Oct. 19, 1971 J. FECKER 3,613,399

METHOD AND APPARATUS FOR KNITTING LADDER-PROOF TUBULAR PRODUCTS

Filed Sept. 4, 1969 4 Sheets-Sheet 1

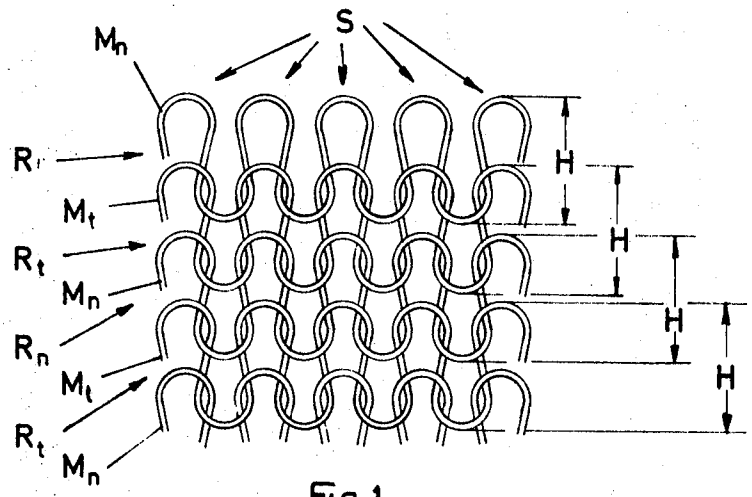


Fig.1

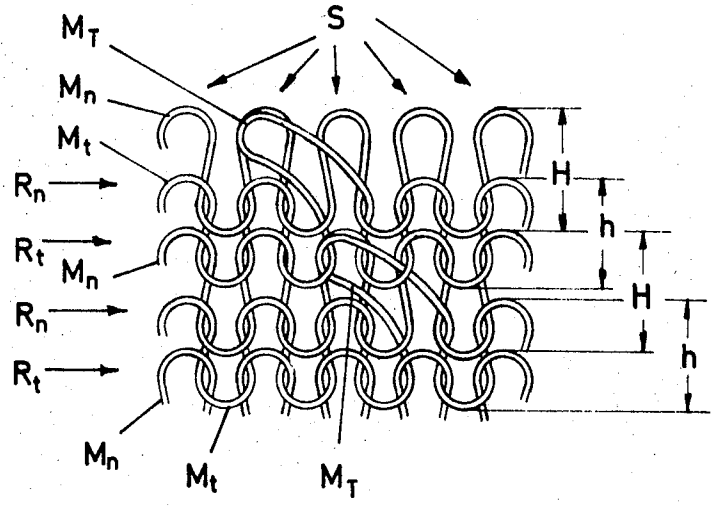


Fig.2

INVENTOR.
JOSEF FECKER

BY
Woodhams, Blanchard & Flynn
ATTORNEYS

Oct. 19, 1971 J. FECKER 3,613,399
METHOD AND APPARATUS FOR KNITTING LADDER-PROOF TUBULAR PRODUCTS
Filed Sept. 4, 1969 4 Sheets-Sheet 2

