Aug. 22, 1961 N. LEVIN 2,996,903

FOUR YARN CROSS COLOR OVERPLAID KNITTING MACHINE AND METHOD OF KNITTING

Filed June 5, 1958 6 Sheets-Sheet 1

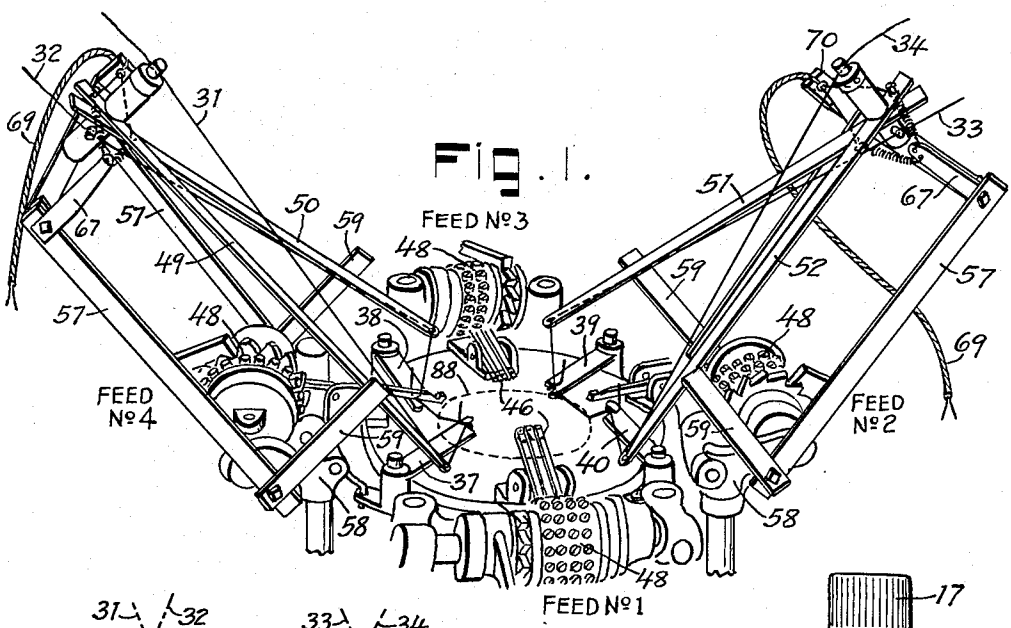


Fig. 1.

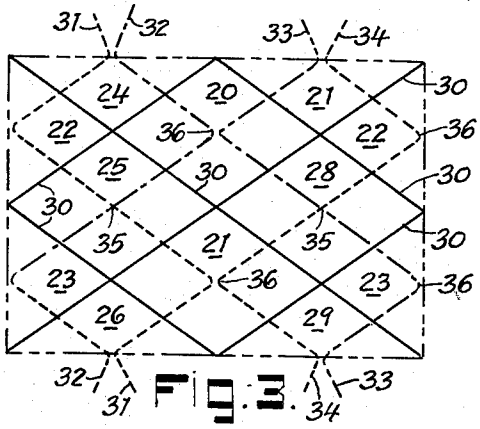


Fig. 3.

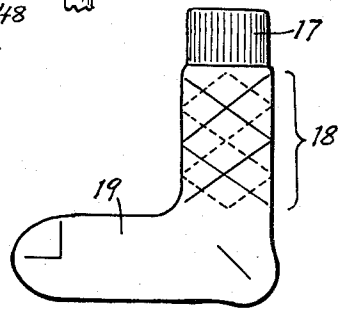


Fig. 2.

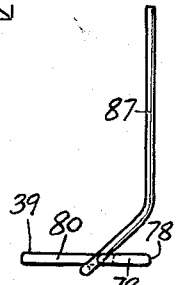


Fig. 6.

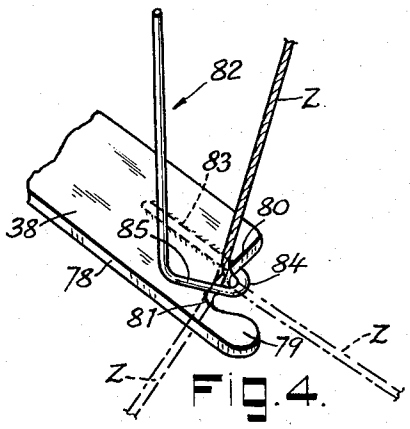


Fig. 4.

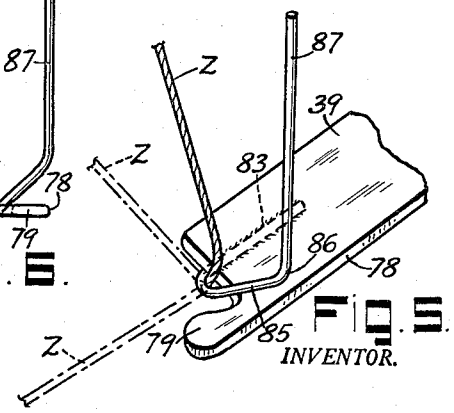


Fig. 5.

INVENTOR.

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FOUR YARN CROSS COLOR OVERPLAID KNITTING MACHINE AND METHOD OF KNITTING

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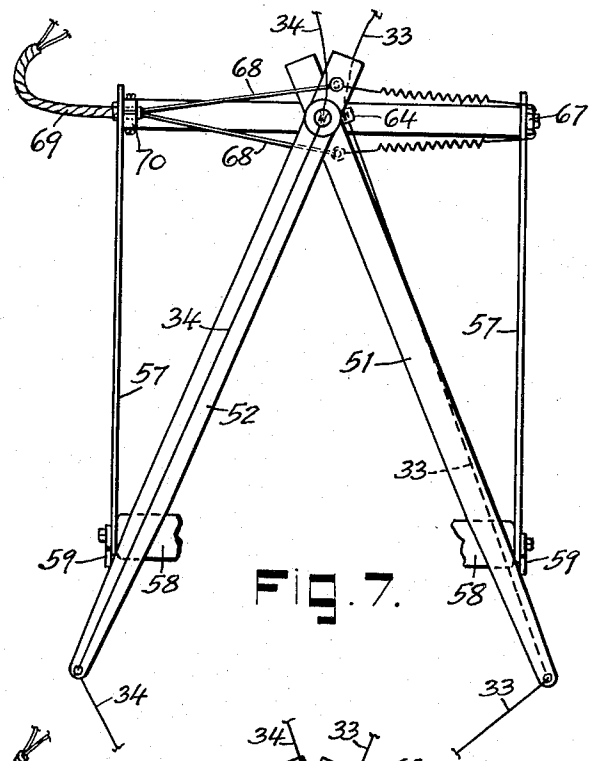


Fig. 7.

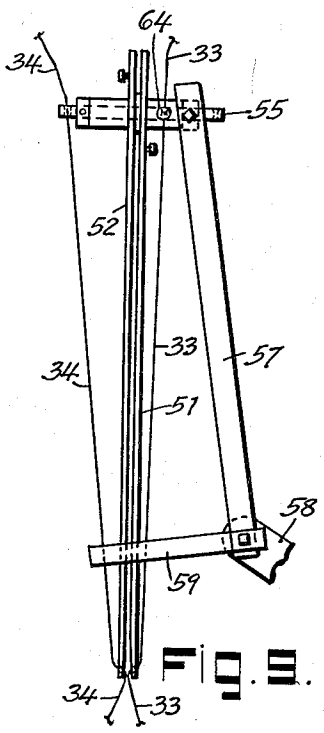


Fig. 9.

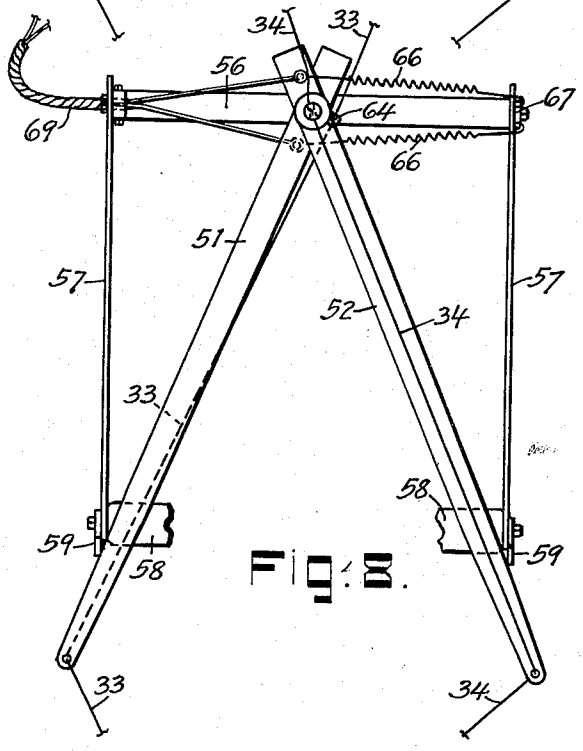


Fig. 8.

