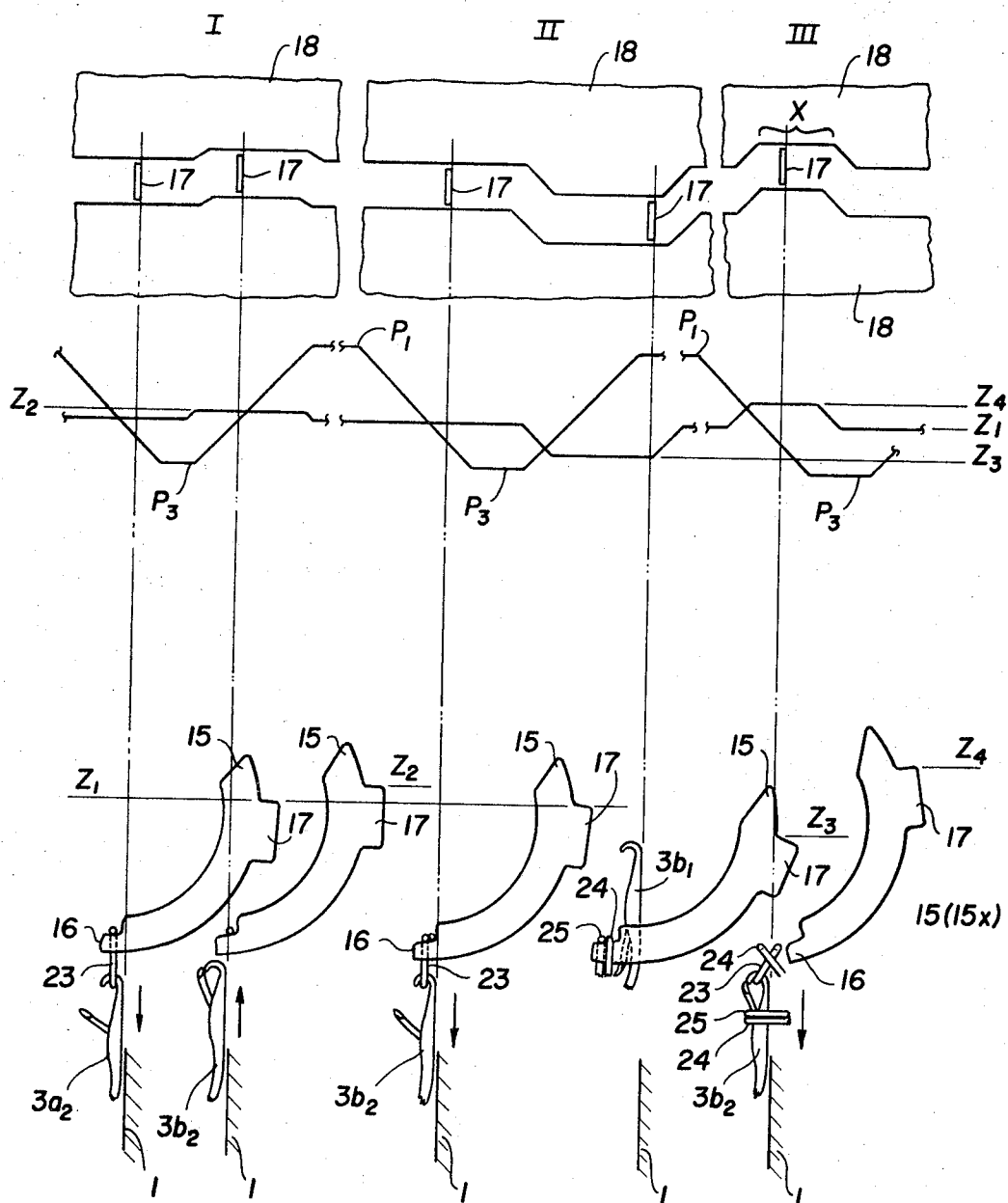


FIG. 10

## METHOD OF KNITTING RUNPROOF COURSES

## BACKGROUND OF THE INVENTION

The present invention relates to the knitting of fabric hosiery and, in particular, to a system for forming a run-proof course or courses in such fabrics on circular knitting machines.

