March 10, 1959 G. E. HART ET AL Re. 24,616

CIRCULAR MULTI-FEED HOSIERY KNITTING MACHINE AND METHOD OF KNITTING

Original Filed May 31, 1955

5 Sheets-Sheet 1

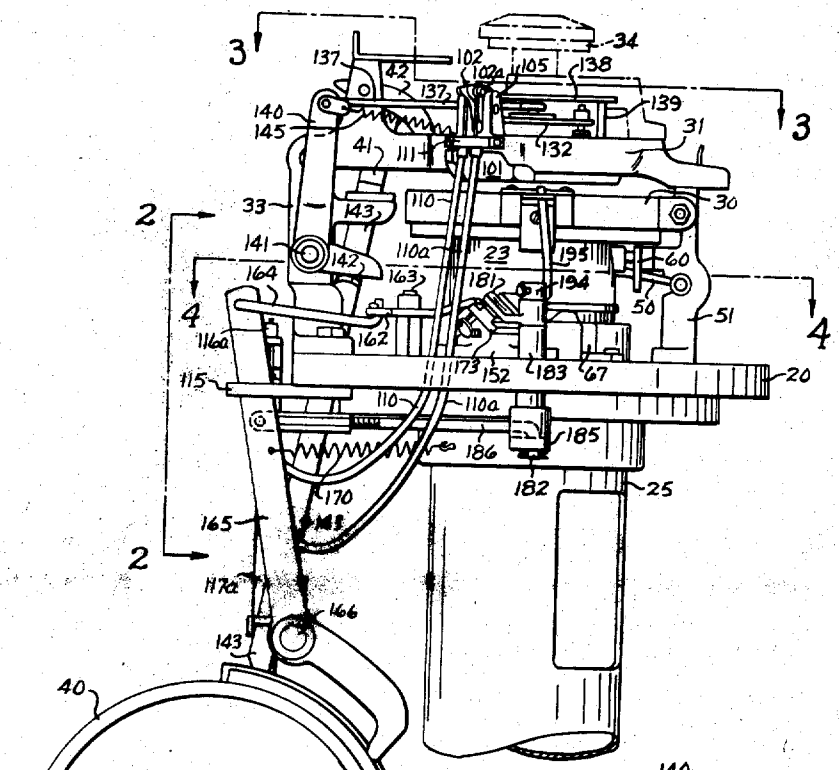


Fig-1

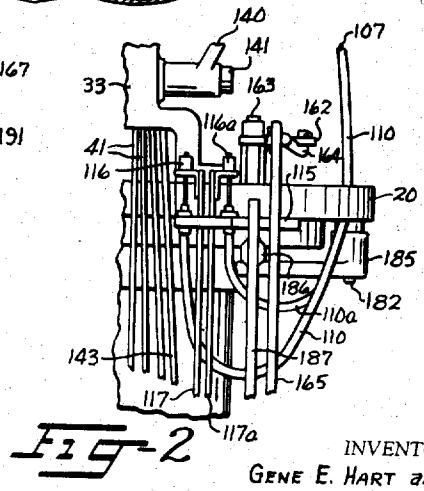


Fig-2

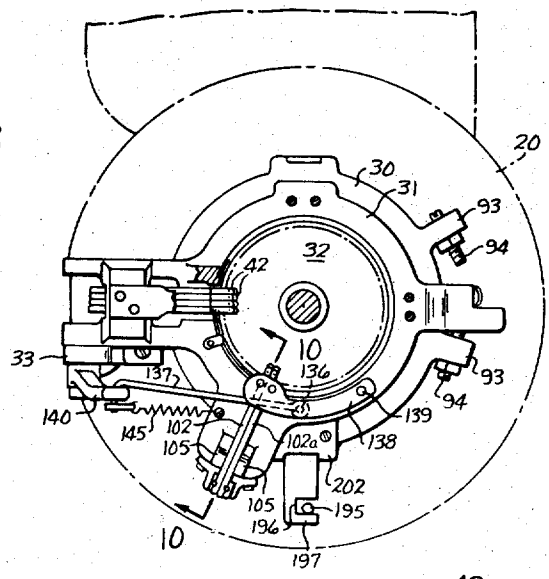
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Fig. 3