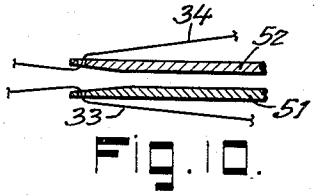


Fig. 10.

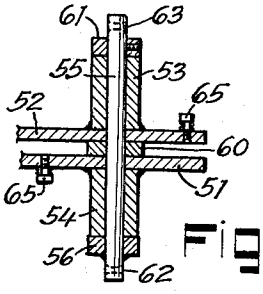


Fig. 11.

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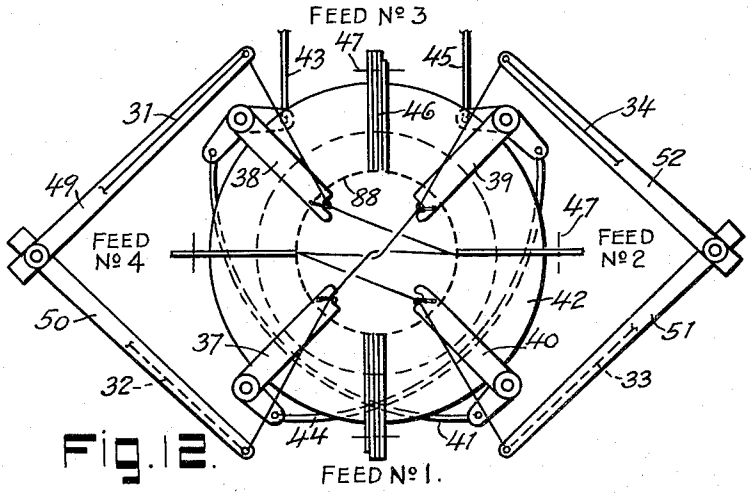


Fig. 12.

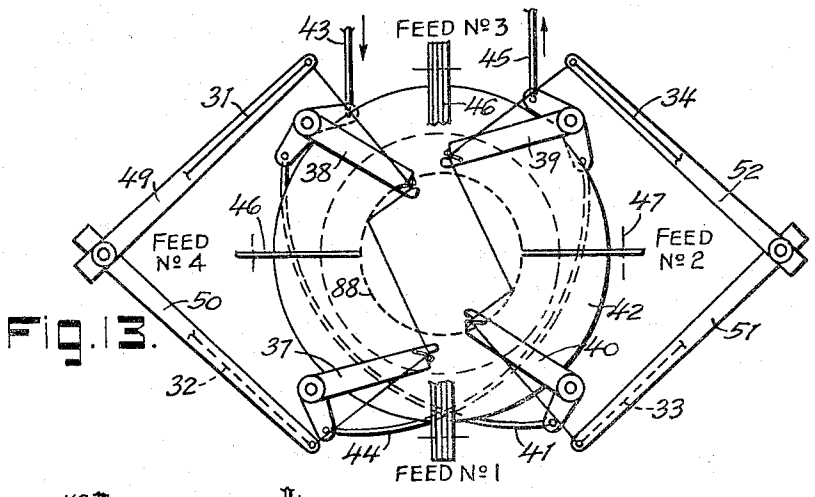


Fig. 13.

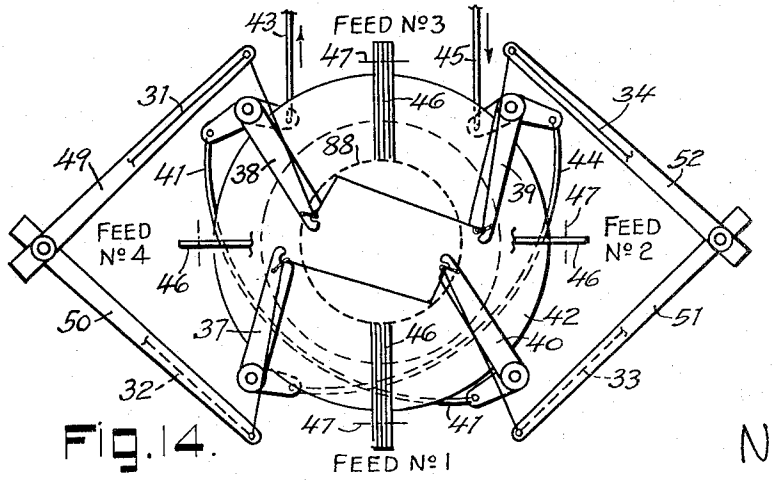


Fig. 14.

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FOUR YARN CROSS COLOR OVERPLAID KNITTING MACHINE AND METHOD OF KNITTING

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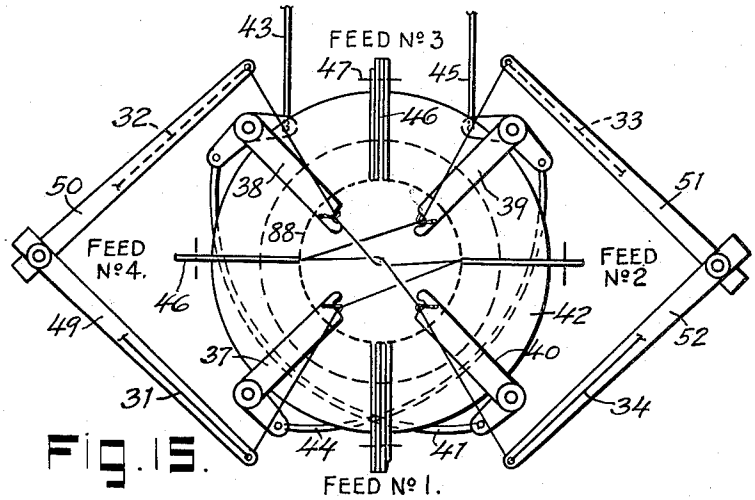


Fig. 15.

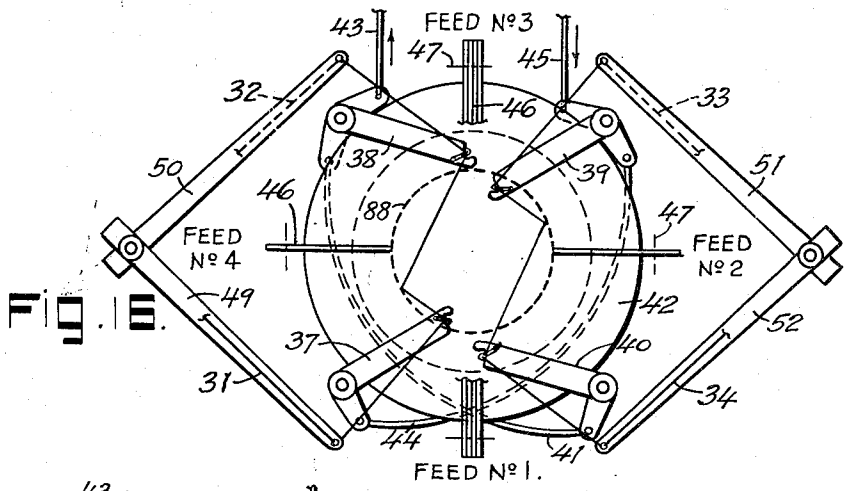


Fig. 16.