Circular knitting machines have heretofore required considerable constructional modification and rebuilding to make them adaptable to the knitting of run-proof fabrics and especially to the knitting of the singular run-proof course after normal knitting of body fabrics have been made. Particularly, it has been difficult to form the final or binding course in such items as ladies' or men's hosiery or the finishing of courses in such gusset parts as formed the heel and toe portion, while the body fabric remains on the circular knitting machine. At best, even with considerable modification, circular knitting machines of the conventional variety and operation have only produced run-proof courses of reduced runability and limited strength.

It is an object of the present invention to provide a system for producing run-proof courses.

It is another object of the present invention to adapt circular knitting machines to produce secure and high strength run-proof courses.

It is another object of the present invention to adapt a circular knitting machine without the need for constructional changes to the production of run-proof courses for final binding of hosiery bodies or for the binding of gusset portions thereof while the fabric remains upon the circular knitting machine.

It is another object of the present invention to provide a circular knitting machine with a system for improving fabric construction.

## SUMMARY OF THE INVENTION

According to the present invention, there is provided a system for knitting run-proof courses in a circular knitting machine having a plurality of needles each having associated with it a knock over sinker and a dividing sinker cooperating to form, from yarn fed thereto, a plurality of sequential loop courses constituting the body portion of the fabric. The system comprises the steps of separating the needles, after the completion of the body portion, into two equal groups in a 1 — 1 ratio; thereafter feeding to the needles of one group, simultaneously, a pair of independent yarns so as to form doubled loops, one yarn forming sinker loops over the edges of the knock-over sinkers, the other yarn forming sinker loops over the active edges of the dividing sinkers. Subsequently feeding to the needles of the second group a second pair of independent yarns, forming doubled loops on those needles, one yarn forming sinker loops over the edges of the knock-over sinkers, the other yarn forming sinker loops over the edges of the dividing sinker. Thus, doubled loop courses are formed by two separate pairs of yarns in alternate needles respectively. Thereafter pulling one of each pair of yarns from the needles of their respective groups through an adjacent loop formed by the needles of the other group, thereby crossing over the yarn to form the run-proof course.

A full description of the system of the present invention together with the various objects and additional advantages thereof is made in the foregoing disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

The following disclosure makes reference to the attached drawings in which:

FIG. 1 is a front elevational view in developed form of a portion of the upper and lower needle cylinders of a circular knitting machine;

FIG. 2 is a side elevational section along line 2—2 of FIG. 1 showing the upper and lower needle cylinders in detail;

FIG. 3 is a view similar to FIG. 1 showing the progress of knitting;

FIG. 4 is a view similar to FIG. 2 taken along line 4—4 of FIG. 3;

FIG. 5 is a view similar to FIGS. 1 and 3 showing further progress of knitting;

FIG. 6 is a view similar to FIGS. 1, 3 and 5 showing still further progress of the knitting operation;

FIG. 7 is a view similar to FIGS. 2 and 4 taken along line 7—7 of FIG. 6;

FIG. 8 is a view similar to FIGS. 2, 4 and 7 taken along line 8—8 of FIG. 6; and

FIG. 9 is an enlarged detailed view of the pattern of the fabric showing the formation of the run-proof course on a body fabric.

FIG. 10 is a schematic view of the sinkers, cam path and sinker curves effecting the operation of the present invention.

An example of the embodiment of the system of the present invention is shown in connection with the circular knitting machine, particularly of the two cylinder variety with multi-feed means for the yarn. In the drawings, only those portions of a circular knitting machine are shown which are necessary for a full understanding of the present invention. It will be obvious that those portions not shown are of conventional design and are used in their conventional and well known manner. Additionally, it will be obvious to those skilled in the art how the present invention may be adapted to circular knitting machines of the singular type or of the single cylinder construction.

Turning now to the figures, the circular knitting machine briefly comprises a pair of opposed cylinders 1 and 12, the lower needle cylinder 1 is mounted on a carrying sleeve 20 and is arranged with a plurality of vertically parallel needle beds or tricks 2, of which one is shown and in each of which a knitting needle 3 is mounted. Intermediate sinkers, patterning sinkers and similar elements are not shown in order to maintain the drawings as simple as possible.

