March 14, 1961 N. LEVIN 2,974,505

FOUR YARN OVERPLAID KNITTING MACHINE

Filed Dec. 9, 1957 3 Sheets-Sheet 1

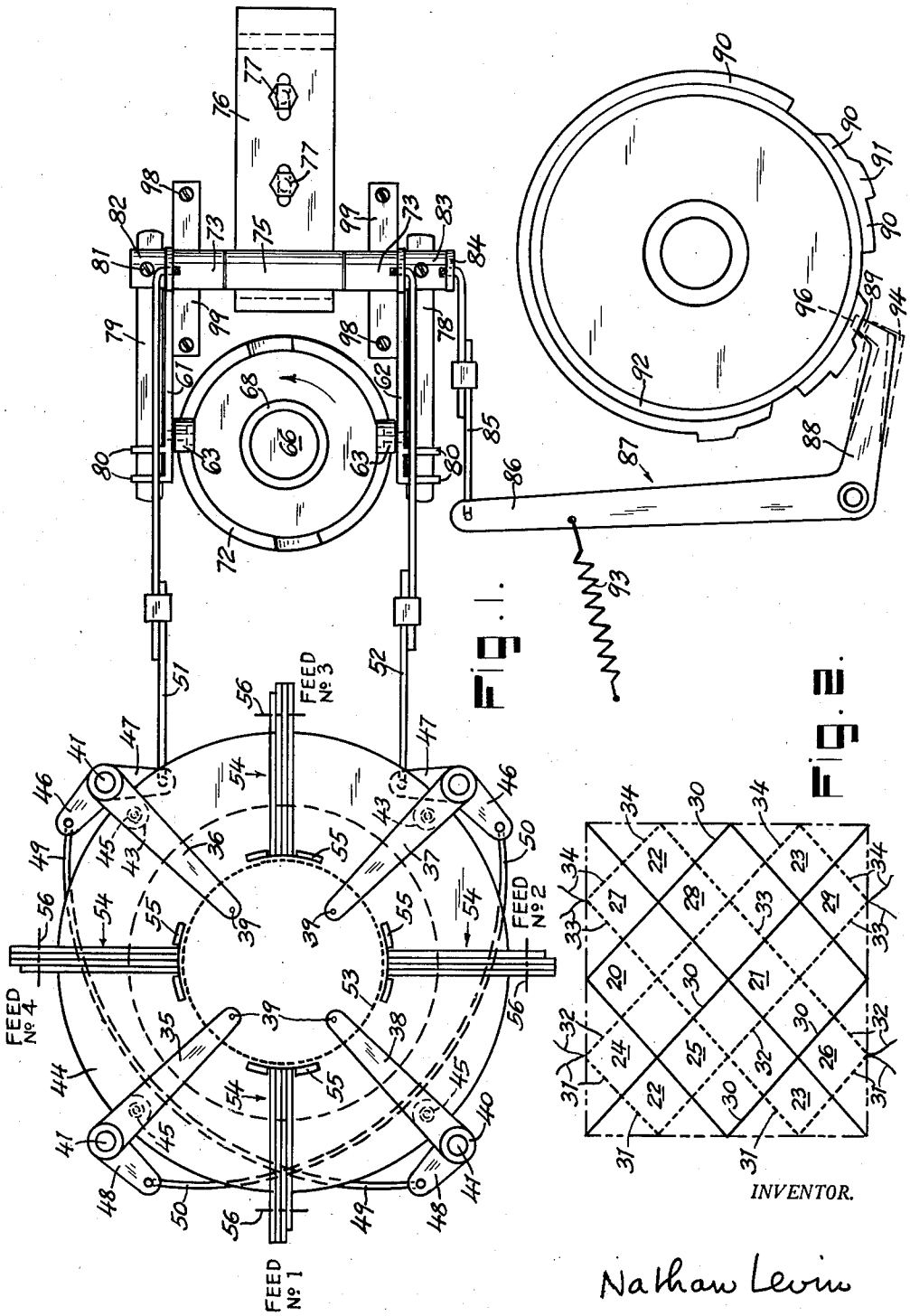


Fig. 1.

Fig. 2.

Fig. 3.

INVENTOR.

Nathan Levin

March 14, 1961 N. LEVIN 2,974,505

FOUR YARN OVERPLAID KNITTING MACHINE

Filed Dec. 9, 1957 3 Sheets-Sheet 2

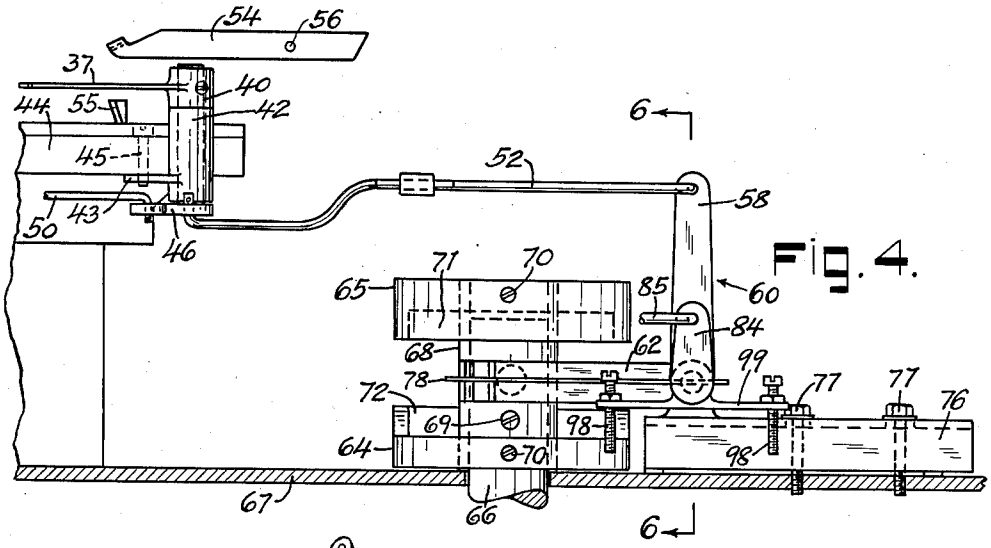


Fig. 4.