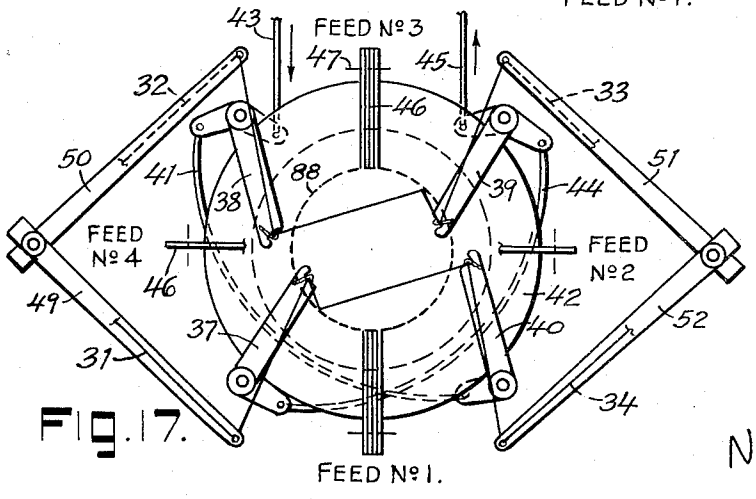


Fig. 17.

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FOUR YARN CROSS COLOR OVERPLAID KNITTING MACHINE AND METHOD OF KNITTING

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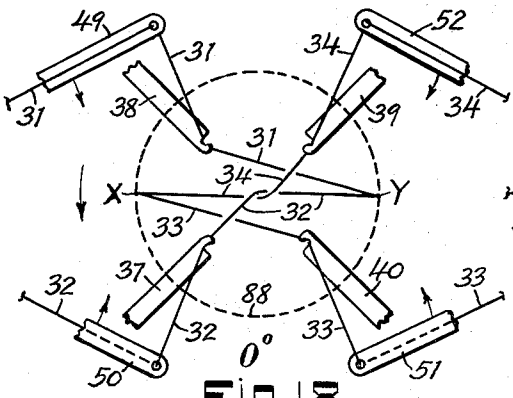


Fig. 18.

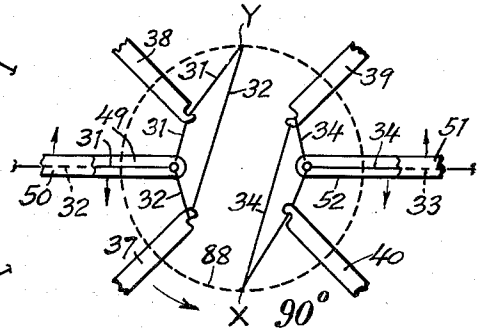


Fig. 19.

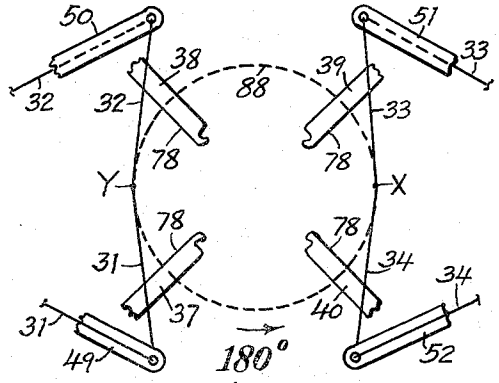


Fig. 20.

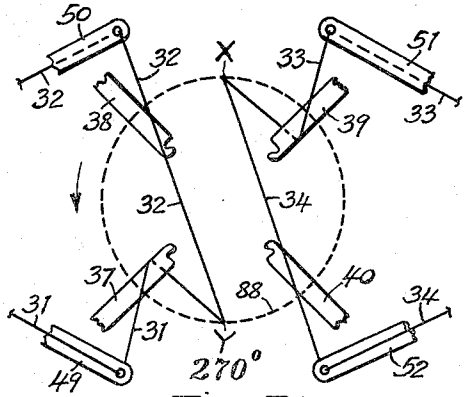


Fig. 21.

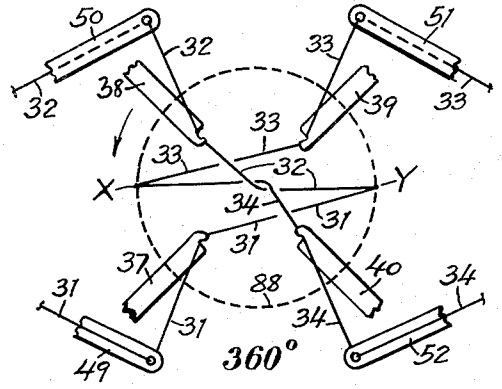


Fig. 22.

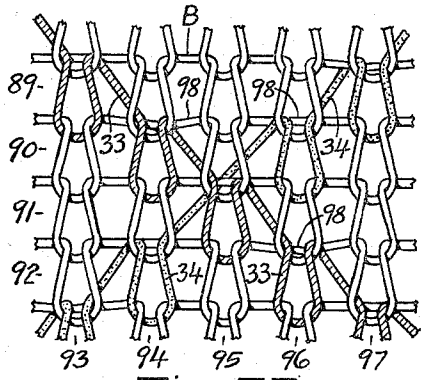


Fig. 25.

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FOUR YARN CROSS COLOR OVERPLAID KNITTING MACHINE AND METHOD OF KNITTING

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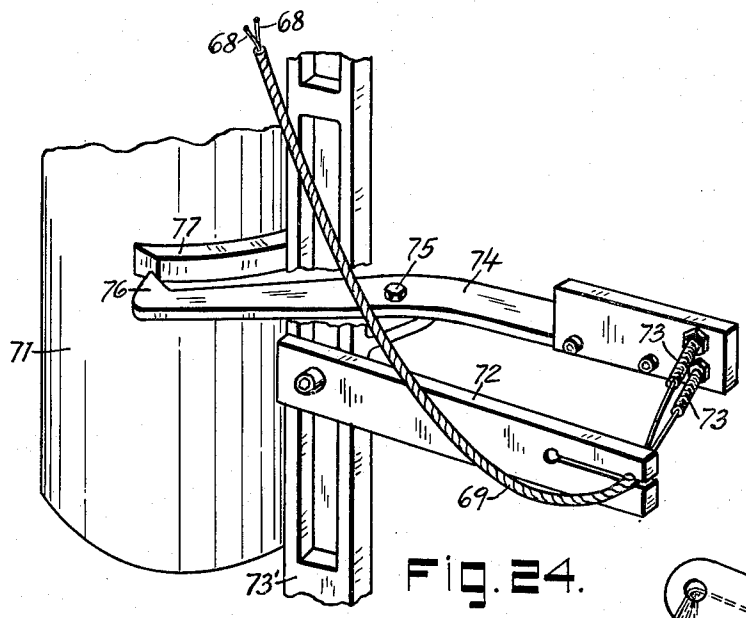


Fig. 24.

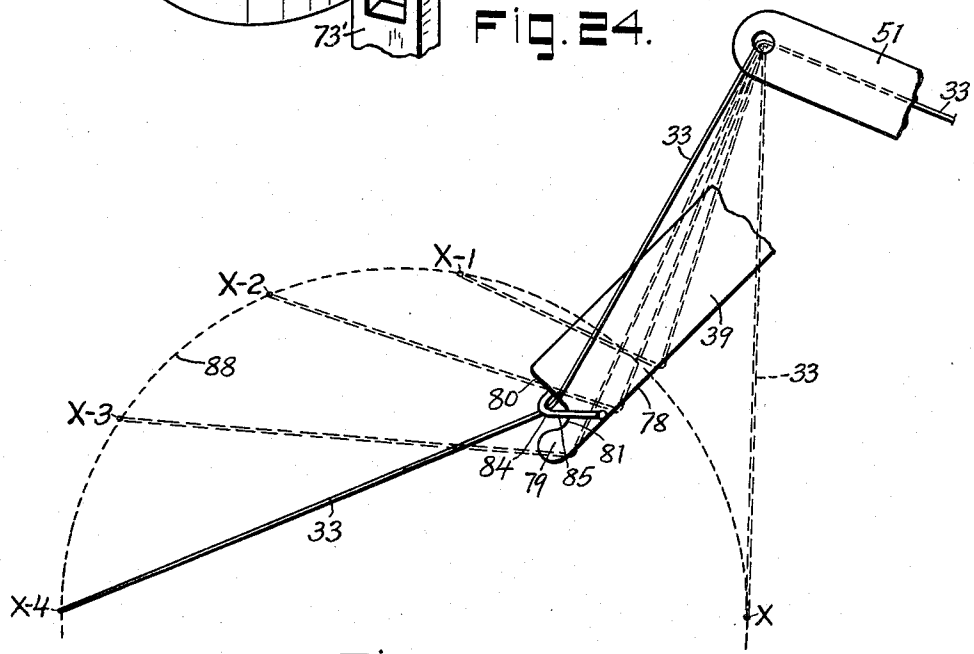


Fig. 23.