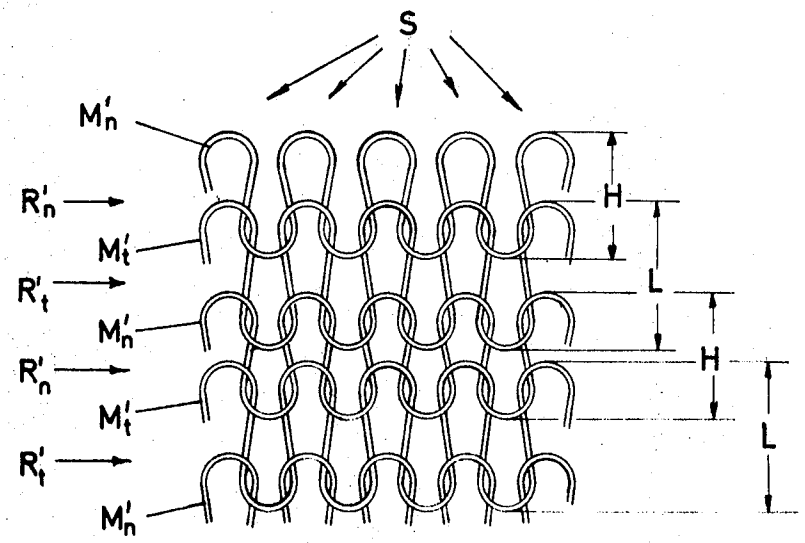


Fig.3

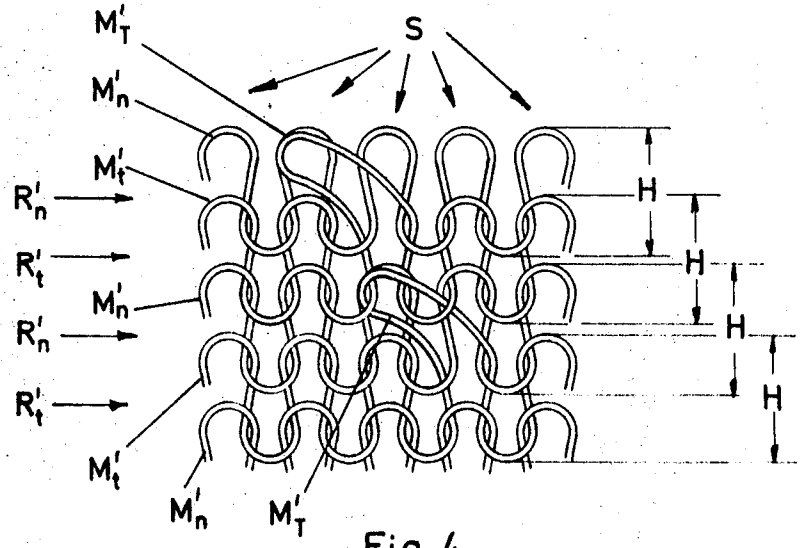
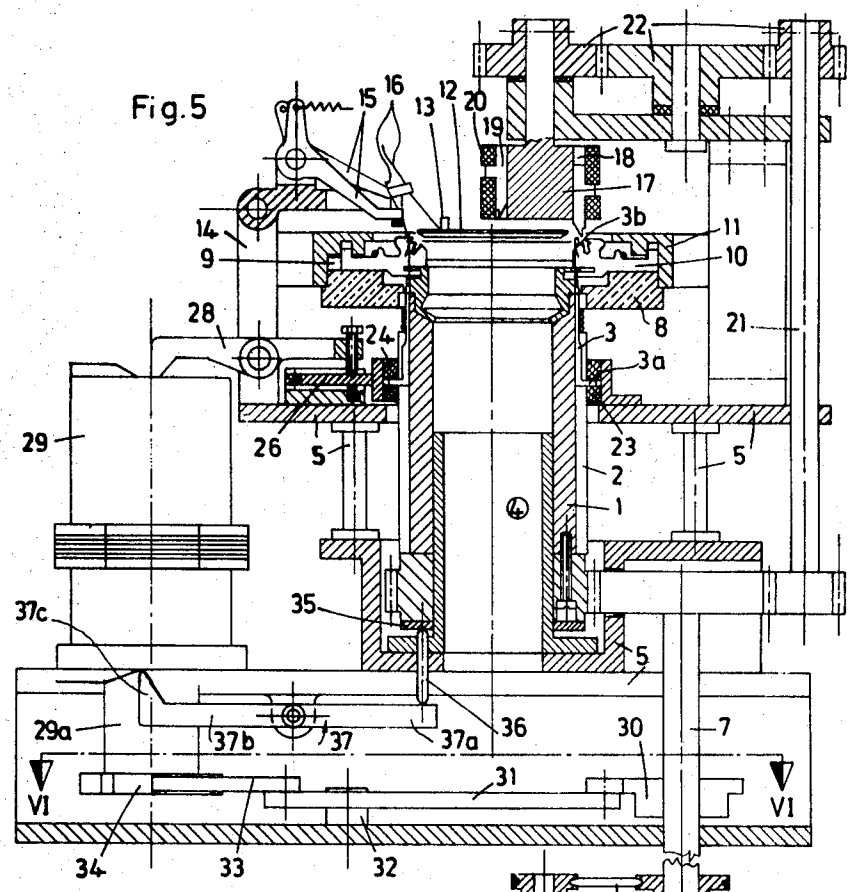