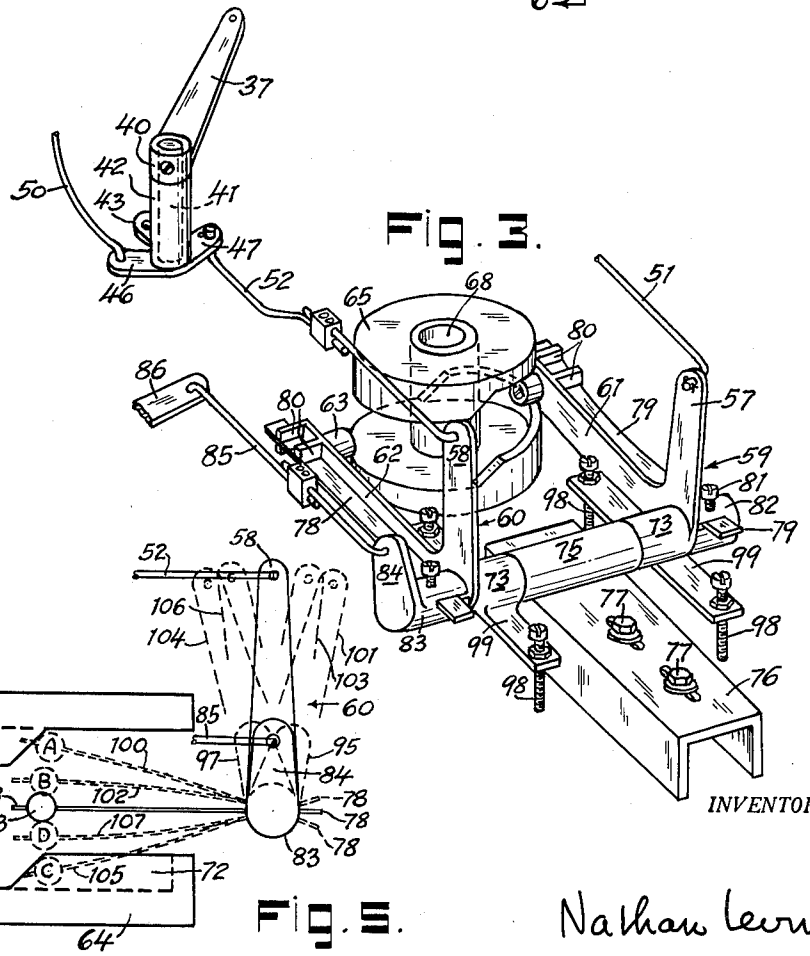


Fig. 3.

Fig. 5.

INVENTOR.

Nathan Levin

March 14, 1961 N. LEVIN 2,974,505

FOUR YARN OVERPLAID KNITTING MACHINE

Filed Dec. 9, 1957 3 Sheets-Sheet 3

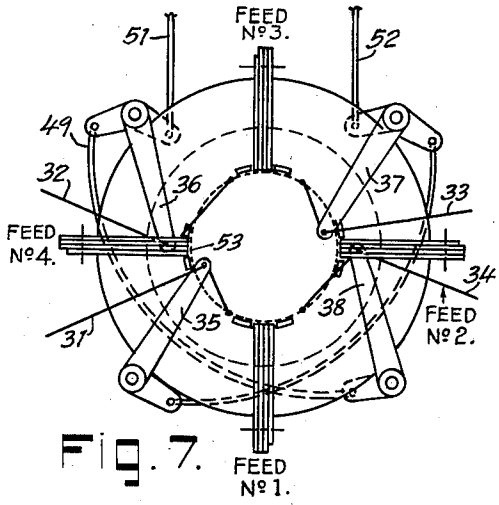


Fig. 7.

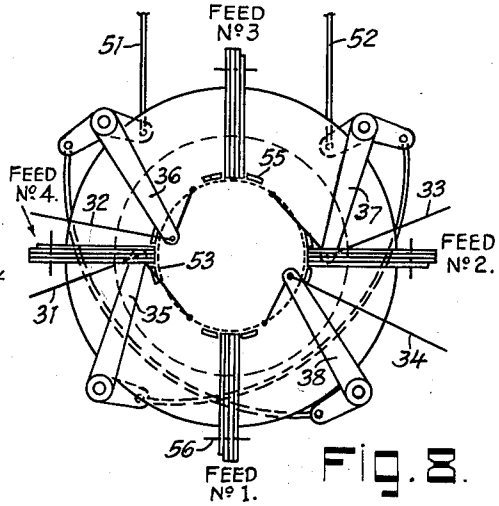


Fig. 8.

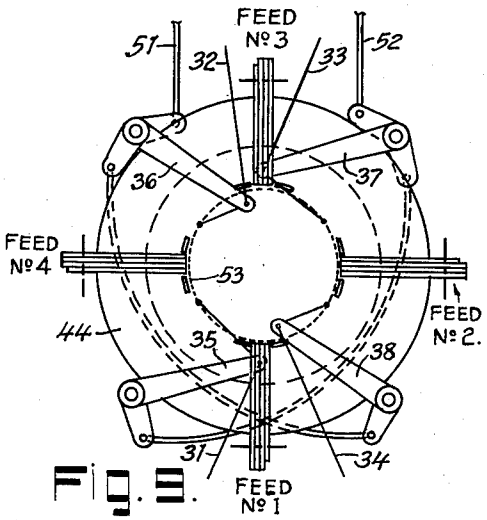


Fig. 9.

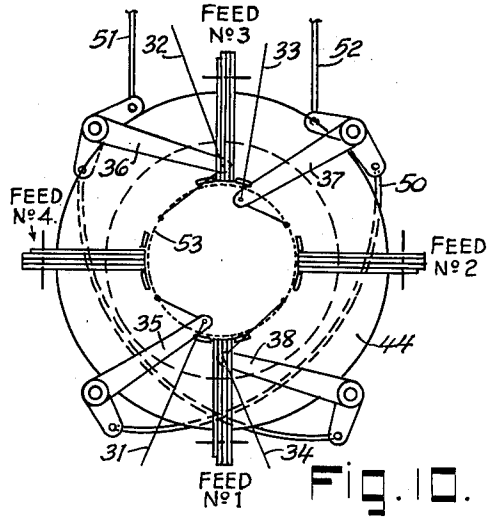


Fig. 10.

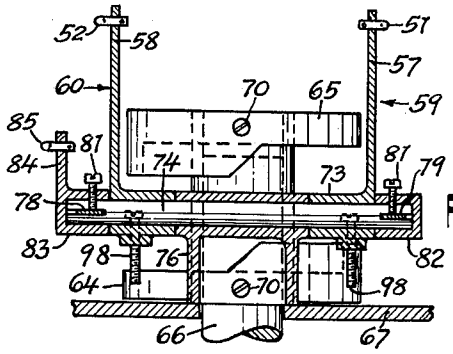


Fig. 5.

INVENTOR.

Nathan Levin

United States Patent Office 2,974,505
Patented Mar. 14, 1961

2,974,505

FOUR YARN OVERPLAID KNITTING MACHINE

Nathan Levin, 722 Edgewood Ave., Trenton 8, N.J.

Filed Dec. 9, 1957, Ser. No. 701,459
24 Claims. (Cl. 66—43)

The present invention relates generally to the art of knitting and more particularly to circular knitting machinery adapted to form overplaid designs of overplaid yarns within suture joined areas of separate fabric sections of argyle hosiery, or the like.

It is an object of the present invention to provide a four feed circular knitting machine with means to knit a true overplaid design in solid color suture joined pattern areas of argyle hosiery by the use of only four overplaid design yarns each of which is adapted to knit to be incorporated in a plurality of said pattern areas knit at each of a plurality of feeds of the machine.

It is a further object of the present invention to provide four yarn guides for the four overplaid design yarns used and to associate each of the yarn guides with an adjoining pair of said pattern areas knit at an adjoining pair of feeds of the machine in such manner that each of said yarn guides may be operated to cause its overplaid design yarn to be selectively knit in one and in the other of its associated pair of areas.

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

In the drawings:

Fig. 1 is a plan view of the present invention shown in position on a four feed Reading CK machine, with the overplaid yarn fingers in their neutral positions,

Fig. 2 is a diagrammatic view of the leg portion of an argyle hose cut along its rear central wale and spread flat,

Fig. 3 is a perspective view of the cam mechanism of the present invention for selectively moving the overplaid yarn fingers,

Fig. 4 is a side elevational view of the cam mechanism shown in Fig. 3, with one of the overplaid yarn fingers shown mounted upon the sinker bed of the machine,

Fig. 5 is a diagrammatic view showing the five positions of an arm of the cam mechanism as it actuates the overplaid yarn fingers,

Fig. 6 is a sectional view of the apparatus taken along the lines 6—6 of Fig. 4, and

Figs. 7 through 10 are diagrammatic views showing the several positions of the overplaid yarn fingers in relation to the several feeding stations of the machine during the knitting process.