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United States Patent Office 2,996,903 Patented Aug. 22, 1961

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FOUR YARN CROSS COLOR OVERPLAID KNITTING MACHINE AND METHOD OF KNITTING

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Filed June 5, 1958, Ser. No. 740,104
20 Claims. (Cl. 66—43)

The present invention relates generally to the art of knitting and more particularly to circular knitting machinery adapted to form crossed color overplaid designs of overplaid yarns in suture joined areas of separate fabric sections of Argyle hosiery, or the like, to the method of knitting the overplaid decorated fabric, and to the fabric resulting therefrom.

The present application is a continuation-in-part of application Serial No. 701,459, filed December 9, 1957, now U.S. Patent No. 2,974,505, as to all common subject matter.

In the said application, a four feed knitting machine is provided with four overplaid yarn guides with each of which an overplaid design yarn is associated, each of said yarn fingers being associated with a designated pair of feeds of the machine in such manner as to cause its associated overplaid design yarn to be knit at one or the other of its associated pair of feeds. The result is that each of the overplaid design yarns is incorporated in at least a quarter section of the tubular fabric of the hose, and is incorporated in the fabric made at a pair of said feeds.

It is the primary object of the present invention to provide a circular knitting machine with means to automatically knit an Argyle hose having a four yarn type of cross-color overplaid therein, to provide the method of knitting said hose, and to provide the hose itself, applicant being the first to so provide.

It is an object of the present invention to provide a four feed circular knitting machine with means to knit a true crossed color overplaid design in solid color suture joined pattern areas of hosiery, or the like, by the use of only four overplaid design yarns of which each is adapted to knit, at appropriate times, at each of at least three feeds of the machine, whereby each of the said yarns may be incorporated in at least a half section of the tubular fabric of the hose, and may be incorporated in the fabric made at three of said feeds.

It is a further object of the present invention to provide at least four yarn fingers, of novel self-threading construction, for the four overplaid design yarns used and to associate a pair of said yarns with a pair of said yarn fingers, and to provide means to selectively place each yarn of said pair of yarns in one or the other of its associated pair of yarn fingers, whereby each yarn finger of said pair of yarn fingers may be operated to cause each of said pair of yarns to be selectively knit at one or the other of its associated pair of feeds, so that the crossed color overplaid design is produced.

It is a still further object of the invention to provide a method of knitting a four yarn overplaid design for hosiery and the like wherein at least a pair of yarns cross each other in the overplaid design in at least one of the areas of the hose.

These and other objects of the invention will become apparent from the following detailed description of one form of the mechanism of the invention, shown in the accompanying drawings, and from the appended claims.

In the drawings:

FIG. 1 is a perspective view of the attachment of the present invention in position on the knitting head of a four feed machine of the Reading CK type.

FIG. 2 is a side view in elevation of an Argyle hose having one type of overplaid crossed color design therein.

FIG. 3 is an enlarged view of the leg portion of the hose of FIG. 2, split along the rear central wale, showing the disposition of the overplaid design yarns.

FIG. 4 is a perspective view of the feeding end of a right hand self-threading yarn finger.

FIG. 5 is a similar view of a left hand self-threading yarn finger.

FIG. 6 is a front end view of the finger shown in FIG. 5.

FIG. 7 is a top plan view of the right hand yarn changing tackle shown in FIG. 1 with the overplaid yarn change arms in one of their two positions.

FIG. 8 is a view similar to FIG. 7 with the overplaid yarn change arms in their other positions.

FIG. 9 is a side elevational view of the tackle shown in FIG. 7.

FIG. 10 is a detail view showing the feeding ends of the yarn change arms.

FIG. 11 is a sectional view through the pivot point of the yarn change arms, in their mid positions.

FIG. 12 is a plan view showing the yarn changing arms in the positions of FIG. 7 with the yarns leading therefrom to each of the four self-threading yarn fingers in their neutral positions.

FIG. 13 is a view similar to FIG. 12 with the fingers operative at feeds Nos. 1 and 3.

FIG. 14 is a view similar to FIG. 12 with the fingers operative at feeds Nos. 2 and 4.

FIG. 15 is a plan view similar to FIG. 12 with the yarn change arms in the positions of FIGS. 1 and 8.

FIG. 16 is a view similar to FIG. 15 with the fingers operative at feeds Nos. 1 and 3.

FIG. 17 is a view similar to FIG. 15 with the fingers operative at feeds Nos. 2 and 4.

FIGS. 18 through 22 are diagrammatic views showing the changing of the yarns, from finger to finger, during a turn of the cylinder in counter clockwise direction, and showing the part played by the needle circle in the yarn change.

FIG. 23 is an enlarged view of the co-action between the needle circle and one of the self-threading yarn fingers as the yarn is caused to enter the latter.

FIG. 24 is a perspective view of one of the two main drums of the machine showing the means operating the flexible cables which move one set of the yarn change arms, there being another pair of cables operated by the other main drum for the other set of arms.

FIG. 25 is a detail showing of the fabric.

One example of Argyle hose made with the present invention is shown in FIG. 2, wherein the hose has the usual top **17**, a leg portion **18** of suture joined fabric areas ornamented with the crossed color overplaid design of four yarns, and the usual foot portion **19**. The overplaid design formed by the present invention is of the four yarn type wherein each straight line portion thereof extending between the center portions of a pair of adjoining areas (and across the suture line therebetween) is formed of a single yarn as distinguished from the eight yarn type of overplaid wherein each similarly disposed straight line portion thereof is formed of a pair of yarns changed at the suture line, so that in the four yarn type a single yarn does the work of a pair of yarns in the eight yarn type. Each such single overplaid yarn (which may also be referred to as a design yarn) may be made up of a composite of individual yarns or strands. It will be understood that the crossed color overplaid design yarns may be arranged in other configurations to produce other designs.

In FIG. 3, the leg portion **18** of the hose of FIG. 2 has been shown in flat relation as it would appear with the leg fabric severed along its rear center wale. The

upper and lower diamond shaped fabric areas of the front of the hose, usually knit upon feed No. 3 of the machine, are indicated at **20** and **21**, respectively. The upper and lower diamond shaped fabric areas of the rear of the hose (here shown split), usually knit upon feed No. 1 of the machine, are indicated at **22** and **23**, respectively. The upper half diamond, the middle diamond, and the lower half diamond shaped fabric areas of one side of the hose, usually knit upon feed No. 2 of the machine, are indicated at **24**, **25**, and **26**, respectively. The upper half diamond, the middle diamond, and the lower half diamond shaped fabric areas of the other side of the hose, usually knit upon feed No. 4 of the machine, are indicated at **27**, **28**, and **29**, respectively. Each of the several separate fabric areas **20** through **29** is joined to the other fabric areas adjacent thereto by suture seams indicated at **30**.

The fabric of FIG. 3 is provided with a crossed color overplaid design formed by four yarns indicated at **31**, **32**, **33**, and **34**, each yarn being knit in the general path of a zig-zag line so disposed that its straight line portions extend across the suture seams **30**, generally in line with the centers of designated ones of the diamond shaped areas. The yarn **31** commences knitting at the center of the widest portion of side half diamond **24**, continues diagonally across suture line **30** to the center of upper rear diamond **22**, then diagonally in the opposite direction across suture line **30** to and across side diamond **25** passing through the center thereof, then in the same diagonal direction across suture line **30** to the center of lower front diamond **21**, and, finally, diagonally in the opposite direction across suture line **30** to the widest part of lower side diamond **26**, where the knitting of over-plaid yarn **31** terminates. The path of the over-plaid yarn **33**, as it is knit and as it extends from the widest portion of upper side half diamond **27**, to the center of upper front diamond **20**, across diamond **28**, to the center of diamond **23**, and then to the widest portion of lower side half diamond **29**, is generally parallel to the path of the yarn **31**. The paths of the yarns **32** and **34** are parallel and are reversely similar to the paths of the yarns **31** and **33**. The yarns **31** and **32** meet in the half diamonds **24** and **26** but cross each other in the diamond **25** at **35**, and similarly, the yarns **33** and **34** meet in the half diamonds **27** and **29** but cross each other in the diamond **28** at **35**. The yarns **32** and **33** meet in the diamonds **20** and **23** at **36**, at the changes in direction of their paths of travel, and, similarly, the yarns **31** and **34** meet in the diamonds **22** and **21** at **36**, at the changes in the direction of their paths of travel.