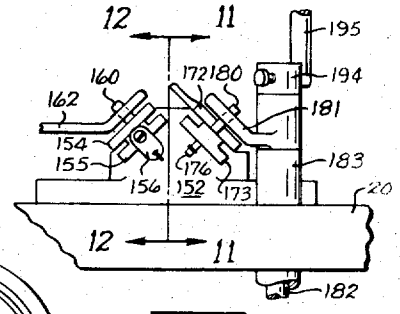


Fig. 5

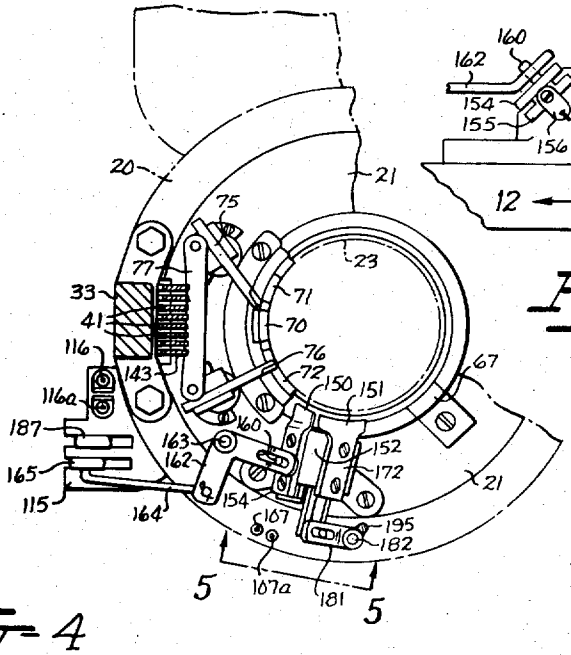


Fig. 4

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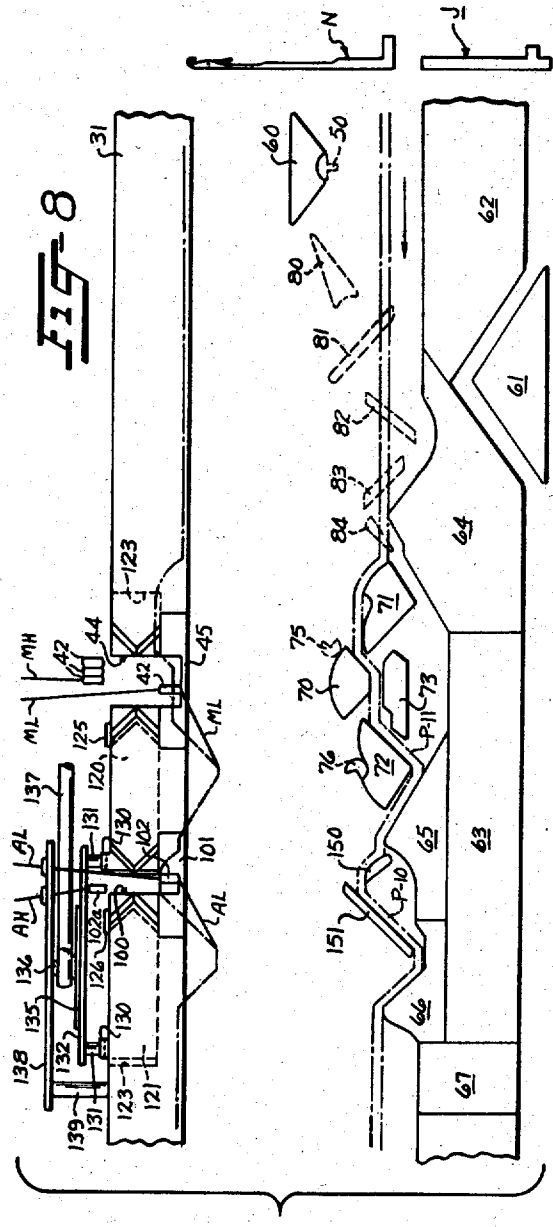


FIG 8

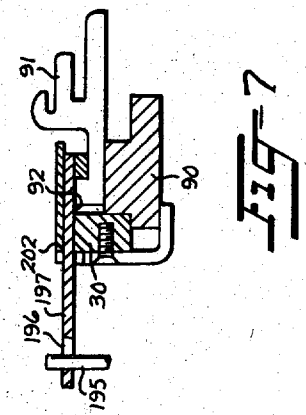


FIG 7

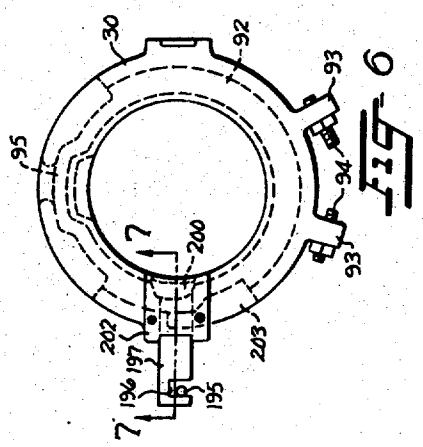


FIG 6

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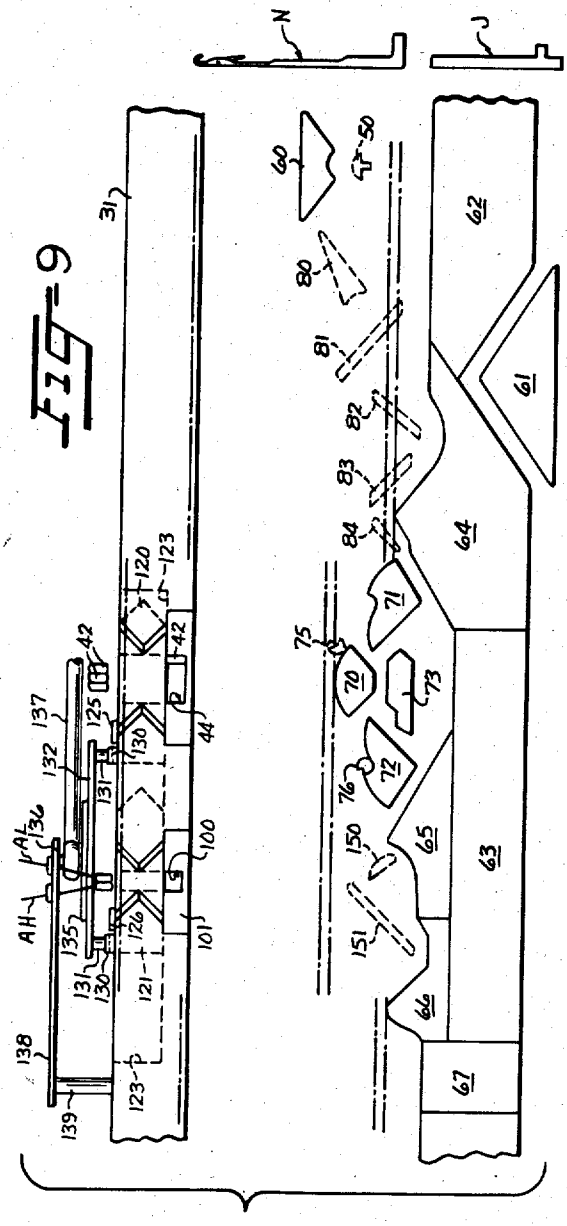


FIG. 9

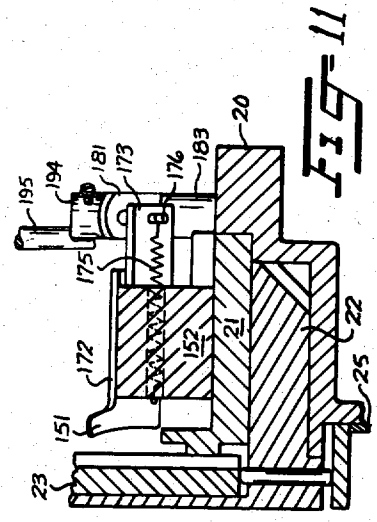


FIG. 11

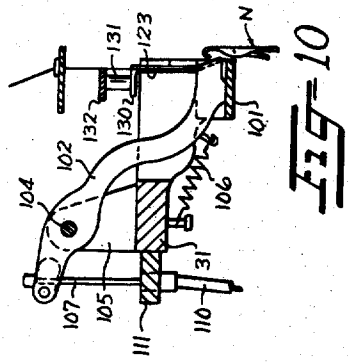


FIG. 10

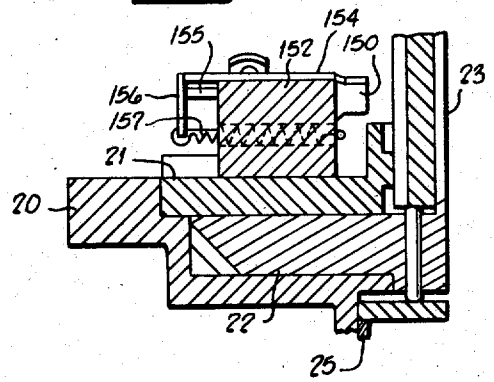
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CIRCULAR MULTI-FEED HOSIERY KNITTING MACHINE AND METHOD OF KNITTING