In Fig. 2, the leg portion of an argyle hose, between its top and its ankle portions, has been shown in flat relation as it would appear with the leg fabric severed along its rear central 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. 2 is provided with an overplaid design formed by four yarns indicated at **31**, **32**, **33**, and **34**, each yarn being knit in the general shape of a zig-zag line so disposed that its straight line portions extend across suture seams **30** from the centers of designated ones of the diamond shaped areas. The yarn **31** commences knitting at the center of side half diamond **24**, continues diagonally across suture line **30** to the center of upper rear diamond **22**, then diagonally across suture line **30** to the center of side diamond **25**, then diagonally across suture line **30** to the center of lower rear diamond **23**, and finally diagonally across suture line **30** to the center of lower side diamond **26**, where the knitting of overplaid yarn **31** terminates. The path of overplaid yarn **33**, as it is knit and as it extends from the center of side half diamond **27**, to the center of front diamond **20**, to the center of side diamond **28**, to the center of front diamond **21**, and then to the center of side half diamond **29**, is generally parallel to the path of the yarn **31**. The knitting paths of the yarns **32** and **34** are parallel and are reversely similar to the paths of the yarns **31** and **33**. The yarn **32** extends from the center of side half diamond **24** (where yarn **31** also starts) to the center of front diamond **20** where it meets yarn **33**, to the center of side diamond **25** where it meets yarn **31**, to the center of front diamond **21** where it again meets yarn **33**, and finally to the center of lower side half diamond **26** where it again meets yarn **31**. The yarn **34** extends from the center of side half diamond **27** (where yarn **33** also starts) to the center of rear diamond **22** where it meets yarn **31**, to the center of side diamond **28** where it meets yarn **33**, to the center of rear diamond **23** where it again meets yarn **31**, and finally to the center of lower side diamond **29** where it again meets yarn **33**. While each of the overplaid yarns **31**, **32**, **33**, and **34**, are arranged in a walewise extending zig-zag path, it will be appreciated that certain straight line sections of these four yarns, for example, the sections extending between the center portions of areas **22**, **24**; **24**, **20**; **20**, **27**; and **27**, **22**; are arranged in a circumferentially or coursewise extending zig-zag path. Similarly, the suture lines **30** may be considered, in relation to certain of the fabric areas, as being arranged in a walewise extending zig-zag path, while, in relation to other of the fabric areas, they may be considered as being arranged in a circumferentially or coursewise extending zig-zag path. The machine is adapted to knit opposite pairs of diamond shaped areas of the hosiery at correspondingly opposite pairs of feeds of the machine while the intervening pairs of feeds incorporate the four yarn overplaid design therein. When no overplaid yarns are being knit into the diamond shaped areas, the machine is adapted to knit the unadorned portions thereof upon all four feeds of the machine at the same time. While each of the overplaid yarns **31**, **32**, **33**, and **34**, (which may also be referred to as design yarns) is shown as a single yarn and may be so referred to, it will be understood that each such single yarn may be made up of a composite of individual yarns or strands.

The mechanism for knitting the fabric of Fig. 2 is shown in Fig. 1, in place upon a Reading CK machine and, as part thereof, four pivotally mounted overplaid

yarn fingers 35, 36, 37, and 38 are provided, each of the fingers having a yarn feeding aperture 39 at the free end thereof. The finger 35 is disposed between feeds Nos. 1 and 4 and is adapted to feed its yarn at each of these feeds, finger 36 is disposed between feeds Nos. 3 and 4 and is adapted to feed its yarn at each of these feeds, finger 37 is disposed between feeds Nos. 2 and 3 and is adapted to feed its yarn at each of these feeds, and finger 38 is disposed between feeds Nos. 1 and 2 and is adapted to feed its yarn at each of these feeds. Each of the fingers extends from a collar 40 suitably adjustably secured to the upper end of a vertical shaft 41 which is rotatably disposed in a bearing 42, the latter having a lower extension 43 by means of which the bearing 42 may be fixed to the sinker bed 44 of the machine. Screws 45 extending through the bed 44 in threaded engagement with extensions 43 of bearings 42 serve to hold the latter in position. Each of the four bearings 42 is fixed to the sinker bed midway between an adjacent pair of feeds. Each of the shafts 41 have a member suitably secured to its lower end by means of which the shaft and associated finger may be turned. In the case of the shafts 41 related to the fingers 36 and 37, the members each comprise a pair of arms 46 and 47 disposed at an angle of 135 degrees, while in the case of the shafts 41 related to the fingers 35 and 38, the members each comprise a single arm 48.

The arms 48 extend toward feed No. 1 and are disposed at right angles to their respective fingers 35 and 38, and, similarly, the arms 46, which extend away from feed No. 3, are disposed at right angles to their respective fingers 36 and 37. The arms 46, 48 of fingers 36, 38, and of fingers 35, 37, are parallel. The free ends of arms 46, 47, and 48, all of which are of equal length, are suitably apertured to receive therein the suitably formed ends of certain control rods. A curved control rod 49 extends between and is pivotally connected to the arms 46 and 48 of the fingers 36 and 38, while a similar curved control rod 50 extends between and is pivotally connected to the arms 46 and 48 of the fingers 35 and 37. The ends of the control rods 49 and 50 may be retained in the apertures of the arms 46 and 48 by suitably disposed cotter pins. The fingers 36 and 38 are now connected by rod 49 while fingers 35 and 37 are connected by rod 50 so that each pair of diagonally opposite fingers is adapted to be moved together. The rods 49, 50 extend around the needle cylinder and under the sinker bed 44 of the machine, being so shaped and disposed as to be free thereof. The arms 47 which extend toward each other, have control rods 51 and 52 pivotally connected with the ends thereof to move the fingers 36, 38 and 35, 37, respectively.

Also shown in Fig. 1 is the needle circle 53 of the machine, along with the plurality of body yarn fingers 54 and the throat plate 55, of each of the feeds. At each feed, the body yarn fingers 54 are adapted to be selectively placed into and out of feeding positions by the usual means (not shown) which pivotally raises and lowers these fingers about a horizontally disposed pivot pin indicated at 56. As appears in Fig. 4, the overplaid yarn fingers, of which finger 37 is shown here, are disposed below the body yarn fingers 54 when the latter are in their raised non-feeding positions, with the result that the overplaid yarn fingers may swing horizontally beneath the raised body yarn fingers above the throat plates 55 at certain times during the knitting operation.

The other ends of the control rods 51 and 52 are suitably pivotally connected to the upright arms 57, 58, of bell crank levers 59, 60, respectively, so that rocking movements of the latter will cause the overplaid fingers to correspondingly move. The horizontal arms 61, 62 of the levers 59, 60, are provided, on their inner faces, with rollers 63 which are selectively acted upon by rotary cams 64, 65. The machine is provided with an upright rotary shaft 66 extending through the bed plate 67, the shaft 66 turning in timed relation to the needle cylinder. During rotary knitting the shaft 66 rotates once to four rotations of the needle cylinder and in reciprocating knitting the shaft 66 rotates once to a forward and a reverse movement of the needle cylinder. A sleeve 68 is adjustably secured to the upper end of the shaft 66 by means of one or more set screws 69. The cams 64, 65 are adjustably secured to the sleeve 68 by one or more set screws 70 so that the cams may be both angularly and vertically adjusted. The cam 65 has a downwardly extending semi-circular cam face 71 while the cam 64 has a similar but upstanding cam face 72, the cam faces 71 and 72 being diametrically opposed.