Thus with the yarns **32** and **33** of one color and yarns **31** and **34** of a second color, the overplaid design in the upper front and lower rear diamonds **20** and **23** will be of one color, the overplaid design in the lower front and upper rear diamonds **21** and **22** will be of the second color, while the overplaid design in the side full diamonds **25** and **28** will be of both colors crossed upon each other, and in the side half diamonds **24**, **26**, **27**, and **29**, the overplaid design will also be of both colors. Each of the overplaid yarns actually extends over 180 degrees of the hose, however, by appropriate choice of colors, as above indicated, each color in line appears as a 360 degree spiral in the hose, the four spirals crossing each other to produce the crossed color effect in the overplaid. It should be understood that in other types of designs wherein the cross color principle is used, such as in a vertical side panel effect in the hose, the overplaid yarns need not extend completely around the hose circumference.

The mechanism for knitting the fabric of FIGS. 2 and 3 is shown in FIG. 1 in place upon a four feed Reading CK machine, and, as part thereof, four pivotally mounted self-threading overplaid fingers **37**, **38**, **39**, and **40** are provided, each of the fingers having yarn feeding means at the free end thereof. The finger **37** is disposed between feeds Nos. 1 and 4 and is adapted to selectively feed one or the other of the yarns **31** and **32** at each of these feeds; fingers **38** is disposed between feeds Nos. 3 and 4 and is adapted to selectively feed one or the other of the yarns **31** and **32** at each of these feeds; finger **39** is disposed between feeds Nos. 2 and 3 and is adapted to selectively feed one or the other of the yarns **33** and **34** at each of these feeds; and finger **40** is disposed between feeds Nos. 1 and 2 and is adapted to selectively feed one or the other of the yarns **33** and **34** at each of these feeds. The attachment for operating the pivotally movable fingers **37** through **40** is fully shown and described in said pending application and need not be fully described again herein.

In the FIGS. 12 and 15, all of the fingers are shown in their neutral non-feeding positions. The fingers **38** and **40** are connected by rod **41** below sinker bed **42**, and reciprocating movement of control rod **43**, operatively related to finger **38**, will cause this pair of fingers to be moved. Movement of the rod **43** in the direction of its arrow, FIG. 13, causes the fingers **38** and **40** to be placed in non-feeding positions relative to feeds Nos. 1 and 3; while movement of the rod **43** in the opposite direction, in the direction of its arrow, FIG. 16, causes these fingers to be placed in feeding positions at these feeds. Movement of the rod **43** in the direction of its arrow, FIG. 14, causes the fingers **38** and **40** to be placed in non-feeding positions relative to feeds Nos. 2 and 4; while movement of the rod **43** in the opposite direction, in the direction of its arrow, FIG. 17, causes these fingers to be placed in feeding positions at these feeds. The fingers **37** and **39** are connected by rod **44** below sinker bed **42**, and reciprocating movement of control rod **45**, operatively related to finger **39**, will cause this pair of fingers to be moved. Movement of the rod **45** in the direction of its arrow, FIG. 13, causes the fingers **37** and **39** to be placed in feeding positions relative to feeds Nos. 1 and 3; while movement of the rod **45** in the opposite direction, in the direction of its arrow, FIG. 16, causes these fingers to be placed in non-feeding positions at these feeds. Movement of the control rod **45** in the direction of its arrow, FIG. 14, causes the fingers **37** and **39** to be placed in feeding positions relative to the feeds Nos. 2 and 4; while movement of the rod **45** in the opposite direction, in the direction of its arrow, FIG. 17, causes these feeds to be placed in non-feeding positions at these feeds. The rods **43** and **45** are adapted to reciprocate in the directions indicated for operation of the various fingers at the proper times at the various feeds, while the rods **43** and **45** are retained at the proper times against movement, in neutral positions, to position and retain the yarn fingers in their neutral positions of FIGS. 12 and 15.

The machine is provided with one or more body yarn guides at each of the feeds to provide for the formation of the body fabric on the needle circle of appropriate body yarns. These yarn guides are indicated generally at **46**, at each of the feeds, where they are pivotally mounted upon a horizontal axis indicated by the lines **47**. When the overplaid fingers are operable at one pair of opposite feeds, the body yarn guides are raised to their upper inactive positions at these feeds by their yarn operating drums, indicated at **48**, in FIG. 1, so that the overplaid fingers may move freely thereunder.

As may be seen in FIG. 1, the yarns **31**, **32**, **33**, and **34**, are directed, from any suitable yarn cone stand, to the fingers **37**, **38**, **39**, and **40**, respectively, by pairs of pivotally disposed yarn change arms **49**, **50**, and **51**, **52**. It should be noted that while FIG. 1 shows overplaid yarn **31** in finger **37**, yarn **32** in finger **38**, yarn **33** in finger **39**, and yarn **34** in finger **40**, this disposition of the yarns and fingers results from the shown positions of the yarn change arms **49** through **52**, and then when these arms are otherwise disposed, as in FIG. 7, yarn **31** will be

in finger 38, yarn 32 in finger 37, yarn 34 in finger 39, and yarn 33 will be in finger 40. This may be clearly seen by referring to FIGS. 12 and 15. One set of arms 49, 50, is disposed on the left side of the machine above feed No. 4 while the other set of arms 51, 52, is disposed on the right side of the machine above feed No. 2. The sets of arms, their construction and operation are reversely similar, so that a detailed description of one will suffice for both. The arms 51, 52, see FIGS. 7 through 11, are provided at one end thereof with upstanding and depending sleeves 54 and 53, respectively, by means of which the arms are rotatably journaled upon a fixed shaft 55 extending upwardly from a suitable elongated base member 56. The opposite ends of the base 56 are suitably secured between a pair of supporting frame members 57, 57, which in turn are secured, at their opposite ends, to any suitable portion of the machine, here shown at the opposite faces of the supports 58, 58, which also position the yarn drums 48 at each of the feeds. Upstanding stops 59, 59, for the arms 51, 52, are also secured to the supports 58, 58. The terminal ends of arms 51, 52, FIG. 10, are provided with yarn eyes for the yarns 33 and 34, and preferably have their near faces tapered to facilitate passage of the yarns past each other as the arms are moved to and from their positions in FIGS. 7 and 8. The arms, FIG. 11, may be spaced slightly by a suitable washer 60 on shaft 55 and may be retained in position by means of a set screw held collar 61. Shaft 55 may have a lower yarn eye 62 for body yarn, an upper yarn eye 63 for overplaid yarn 34, while a yarn eye 64 may be secured to lower sleeve 54 for overplaid yarn 33.

The arms 51 and 52 are provided with depending and upstanding studs 65, 65, oppositely equally disposed relative to the shaft 55. Tension springs 66, 66, anchored on the studs 65, 65 and on a suitable upright member 67, at one end of base 56, hold the arms 51 and 52 in the positions of FIG. 7 wherein the arms lie against the stops 59, 59. To move the arms to their other positions of FIG. 8, a pair of flexible cables 68, 68 are provided, one being secured to stud 65 of arm 51 while the other is secured to stud 65 of arm 52. The cables pass through flexible sheathing 69, one end of which is secured in a member 70 extending upwardly from the opposite end of base 56. The sheathing and cables, FIG. 24, extend to a point adjacent a main cam drum 71 where the sheathing terminus is suitably anchored in bracket 72 fixed on frame 73' of the machine, while the cables extend to adjusting screws 73, 73, to which they are secured, the screws 73, 73, being adjustably secured to one end of a pivotally movable lever 74. The lever 74 is pivoted at 75 on the machine frame 73' so that its other end 76 may be contacted by a cam 77 as the cam drum 71 is indexed. It will be seen that as lever 74 is moved by cam 77, the cables 68, 68 will be pulled to swing the yarn change arms 51 and 52 in opposite directions from their positions of FIG. 7 to those of FIG. 8. When the cam 77 passes lever 74, the yarn change arms 51 and 52 will return to their positions of FIG. 7 by the action of springs 66, 66. Separate sheathings may be used for each cable, if so desired.