Fig. 4

INVENTOR.
JOSEF FECKER
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

Oct. 19, 1971 J. FECKER 3,613,399
METHOD AND APPARATUS FOR KNITTING LADDER-PROOF TUBULAR PRODUCTS
Filed Sept. 4, 1969 4 Sheets-Sheet 3

Fig.5



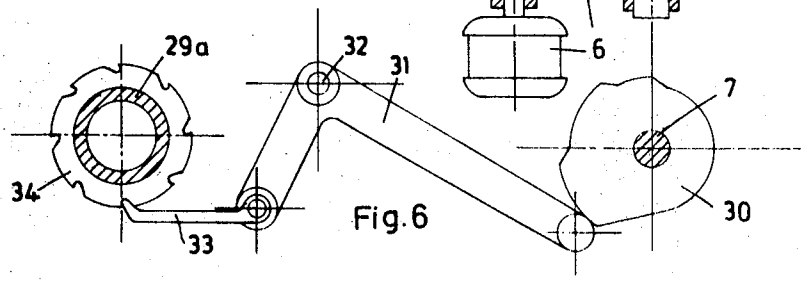
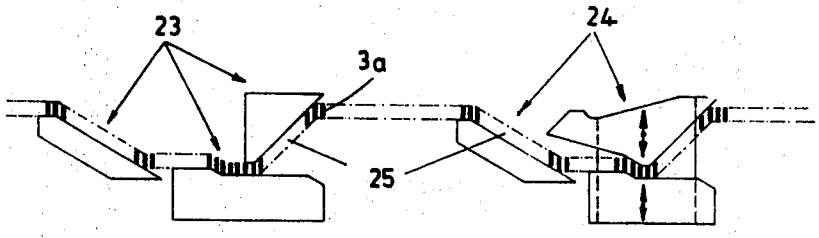


Fig.6

INVENTOR.
JOSEF FECKER
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

Oct. 19, 1971 J. FECKER 3,613,399
METHOD AND APPARATUS FOR KNITTING LADDER-PROOF TUBULAR PRODUCTS
Filed Sept. 4, 1969 4 Sheets-Sheet 4

Fig.7



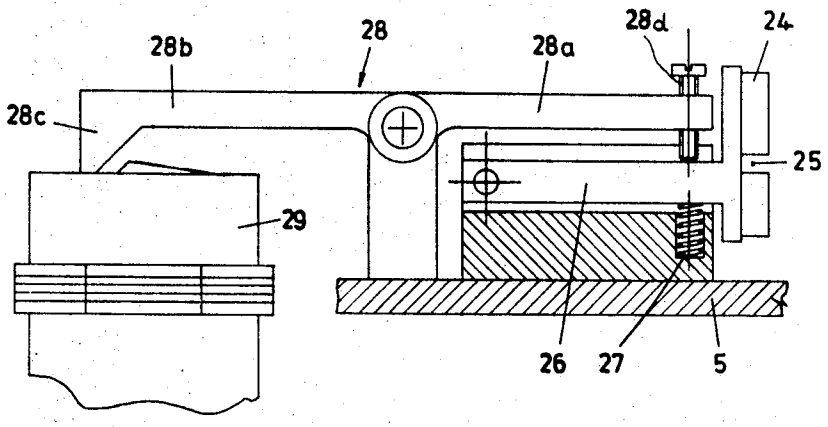


Fig.8

INVENTOR.
JOSEF FECKER
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

United States Patent Office 3,613,399
Patented Oct. 19, 1971

3,613,399

METHOD AND APPARATUS FOR KNITTING LADDER-PROOF TUBULAR PRODUCTS

Josef Fecker, Freudenstadt, Wurttemberg, Germany, assignor to Texpatent GmbH, Fribourg, Switzerland

Filed Sept. 4, 1969, Ser. No. 855,235
Int. Cl. D04b 9/48, 15/02
U.S. Cl. 66—55 10 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for knitting ladder-proof tubular products in which the loops are transferred laterally from certain courses to adjacent wales. The loops in the courses from which the loops are transferred are made larger than the loops in the other courses such that, after transfer, all of the courses have loops of approximately the same size.

METHOD AND APPARATUS FOR KNITTING LADDER-PROOF TUBULAR PRODUCTS

The invention relates to a method of knitting ladder-proof tubular products in which loops are transferred laterally from certain courses to adjacent wales, as well as to a circular knitting machine for carrying out said method.