Each knitting needle 3 is provided with a hook 4 and a cooperating latch 5 so as to catch and hold the yarn during the looping operation. The upper part of the lower cylinder 1 is provided with an integrally formed sinker ring 6 from which is spaced a fixed control ring 7 provided with a cam groove 7a. The ring 7 is secured to a circular member 11 forming the inner throat of the cylinder 1. In the space between the rings 6 and 7, there is provided a plurality of knock-over sinkers 8 each having a butt 9 located in the cam groove 7a. There is one knock-over sinker 8 for each needle 3. Each knock-over sinker 8 has a hook 10 which cooperates with the respective needle hooks 4 to form a yarn loop.

Mounted above and coaxially with the needle cylinder 1 is the upper needle cylinder 12. The needle cylinder 12 is also provided with longitudinally parallel needle beds 13 and with a grooved ring 14 from which is

spaced a fixed control ring 18 having a cam 18a. In the space between the grooved ring 14 and the control ring 18 are arranged a plurality of dividing sinkers 15, one each for each needle. Each dividing sinker 15 has an edge 16 which is adapted to engage the yarn in similar fashion as the sinker hook 10 and is also provided with a butt 17 which rides in the cam groove 18a. The control ring 18 is fixed to a circular member 19 forming the inner mouth of the cylinder 12. Yarn guides and feeds are not shown but are included in the obvious manner.

Turning to FIG. 9, it will be seen that the knitted fabric, according to the present invention, is formed from a base yarn 21 from which the complete body of a hose, for example, is made and a run-proof course comprising two sets of paired yarns. One set comprises a main yarn 22 and an auxiliary yarn 23 fed by suitable guides (not shown) in what will hereafter be called a first knitting system. The other set comprises a second main yarn 24 and a second auxiliary yarn 25 also fed by suitable guides (not shown) in what will hereafter be called a second knitting system. The auxiliary yarns 23 and 25 of each of the knitting systems are lapped over in a third knitting system in cross-over fashion so that they extend to the loops on either side of themselves.

It is preferred that each set of yarn is made up of yarn of dissimilar characteristics. The pulled or crossed-over yarn is preferred to be highly elastic or of a crimped nature.

For the purpose of fully explaining the procedure by which the present invention produces the fabric of FIG. 9, reference is made to FIGS. 1, 3, 5 and 6, in particular, which show progressive stages of the procedure. Each figure is a developed form of the front elevation of the upper and lower needle cylinders 1 and 12 in the proximity of the knocking-over plane. FIG. 1 shows the initial stages of the first knitting system, FIG. 3 shows the advanced stages of the first knitting system, FIG. 5 shows the stage of the second knitting system while FIG. 6 shows the third knitting system and the cross-over of the auxiliary loops.

The needles 3 are grouped into two sets, one labeled a, the second set labeled b. The groups are determined in a 1—1 ratio by which the needles are alternately separated. Each needle of each group is given an ordinal sub-number (1), (2) and (3) designating the operative position of the needle at any given moment. The numeral (1) designating the lay-up or rest position of the needle, the numeral (2) designating the drawing in of the needle and numeral (3) designating the kinking or knock over position of the needle. The arrow S as seen in the drawings designates the direction of movement of the cylinders 1 and 12 and the direction by which knitting or looping takes place.

Specifically, the apparatus is operated so that the main body of the fabric is formed from the yarn 21 by rotational knitting in the conventional manner. Upon finishing the last of the predetermined courses of the body from the yarn 21, all of the needles 3 are drawn down into the lower needle cylinder 1 and thereafter are divided into their 1—1 ratio forming the groups of needles 3a<sub>1</sub>, 3a<sub>2</sub>, 3a<sub>3</sub> and the second group of needles 3b<sub>1</sub>, 3b<sub>2</sub>, 3b<sub>3</sub>.