In this way the feeding end of arm 52 and yarn 34 may be placed between feeds Nos. 1 and 2 or between feeds Nos. 2 and 3, and conversely the feeding end of arm 51 and the yarn 33 may be placed between feeds Nos. 2 and 3 or between feeds Nos. 1 and 2. The same relationship exists for the yarns 31 and 32 relative to feeds Nos. 1 and 4 and feeds Nos. 3 and 4. The overplaid yarns extend from the yarn change arms to the self-threading overplaid fingers. The feeding ends of the fingers may be seen in FIGS. 4, 5, 6, and 23. The fingers are reversely similar so that a description of one will suffice for both, the right hand fingers, FIG. 4, being those indicated at 38 and 40, while the left hand fingers, FIG. 5, are those indicated at 37 and 39. The fingers, 38, 39, are generally of flat rectangular shape having a leading edge 78 in line with one side of off center forwardly extending rounded nose projection 79 forming the end of the finger. Spaced rearwardly from nose 79 is a transversely extending edge portion 80 which meets the nose 79 along the curve 81. A specially shaped wire 82 forms a part of each finger and preferably comprises a base portion 83 centrally secured to the bottom side of the finger, as by soldering or the like, generally parallel to edge 78. The wire is provided with a reverse bend at 84 so as to extend around the transverse edge 80 and to then extend rearwardly at an angle to the plane of the finger at 85 to substantially the edge 78, to the rear of the transverse edge 80, at which point 86 the wire is bent to extend vertically as at 87 for a short distance. It will be noted that the bend 84 is spaced from edge 80 sufficiently to permit a yarn to freely pass therethrough, the portion 85 extends across the curved edge 81 being spaced therefrom a distance sufficient for a yarn to freely pass therebetween, and that bend 86 is further vertically spaced from the edge 78. The relationship is such that when the fingers are operable at feeds Nos. 2 and 4, FIGS. 14 and 17, the yarn shown at Z, FIG. 5, feeds through wire loop 84 and, as it is taken by needles of the reciprocating needle circle and moved thereby, it swings back and forth between the dotted line positions of the yarn Z, generally free of the nose portion 79. When the fingers are operable at feeds Nos. 1 and 3, FIGS. 16 and 13, the yarn shown at Z, FIG. 4, feeds through the wire loop 84, and, as it is taken by needles of the reciprocating needle circle and moved thereby, it swings back and forth between the dotted line positions of the yarn Z, generally under the nose portion 79.

As was stated in connection with FIG. 3, the yarns cross at the points 35 in the side diamonds 25 and 28, the fabric of the latter then being knit at feeds Nos. 2 and 4 while the overplaid yarns are incorporated in these fabric areas at feeds Nos. 1 and 3. This is generally the widest courses of the diamonds 25 and 28, at which time the overplaid yarns 31 and 32 have been knit upon the same or upon closely adjacent needles in diamond 25 at about the mid point of half the needle circle while the overplaid yarns 33 and 34 have likewise been knit upon the same or upon closely adjacent needles in diamond 28, at about the mid point of the other half of the needle circle. It is in this course or courses of the knitting, which have been shown in the drawings, that the yarn crossing takes place. In the FIGS. 12 through 22, X indicates the needle or needles of needle circle 88 then having knit the yarns 33 and 34, while Y indicates the needle or needles then having knit the yarns 31 and 32. The arrangement of the yarn change arms, the overplaid yarns, and the overplaid yarn fingers then being indicated in FIG. 13.

Once the widest courses of diamonds 25 and 28 have been knit, knitting is suspended upon all of the needles while the needle cylinder continues to reciprocate, this being done by arranging the needle selecting devices to cause the needles to travel along their low inactive level paths. Then the fingers 37 through 40 are caused to assume their neutral positions of FIGS. 12 and 18, and at the same time movement of cam drum 71 will cause cam 77 to move the yarn change arms 49 and 50 and 51 and 52 toward each other, in the directions of the arrows shown in FIG. 18. At this time the needle cylinder 88 has completed its clockwise reciprocation and is about to start its counter clockwise movement, this being indicated in FIG. 18 at 0 degree. As the needle circle 88 completes about 90 degrees of movement, FIG. 19, the yarn change arms move toward each other to about the mid points of their strokes, at the same time the needles X and Y carry the knit ends of the overplaid yarns with them. The combined movement of the knit ends of the overplaid yarns by the needles X and Y, and the movement of the yarns themselves by the yarn

change arms 49 through 51 is sufficient to cause these yarns 31 through 34, to move out of the fingers 37 through 40, as movement of the needle circle 88 continues, so that by the time the needle circle has moved 180 degrees, FIG. 20, the yarns are completely out of the fingers and the yarn change arms are in their new positions. In FIGS. 18 through 22, the yarn wires 82 are not shown on the fingers since they would be so small that the actual threading and unthreading could not be clearly shown. However, the action upon the finger 39 is shown in greatly enlarged detail in FIG. 23, and a later description thereof will suffice to explain the self-threading action of all of the fingers. As the cylinder continues its movement, FIG. 21 at the 270 degree position, the needles X and Y are now drawing the yarns over the leading edges 78 of the fingers 37 through 40, and as the 360 degree movement is completed, FIG. 22, the yarns have been self threaded through the feeding ends of these fingers, so that now the yarn 33 is in finger 39 where previously it was in finger 40 and yarn 34 is now in finger 40 where previously it was in finger 39. Similarly yarns 31 and 32 have changed places in fingers 37 and 38.

It will be noted, FIG. 21, that yarns 31 and 33 are wrapped around the leading edges of fingers 37 and 39 to a greater extent than the yarns 32 and 34 are wrapped about fingers 38 and 40, the greater the extent of the wrapping action, the more certain is the threading action. While the single oscillation shown may be sufficient to thread up all the fingers, it is preferred that the needle cylinder have at least one more idle non-knitting oscillation in the opposite direction to insure that all the fingers are threaded, and it will be seen that during this oscillation in the opposite direction, the extent of the wrapping of the yarns about their respective fingers will be reversed. Obviously additional idle reciprocations of the cylinder may be provided, if so desired.

In FIG. 23 a portion of FIG. 20 has been enlarged to show the threading action upon finger 39, several positions of the yarn 33 being indicated. The cylinder has moved about 180 degrees and contact has not yet been made between edge 78 and the yarn 33, this taking place at about 225 degrees of movement. As needle X moves to position X–1 the yarn 33 is wrapped about the leading edge 78 of finger 39 and as the needle X moves successively to positions X–2 and X–3, the yarn 33 is caused to slide along the edge 78 toward the nose 79, at the same time moving under portion 85 of the wire 82. By the time that point X–4 has been reached, the yarn 33 has slipped over the nose 79 and is guided by the wire 82 into the bend 84 thereof. It will be noted that the needle X holds the knit end of yarn 33 below the plane of finger 39 while the arm 51 directs the yarn from a point above the plane of the finger and to one side thereof. It will be understood that the unthreading of the finger 39, and the other fingers, takes place as the yarn change arms are crossed, this action causing the yarns to be simply drawn out from under the wires 82.

Now that the yarns have exchanged their positions in the fingers, the parts are as shown in FIGS. 15 and 22 with the fingers still in their neutral positions. As knitting recommences upon all of the feeds of the machine, the fingers are moved from their neutral positions to their active positions at feeds Nos. 1 and 3, as shown in FIG. 16, and the second half of the diamonds 25 and 28 are knit. Since the yarns 31 through 34 are now in new fingers, the overplaid lines of the yarns continue straight across the diamonds to the diamonds 21 and 23. These latter diamonds are knit at feeds Nos. 1 and 3 and the overplaid yarns 31 through 34 and their fingers are made active at feeds Nos. 2 and 4, as in FIG. 17, to knit the overplaid therein. Generally the knitting takes place in the manner set forth in said application, except for the modification thereof caused by the interchange of the overplaid yarns halfway through the leg portion of the hose. Upon completion of the leg of the stocking, preferably prior to the knitting of the heel, the yarn change arms 49 through 52 are permitted, by the appropriate length of cam 77, to swing back to their first positions to be ready for the formation of the first half of the next hose. At this time, unthreading and threading of the overplaid yarns with the fingers to establish their first relationship, takes place in the same manner but in reverse action.