Each of the levers 59, 60 is provided with a centrally disposed sleeve bushing 73 within which a horizontal shaft 74 is rotatably disposed. The shaft 74 may also turn within a bearing base member 75 of base 76 by means of which the apparatus is secured to the bed plate 67 of the machine with the adjustable screws 77 which extend through slots in the base 76 in threaded engagement with the bed plate 67. The opposite ends of shaft 74 are similarly diametrically slotted to receive therein the flat springs 78 and 79, which extend from the chaft 74 along the outer sides of the lever arms 61, 62 to the terminal ends thereof where the flat springs are slidingly received within the slotted outwardly extending projections 80, 80 of the lever arms. The flat spring 79 is held in place at one end of the shaft 74 by means of a suitable adjusting screw 81 which extends through the slotted cap 82 in threaded engagement with the shaft 74. Similarly flat spring 78 is held in place at the other end of shaft 74 by a screw 81 extending through slotted cap 83 in threaded engagement with the shaft 74. The screws 81 also serve to fixedly secure the caps 82 and 83 in position on the shaft 74.

In order to selectively turn the shaft 74 to any one of three angular positions, the cap 83 is provided with an upright arm 84, the upper end of which is suitably apertured to pivotally receive therein one end of a control rod 85, the other end of which is similarly connected to one end of an arm 86 of a pivotally mounted pattern lever 87. The other arm 88 of lever 87 is provided with a nose 89 which is adapted to ride against the cams 90 and 91 affixed to the outer circumference of the regular indexable main pattern control drum 92, the arm 88 being urged toward the drum 92 by a suitably anchored tension spring 93 secured to the arm 86 of lever 87. When the nose 89 of lever 87 rides upon any one of the several cams 90 on the drum 92, Fig. 1, the arm 84 is positioned vertically as in Fig. 5 to hold the shaft 74 in neutral position wherein the flat springs 78, 79 are horizontal. With the nose 89 on one of the several cams 91, as shown in its outer dotted line position 94, Fig. 1, the arm 84 is caused to turn to the right, Fig. 5, to its dotted line position 95 to hold shaft 74 in such position that the flat springs 78, 79 are caused to be tilted upwardly. When the nose 89 of lever 87 is free of the cams 90 and 91 and is spaced from the face of the drum 92, as shown in dotted line position 96 of Fig. 1, the action of spring 93 is such as to turn arm 84 to the left, Fig. 5, to its dotted line position 97, to hold shaft 74 in such position that the flat springs 78, 79 are caused to be tilted downwardly. The rocking movements of the levers 59 and 60, as they are caused to move by movements of the flat springs 78, 79, which in turn are moved by the shaft 74, are limited by pairs of adjustable stop screws 98, 98, set in the opposite ends of individual stop plates 99, 99 fixed to the sleeves 73 of the levers, the stop screws taking against the upper face of the bed plate 67 of the machine.

The shaft 74 is free to turn within the bearings 73, 73, and 75 in accordance with the position of the turning arm 84 which, via lever 87 and rod 85, is under control of the main cam drum 92. Turning of the shaft 74 causes the two flat springs 78 and 79 to be accordingly tilted, and since these are connected to the arms 61 and 62 of the levers 59 and 60 by means of the blocks 80, 80, this movement of the flat springs will cause appropri-

ate movement of the levers 59 and 60. Referring to Fig. 5, with the nose 89 of lever 87 in full line position, Fig. 1, the turning arm 84 is in full line upright position which causes shaft 74 to position spring 78 (and spring 79) in full line horizontal position with the lever 60 (and lever 59) to be in its full line vertical position. In this position, known as the neutral positions of the overplaid yarn fingers as shown in Fig. 1, the rollers 63 are spaced from the constantly turning cams 64, 65 and will not be moved thereby. The levers 59 and 60 will thus remain in their full line vertical positions.

When the nose 89 of lever 87 is in dotted line position 94 on a cam 91, Fig. 1, the turning arm 84 is moved to its dotted line position 95, Fig. 5, which causes shaft 74 to move spring 78 (and spring 79) to its uppermost dotted line position 100 and this in turn causes the lever 60 (and lever 59) to turn to its rear dotted line position 101, this position of lever 60 being adjustably determined by the action of its rearmost stop screws 98 in contact with the bed plate 67. This position of lever 60 (and 59) will raise its roller 63 to position A in the path of rotary cam 65, to be recurrently engaged by the semi-circular cam face 71 thereof, thereby moving the roller to position B. As roller 63 of lever 60 is lowered to position B by cam 71, the lever itself is moved to position 103 from its position 101, this action causing the spring 78 to be further flexed to position 102. Then as cam 71 moves out of contact with roller 63, the lever 60 under the action of flexed spring 78 is caused to move back to its position 101 at which time its roller 63 returns to position A and spring 78 returns to the lesser flexed position 100. Thus each time (for one half of each revolution of shaft 66) cam face 71 acts to depressingly engage roller 63 from position A to position B, lever 60 is caused to move from position 101 to position 103, and at the same time spring 78 is further flexed from position 100 to position 102. And each time (for the other half of each revolution of shaft 66) cam face 71 is free of roller 63, the spring 78 returns the lever 60 from position 103 to position 101 thus returning the roller 63 from position B to position A, during the course of which spring 78 returns to position 100 from position 102. Accordingly the lever 60 is rocked back and forth in timed relation to the rotation of shaft 66, and since lever 60 is connected, via control rod 52, to the pair of overplaid yarn fingers 35 and 37, the latter are accordingly rocked to swing their feeding ends across the needle circle 53. When the lever 60 is in the position 101 of Fig. 5, the control rod 52 has been moved to the right and the overplaid fingers 35 and 37 have been moved to the positions shown in Fig. 9 wherein they are in feeding positions at feeds Nos. 1 and 3; when the lever 60 is in the position 103 of Fig. 5, control rod 52 has been moved to the left and the overplaid fingers 35 and 37 have been moved to the positions shown in Fig. 10 wherein they are in non-feeding positions at feeds Nos. 1 and 3.

In connection with the above description of Fig. 5 as it relates to lever 60, it will be understood that lever 59 is similarly moved by the shaft 74 and its spring 79 to an initial position corresponding to the position 101 of lever 60, and that its spring 79 and roller 63 are also similarly positioned. The cam face 71, as it rotates, alternately engages and depresses the diametrically spaced rollers 63 of the levers 59 and 60, so that the lever 59 is caused to traverse the same rocking action as lever 60, but at a different time in relation to the rotation of shaft 66. Inasmuch as cam face 71 is semi-circular in extent, its action causes levers 59 and 60 to be rocked in alternation, so that when lever 60 is in the 101 position, lever 59 is in the 103 position, and vice versa. When lever 59 is in the 101 position, its control rod 51 will have moved the overplaid yarn fingers 36 and 38 to their feeding positions as shown in Fig. 10 at feeds Nos. 1 and 3, while, when lever 59 is in the 103 position, its control rod 51 will have moved the overplaid yarn fingers 36 and 38 to their nonfeeding positions at feeds Nos. 1 and 3 as shown in Fig. 9. Thus for each revolution of shaft 66, the opposite pairs of the overplaid yarn fingers have each been placed in feeding and in nonfeeding positions at the feeds Nos. 1 and 3.