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Fig-12



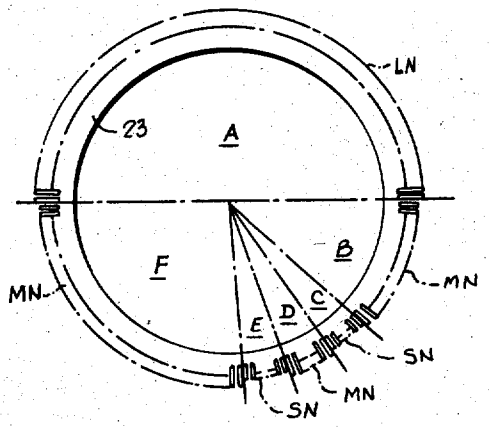


Fig-13

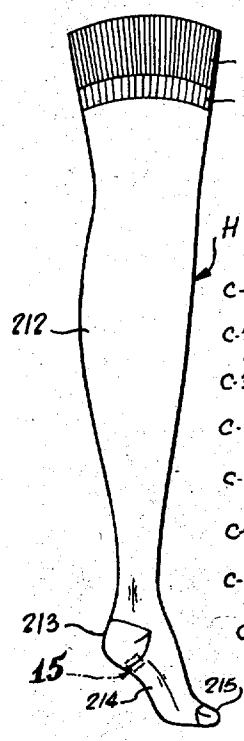


Fig-14

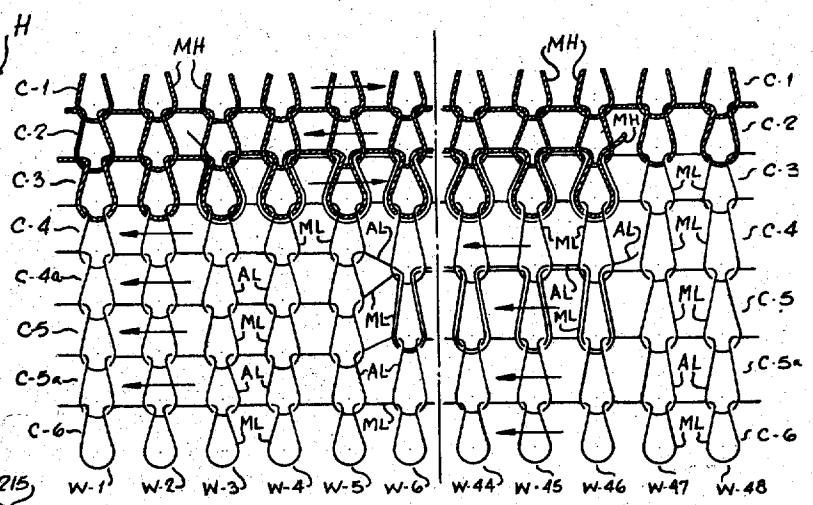


Fig-15

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Reissued Mar. 10, 1959

24,616

CIRCULAR MULTI-FEED HOSIERY KNITTING MACHINE AND METHOD OF KNITTING

Gene E. Hart and Howard F. Metcalf, Charlotte, N. C., assignors to Carolina Knitting Machine Corporation, Charlotte, N. C., a corporation of North Carolina

Original No. 2,785,553, dated March 19, 1957, Serial No. 511,936, May 31, 1955. Application for reissue January 23, 1958, Serial No. 710,830

6 Claims. (Cl. 66—42)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to circular knitting machines and more especially to a circular multi-feed knitting machine adapted to knit from a plurality of feeding stations during rotary knitting.

Heretofore there have been attempts to make multi-feed knitting machines using two or more feeds to thus increase the speed of knitting such articles as ladies' fine-gauge hosiery, but heretofore the second or auxiliary yarn in the multi-feed set-up has been supplied by an auxiliary finger placed between the latch ring and needles which interferes with the normal free operation of the latches on the latch needles in the needle cylinder.

It is therefore a primary object of this invention to provide a multi-feed circular knitting machine which has a main or primary feeding station comprising a throat opening having a throat plate and gap closer for closing the throat during reciprocatory knitting as well as an auxiliary feeding station comprising a throat opening having a throat plate and gap closer for closing the auxiliary throat during reciprocatory knitting, to thus provide a smooth inner race against which the latches of the latch needles may ride during reciprocatory knitting.

It is another object of this invention to provide an auxiliary feeding station with the throat cut in the latch ring in the same manner as the throat at the main feeding station.

A needle raising cam and a needle lowering cam form an auxiliary stitching station spaced below the auxiliary feeding stations apart from the main stitch cams including the top center stitch cam and the right and left-hand stitch cams. The main stitch cams are spaced below the main feeding station. The auxiliary stitching cams including the needle raising cam and the needle lowering cam are movable radially into and out of engagement with the needle cylinder.

It is another object of this invention to provide a means and method of introducing yarn at the auxiliary feeding finger to the needles in the needle cylinder which prevents holes and cat-eyes being formed in the fabric when this auxiliary yarn feeding finger is moved into feeding position. This novel method of starting to knit with the auxiliary yarn feed finger is made possible by the arrangement of needle butts of varying lengths in the needle cylinder.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which—

Figure 1 is a side elevation of the upper portion of a knitting machine of the circular type and showing the invention applied thereto;

Figure 2 is a fragmentary rear elevation of the knitting machine being taken substantially along the line **2—2** in Figure 1;

Figure 3 is a sectional plan view taken substantially along the line **3—3** in Figure 1;

Figure 4 is a fragmentary sectional plan view taken substantially along the line **4—4** in Figure 1;

Figure 5 is an enlarged elevation looking substantially along the line **5—5** in Figure 4;

Figure 6 is a plan view of the sinker cap removed from the knitting machine;

Figure 7 is an enlarged transverse vertical sectional view taken substantially along the line **7—7** in Figure 6;

Figure 8 is a somewhat schematic developed view of the cams surrounding the needle cylinder and taken as if looking outwardly from the needle cylinder and showing the path of travel of the needles during circular knitting;

Figure 9 is a view similar to Figure 8 except showing the path of travel of the needles during reciprocatory knitting;

Figure 10 is a vertical sectional view, at an enlarged scale, and being taken substantially along the line **10—10** in Figure 3;

Figure 11 is an enlarged vertical sectional view through the auxiliary stitch cam block and being taken substantially along the line **11—11** in Figure 5;

Figure 12 is an enlarged vertical sectional view taken through the auxiliary stitch cam block and being taken substantially along the line **12—12** in Figure 5;

Figure 13 is a somewhat schematic sectional plan view of the needle cylinder and showing the arrangement of the needles in the needle cylinder according to the length of the butts thereon;

Figure 14 is a perspective rear view of the ladies' hose as it appears on the wearer's leg;

Figure 15 is an enlarged fragmentary view of that portion of the hose indicated by the dotted rectangle **15** in Figure 14 and showing where the auxiliary yarn feeding finger and the auxiliary stitch cams are moved into operation.