If ladder-proof tubular mesh is produced by loops being extracted from certain courses and being transferred from the side to adjacent wales, the loops of these courses for which the loops are removed for transference become smaller. This is the inevitable consequence of expanding the loops to be transferred, which proceeds irrespective of the size of the remaining loops of the same course. With the conventional knitting methods the loops of all courses are the same size and are uniformly altered in size, irrespective of whether or not they belong to courses having transfer loops. For example, when a ladies' stocking is knitted, loops of like size are knitted in all courses from the opening of the stocking to approximately its longitudinal centre, and then the size of the loop is gradually reduced as far as the foot of the stocking. By transferring loops, courses having normal size loops and courses with loops reduced by transference succeed one another in this type of tubular mesh. The radial elasticity or extensibility of such tubular mesh is determined only by the elasticity of the courses having smaller loops. Only these courses bear radial stress. The result is that, at least in certain sections, the tubular mesh has less radial extensibility than would actually be required. Particularly in the case of stockings, the upper section cannot be expanded to the required extract by reducing the size of the loops in the courses having transfer loops. This upper section is also subject to tearing since the stress is concentrated on the courses having transfer loops.

The problems underlying the invention is to provide a method of the initially described type so that there are loops of essentially the same size despite loop transfer in all courses.

This problem is solved in accordance with the invention in that the loops of those courses from which they are extracted are so much larger than in the other courses that, after transfer, all the courses have loops of the same size.

In the method according to the invention, the loops of the transfer courses are originally larger than the loops of the other courses in those sections of the tubular mesh in which great radial elasticity is required. By expanding the transfer loops, the remaining loops of the transfer courses are then reduced to such an extent that they are essentially the same size as the loops in the courses from which no loops are laterally transferred.

The invention however, also provides that the reduction in size of the loops in the transfer courses can be used systematically to produce sections of less radial elasticity when tubular mesh is knitted. Also, in the sections having less radial elasticity, the size of the loops of those courses from which they are transferred is reduced in relation to the size of the sections having greater radial elasticity, to such an extent that, after transfer, they are smaller than the loops of those courses from which no loop transfer is made.

The method according to the invention may be applied particularly to the knitting of ladder-proof ladies' hose such as stockings or tights. In this connection, from the opening of the stocking as far as its longitudinal centre the loops of those courses from which they are transferred are so much larger than in the other courses that, after transfer, all the courses have loops of approximately the same size, whereas, from the longitudinal centre of the stocking as far as the foot, the loops of those courses from which they are transferred are so much smaller than those above the longitudinal centre that, after transfer, they are smaller than the remaining loops. The stocking or stocking tights is then relatively highly extensible above the longitudinal centre and all the courses show this elasticity in this section which is subject to considerable radial stress. The normal downward conicity of the stocking together with simultaneously reduced elasticity is produced by reducing the loops in the transfer courses.

In this connection another reduction can be added to the reduction of the loops due to the transfer, the result of which is that all the loops from the longitudinal centre of the stocking downwards are also reduced to the same extent in a manner known per se.

A further problem underlying the invention is to provide a circular knitting machine comprising a needle cylinder, a loop transfer arrangement, and at least two knitting systems and having a relative vertical adjustability between the needle cylinder and cylinder cams, wherein the size of the loops in the transfer courses can be varied or altered irrespective of the size of the loops in the other courses.

The invention solves this problem in that each cylinder cam associated with a knitting system for producing the loops to be transferred is vertically adjustable relative to the needle cylinder in addition to the relative vertical adjustability between the needle cylinder and all the cylinder cams. The size of the loops in the transfer courses can therefore be independently selected so that the required loop size is produced in the transfer courses.

In the case of a circular knitting machine comprising a vertically adjustable needle cylinder and at least one stationary cylinder cam associated with a knitting system which does not produce loops to be transferred, it is provided in an embodiment of the circular knitting machine according to the invention that each cylinder cam associated with a knitting system for producing loops to be transferred is vertically adjustable. By adjusting the cylinder cam or each cylinder cam associated with a knitting system for producing transfer loops opposite the stationary cylinder cams, the size of the loops in the transfer courses can then be adapted as required.