At other times it is necessary that the overplaid yarn fingers be similarly moved with respect to feeds Nos. 2 and 4. For this the main drum 92 is moved so that there is no cam beneath the lever 87 and its nose 89 is then in the position indicated at 96, Fig. 1, at which time spring 93 will cause the shaft to be turned so that arm 84 is in the position 97 in Fig. 5. This will cause lever 60 to assume the forward position shown at 104, its roller 63 will be in position C, while its spring 78 will be tilted to position 105, the forward stop screw 98 limiting the movement of lever 60. The action of rotary cam 64 is now similar to the action of cam 65 except that its cam face 72 acts to raise roller 63 from position C to position D, which causes lever 60 to be moved from position 104 to position 106 and at the same time causes spring 78 to be further flexed as it is moved from position 105 to position 107. Similarly, when roller 63 is free of the cam face 72, the action of spring 78, in returning from position 107 to position 105, causes lever 60 to be returned from position 106 to position 104, the roller 63 at the same time returning to position C from position D. Inasmuch as cam 64 is diametrically opposed to cam 65 on shaft 66, the timing of the rocking action of lever 60 by cam face 72 will be accordingly different from the timing of the rocking action caused by the cam face 71. The action of the cam face 72 on the roller 63 of the lever 59, will also cause that lever to rock between the 104 and the 106 positions. When the lever 59 is in the 104 position, the lever 60 will be in the 106 position, and when the lever 59 is in the 106 position, the lever 60 will be in the 104 position.

When the lever 60 is in the 104 position, the control rod 52 will cause the overplaid yarn fingers 35 and 37 to be in feeding positions at feeds Nos. 2 and 4 as in Fig. 8; when the lever 60 is in the 106 position, the control rod 52 will cause the overplaid yarn fingers 35 and 37 to be in the non-feeding positions at feeds Nos. 2 and 4 as in Fig. 7. Also, when the lever 59 is in the 104 position, the control rod 51 will cause overplaid yarn fingers 36 and 38 to be in feeding positions at feeds Nos. 2 and 4; and when the lever 59 is in the 106 position, the control rod 51 will cause the overplaid yarn fingers 36 and 38 to be in non-feeding positions at feeds Nos. 2 and 4.

In Figs. 7 and 8 all of the body yarn fingers 54 at feeds Nos. 2 and 4 are in their raised non-feeding positions so that the overplaid yarn fingers may alternately swing across the needle circle to feeding positions at these feeds beneath the raised body yarn fingers and to non-feeding positions inside the needle circle. In feeding positions, the overplaid yarn fingers are above the throat plates 55 at feeds Nos. 2 and 4 to feed their yarns to selected overplaid forming needles. At feeds Nos. 1 and 3, selected ones of the body yarn fingers 54 are in feeding positions at their throat plates 55 to feed their body yarns to selected needles forming an opposite pair of the diamond shaped fabric areas of the hose, while the overplaid design is incorporated therein at the feeds Nos. 2 and 4. Similarly, in Figs. 9 and 10 all of the body yarn fingers 54 at feeds Nos. 1 and 3 are in their raised non-feeding positions so that the overplaid yarn fingers may now alternately swing across the needle circle to feeding positions at these feeds beneath the raised body yarn fingers and to non-feeding positions inside the needle circle. In feeding positions, the overplaid yarn fingers are above the throat plates at feeds Nos. 1 and 3 to feed their yarns to selected overplaid forming needles. At feeds Nos. 2 and 4, selected ones of the body yarn fingers 54 are in feeding positions at their throat plates 55 to feed their body yarns to selected needles forming

an intermediate pair of the diamond shaped fabric areas of the hose, while the overplaid design is incorporated therein at feeds Nos. 1 and 3. There are times, during reciprocating and rotary knitting, when no overplaid design yarns are being incorporated into the fabric and at such times the overplaid design fingers are maintained in their neutral positions, Fig. 1, by a cam **90** on the main drum **92**. As may be seen, the disposition of the cams **90** on the drum **92** is such that there are a number of times during which the overplaid yarn fingers are in their neutral positions, at which times the machine may be operated to knit at some or at all of its four feeds.

The overplaid design formed on a four feed machine by the means of the present invention is of the four yarn type wherein each straight line portion thereof extending between the interior 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.

I claim:

1. A circular knitting machine having a single feed, generally radially extending body yarn fingers at said feed vertically movable to raised non-feeding and to lowered feeding positions, an additional yarn finger disposed so as to be generally horizontally movable to non-feeding and to feeding positions at said feed, the feeding position of said additional finger transversely underlying said body yarn fingers in their raised non-feeding positions while the non-feeding position of said additional finger is such as to permit said body yarn fingers to be in their lowered feeding positions.

2. A circular knitting machine having a pair of feeds, body yarn fingers at each of said feeds movable to raised non-feeding and to lowered feeding positions, an additional yarn finger movable to non-feeding and to feeding positions at each of said pair of feeds, the feeding position of said additional finger at each of said pair of feeds being beneath the body yarn fingers in their raised non-feeding positions while the non-feeding position of said additional finger at each of said pair of feeds is such as to permit said body yarn fingers to be in their lowered feeding positions.

3. A circular knitting machine having a pair of feeds and adapted to reciprocate to knit at said feeds, a yarn finger adapted to be periodically placed in feeding and in non-feeding positions at each of said pair of feeds during reciprocating knitting, a rotary shaft, a pair of spaced cams operatively related to said shaft, and a lever operatively related to said yarn finger and adapted to be selectively operated by said pair of cams, one of said cams acting to periodically place said yarn finger in feeding and in non-feeding positions at one of said pair of feeds while the other of said cams acts to periodically place said yarn finger in feeding and in non-feeding positions at the other of said pair of feeds.

4. A circular knitting machine having four circumferentially spaced feeds adapted to reciprocate to knit at said feeds, a pair of yarn fingers adapted to be placed in and to remain in non-feeding positions and also adapted to be periodically placed in feeding and in non-feeding positions at an opposite pair of said feeds and at the intervening pair of said feeds during reciprocating knitting, a rotary shaft, a pair of axially spaced cams secured to said shaft, said cams being semi-circular and diametrically opposed, a lever operatively related to said pair of yarn fingers and adapted to be operated by said pair of cams, and pattern means, said pattern means positioning said lever to be free of said pair of cams whereby said pair of yarn fingers is placed in and maintained in its non-feeding positions, said pattern means also positioning said lever to be acted upon by one of said pair of cams to periodically place said pair of yarn fingers in feeding and in non-feeding positions at said opposite pair of feeds, said pattern means also positioning said lever to be acted upon by the other of said pair of cams to periodically place said pair of yarn fingers in feeding and in non-feeding positions at said intervening pair of feeds.

5. A circular knitting machine having a pair of feeds and adapted to reciprocate to knit at said feeds, a yarn finger adapted to be placed in and to remain in non-feeding position and also adapted to be periodically placed in feeding and in non-feeding positions at each of said pair of feeds during reciprocating knitting, a rotary shaft, a pair of spaced cams secured to said shaft, said cams being semi-circular and diametrically opposed, a lever operatively related to said yarn finger and adapted to be operated by said pair of cams, and pattern means, said pattern means positioning said lever to be free of said pair of cams whereby said yarn finger is placed in and maintained in its non-feeding position, said pattern means also positioning said lever to be acted upon by one of said pair of cams to periodically place said yarn finger in feeding and in non-feeding positions at one of said pair of feeds, and said pattern means also positioning said lever to be acted upon by the other of said pair of cams to place said yarn finger in feeding and in non-feeding positions at the other of said pair of feeds.