Referring more specifically to the drawings, the numeral **20** indicates the bed plate of a conventional circular knitting machine having the usual cam bed plate **21** (Figures 4, 11 and 12) fixedly secured thereto as well as the conventional bevel gear **22** for driving the needle cylinder **23**. A sock horn **25** extends upwardly into the bed plate **20** and has conventional means provided therewith to raise and lower the needle cylinder to produce longer or shorter stitches in a conventional manner. The knitting machine is also provided with the usual sinker cap **30**, a latch ring **31**, the usual dial **32** (Figure 3) and gearing **34** (Figure 1) for driving the dial **32** in making the usual turned welt of the ladies' hose. The latch ring **31** is supported at its rear end on a support post **33**.

The knitting machine is also provided with a conventional main pattern drum **40** on which the lower ends of a plurality of thrust bars **41** rest and the upper ends of which are adapted to engage a plurality of conventional yarn feeding fingers **42** (Figures 1, 3, 8 and 9) which are pivotally mounted on an upstanding portion on the latch ring **31**. A heavy weight or denier main yarn MH (Figure 8 and 9) is fed to one of the yarn feeding fingers **42** for use in knitting the welt, heel and toe of the hose H (Figure 14) and a light weight main yarn ML is fed to another of the yarn feeding fingers **42** for use in knitting the leg and foot of the hose H. The latch ring **31** is also provided with a main throat **44** having a throat plate **45** (Figures 8 and 9). The knitting machine is also provided with the usual widening pick **50** (Figures 1, 8 and 9) which is pivotally mounted on a bunter post **51**, the lower end of which is suitably secured to the bed plate **20**. The widening pick **50** is adapted to at times

nest in a fixed guide cam **60** suitably secured on the bunter post **51**.

A plurality of fixed needle cams encircle the needle cylinder, including a jack raising cam **61** (Figures 8 and 9), a first fixed cam segment **62**, a second cam segment **63**, respective right-hand and left-hand hardened cams **64** and **65**, an auxiliary hardened cam **66** and a jack gate **67**. The usual stitch cams are provided, including a top center stitch cam **70**, respective right and left stitch cams **71** and **72** as well as a bottom center cam **73**. A pair of conventional narrowing picks **75** and **76** are connected by a link **77** (Figure 4) and work in conjunction with the respective right-hand and left-hand stitch cams **71** and **72**.

Among the conventional movable cams around the needle cylinder are included a switch needle lowering cam **80**, a switch needle raising cam **81**, a needle transfer cam **82** and a pair of needle raising and lowering cams **83** and **84** which are used in the make-up to start a new hose. The pair of switch cams **80** and **81** are used in switching part of the needles in the needle cylinder into and out of action in making the toe and heel pockets during reciprocatory knitting in a conventional manner. The transfer cam **82** is used when transferring from knitting on the dial needles, not shown, to knit stitches with the cylinder needles N. The cams shown in Figures 8 and 9 are adapted to operate conventional needle jacks indicated at **J**.

The sinker cap partially encloses a sinker bed **90** (Figure 7) which is fixedly secured to the upper end of the needle cylinder **23** and has radial grooves therein for reception of conventional sinkers **91**, the tail portions of which ride in a concentric groove **92** (Figures 6 and 7) in the sinker cap **30**. The sinker cap **30** is provided with lugs **93** which have threadably embedded bunters **94** adapted to alternately engage opposite sides of the bunter post **51** as the sinker cap **30** is reciprocated during reciprocatory knitting. The concentric groove **92** in the sinker cap **30** is provided with an outwardly extending portion **95** which is in vertical alinement with the top center cam **70** and is provided to move the sinkers outwardly radially of the needle cylinder when the yarn is being fed at the main throat **44** so that a main yarn will be fed beneath the nibs of the sinkers **91** in a conventional manner.

All of the parts heretofore, described are conventional in a Scott and Williams model K circular knitting machine, with the exception of the auxiliary hardened cam **66**, and it is with these parts that the present invention is adapted to be associated.

The novel features of this invention include an auxiliary throat **100** cut in the latch ring **31** and the lower end of the throat **100** is closed by a throat plate **101** which is adapted to selectively support the inner lower ends of one of a pair of yarn feeding fingers **102** and **102a** (Figures 3, 8, 9 and 10). Although only two yarn feeding fingers **102** and **102a** are shown in the throat **100**, it is to be understood that any desired number of yarn feeding fingers could be mounted in the auxiliary throat **100** of the latch ring **31**.

The auxiliary yarn feeding fingers **102** and **102a** are oscillatably mounted as at **104** (Figure 10) on upstanding portions **105** which are cast integral with the latch ring **31** adjacent opposite sides of the throat **100** and form a novel part of this invention. The yarn feeding fingers **102** and **102a** are resiliently urged into engagement with the throat plate **101** by a pair of springs **106**, only one of which is shown, which springs extend from respective yarn feeding fingers **102** and **102a** to the latch ring **31**. The yarn feed fingers **102** and **102a** are moved into and out of engagement with the throat plate **101** by a pair of respective Bowden wires **107** and *107a*, the upper ends of which are secured to the outer or free ends of the yarn feeding fingers **102**, **102a**. The wires **107**, *107a* have sliding movement in casings **110**, **110a**, the upper

ends of which are secured in a bracket **111** fixed on the latch ring **31** (Figure 10).

The casings **110** and **110a** pass downwardly (Figure 1) through the bed plate **20** and are bent upwardly and their ends remote from the bracket **111** are fixed in a bracket **115** mounted on the lower edge of the bed plate **20** (Figures 2 and 4). The wires **107**, **107a** extend from the lower ends of the casings **110**, **110a** and are connected as at **116**, **116a** to the upper ends of respective thrust bars **117**, **117a**. The lower ends of the thrust bars **117**, **117a** are adapted to, at times, engage the outer periphery of the main pattern drum **40** and at other times to engage suitable segmental cams mounted thereon, not shown, for raising and lowering the respective wires **116**, **116a**. Vertical movement of the thrust bars **117**, **117a** will thus move the corresponding auxiliary yarn feeding fingers **102**, **102a** into and out of feeding position in the throat **100**.

Another of the novel features of this invention is the novel means for closing the main throat **44** as well as the auxiliary throat **100** by a pair of gap closing plates **120**, **121** which operate together to close the respective throats **44** and **100** simultaneously during reciprocatory knitting (Figures 8 and 9). This feature is important in that it makes possible a further increase in the production of high speed knitting machines which produce such articles as ladies' fine-gauge seamless hose.

Prior attempts to increase production by adding auxiliary feeding fingers for knitting the long leg portion of a ladies' seamless hose two courses at a time have failed because there has never been provided two throats in the latch ring and means for selectively closing these two throats to provide a smooth inner surface in the latch ring for the latches of the inoperative or raised needles to ride against. Without the two gap closing plates **120**, **121**, the latches of the raised or inoperative needles tend to fly outwardly by centrifugal force during high speed operation and may become bent or broken when they engage the open throats heretofore provided.