It will be understood that the exchange of the overplaid yarns relative to the fingers may take place more than once during the formation of each hose, this being dependent entirely upon the particular type of overplaid design being knit. While the attachment has been shown as exchanging the overplaid yarns while they are being knit at feeds Nos. 1 and 3 for incorporation in fabric being knit at feeds Nos. 2 and 4, the invention is not so limited and includes the concept of exchanging the overplaid yarns in other arrangements, for example, exchanging them while they are being knit at feeds Nos. 2 and 4 for incorporation in fabric being knit at feeds Nos. 1 and 3.

The positioning of the yarn change arms 49 through 52 against stops 59 causes their feeding yarn eyes to feed the yarns to the overplaid fingers 37 through 40 from points which are above and relatively close to the plane of the fingers themselves, these points being so disposed, relative to the feeding ends of the fingers, that the yarns are maintained within the wires 82, the yarns being under their normal take-up tensions for this type of knitting.

The overplaid fingers are placed in their neutral positions during the yarn interchange so that they may extend more or less radially of the needle circle and across the same in fixed positions while the yarns are moved around the needle circle by the needles X and Y, last knitting these yarns.

A portion of the fabric itself, at the place 35 in diamond 28 where the paths of the stitches of yarns 33 and 34 cross each other, is shown in enlarged detail in FIG. 25 wherein B indicates the yarn of the body fabric stitches in courses 89 through 92 and in wales 93 through 97 thereof. The body yarn B is floated, as at 98, where stitches of the overplaid yarns 33 and 34 are formed in the fabric. The paths of the overplaid stitches, of yarns 33 and 34, converge in courses 89 and 90, and knitting may temporarily cease after the course 90, or after the course 91, at which time the relative positions of yarns 33 and 34 are changed in the yarn fingers 39 and 40, as explained, and, thereafter, as knitting recommences, the paths of the overplaid yarn stitches diverge as shown in in the following courses of the fabric. It is a matter of selection whether the yarn 33 or the yarn 34 is knit in wale 95 of course 91, the non-knit one of these yarns passing to the rear of the knit one thereof. While individual overplaid yarn stitches of each of the yarns 33, 34 have been shown in each of the courses in single stitch step relation, it will be understood that other arrangements, such as pairs of stitches in double step stitch relation may be used, the floats of body yarn B being arranged accordingly.

I claim:

1. A circular knitting machine of the type having means to reciprocatingly knit body yarn thereon at four circumferentially spaced feeds to provide tubular body fabric formed of a plurality of adjoining suture joined diamond shaped body fabric areas arranged so that said tubular fabric is provided with upper and lower diamond shaped areas at a front and at a rear thereof and is provided on each of its sides with upper and lower half-diamond shaped areas spaced by a side diamond shaped area, means to knit design yarns of a first and of a second color in the wales of one side only of said tubular fabric to form lines of design stitches thereof to provide lines of first color stitches and lines of second color stitches where-

in each of said lines of stitches is arranged in a zig-zag shaped path extending over said wales, said lines of first color stitches extending from the center portion of the upper half-diamond area on said one side of said tubular fabric to the center portion of said upper front diamond area thence to the center portion of the side diamond area on said one side of said tubular fabric thence to the center portion of said lower rear diamond area and thence to the center portion of the lower half-diamond area on said one side of said tubular fabric, said lines of second color stitches extending from the center portion of said last named upper half-diamond area to the center portion of said upper rear diamond area thence to the center portion of said last named side diamond area thence to the center portion of said lower front diamond area and thence to the center portion of said last named lower half-diamond area, said design yarns being knit independently of said body yarn knitting in such manner that each line of design stitches or portion thereof extending between the center portions of an adjoining pair of said areas is formed of a single yarn and is incorporated in said last named areas and extends uninterruptedly across the suture therebetween.

2. A circular knitting machine of the type having a circle of needles and having means to reciprocate said needle circle to knit body yarn thereon at four circumferentially spaced feeds to provide tubular fabric formed of a plurality of adjoining suture joined diamond shaped body fabric areas arranged so that said tubular fabric is provided with an upper and lower diamond shaped areas at a front and at a rear thereof and is provided on each of its sides with upper and lower half-diamond shaped areas spaced by a side diamond shaped area wherein said front and rear and one of said side areas have a group of common wales formed on a related group of said needles, means adapted to feed design yarns of a first and of a second color to said group of needles only to permit said group of needles to knit said yarns to form lines of design stitches thereof to provide lines of first color stitches and lines of second color stitches wherein each of said lines of stitches is formed by said group of needles and is arranged in a zig-zag shaped path extending over said common wales, said lines of first color stitches extending from the center portion of the upper half-diamond area on said one side of said tubular fabric to the center portion of said upper front diamond area thence to the center portion of the side diamond area on said one side of said tubular fabric thence to the center portion of said lower rear diamond area and thence to the center portion of the lower half-diamond area on said one side of said tubular fabric, said lines of second color stitches extending from the center portion of said last named upper half-diamond area to the center portion of said upper read diamond area thence to the center portion of said last named side diamond area thence to the center portion of said lower front diamond area and thence to the center portion of said last named lower half-diamond area, said design yarns being knit independently of said body yarn knitting in such manner that each line of design stitches or portion thereof extending between the center portions of an adjoining pair of said areas is formed of a single yarn and is incorporated in said last named areas and extends uninterruptedly across the suture therebetween.

3. A circular knitting machine of the type having a circle of needles and having means to reciprocate said needle circle to knit body yarn thereon at four circumferentially spaced feeds to provide tubular fabric formed of a plurality of adjoining suture joined diamond shaped body fabric areas arranged so that said tubular fabric is provided with upper and lower diamond shaped areas at a front and at a rear thereof and is provided on each of its sides with upper and lower half-diamond shaped areas spaced by a side diamond shaped area wherein said front and rear and one of said side areas have a group of common wales formed on a related semi-circular group of said needles, there being two of such common wale and related needle groups, means adapted to feed design yarns of a first and of a second color to one of said needle groups only and to feed other design yarns of said first and of said second color to the other of said needle groups only to permit each of said needle groups to knit said yarns to form lines of design stitches thereof to provide lines of first color stitches and lines of second color stitches wherein each of said lines of stitches is formed by one of said groups of needles and is arranged in a zig-zag shaped path extending over one of said groups of common wales, one of said lines of first color stitches extending from the center portion of the upper half-diamond area on one side of said tubular fabric to the center portion of said upper front diamond area thence to the center portion of said side diamond area on said one side of said tubular fabric thence to the center portion of said lower rear diamond area and thence to the center portion of the lower half-diamond area on said one side of said tubular fabric, one of said lines of second color stitches extending from the center portion of said last named upper half-diamond area to the center portion of said upper rear diamond area thence to the center of said last named side diamond area thence to the center portion of said lower front diamond area and thence to the center portion of said last named lower half-diamond area, the other of said lines of first color stitches and the other of said lines of second color stitches being similarly disposed on the other side of said tubular fabric whereby the first color stitches are in said upper front and in said lower rear diamond areas and whereby the second color stitches are in said upper rear and in said lower front diamond areas while the stitches of both of said colors are in said upper and lower half-diamond areas and are in said side diamond areas, said design yarns being knit independently of said body yarn knitting at said feeds in such manner that each line of design stitches or portion thereof extending between the center portions of an adjoining pair of said areas is formed of a single yarn and is incorporated in said last named areas and extends uninterruptedly across the suture therebetween.

4. A circular knitting machine having at least three feeds and adapted to reciprocate to knit body fabric of a body yarn at each of said feeds, means to feed an additional yarn, and means to feed said additional yarn at each of said feeds during reciprocating knitting.

5. A circular knitting machine having at least three feeds and adapted to reciprocate to knit at least three suture joined individual sections of body fabric at said feeds of correspondingly individual body yarns, means to feed a design yarn, and means to feed said yarn at each of the feeds during reciprocating knitting for incorporation in said fabric sections.

6. A circular knitting machine having at least three feeds and adapted to reciprocate to knit body fabric of a body yarn at one of said feeds, means to feed a design yarn, and means to feed said design yarn at each of the remaining pair of said feeds during reciprocating knitting for incorporation in said body fabric.

7. A circular knitting machine having at least three feeds and adapted to knit body yarn at each of said feeds, means to feed at least one design yarn, means to reciprocatingly knit said design yarn at one of said feeds while body yarn is reciprocatingly knit at the remaining pair of said feeds, and means to reciprocatingly knit said design yarn at each of said pair of feeds while body yarn is reciprocatingly knit at said one feed.