6. A circular knitting machine having a pair of feeds and adapted to reciprocate to knit at said feeds, a yarn finger adapted to be placed in and to remain in non-feeding position and also adapted to be periodically placed in feeding and in non-feeding positions at each of said pair of feeds during reciprocating knitting, a rotary shaft, a pair of spaced cams secured to said shaft, said cams being semi-circular and diametrically opposed, a lever operatively related to said yarn finger and adapted to be moved by said pair of cams, pattern means, and spring means between said pattern means and said lever, said pattern means positioning said lever to be free of said pair of cams whereby said yarn finger is placed in and maintained in its non-feeding position, said pattern means also positioning said lever to be acted upon by one of said pair of cams and by said spring means to periodically place said yarn finger in feeding and in non-feeding positions at one of said pair of feeds, and said pattern means also positioning said lever to be acted upon by the other of said pair of cams and by said spring means to periodically place said yarn finger in feeding and in non-feeding positions at the other of said pair of feeds.

7. A circular knitting machine having four circumferentially spaced feeds and adapted to reciprocate to knit at said feeds, four circumferentially spaced yarn fingers adapted to be placed in and to remain in non-feeding positions, each opposite pair of said yarn fingers also being adapted to be periodically placed in feeding and in non-feeding positions at an opposite pair of said feeds and at the intervening pair of said feeds during reciprocating knitting, a rotary shaft, a pair of axially spaced cams secured to said shaft, said cams being semi-circular and diametrically opposed, a pair of spaced levers, each of said levers being operatively related to an opposite pair of said yarn fingers and adapted to be moved by said pair of cams, and pattern means, said pattern means positioning said levers to be free of said cams whereby said yarn fingers are placed in and maintained in their non-feeding positions, said pattern means also positioning said levers to be acted upon in alternation by one of said pair of cams to periodically and alternately place each opposite pair of said yarn fingers in feeding and in non-feeding positions at each of said opposite pair of said feeds, and said pattern means also positioning said levers to be acted upon in alternation by the other of said pair of cams to periodically and alternately place each opposite pair of said yarn fingers in

feeding and in non-feeding positions at each of said intervening pair of feeds.

8. A circular knitting machine having four circumferentially spaced feeds and adapted to reciprocate to knit at said feeds, four circumferentially spaced yarn fingers adapted to be placed in and to remain in non-feeding positions, each opposite pair of yarn fingers also being adapted to be periodically placed in feeding and in non-feeding positions at an opposite pair of said feeds and at the intervening pair of said feeds during reciprocating knitting, a rotary shaft, a pair of axially spaced cams secured to said shaft, said cams being semi-circular and diametrically opposed, a pair of levers diametrically opposed relative to said shaft, each of said levers being operatively related to an opposite pair of said yarn fingers, pattern means, and spring means between said pattern means and said levers, said pair of levers being movable by said cams and by said spring means, said pattern means positioning said levers to be free of said cams whereby said yarn fingers are placed in and maintained in their non-feeding positions, said pattern means also positioning said levers to be acted upon by one of said cams and by said spring means in alternation to periodically and alternately place each opposite pair of said yarn fingers in feeding and in non-feeding positions at each of said opposite pair of feeds, and said pattern means also positioning said levers to be acted upon in alternation by the other of said pair of cams and by said spring means to periodically and alternately place each opposite pair of said yarn fingers in feeding and in non-feeding positions at each of said intervening pair of said feeds.

9. A circular knitting machine having a pair of feeds and adapted to reciprocate to knit at said feeds, a yarn finger adapted to be placed in non-feeding position relative to said pair of feeds and also adapted to be repeatedly placed in feeding and in non-feeding positions at each of said pair of feeds, a rotary shaft, a pair of axially spaced cams secured to said shaft, said cams being semi-circular and diametrically opposed, a lever operatively related to said yarn finger, pattern means, and spring means interposed between said lever and said pattern means, said lever being movable by said cams and by said pattern means and by said spring means, said pattern means positioning said lever to be free of said cams to place said yarn finger in its non-feeding position, said pattern means also positioning said lever to be acted upon by one of said cams, the said one of said cams acting to periodically place said yarn finger in non-feeding position at one of said pair of feeds and at the same time acting to energize said spring means to periodically return said yarn finger to its feeding position at said one of said pair of feeds, and said pattern means also positioning said lever to be acted upon by the other of said cams, the said other of said cams acting to periodically place said yarn finger in non-feeding position at the other of said pair of feeds and at the same time acting to energize said spring means to periodically return said yarn finger to its feeding position at the other of said pair of feeds.

10. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit a yarn thereon at the first and at the second of at least a pair of feeds, a yarn finger adapted to feed said yarn to said needle circle at each of said feeds, said yarn finger being actuated during each of a first series of needle circle reciprocations to periodically place said finger in feeding and in non-feeding positions at said first feed during said knitting of said yarn thereat, said finger also being actuated during each of a second series of needle circle reciprocations to periodically place said finger in feeding and in non-feeding positions at said second feed during said knitting of said yarn thereat, and pattern controlled means to so actuate said finger.

11. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit a yarn thereon at the first and at the second of at least a pair of feeds, a yarn finger adapted to feed said yarn to said needle circle at each of said feeds, a rotary member adapted to rotate once per needle circle reciprocation, said finger being actuated during each of a first series of rotations of said member to periodically place said finger in feeding and in non-feeding positions at said first feed during said knitting of said yarn thereat, said finger also being actuated during each of a second series of rotations of said member to periodically place said finger in feeding and in non-feeding positions at said second feed during said knitting of said yarn thereat, and pattern controlled means including an operative connection between said member and said finger whereby the former is adapted to so actuate the latter.

12. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit four yarns thereon at four circumferentially spaced feeds, four circumferentially spaced yarn fingers each adapted to feed one of said four yarns and arranged so that each adjacent pair of said fingers is adapted to feed its pair of yarns in alternation at one of said feeds, each such adjacent pair of said fingers being actuated during each of a series of successive needle circle reciprocations to alternately and periodically place the first and the second finger of each such adjacent pair thereof in feeding and in non-feeding positions during each reciprocation of said series thereof at the appropriate one of said feeds during said knitting thereat in such manner that when said first finger is in said feeding positions said second finger is in said non-feeding positions and vice versa, and pattern controlled means common to said fingers to so actuate the same.

13. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit four yarns thereon at four circumferentially spaced feeds, four circumferentially spaced yarn fingers each adapted to feed one of said four yarns and arranged so that one adjacent pair of said fingers is adapted to feed its pair of yarns in alternation at one feed of an opposite pair thereof while the other adjacent pair of said fingers is adapted to feed its pair of yarns in alternation at the other feed of said opposite pair thereof, each of the opposite pairs of said fingers being actuated in unison during each of a first series of needle circle reciprocations to alternately and periodically place each of said opposite pairs of fingers in feeding and in non-feeding positions at a first opposite pair of said feeds during said reciprocating knitting in such manner that when one of said opposite pairs of fingers is in said feeding positions the other of said opposite pairs of fingers is in said non-feeding positions and vice versa, each of said opposite pairs of said fingers also being actuated in unison during each of a second series of needle circle reciprocations to alternately and periodically place each of said opposite pairs of fingers in feeding and in non-feeding positions at the remaining opposite pair of said feeds during said reciprocating knitting in such manner that when one of said opposite pair of fingers is in feeding positions the other of said opposite pair of fingers is in said non-feeding positions and vice versa, and pattern controlled means common to said fingers to so actuate the same.