The gap closers **120**, **121** are slidably mounted in a groove **123** in the latch ring **31** (Figures 8, 9 and 10) and are prevented from upward movement out of the groove **123** by a pair of hold down plates **125** and **126** which are secured on the latch ring and overlie the groove **123**. Each of the gap closers **120**, **121** is provided with an upwardly and outwardly extending tail portion **130** (Figure 10) in which the lower ends of upstanding pins **131** are embedded, the upper ends of which are fastened to a connecting link **132** which extends between the pins **131**. The connecting link **132** has a plate **135** adjustably mounted thereon in which an upstanding pin **136** is fixedly secured.

The pin **136** is engaged by a gap actuating control rod **137** (Figures 3, 8 and 9) which extends away from the latch ring **31** and to the left of the machine in Figures 1 and 3 and is oscillatably mounted on the upper leg of a crank arm **140** pivotally mounted on the latch ring support **33** as at **141**. A yarn guide plate **138** is spaced above the latch ring **30** and supported on an upstanding post **139** for guiding auxiliary light and heavy weight yarns AL and AH to the respective auxiliary yarn feeding fingers **102**, **102a** through suitable yarn guides in the plate **138**.

The lower leg of the bell crank **140** is adapted to be engaged by a bracket **142**, fixed on a thrust bar **143**, the lower end of which is adapted to at times engage the outer periphery of the pattern drum **40** and at other times to engage segmental cams placed thereon, not shown, for raising and lowering the thrust bar **143**. When the lower end of the thrust bar **143** is engaged by one of the segmental cams on the main pattern drum **40** the thrust bar **143** will be raised upwardly to thus rotate the bell crank **140** (Figure 1) in a counterclockwise direction to thus move the gap closing plates **120**, **121** from left to

right in Figure 8 or to the position shown in Figure 9 and close the respective throats **44, 100**. A spring **145** (Figures 1 and 3) which is fixed at one end to the latch ring **31** and at the opposite end to the upper end of the crank **140**, urges the bell crank **140** in a clockwise direction to thus move the control rod **137** along with the gap closing plates **120, 121** from right to left in Figure 9 or to the position shown in Figure 8 and open the throats **44, 100** upon the thrust bar **143** moving off of one of the segmental cams and into engagement with the outer periphery of the pattern drum **40**.

An auxiliary stitch drawing station is provide beneath the auxiliary throat **100** and comprises an auxiliary needle raising cam **150** and an auxiliary needle lowering or stitch drawing cam **151** (Figures 5, 11 and 12). The auxiliary needle raising cam **150** has a stem **154** thereon which extends rearwardly and is in sliding engagement with one beveled edge of the cam block **152**. The stem **154** is fixed on a T-shaped guide block **155** which slides in a groove cut in the cam block **152** and has a spring perch **156** secured to its outer free end.

The needle raising cam **150** as well as the guide block **155** are urged inwardly into engagement with the needle cylinder **23** by a tension spring **157** (Figure 12), the inner end of which is fixedly secured to the block **152** and penetrates a bore in the block **152** while its outer end is connected to the spring perch **156**.

The stem **154** of the auxiliary needle raising cam **150** has an outwardly extending abutment **160** secured therein which penetrates a slot in one leg of a bell crank **162** (Figures 4 and 5) pivotally connected as at **163** on the cam plate **21**. The opposite leg of the bell crank **162** has one end of a control rod **164** oscillatably mounted therein, and the other end of the control rod **164** is oscillatably mounted on the upper end of a bell crank **165** (Figures 1 and 4), the upper end of which is guided in the plate **115**. The bell crank **165** is oscillatably mounted on a support shaft **166** and the lower or reading end thereof is adapted to at times engage the outer periphery of the main pattern drum **40** and at other times to engage one of two segmental cams **167** and **167a** fixed on the pattern drum **40**.

The bell crank **165** is urged into engagement with the segmental cams **167, 167a** or the outer periphery of the main pattern drum **40** by a tension spring **170** (Figure 1), one end of which is secured to the bell crank **165** and the opposite end of which is secured to the bed plate **20**. When the reading end of the bell crank **165** is in engagement with one of the segmental cams **167, 167a**, the bell crank **162** will be moved in a clockwise direction in Figure 4 to thus move the needle raising cam **150** radially away from the needle cylinder **23** to substantially the position shown in Figures 4 and 12. Thus, any needles N passing thereby will not be raised by the needle raising cam **150**.

Upon the reading end of the bell crank **165** moving into engagement with the outer periphery of the main pattern drum **40**, the bell crank **165** will be moved in a clockwise direction to thus allow the spring **157** in the auxiliary stitch cam block **152** to move the bell crank **162** in a counterclockwise direction and move the auxiliary needle raising cam **150** radially towards the needle cylinder **23**. Thus, any needles N passing by the needle raising cam **150** will be raised thereby to a position high enough so that the hooks thereof will pick up any yarn fed by the fingers **102, 102a**. *It should be noted that the yarn feed fingers 42, 120 and 102a form serially arranged yarn feeding stations, and the cams 70—73 and 150, 151 form serially arranged knitting stations.*

The needle lowering or auxiliary stitch cam **151** is provided with a stem **172** (Figures 4 and 11) which is secured to a T-shaped guide block **173** slidably mounted in a suitable groove in the auxiliary stitch cam block **152**. The auxiliary stitch cam **151** is normally urged into engagement with the needle cylinder **23** by a tension spring **175** (Figure 11), the inner end of which is secured on the auxiliary cam block **152**. The spring **175** passes through a bore in the block **152** and the outer end of the spring **175** is secured on a spring perch **176** fixed on the T-shaped guide bar **173**.

The T-shaped guide bar **173** is also provided with an outwardly extending abutment **180** (Figure 5) which engages a slot in a control arm **181**, the inner end of which is fixed on a vertically extending control rod **182** oscillatably mounted in the bed plate **20**. The arm **181** is spaced above the bed plate **20** by a spacing collar **183** and the control rod **182** extends below the bed plate **20** (Figures 1 and 2) and has one end of a lever arm **185** (Figures 1 and 2) fixed thereon to the inner end of which is oscillatably connected one end of an adjustable control rod **186**.

The control rod **186** extends rearwardly and is oscillatably mounted on one leg of a downwardly extending bell crank **187** (Figure 2) pivotally mounted on the support shaft **166**. The reading end of the bell crank **187** is adapted to at times engage segmental cams **191** and **191a** (Figure 1) and at other times to engage the outer periphery of the main pattern drum **40**.