8. A circular knitting machine having four circumferentially spaced feeds and adapted to reciprocate to knit at said feeds, means to feed a first pair of yarns at one of an opposite pair of said feeds and to feed a second pair of yarns at the other of said pair of feeds during reciprocating knitting, and means to feed said second pair of

yarns at said one of said pair of feeds and to feed said first pair of yarns at said other of said pair of feeds during reciprocating knitting.

9. A circular knitting machine having at least three circumferentially spaced feeds and adapted to reciprocate to knit at said feeds, a first yarn finger between a first pair of said feeds adapted to selectively feed each of a pair of yarns at each of said first pair of feeds, and a second yarn finger between a second pair of said feeds adapted to feed each of said pair of yarns at each of said second pair of feeds.

10. A circular knitting machine having a reciprocating needle circle and at least one self-threading yarn finger adapted to feed a yarn to the needles of said needle circle to be knit thereon, means to thread said yarn in said finger, said means including the movement of said needle circle.

11. A circular knitting machine having a reciprocating needle circle, a first self-threading yarn finger, a second self-threading yarn finger, a first yarn and a second yarn, said first finger being adapted to feed said first yarn and said second fiinger being adapted to feed said second yarn to the needles of said needle circle to knit thereon, means to exchange the positions of said yarns in said fingers so that said first finger feeds said second yarn and said second finger feeds said first yarn, said means including the reciprocating movement of said needle circle.

12. A circular knitting machine having a reciprocating circle of needles and a first and a second self-threading yarn finger each of which is movable to and from feeding and non-feeding positions, respectively, outside of and inside of said needle circle, said first and said second fingers in feeding positions being respectively adapted to feed a first and a second yarn to the needles of said needle circle to be knit upon certain of the needles thereof, means to exchange the yarn positions in said fingers in their non-feeding positions so that said first finger feeds said second yarn and said second finger feeds said first yarn, said means including movement of said yarns by movement of the knit portions thereof on said certain of the needles as the latter reciprocates with said needle circle.

13. A circular knitting machine having a reciprocating circle of needles and a first and a second yarn finger each of which is provided with a self-threading yarn feeding eye portion and a yarn directing portion operatively related thereto, said fingers being movable to and from feeding and non-feeding positions wherein their yarn feeding eye portions are respectively outside of and inside of said needle circle, said fingers in their non-feeding positions having their yarn directing portions extending across said needle circle, said first and said second fingers in feeding positions being respectively adapted to feed a first and a second yarn to the needles of said needle circle to be knit upon certain of the needles thereof, means to exchange the yarn positions in said fingers in their non-feeding positions so that said first finger feeds said second yarn and said second finger feeds said first yarn, said means including movements of said yarns along said yarn directing portions of said fingers to and into their yarn eyes as said yarns are moved by movement of the knit portions thereof on said certain of the needles as the latter reciprocates with said needle circle.

14. A self-threading yarn finger for a knitting machine comprising a generally flat elongated shaped member having a generally lengthwise extending edge portion thereof generally aligned with one side edge of a rounded nose portion forming an off center projection at one end of said flat member, said flat member having a generally transversely extending edge portion one end of which is generally aligned with the opposite side edge of said nose portion defining a pocket area therebetween, and a wire member forming a part of said finger, said wire being secured to the under side of said flat member and having a reverse bend therein which extends around said transverse edge in said pocket area and extends across the base of said nose portion at an angle to the plane of said flat member and to said longitudinal edge, the wire being spaced from the top side of said flat member and said wire bend being spaced from said transverse edge a distance for a yarn to pass freely therebetween.

15. A circular knitting machine having a reciprocating needle circle, a first self-threading yarn finger, a second self-threading yarn finger, a first yarn and a second yarn, said first finger being adapted to feed said first yarn and said second finger being adapted to feed said second yarn to the needles of said needle circle to knit thereon, means to exchange the positions of said yarns in said fingers so that said first finger feeds said second yarn and said second finger feeds said first yarn, said means including the reciprocating movement of said needle circle, and a pair of yarn change arms directing said yarns to said fingers.

16. A knitting machine as set forth in claim 12 wherein said first yarn is associated with one of said arms and said second yarn is associated with the other of said arms, means to move each of said arms to one or the other of two positions, said one of said arms in one of its positions directing said first yarn to said first finger and in the other of its positions directing said first yarn to said second finger while said other of said arms in one of its positions directing said second yarn to said second finger and in the other of its positions directing said second yarn to said first finger.

17. A circular knitting machine having at least three feeds adapted to reciprocatingly knit upon a reciprocating needle circle, a first self-threading yarn guide adapted to feed a first yarn at a first and at a second of said feeds, a second self-threading yarn finger adapted to feed a second yarn at said second and at the third of said feeds, a first yarn change arm to direct said first yarn and a second yarn change arm to direct said second yarn, means to move said yarn change arms so that said first arm directs said first yarn from a position between said first and said second feeds to said first finger and directs said first yarn from a position between said second and said third feeds to said second finger while said second arm directs said second yarn from a position between said second and said third feeds to said second finger and directs said second yarn from a position between said first and said second feeds to said first finger.

18. A circular knitting machine having at least three feeds and having a reciprocating needle circle, a first and a second self-threading yarn finger each of which is movable to and from feeding and non-feeding positions respectively outside of and inside of said needle circle, a first member directing a first yarn from between a first and a second of said feeds to said first finger in feeding position at said first feed to reciprocatingly knit said first yarn upon certain of the needles of said needle circle, a second member directing a second yarn from a point between said second and the third of said feeds to said second finger in feeding position at said third feed to reciprocatingly knit said second yarn upon certain of the needles of said needle circle, means to exchange the yarn positions in said fingers in their non-feeding positions so that said first finger feeds said second yarn and said second finger feeds said first yarn, the said yarn exchanging means including means to exchange the relative positions of said first and second members so that said first member now directs said first yarn to said second finger from between said second and said third feeds while said second member now directs said second yarn to said first finger from between said first and second feeds, the said yarn exchanging means also including movements of the yarns as caused by movements of knit portions thereof on said certain of the needles as the latter reciprocates with said needle circle.

19. A circular knitting machine having at least three feeds and having a reciprocating needle circle, a first self-threading yarn finger swingable to move across the needle circle to non-feeding position and to move outside of the needle circle to feeding position to feed a first yarn to the needle circle at a first of said feeds, a second self-threading finger similarly swingable to move across the needle circle to non-feeding position and to move outside of the needle circle to feeding position at a third of said feeds to feed a second yarn to the needle circle, a first and a second yarn change arm commonly pivoted at one of their ends above said second feed and having yarn directing eyes at their other ends, said first arm eye directing said first yarn to said first finger from a point disposed between said first and second feeds while said second arm eye directs said second yarn to said second finger from a point disposed between said second and third feeds, means to exchange the positions of said yarns in said fingers so that said first yarn is fed by said second finger and said second yarn is fed by said first finger, said exchange means including main cam drum actuated cables to swing said yarn change arms to exchange their positions relative to said second feed when said fingers are in their non-feeding positions.

20. A method of knitting upon a needle circle of a circular knitting machine having four feeds including the step of reciprocatingly knitting individual first fabric areas of body yarns upon an opposite pair of said feeds, the step of reciprocatingly knitting only the same first pairing of two of four design yarns at each of the intervening pair of said feeds for incorporation thereof in said first fabric areas during the knitting thereof, each first pair of said design yarns being thus associated with one only of said intervening feeds, the step of reciprocatingly knitting individual second fabric areas of body yarns upon said intervening pair of feeds, the step of reciprocatingly knitting a second pairing of two of said four design yarns at each of said opposite pair of feeds for incorporation thereof in said second fabric areas, and the step of alternating the association of each second pair of said design yarns with each of said opposite pair of feeds to accordingly change the incorporation of said design yarns in said second fabric areas, each second pair of said design yarns being thus associated with each of said opposite pair of feeds.

References Cited in the file of this patent

UNITED STATES PATENTS

2,217,022	Lawson et al.	Oct. 8, 1940
2,642,732	Thurston	June 23, 1953
2,680,961	Thurston	June 15, 1954
2,693,094	Marlette et al.	Nov. 2, 1954
2,775,880	Philip	Jan. 1, 1957