14. A circular knitting machine having a needle circle and having means to reciprocate said needle circle to knit four yarns thereon, a member adapted to rotate in timed relation to each needle circle reciprocation, four yarn fingers each adapted to feed one of said four yarns to said needle circle during said reciprocating knitting, each of said fingers being pivotally and operatively supported by said machine at one of four equally circumferentially spaced fixed locations thereon, the fingers of each opposite pair thereof being operatively related to be actuated in unison during each of a series of rotations of said member to alternately and periodically place said fingers of each of said opposite pairs thereof in feeding

and in non-feeding positions relative to said needle circle during said knitting thereon in such manner that when the fingers of one of said opposite pairs thereof are in said feeding positions the fingers of the other of said opposite pairs thereof are in said non-feeding positions and vice versa, and pattern controlled means common to said four fingers including an operative connection between said member and said fingers whereby the former is adapted to so actuate the latter, said means also placing said fingers in positions other than said described positions wherein they are idle relative to said needle circle.

15. A circular knitting machine having a needle circle and having means to reciprocate said needle circle to knit four yarns thereon at four circumferentially spaced feeds, a member adapted to rotate in timed relation to each needle circle reciprocation, four yarn guides each adapted to feed one of said four yarns to said needle circle during said reciprocating knitting, each of said fingers being pivotally and operatively supported by said machine at one of four equally circumferentially spaced fixed locations thereon, the fingers of each opposite pair thereof being operatively related to be actuated in unison during each of a series of rotations of said member to alternately and periodically place said fingers of each of said opposite pairs thereof in feeding and in non-feeding positions during said knitting at said four feeds in such manner that when the fingers of one of said opposite pairs thereof are in said feeding positions the fingers of the other of said opposite pairs thereof are in said non-feeding positions and vice versa, and pattern controlled means common to said four fingers including an operative connection between said member and said fingers whereby the former is adapted to so actuate the latter, said means also placing said fingers in positions other than said described positions thereof wherein they are idle relative to said feeds.

16. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit a first body yarn at the first of and a second body yarn at the second of at least a pair of circumferentially spaced feeds to form a corresponding pair of adjoining first and second diamond shaped body fabric areas having wales in common and having common suture joined edges extending at a first angle to their wales, a member adapted to rotate in timed relation to each needle circle reciprocation, a yarn finger adapted to feed a design yarn to said needle circle during said reciprocation thereof to permit the group of needles forming said common wales to knit said design yarn to incorporate the same in both of said areas during their formation, said finger being so arranged as to provide a first feeding disposition of said design yarn at said first feed and a second feeding disposition of said design yarn at said second feed, said finger being actuated during each of a first series of rotations of said member to periodically place said finger in feeding and in non-feeding positions at said second feeding disposition of said design yarn so that those of said group of needles which are to incorporate said design yarn in said first area may have said design yarn fed thereto during said formation of said first area at said first feed, said finger also being actuated during each of a second series of rotations of said member to periodically place said finger in feeding and in non-feeding positions at said first feeding disposition of said design yarn so that those of said group of needles which are to incorporate said design yarn in said second area may have said design yarn fed thereto during said formation of said second area at said second feed, said machine having pattern controlled means including an operative connection between said member and said finger whereby the former is adapted to so actaute the latter and to cause said group of needles to knit said design yarn independently of said body yarn knitting at said feeds to form a line of design stitches thereof incorporated in said common wales and extending uninterruptedly across said suture joined edges of said areas at a second angle to said wales to thereby provide an overplaid design of said design yarn in said areas.

17. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit a first body yarn at the first of and a second body yarn at the second of at least a pair of circumferentially spaced feeds to form a corresponding pair of adjoining first and second diamond shaped body fabric areas having wales in common and having common suture joined edges extending at a first angle to their wales, a member adapted to rotate in timed relation to each needle circle reciprocation, a yarn finger adapted to feed a design yarn to said needle circle during said reciprocation thereof to permit the group of needles forming said common wales to knit said design yarn to incorporate the same in both of said areas during their formation, said finger being so arranged as to provide a first feeding disposition of said design yarn relative to said first feed and a second feeding disposition of said design yarn relative to said second feed, said finger being actuated during each of a first series of rotations of said member to periodically place said finger in feeding and in non-feeding positions at said first feeding disposition of said design yarn so that those of said group of needles which are to incorporate said design yarn in said first area may have said design yarn fed thereto during said formation of said first area at said first feed, said finger also being actuated during each of a second series of rotations of said member to periodically place said finger in feeding and in non-feeding positions at said second feeding disposition of said design yarn so that those of said group of needles which are to incorporate said design yarn in said second area may have said design yarn fed thereto during said formation of said second area at said second feed, said machine having pattern controlled means including an operative connection between said member and said finger whereby the former is adapted to so actuate the latter and to cause said group of needles to knit said design yarn independently of said body yarn knitting at said feeds to form a line of design stitches thereof incorporated in said common wales and extending uninterruptedly across said suture joined edges of said areas at a second angle to said wales to thereby provide an overplaid design of said design yarn in said areas.

18. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit a first body yarn at the first of and a second body yarn at the second of at least a pair of circumferentially spaced feeds to form a corresponding pair of adjoining first and second diamond shaped body fabric areas having wales in common and having common suture joined edges extending at a first angle to their wales, a member adapted to rotate in timed relation to each needle circle reciprocation, a yarn finger adapted to feed a design yarn to said needle circle during said reciprocation thereof to permit the group of needles forming said common wales to knit said design yarn to incorporate the same in both of said areas during their formation, said finger being actuated during each of a first series of rotations of said member to periodically place said design yarn in feeding and in non-feeding positions relative to said needle circle so that those of said group of needles which are to incorporate said design yarn in said first area may have said design yarn fed thereto during said formation of said first area at said first feed, said finger also being actuated during each of a second series of rotations of said member to periodically place said design yarn in feeding and in non-feeding positions relative to said needle circle so that those of said group of needles which are to incorporate said design yarn in said second area may have said design yarn fed thereto during said formation of said second area at said second feed, said machine having pattern controlled means including an operative connection between said member and said finger whereby

the former is adapted to so actuate the latter and to cause said group of needles to knit said design yarn independently of said body yarn knitting at said feeds to form a line of design stitches thereof incorporated in said common wales and extending uninterruptedly across said suture joined edges of said areas at a second angle to said wales to thereby provide an overplaid design of said design yarn in said areas, said means also placing said finger in a position other than said described positions thereof wherein it is idle relative to said needle circle.