When the bell crank **187** is in engagement with either of the segmental cams **191, 191a**, the lever arm **181** (Figure 4) is moved in a counterclockwise direction to thus move the T-shaped guide bar **173** and the needle lowering or stitch cam **151** radially away from the needle cylinder **23** so that any needles N which pass the needle lowering or stitch cam **151** will not be lowered by the cam **151**.

Upon the reading end of the bell crank **187** moving into engagement with the outer periphery of the main pattern drum **40**, the bell crank **187** is moved in a clockwise direction in Figure 1 to thus move the crank arm **181** in a clockwise direction in Figure 4 so that the spring **187** may move the T-shaped guide bar **173** as well as the needle lowering cam **151** into engagement with the needle cylinder **23** to thus lower any needle N passing the auxiliary stitch cam **151**.

The post **182** has a collar **194** (Figures 1 and 5) fixed thereto to which the lower end of an upstanding control rod **195** is secured, the upper end of the control rod **195** engaging a slot or cutout portion **196** in a plate **197** (Figure 6). A sinker retracting cam **200** is secured to the inner end of the plate **197** which plate is slidably mounted in the sinker cap **30** and is held in position by a plate member **202** (Figures 6 and 7). The sinker cap **30** is also cut horizontally and a sinker returning cam **203** is secured in the concentric cavity **93** to return the sinkers **91** to their innermost position after being moved outwardly radially of the needle cylinder by the sinker retracting cam **200**.

Since the control rod **195** is fixed on the shaft **182** and the lever arm **181** is also fixed on the shaft **182**, it is thus seen that as the lever arm **181** is moved in a counterclockwise direction in Figure 4 the control rod **195** will also be moved in a counterclockwise direction to thus move the plate **197** and the sinker retracting cam **200** inwardly toward the needle cylinder **23** as the stitch cam **151** is moved outwardly away from the needle cylinder.

Conversely, as the lever arm **181** is moved in a clockwise direction in Figure 4, the control rod **195** will also be moved in a clockwise direction (Figure 4) to thus cause the control rod **195** (Figure 6) to engage the outer edge of the slot **196** and move the plate **197** and the sinker cam **200** outwardly radially of the needle cylinder to substantially the position shown in Figure 6 as the cam **151** is moved towards the needle cylinder **23**. In this manner all of the sinkers passing the cam **200** will be moved outwardly radially of the needle cylinder **23** so the yarn being fed by either of the yarn feeding fingers **102, 102a** may be fed beneath the nibs of the sinkers **91** to thus hold the fabric below the nibs of the sinkers. It is important that the sinkers **91** be withdrawn at the auxiliary feeding

station so that the yarn fed thereto will be held underneath the nibs of sinkers as the needles forming stitches are again raised by the auxiliary hardened cam **66** heretofore described.

It is thus seen that any time the needle lowering or auxiliary stitch cam **151** is in operative position so that the needles travel the path indicated at P–**10** in Figure 8, the sinker retracting cam **200** will be in the position shown in Figure 6 and the yarn feeding finger **102** will be in the position shown in Figure 8 so that stitches will be drawn as the needles N pick up the yarn AL. After the needles N are lowered along the path P–**10** by the auxiliary stitching cam **151** they will subsequently be raised by the auxiliary hardened cam 66 in Figure 8. The left-hand stitch cam **72** lowers the needles N along a path P–**11** (Figure 8) to form stitches with the yarn ML so that two courses are formed with each revolution of the needle cylinder **23**.

It will be appreciated that the arrangement of the varying lengths of needle butts in the needle cylinder **23** is important in inserting and removing the auxiliary stitch cams **150, 151**. This is also a novel feature of this invention since it provides a means of removing the auxiliary yarn in action which insures that there are no holes or cat-eyes in the fabric at the juncture where the auxiliary yarn starts to feed to make an additional course in the fabric.

As shown in Figure 13, the needle cylinder is preferably divided into six sections; sections A, B, C, D, E, and F, and, in a five hundred needle knitting machine, for example, there would be substantially two hundred fifty long butt needles indicated at LN in section A. Section B preferably comprises sixty medium butt needles indicated at MN, section C preferably comprises twenty short butt needles indicated at SN, section D preferably comprises twenty medium butt needles indicated at MN, section E preferably comprises twenty short butt needles indicated at SN and section F preferably comprises 130 medium butt needles indicated at MN. The sections B, C, D, E and F preferably comprise approximately half the distance around the needle cylinder and are the needles on which the heel and toe pockets of the hose are knit.

The stocking or hose H shown in Figure 14 includes a double thickness turned welt **210** and a single thickness shadow welt **211**, a leg portion **212**, a heel pocket **213**, a foot portion **214** and a toe pocket **215**. The enlarged fragmentary view of the fabric shown in Figure 15 which is taken at the start of the foot portion **214** illustrates in the seven courses C–**1** through C–**6** and in the wales illustrated at W–**1** through W–**48** how the two yarns are introduced after knitting a single feed knit heel pocket with a relatively heavy denier yarn to a knit two-feed foot portion with a finer denier yarn. Figure 15 also illustrates how the yarn is introduced to add an additional course without forming a hole or cat-eye in the fabric. In Figure 15 the wales W–**7** to W–**43** are omitted since they would be identical to the wales W–**44** and W–**45**.

In operation, the machine starts to knit a hose on bare needles using one of the main yarn feed fingers 42 and feeding the yarn MH at only the throat **44** with stitches being drawn or formed at the left-hand stitch cam **72** with the auxiliary stitch cams **150, 151** as well as the auxiliary yarn feeding fingers **102, 102a** being in withdrawn position. This make-up consists of four to eight courses with one of the main yarn feed fingers 42 in operation and with the leading course of the fabric being held on the dial needles and hooks so that the fabric may be knit for any desired length. The top edge of the fabric is held on the dial needles and is subsequently transferred onto the cylinder needles to form a double thickness welt such as illustrated at **210** in a conventional manner.

The auxiliary yarn feed finger **102a** with the heavy denier yarn AH is moved into operative position after the first four to eight courses and the auxiliary stitch cams **150, 151**, as well as the sinker retraction cam **200** are moved into position to start feeding the auxiliary yarn AH to thus knit two courses with each revolution of the needle cylinder in a manner to be more fully described. The welt **210** is thus knit with two-feed knitting as well as the shadow welt **211**.

After knitting the shadow welt **211**, the yarn feeding fingers 42 change in the main throat 44 so that a lighter or finer denier yarn ML is fed to the main throat plate **45**. Also, the yarn feed finger **102** moves into *operative position* [engagement] to feed a lighter denier yarn AL to make the leg **212** of the hose H with a two-feed operation. The auxiliary yarn feed finger **102** is then moved out of operation and the heel pocket **213** is made by single feed with the knitting machine operating with the yarn MH being supplied from the main throat **44** only in a reciprocatory manner. During reciprocatory knitting the gap closing plates **120, 121** are moved into operating or closed position as shown in Figure 9.