In the latter modification of the circular knitting machine according to the invention it is advantageous if the needle cylinder and each vertically adjustable cylinder cam can be essentially simultaneously adjusted in the opposite directions to one another. During the knitting of stockings or tights, the resulting effect is that a reduction of the loops in the transfer courses by raising the pertinent cylinder cam can be simultaneously added to

the normal reduction of loops by lowering the needle cylinder.

The invention is described below with the aid of a practical embodiment.

FIG. 1 shows an enlarged view of a knitted section with loops being the same size in all courses;

FIG. 2 shows a view of the mesh according to FIG. 1 after loops are transferred in every second course;

FIG. 3 shows a view, corresponding to FIG. 1, of a knitted section having enlarged loops in the transfer courses before the loops are transferred;

FIG. 4 shows the knitted section according to FIG. 3 after the loops are transferred;

FIG. 5 shows a vertical section through a circular knitting machine according to the invention;

FIG. 6 shows a horizontal section through the circular knitting machine along the line VI—VI of FIG. 5;

FIG. 7 shows a schematic representation and modification of the cylinder cam arrangement of the circular knitting machine as shown in FIG. 5;

FIG. 8 shows a constructional detail of the circular knitting machine according to FIG. 5, showing the adjustability of a cylinder cam.

The mesh according to FIGS. 1 and 2 contains loops in the form of wales S and courses R_n and R_t. The loops of the former are designated by M_n, those of the latter by M_t. As shown in FIG. 1, the loops M_n and M_t are the same in height, and therefore all have the same size H. If the needle now engages the courses M_t, grips several loops M_t and transfers them laterally into an adjacent wale, a loop configuration is produced as shown in FIG. 2. There all the loops M_n of the courses R_n have the same size H. The loops M_t of the courses R_t, however, have become smaller as a result of the expansion of the loops M_t and only have the size *h*. The courses R_t with the reduced loop size *h* determine the elasticity of the mesh and only have to bear the radial stress on the tubular article.

If, on the other hand, a mesh is used as shown in FIG. 3, then courses R'_n having loops M'_n of the size H are first obtained, and then courses R'_t having loops M'_t of the size L. In this connection L is greater than H.

If a needle now engages the courses R'_t and in turn transfers several loops M'_t therefrom, the loop configuration as shown in FIG. 4 results.

By expanding the loops M'_t the size of the loops in the courses R'_t is reduced from L to H. Thus, the loops are the same size in all courses.

A tubular article having the loop configurations shown in FIGS. 1 to 4 can be produced on the circular knitting machine according to FIGS. 5 to 8. This circular knitting machine comprises a needle cylinder **1**, in the outer face of which latch needles **3** with laterally projecting feet **3***a* and needle heads **3***b* are arranged for longitudinal displacement in longitudinal grooves **2**. The needle cylinder **1** is rotatably mounted on a bush **4** which is in turn rigidly connected to a multisectional machine frame **5**. The needle cylinder **1** is rotatably driven by a main drive schematically represented at **6** via a main drive shaft **7**. The upper edge of the needle cylinder **1** is surrounded by a sinker ring **8** which rotates synchronously therewith and contains longitudinally displaceable cast-off sinkers **10** in radial grooves **9**. The movement of the sinkers is controlled by means of a stationary sinker cam ring **11**. The illustrated sinkers **10** are special sinkers which both co-operate with the needles **3** to knit the loops and assume the task normally fulfilled by sinkers of a welt dial, namely to temporarily retard the first courses when the double welt of a stocking is formed. Therefore, only a stationary cover plate **12** and a thread-gripping device **13** are located above the needle cylinder **3**.

Two thread guides **15** are pivotably mounted on a bearing pedestal **14** which is supported on the housing **5**, said thread guides delivering a thread **16** to the knitting needles or feeding the thread when the thread-gripping device **13** is in its inoperative position. The control of these thread guides **15** is effected in the known manner and is therefore not shown in detail.

A cylindrical carrier body **17** which contains transfer sinkers **19** in longitudinal grooves **18** is located above the needle cylinder and staggered slightly eccentrically thereto. Its movement is controlled by a stationary cam ring **20**. The carrier body **17** is driven by the main drive shaft **7** via an intermediate shaft and a gear **22** is driven at such a rotational speed that the orbit speed of the transfer sinkers **19** differs slightly from the orbit speed of the needles **3**. The transfer sinkers **19** are controlled so that they engage in certain courses, preferably after they are cast off the needles **3**, and several loops are transferred laterally into adjacent wales in the manner shown in FIGS. 2 and 4.