The needles of the first group are then lifted into a lay-up position (3a<sub>1</sub>). The yarns 22 and 23 are then fed simultaneously but independently to the hooks 4 of the needles (3a<sub>2</sub>) while rotation of the cylinders 1 and 12 is continued. The needles (3a<sub>2</sub>) then move into the

kinking position designated 3a<sub>3</sub> at which moment doubled loops are formed on the hooks 4 of each of the needles (3a<sub>3</sub>). The doubled loops comprise the main and auxiliary yarns 22 and 23 of this first system. The main yarn 22 forms sinker loops over the edges of the knocking-over sinkers 8 while the auxiliary yarn 23 is fed so that its sinker loops are formed over the edge 16 of the dividing sinkers 15. This situation is seen best in FIG. 1. Meanwhile, the needles of the second group (3b<sub>3</sub>) remain in their kinking position since they were initially positioned so in the lower cylinder 1.

After all of the needles pass through this first knitting system, all of the needles are then for a short time in the kinking position shown in the left hand side of FIG. 3 and designated (3a<sub>3</sub>) or (3b<sub>3</sub>). Before the second system begins to take effect, the needles of the second group are lifted in front of yarn 23 held by the sinkers 15 to lay-up positions (3b<sub>1</sub>) while the needles of the first group are maintained in their kinking positions (3a<sub>3</sub>), as seen in the right hand side of FIG. 3. This, of course, is the converse of the positions taken during operation of the first system. As seen in FIG. 4, as the needles 4 move upwardly the sinker 15 is withdrawn from the position seen in FIG. 2 so that the needle can pass in front of yarn 23. Upon cessation of upward needle movement dividing sinkers are readvanced to engage the main yarn 24 and auxiliary yarn 25 laid in the second system. Now the second system's main yarn 24 and its auxiliary yarn 25 are fed independently but simultaneously to the hooks 4 of the needles of this second group and knitting proceeding once again from the initial position (3b<sub>1</sub>) to the take up position (3b<sub>3</sub>). Thus, the second system also produces in the hooks of the needles of this group two double loops. The double loops comprise sinker loops of the yarn 24 made over the edges of the kinking sinkers 8 and sinker loops of the auxiliary yarn 25 formed over the edges 16 of the dividing sinkers 15.

At the moment when all of the needles of the second system are in kinking position (3b<sub>3</sub>), then each hook 4 of all of the needles 3 contain double loops in such a manner that the loops of the first set of yarn 22 and 23 alternate with loops of the second set of yarn 24 and 25 in alternate needles respectively as seen in FIGS. 5 and 6.

The needles then enter the third phase or system. Prior to this, however dividing sinkers are advanced as depicted in FIG. 7 and, all of the needles are again lifted (as seen in FIG. 6 left side) from the kinking position (3a<sub>3</sub> and 3b<sub>3</sub>) to the lay-up position (3a<sub>1</sub> and 3b<sub>1</sub>) to provide the basis for finishing the final course. This situation is shown in FIG. 7 where the needles 3b<sub>1</sub> from the second group of separation are shown having a loop formed on their shanks of the second set main yarn 24 and its auxiliary yarn 25. The auxiliary yarn 25 is caught in the working end 16 of the dividing sinker where the yarns 23 and 22 of the first system set are also caught. Their loops are held on both the dividing sinkers and the adjacent shanks of each needle.

In the operation of the third system, the advancing rotation of the cylinders in the direction of arrow S seen in FIG. 6 carries all of the needles downwardly into the kinking position (3a<sub>3</sub> and 3b<sub>3</sub>). As the needles descend dividing sinkers are retracted and, the hooks 4 take up the yarns forming the loops over the sinker edges 16 of the dividing sinkers 15. Thus, the needles of the first group a (first system) serially catch within



its hooks 4 the auxiliary yarn 25 so that as a consequence, the auxiliary yarn 25 is pulled through the double loop made of the yarns 23 and 22 of the first system. In a similar manner, the needles of the second group b (second system) serially catch the auxiliary yarn 23 of the second system set and pull the yarn 25 through the doubled loop formed from the yarn 22 and auxiliary yarn 23 of the first system. Thus, the run-proof course is finally finished.

At this stage, the individual loops may be removed from the needles in a conventional and well known manner, as by binding off if it is the final run of the hose or by connection with another gusset portion if it is the gusset end.