As the heel pocket **213** is being completed (Figure 15), the course C–**1** is made from left to right with a heavy denier yarn MH being fed by one of the yarn feeding fingers **42**, the auxiliary yarn feeding fingers **102, 102a** and the auxiliary stitch cams **150, 151** being out of operation. The next course C–**2** is made with the needle cylinder traveling in the opposite direction or with the fabric being formed from right to left in Figure 15. The next succeeding course C–**3** is made from left to right in Figure 15 and it is during this course that yarn feeding fingers **42** change to remove the yarn MH and the lighter denier yarn ML is inserted for knitting alternate courses in the foot **214**.

The light denier yarn ML is introduced with one of the main yarn feeding fingers 42 at the course C–**3** and the needle wale W–**3** (Figure 15). Thus two yarns ML and MH are fed to each of the needles in the wales W–**3** through W–**46** at course C–**3** to form stitches with both yarns to tie the leading end of the light yarn ML, from one of the main yarn feeding fingers 42, into the fabric before the heavy yarn MH is removed from the fabric at course C–**3** and wale W–**46**. The next course C–**4** and the succeeding courses are made with the machine moving in a continuous circular manner and forming the fabric from right to left in Figure 15 and it is in this course C–**4** that the auxiliary yarn AL is added to start an additional course C–**4a**. Course C–**4** is the first circular course after making the heel pocket and this description will apply to the manner in which the yarn is introduced each time, since each time the auxiliary yarn is introduced, it is done in an identical manner.

During the first counterclockwise revolution of the needle cylinder **23** in making the first rotary course of the foot **214**, the auxiliary yarn feeding finger **102** feeding the yarn AL is lowered as section B of the needle cylinder passes thereby and the needle raising cam **150** is moved into engagement with the short butt needles in section C to raise the needles in section D and the remainder of the needles in sections E and F to take the auxiliary yarn AL in the hooks thereof. The needle lowering or auxiliary *stitch* [switch] cam **151** is moved into engagement with the short butt needles in section E as they pass thereby to thus pull down the medium butt needles in section F along the path P–**10**, and allow the needles in *sections* [section] D and E to *initially* pass the stitch cam **151** without being lowered to thus lay the yarn in the hooks of these forty needles in sections D and E but not to form stitches with the same during this revolution but to start forming *a new course of* stitches *C–4a* with the needles in section F as they are lowered to pull the yarn through the loops previously formed *at the main left-hand stitch cam 72* in course *C–4* [C–**3**]. The *course C–4a continues to course C–5 and the* forty needles in which the yarn *AL* was laid in the hooks thereof in sections D and E but which was not knitted at the auxiliary yarn station then is knit with the yarn ML picked up from

the main yarn feeding fingers **42** to form approximately forty wales in course *C–5* [C–4] from both the main yarn ML and the auxiliary yarn AL from the wale W–6 to the wale W–46. *It should be noted that the* [A] new course C–4a *started* [is begun] at wale W–5 in Figure 15 with the yarn AL only and [starting] on the first medium butt needle MN in section F.

It is thus seen that the end of the yarn AL when introduced from the auxiliary yarn feeding finger is firmly anchored in the forty stitches *in course C–5 formed after course C–4a, but which forty needles actually precede* [preceding] the new course C–4a and *prevent* [prevents] a hole, open place or cat-eye from being formed between the wales W–5, W–6 in course C–4 and subsequent courses, as would have been formed had not this end been tied into the *adjacent* [previously] knit course. Thus, alternate courses in the two-feed knitting are supplied yarn from the main throat **44** and the auxiliary throat **100**. This method of knitting the loose end of the yarn AL into the next succeeding course *after laying said loose end in the hooks of needles* also prevents the end of the yarn AL from being unraveled after it is trimmed in the finishing operation.

After the foot **214** has been knit, the yarn AL may be removed from the two-feed knitting operation to permit knitting of the toe pocket **215** in a reciprocatory manner in a single feeding knitting operation. The needle raising cam **150** is removed during the last circular course while section D is passing the auxiliary throat **100** and the needle lowering cam **151** is removed as the last needle raised by the cam **150** is lowered and the yarn feed finger **102** is raised. The gap closing plates **120, 121** are moved into position across the throats **44, 100** and the toe pocket is knit in a conventional manner by switching the long butt needles in section A up to take the yarn MH from the throat **44** and the machine starts to reciprocate to knit the toe, first with narrowing and then widening to complete the sock or hose.

It is thus seen that there has been provided a method and apparatus for knitting two feeds simultaneously during circular knitting which includes at least two improved gap closers as well as at least two separate knitting stations, one of which is separate and apart from the main conventional knitting station as well as a novel method of introducing auxiliary yarn to the fabric which insures that no loose ends may pull out and no holes or cat-eyes will appear in the fabric knit in this manner with two feeds. Since alternate courses are knit with yarn from different yarn feeding fingers it is seen that this improved method of knitting is easily adaptable to knitting the new "stretch" yarns which are twisted in opposite directions.

In the drawings and specification there has been set forth a preferred embodiment of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

We claim:

[1. In a method of knitting seamless hosiery having a first portion knit from at least one first yarn and a second portion knit from at least one second yarn and at least one third yarn, the steps of knitting a plurality of courses solely from the first yarn during reciprocatory knitting to form said first portion, knitting a few stitches from the first and second yarns in a medial portion of the final course in the first portion, then continuing knitting solely from the second yarn to complete said final course, then commencing rotary knitting solely from the second yarn for a substantial part of another course, knitting a few stitches each from the second and third yarns and then knitting successive circular courses solely from the third yarn and soley from the second yarn in alternation.]

[2. A method of knitting on a circular knitting machine which includes the steps of feeding a plurality of first yarns separately to the needles during rotary knitting of a first fabric section so that any one yarn appears only in recurring courses, feeding a second yarn to needles during reciprocatory knitting of a second fabric section while progressively idling the needles by at least one needle for each rotary movement of the needle cylinder for a plurality of movements and progressively returning the needles into action by at least one needle for each rotary movement of the needle cylinder for a plurality of movements, feeding any one of said first yarns and also feeding the second yarn to a few needles while knitting a final course in the second fabric section and then feeding said first yarns separately to the needles during rotary knitting of a third fabric section so that any one of said first yarns appears only in recurring courses.]