19. A circular knitting machine having a circle of needles and having means to reciprocate said needle circle to knit a first and a second body yarn thereon to form a corresponding pair of adjoining first and second diamond shaped body fabric areas having wales in common and having common suture joined edges extending at a first angle to their wales, a member adapted to rotate in timed relation to each needle circle reciprocation, a yarn finger adapted to feed a design yarn to said needle circle during said reciprocation thereof to permit the group of needles forming said common wales to knit said design yarn to incorporate the same in both of said areas during their formation, said finger being actuated during each of a first series of rotations of said member to periodically place said design yarn in feeding and in non-feeding positions relative to said needle circle so that those of said group of needles which are to incorporate said design yarn in said first area may have said design yarn fed thereto during said formation of said first area, said finger also being actuated during each of a second series of rotations of said member to periodically place said design yarn in feeding and in non-feeding positions relative to said needle circle so that those of said group of needles which are to incorporate said design yarn in said second area may have said design yarn fed thereto during said formation of said second area, said machine having pattern controlled means including an operative connection between said member and said finger whereby the former is adapted to so actuate the latter and to cause said group of needles to knit said design yarn independently of said body yarn knitting to form a line of design stitches thereof incorporated in said common wales and extending uninterruptedly across said suture joined edges of said areas at a second angle to said wales to thereby provide an overplaid design of said design yarn in said areas.

20. A circular knitting machine as set forth in claim 19 wherein said means is adapted to place said finger in a position other than said described positions wherein it is idle relative to said needle circle.

21. A circular knitting machine 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 diamond shaped body fabric areas having common suture joined edges extending angularly to their wales in four separate walewise extending zig-zag suture lines wherein those of said areas formed at each adjacent pair of said feeds have a group of common wales formed on a related group of needles, there being four of such common wale and related needle groups, four yarn fingers each adapted to feed a design yarn to one of said four needle groups to permit each of said needle groups to knit one of said design yarns to incorporate the same in each of the areas with which each such needle group is related, each of said fingers being pivotally and operatively supported by said machine at one of four equally circumferentially spaced fixed locations thereon, a member adapted to rotate in timed relation to each needle circle reciprocation, the fingers of each opposite pair of said four fingers being operatively related to be actuated in unison during each of a series of rotations of said member to alternately and periodically place said fingers of each of said opposite pairs thereof in feeding and in non-feeding positions at said feeds during the formation of said areas in such manner that when the fingers of one of said opposite pairs thereof are in said feeding positions the fingers of the other of said opposite pairs thereof are in said non-feeding positions and vice versa, said machine having pattern controlled means common to said four fingers including an operative connection between said member and said fingers whereby the former is adapted to so actuate the latter and to cause said four design yarns to be knit independently of said body yarn knitting at said four feeds to form four separate walewise extending zig-zag lines of design stitches of said four design yarns, the said zig-zag suture and design lines being so disposed that each straight line portion of each of said lines of design stitches extends uninterruptedly across the suture joined edges of an adjoining pair of said areas angularly to their wales and is incorporated therein in said common wales thereto to thereby provide a four yarn type of overplaid design for said tubular fabric, said means also placing said fingers in positions other than said described positions thereof wherein they are idle relative to said feeds.

22. A circular knitting machine 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 diamond shaped body fabric areas having common suture joined edges extending angularly to their wales in four separate walewise extending zig-zag suture lines wherein those of said areas formed at each adjacent pair of said feeds have a group of common wales formed on a related group of needles there being four of such common wale and related needle groups, four circumferentially spaced yarn fingers each adapted to feed a design yarn to one of said four needle groups to permit each of said needle groups to knit one of said design yarns to incorporate the same in each of the areas with which each such needle group is related, a member adapted to rotate in timed relation to each needle circle reciprocation, the fingers of each opposite pair of said four fingers being operatively related to be actuated in unison during each of a series of rotations of said member to alternately and periodically place said fingers of each of said opposite pairs thereof in feeding and in non-feeding positions at said feeds during the formation of said areas in such manner that when the fingers of one of said opposite pairs thereof are in said feeding positions the fingers of the other of said opposite pairs thereof are in said non-feeding positions and vice versa, said machine having pattern controlled means common to said four fingers including an operative connection between said member and said fingers whereby the former is adapted to so actuate the latter and to cause said four design yarns to be knit independently of said body yarn knitting at said four feeds to form four separate walewise extending zig-zag lines of design stitches of said four design yarns, the said zig-zag suture and design lines being so disposed that each straight line portion of each of said lines of design stitches extends uninterruptedly across the suture joined edges of an adjoining pair of said areas angularly to their wales and is incorporated therein in said wales common thereto to thereby provide a four yarn type of overplaid design for said tubular fabric.

23. A circular knitting machine having a needle circle 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 diamond shaped body fabric areas having common suture joined edges extending angularly to their wales in four separate walewise extending zig-zag suture lines wherein those of said areas formed at each adjacent pair of said feeds have a group of common wales formed on a related group of needles there being four such common wale and related needle groups, four circumferentially spaced yarn fingers each adapted to feed a design yarn to one of said four needle groups to permit each of said

needle groups to knit one of said design yarns to incorporate the same in each of the areas with which each such needle group is related, the fingers of each opposite pair of said four fingers being operatively related to be actuated in unison during each of a series of needle circle reciprocations to alternately and periodically place said fingers of each of said opposite pairs thereof in feeding and in non-feeding positions at said feeds during the formation of said areas in such manner that when the fingers of one of said opposite pairs thereof are in said feeding positions the fingers of the other of said opposite pairs thereof are in said non-feeding positions and vice versa, said machine having pattern controlled means common to said four fingers to so actuate the same and to cause said four design yarns to be knit independently of said body yarn knitting at said four feeds to form four separate walewise extending zig-zag lines of design stitches of said four design yarns, the said zig-zag suture and design lines being so disposed that each straight line portion of each of said lines of design stitches extends uninterruptedly across the suiture joined edges of an adjoining pair of said areas angularly to their wales and is incorporated therein in said wales common thereto to thereby provide a four yarn type of overplaid design for said tubular fabric.

24. A circular knitting machine having a needle circle and having means to reciprocate said needle circle to knit body yarn thereon to provide tubular fabric formed of a plurality of adjoining diamond shaped body fabric areas having common suture joined edges extending angularly to their wales in four separate walewise extending zig-zag suture lines wherein those of said areas joined by each of said zig-zag suture lines have a group of common wales formed on a related group of needles there being four of such common wale and related needle groups, four circumferentially spaced yarn fingers each adapted to feed a design yarn to one of said four needle groups to permit each of said needle groups to knit one of said design yarns

to incorporate the same in each of the areas with which each such needle group is related, the fingers of each opposite pair of said four fingers being operatively related to be actuated in unison during each of a series of needle circle reciprocations to alternately and periodically place said fingers of each of said opposite pairs thereof in feeding and in non-feeding positions during the formation of said areas in such manner that when the fingers of one of said opposite pairs thereof are in said feeding positions the fingers of the other of said opposite pairs thereof are in said non-feeding positions and vice versa, said machine having pattern controlled means common to said four fingers to so actuate the same and to cause said four design yarns to be knit independently of said body yarn knitting to form four separate walewise extending zig-zag lines of design stitches of said four design yarns, each of said zig-zag suture and design lines being so disposed that each straight line portion of each of said lines of design stitches extends uninterruptedly across the suture joined edges of an adjoining pair of said areas angularly to their wales and is incorporated therein in said wales common thereto to thereby provide a four yarn type of overplaid design for said tubular fabric.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 23,929	Green	Jan. 25, 1955
2,217,022	Lawson et al.	Oct. 8, 1940
2,235,726	Pass	Mar. 18, 1941
2,680,961	Thurston	June 15, 1954
2,775,880	Philip	Jan. 1, 1957
2,919,565	Levin	Jan. 5, 1960
2,924,956	Levin	Feb. 16, 1960

FOREIGN PATENTS

308,421	Great Britain	Mar. 28, 1929