The movement of the needles **3** in their grooves **2** is controlled by cylinder cams **23** and **24**. The circular knitting machine shown as a practical embodiment has two such cylinder cams corresponding to the present two thread guides **15**. As can be seen particularly in FIG. 7, the parts of the cylinder cams **23** and **24** enclose a track **25** along which the feet **3***a* of the needles are guided.

The cylinder cam **23** is rigidly mounted in a vertical direction on part of the housing **5**, whereas the three part cylinder cam **24** is vertically adjustable. As is shown particularly in FIG. 8, it is for this purpose mounted on a pivot lever **26** which is pressed upwards by a spring **27** supported against the housing **5**. A two-armed tilting lever **28** presses with a press screw **28***d*, screwed into its arm **28***a*, downwards against the pivot lever **26**. A tracking projection **28***c* which bears from above against a cam control drum **29** is located on the other arm **28***b* of the tilting lever **28**.

The cam control drum **29** is driven stepwise by the main drive shaft **7**. For this purpose a driving cam **30** which pivots a two-armed bell-crank lever **31** back and forth about an axle **32** rigidly mounted on the housing is keyed on the main drive shaft **7**. This lever bears a ratchet and pawl **33** which co-operates with a ratchet wheel **34** which is non-rotatably supported on a coaxial extension **29***a* of the cam control drum **29**.

The needle cylinder **1** can be vertically adjusted along the bush **4** opposite the housing **5**. For this purpose its lower end is provided with a pressure ring **35** on which one end of a pressure pin **36** engages. The other end of the pressure pin is supported on an arm **37***a* of a tilting lever **37**, the other arm **37***b* of which has a tracking projection **37***c* which is in turn influenced by the cam control drum **29**.

The cams on the cam control drum **29** are arranged so that the tilting levers **28** and **37** are pivoted at essentially the same time and in opposite directions to one another.

In order to knit a ladder-proof, hose-shaped stocking on the circular knitting machine described, the operation proceeds as follows:

The needle cylinder **3** is first located in the elevated position. The cylinder cam **24** is lowered and knitting commences on the double welt. A mesh is produced, as illustrated in FIG. 3. This is caused by the fact that the cam **24** is pressed downwards by the tilting lever **28** to a level which lies below the level of the cam **23**. Therefore, the courses R'_t which are produced when the needles **3** are controlled by the cams **24** become larger than the courses R'_n produced by means of the cylinder cam **23**. The transfer sinkers **19** are controlled so that they engage in the courses R'_t and laterally transfer several loops M'_T from these courses into adjacent wales. The upper section of the stocking which passes into the needle cylinder **3** therefore has a loop configuration as shown in FIG. 4.

If the longitudinal centre of the stocking is then reached, from which point the stocking is supposed to taper conically, then the needle cylinder **3** is lowered by

means of the cam control drum **29** via the tilting lever **37** and the pressure pin **36**. This step causes all the loops to be reduced by the same amount. At the same time the movable cylinder cam **24** is adjusted upwards by the cam control drum **29** by pivoting the tilting lever **28** in the opposite direction. This cylinder cam which is associated with the knitting system for producing the transfer loops then causes the transfer courses to produce loops of equally reduced size. For example, the hitherto larger loops of the transfer courses can be reduced to the size of the loops in the other courses. In addition, the movable cylinder cam **24** is raised by the force of the spring **27** to the same level as the stationary cylinder cam **23**. Then a loop configuration is first produced as shown in FIG. 1, the loops however being smaller than the loops of courses R'_n. After the loop transfer, the size of the loops is also reduced in the transfer courses, similar to FIG. 2. The stocking therefore obtains the required conicity and reduced elasticity in its lower section.

The invention is not limited to the illustrated embodiment, but may also be applied for example to a circular knitting machine having a needle cylinder stationary in its vertical position, wherein all the cylinder cams are vertically adjustable in the usual manner. Each cylinder cam associated with a knitting system for producing transfer loops must also be vertically adjustable relative to the other cylinder cams. Also the invention is applied not only to ladies' stockings, but particularly also to stocking tights and other hose-shaped mesh, wherein, despite the ladder-proof design, all the loops are supposed to be the same size after loop transfer or the size of the loops in certain courses are to be systematically reduced by loop transfer.