It will be appreciated that in order to perform the procedure, the dividing sinkers 15 must have a special shape. Accordingly, they are provided at their ends with a recess for holding yarn and an active edge 16 for engaging yarn and while they are mounted in an analogous manner to the knock-over sinkers 8, their movement must in order to terminate their grip on the sinker loop be at the moment when the hook 4, after gripping the sinker loop caught in the active edge 16, takes a position below the knock-over plane. An example of this is shown in FIGS. 8 & 10. The point at which the dividing sinker must be withdrawn being marked by the numeral 15x in FIG. 6.

The action of said sinkers 15 in forming the said ladderproof stitch course, is obvious from FIG. 10. The graphic representation is based on specified parts heretofore described. The knitting systems, referred to, are denoted respectively as the first I, second II and third III knitting system. The course of the controlling butts 17 of the dividing sinkers 15, is represented both in the guiding path formed by fixed controlling rings 18 and graphically by a curve whose extreme positions are denoted by the letters Z<sub>1</sub>, Z<sub>2</sub>, Z<sub>3</sub>, and Z<sub>4</sub>. Below this curve a specific adjustment of the sinkers to these extreme positions is shown. Their direction of movement, denoted by arrows, in the needle cylinder 1 and the yarn of which the desired ladderproof course is formed are also shown. Finally, the specified knitting systems are in the figure divided by thin vertical straight lines interlined by two points.

The curve crossing the graphically expressed path Z of the dividing sinkers 15 is at its verteces denoted by the symbols P<sub>1</sub> and P<sub>3</sub> and shows the sinking, tuck and lapping positions of the needles being just placed in action in cooperation with the dividing sinkers. The position denoted as P<sub>1</sub> means the lapping position and the one denoted as P<sub>3</sub> means the sinking position. This marking by the index 1 and 3 is coincident again with that appearing in the previous description.

From the foregoing, it will be seen that a simple and

improved system for utilizing a circular knitting machine for the formation of run-proof courses has been effected. It will also be seen that the run-proof course is in fact strong, stable and highly effective.

It will also be obvious to those skilled in the art that the system may be adapted to a single system knitting machine or to a single cylinder knitting machine, the essence being in the formation of the doubled loops which can be effected in a variety of ways. Since it is advantageous as well to choose the auxiliary yarns for special purposes, as for beauty, design, strength or stretchability, a variety of home forms can be made.

What is claimed:

1. A method for knitting a run-proof course on a double cylinder circular knitting machine having a plurality of needles each having an associated knock-over sinker in the lower cylinder and a dividing sinker in the upper cylinder cooperating to form a series of loop courses from yarn fed thereto comprising, the steps of separating said needles in the lower cylinder in a one to one ratio to form two groups therefrom, holding one group of said needles inactive and moving the dividing sinkers forward and simultaneously feeding to the other one of said groups of needles a first pair of independent yarns so as to form knit stitches with both yarns in each stitch with one yarn on the knock-over sinkers to form a first set of loops and the other yarn on the dividing sinkers to form a first set of loops, withdrawing the dividing sinkers to permit the needles of said one group to pass in front of the loops held thereon, thereafter holding said other group of needles inactive on said lower cylinder and thereafter simultaneously feeding to said one group of needles a second pair of independent yarns to form knit stitches with both yarns in each stitch with one yarn on the knock-over sinkers to form a third set of loops and the other yarn on the dividing sinkers, whereby a single course is formed having stitches of the first pair of yarns alternating with loops of the second pair of yarns, thereafter moving said dividing sinkers forward to permit the needles of both groups to pass to the rear of said second and fourth sets of loops on said dividing sinkers, raising said needles, withdrawing said dividing sinkers as needles of both groups are lowered to feed said second and fourth sets of loops on said dividing sinkers to said needles, and thereafter continuing to lower said needles to pull said second and fourth sets of loops through the said knit stitches of said first and second pairs of yarns and thereafter finishing off said pulled loops.

2. The method according to claim 1 wherein each pair of yarns comprise a main yarn and an auxiliary yarn and said main and auxiliary yarns are of a different character.

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