[3. A method of knitting on a circular knitting machine of a type having first and second serially arranged knitting stations which includes the step of feeding a first yarn to all of the needles and drawing stitches therewith at the first knitting station, feeding a second yarn to all of the needles and drawing stitches therewith at the second knitting station during rotary knitting of a first fabric section, then feeding only a third yarn to needles and drawing stitches therewith at the first knitting station during reciprocatory knitting of a second fabric section, then feeding the first and third yarns to a few needles and drawing a few stitches therewith at the first knitting station during the knitting of the final course in the second fabric section, then feeding only the first yarn to needles and drawing stitches therewith at the first knitting station to complete the latter course, resuming rotary knitting while feeding the first yarn and drawing stitches therewith at the first knitting station for at least a portion of a course immediately succeeding the final course in the second fabric section, feeding the first and second yarns to a few needles and drawing stitches therewith at the first knitting station only, then feeding the first yarn to all the needles and forming stitches therewith at the first station, and feeding the second yarn to all the needles and forming stitches therewith at the second knitting station with a plurality of successive revolutions of the needle cylinder during rotary knitting to form a third fabric section.]

[4. A method of knitting on a circular knitting machine of a type having first and second serially arranged yarn feeding stations and respective first and second serially arranged knitting stations which includes the steps of feeding a first yarn to all of the needles at the first feeding station and drawing stitches therewith at the first knitting station, feeding a second yarn to all of the needles at the second feeding station and drawing stitches therewith at the second knitting station during rotary knitting of a first fabric section, then knitting solely from a third yarn by feeding only the third yarn to needles at the first feeding station and drawing stitches therewith at the first knitting station during reciprocatory knitting of a second fabric section, then feeding the first and third yarn to a few needles at the first feeding station and drawing a few stitches therewith at the first knitting station during the knitting of the final course in the second fabric section, then feeding only the first yarn at the first feeding station and drawing stitches therewith at the first knitting station to complete the latter course, resuming rotary knitting while feeding the first yarn at the first feeding station and drawing stitches at the first knitting station for at least a portion of a course immediately succeeding the final course in the second fabric section, feeding the first yarn at the first yarn feeding station and the second yarn at the second yarn feeding station to a few of the needles and drawing stitches therewith at the first knitting station only, then feeding the first yarn at the first feeding station and forming stitches therewith at the first knitting station and feeding the second yarn at the second feeding station and forming stitches therewith at the second knitting station in knitting successive courses

with a plurality of successive revolutions of the needle cylinder during rotary knitting to form a third fabric section.]

5. In a circular knitting machine having a cylinder with needles and means for effecting rotary and reciprocatory movement to said cylinder in alternation; the combination of a main station with first and second yarn feeds and first and second main stitch cams, an auxiliary yarn feed and an auxiliary stitch cam at a station spaced circumferentially of the cylinder from the main station, means to move the second yarn feed into operative position, means to raise needles for taking the second yarn for drawing stitches at the first and second main stitch cams in alternation during reciprocatory movements of the cylinder, means to move the first yarn feed into operative position while knitting a final course during reciprocatory knitting to cause needles to take both the first and second yarns for drawing stitches at one of said main stitch cams, means to then withdraw the second yarn feed to cause needles to take only the first yarn to draw stitches therewith at said one of said main stitch cams to complete said final course, said first yarn being taken by all the needles and stitches drawn therewith at the other main stitch cam during the next succeeding rotary movement of said cylinder, means for moving the auxiliary yarn feed into operative position, means to raise all the needles to take the auxiliary yarn during said last-mentioned rotary movement, means to move said auxiliary stitch cam into operative position upon a few of said needles having taken said auxiliary yarn whereby stitches are drawn with the remaining needles as they pass the auxiliary stitch cam and whereby said few of the needles draw stitches with both the first and auxiliary yarns and said remaining needles draw stitches with the first yarn only at said other main stitch cam during the next succeeding revolution of the cylinder, and whereby all needles take and knit said first and auxiliary yarns in alternation to knit a plurality of successive courses in rotary knitting in which the first and auxiliary yarns appear in respective alternate and intervening courses.

6. A structure according to claim 5 wherein said machine has a circular series of sinkers co-operating with said needles, an auxiliary sinker withdrawing cam disposed adjacent said auxiliary yarn feed, and means operable automatically to move said auxiliary sinker cam into operative position for withdrawing the sinkers whenever the auxiliary stitch cam is operative and to move the sinker cam to inoperative position whenever the auxiliary stitch cam is inoperative.

7. A structure according to claim 5, wherein said auxiliary stitch cam is in the form of a radially movable needle lowering cam, a needle raising cam arranged to move successive needles upwardly after they have passed the first knitting station and in advance of the lowering cam to take yarn in the hooks of the latter needles so the lowering cam then moves successive needles downwardly to draw stitches therewith with movement of the needles in one direction, and cam means disposed subsequent to the needle lowering cam for deflecting successive needles upwardly sufficiently to move the latches thereof upwardly through the stitches thus formed.

8. A structure according to claim 7 including means to move the needle raising cam into and out of operative position, and means to move the latter needle lowering cam from inoperative to operative position a predetermined period after each time the needle raising cam is moved into operative position.

9. A method of knitting on a circular knitting machine of a type having a cylinder with needles and first and second serially arranged knitting stations which includes the steps of feeding a first yarn to all of the needles and drawing stitches therewith at the first knitting station during knitting of a first fabric section, then feeding the first yarn and a second yarn to a few needles and drawing a few stitches therewith at the first knitting station during the knitting of the final course in the first fabric section, then feeding only the second yarn to needles and drawing stitches therewith at the first knitting station to complete the latter course, feeding a third yarn to a few needles without drawing stitches therewith, then feeding the third yarn to all remaining needles and forming stitches therewith at the second knitting station, then feeding the second yarn to all the needles, including said few needles, and drawing stitches therewith at the first knitting station whereby stitches are formed of both second and third yarns together by said few needles, and then feeding and knitting the second and third yarns in alternation at the respective first and second knitting stations.

10. A method of knitting on a circular knitting machine of a type having a cylinder with needles and first and second serially arranged knitting stations which includes the steps of feeding a first yarn to all of the needles and drawing stitches therewith at the first knitting station and feeding a second yarn to all of the needles and drawing stitches therewith at the second knitting station during rotary knitting of a first fabric section, then feeding only a third yarn to needles and drawing stitches therewith at the first knitting station during reciprocatory knitting of a second fabric section, then feeding the first and third yarns to a few needles and drawing a few stitches therewith at the first knitting station during the knitting of the final course in the second fabric section, then feeding only the first yarn to needles and drawing stitches therewith at the first knitting station to complete the latter course, resuming rotary knitting while feeding the first yarn and drawing stitches therewith at the first knitting station for at least a portion of a course immediately succeeding the final course in the second fabric section, feeding the second yarn to a few needles without drawing stitches therewith, then feeding the second yarn to all remaining needles and forming stitches therewith at the second knitting station, feeding the first yarn to all the needles, including said few needles, and drawing stitches therewith at the first knitting station whereby stitches are formed of both first and second yarns together by said few needles, and then feeding and knitting the first and second yarns in alternation at the respective first and second knitting stations.

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