What I claim is:

1. A method of knitting ladder-proof tubular mesh on a circular knitting machine in which loops are transferred laterally from wales of certain courses into adjacent wales, characterized in that, at least over an axially extending section of the mesh, substantially all of the loops of those courses from which loops are transferred are initially larger than the loops in the other courses in which loops are not transferred so that, after transfer, substantially all untransferred loops of all the courses are of approximately the same size.

2. A method according to claim **1** for knitting tubular mesh having in addition to said first-mentioned section, at least one further section of reduced radial elasticity, characterized in that, in the further section the size of the remaining loops of those courses from which loops are transferred is reduced as a result of expansion of the loops being transferred, both in relation to the size of the finished loops in said first-mentioned section and in relation to the loops of those courses of said further section from which no loop traansfer is made.

3. A method according to claim **2** of knitting ladder-proof hose wherein said first-mentioned section is knitted from the opening of the hose as far as a predetermined point, and said further section is knitted from the said point as far as the foot.

4. A method according to claim **3**, in which the mesh is knitted with all the loops in said further section of reduced size in relation to all of the loops of said first-mentioned section and wherein said predetermined point is substantially at the longitudinal center of the hose.

5. A method of knitting a section of ladder-proof tubular mesh on a circular knitting machine, comprising the steps of knitting a first course consisting of loops of a predetermined size, knitting a second course consisting of loops of a size larger than the loops in said first course, enlarging at least some of the loops of said second course while simultaneously causing a reduction in the size of the remaining loops of said second course until the remaining loops of said second course are approximately the same size as the loops of the first course, and transferring the enlarged loops into adjacent wales, whereby all of the loops of the first and second courses, with the exception of the transferred loops, are of approximately the same size.

6. A method according to claim **5**, wherein the transferred loops of said second course are transferred to adjacent wales of said first course.

7. A circular knitting machine for knitting ladder-proof tubular mesh in which loops are transferred laterally from certain courses, into adjacent wales, comprising:

a needle cylinder having a plurality of needles mounted for longitudinal movement thereon;

a first knitting system coacting with said needles for producing a first course of said mesh, said first knitting system including therein a first cylinder cam disposed for coaction with said needles;

a second knitting system coacting with said needles for producing a second course consisting of loops therein which are initially larger than the loops of said first course, the second knitting system also including a second cylinder cam disposed for coaction with said needles;

loop transfer means coacting with selected loops of said second course for enlarging and transferring said selected loops laterally into adjacent wales and for causing the size of the remaining loops of said second course to be reduced to approximately the same size as the loops of the first course;

first adjustment means for permitting said second cam to be longitudinally moved relative to said needle cylinder to selectively vary the relative longitudinally positional relationship therebetween, thereby permitting the initial size of the loops of the second course to be selectively varied; and

second adjustment means coacting between said needle cylinder and said first and second cams for permitting longitudinal movement of said needle cylinder relative to both said first and second cams.

8. A circular knitting machine according to claim **7**, wherein said needle cylinder is mounted for movement in its axial direction and is selectively movable in said axial direction by said second adjustment means, said first cam being substantially stationarily mounted to the frame of the knitting machine, and said second cam being mounted for movement relative to both said frame and said needle cylinder in a direction substantially parallel to the axial direction of said needle cylinder.

9. A circular knitting machine according to claim **8**, further including control means coacting with said first and second adjustment means for permitting said needle cylinder and said second cam to be simultaneously adjusted in opposite directions relative to one another.

10. A circular knitting machine according to claim **9**, wherein said control means includes a common rotatable control drum coacting with both said first and second adjustment means.

References Cited

UNITED STATES PATENTS

981,318	1/1911	Scott	66—95
2,060,020	11/1936	Boaler	66—95
3,157,037	11/1964	Neber et al.	66—198
3,318,113	5/1967	Nebel	66—54 X
3,470,715	10/1969	Parthum	66—95
3,491,559	1/1970	Fecker	66—97

FOREIGN PATENTS

142,013	7/1903	Germany	66—198
146,556	4/1902	Germany	66—198
17,907	1902	Great Britain	66—198

WM. CARTER REYNOLDS, Primary Examiner

U.S. Cl. X.R.

66—95, 177, 178, 189, 198