(12) UK Patent Application (19) GB (11) 2 065 723 A

(21) Application No 8037325
(22) Date of filing 20 Nov 1980
(30) Priority data
(31) 102453
(32) 11 Dec 1979
(33) United States of America (US)
(43) Application published 1 Jul 1981
(51) INT CL³ D04B 15/48
(52) Domestic classification D1C 17
(56) Documents cited None
(58) Field of search D1C
(71) Applicants Stevcoknit, Inc., 1450 Broadway, New York, New York 10018, United States of America
(72) Inventors John Christopoulos, Burt Diamond, Dennis E. Poloff
(74) Agents Potts, Kerr & Co., 15 Hamilton Square, Birkenhead, Merseyside, L41 6BR

(54) **Self actuating yarn feed and drive belt arrangement for circular knitting machines**

(57) This invention relates to a self actuating, positive yarn feed device for use in conjunction with circular knitting machines allowing either uniform or non-uniform intermittent positive feed of yarn during the knitting operation. This invention also relates to a drive arrangement in conjunction with the positive yarn feed device that utilizes a plurality of separately controllable drive belts. The present invention utilizes a feed wheel continuously rotated by one of the plurality of drive belts. The feed wheel has both high and low friction surfaces to provide positive feed of yarn in a manner that is responsive to actual demand. The present invention can be utilized on circular knitting machines having striper boxes, pattern wheels or other conventional devices requiring non-uniform or intermittent yarn feed as well as on machines requiring uniform feed of yarn during the knitting operation.

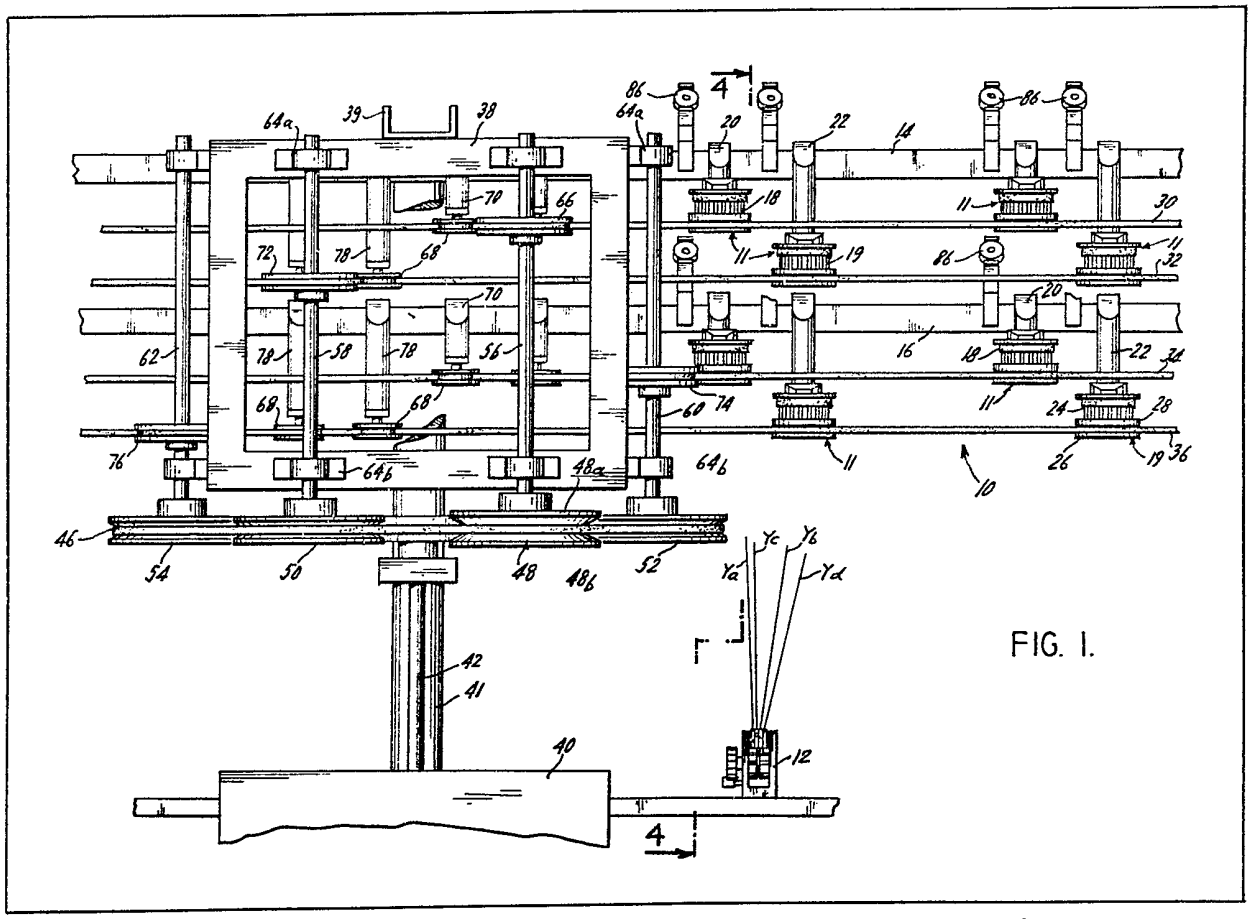


FIG. 1.

GB 2 065 723 A

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

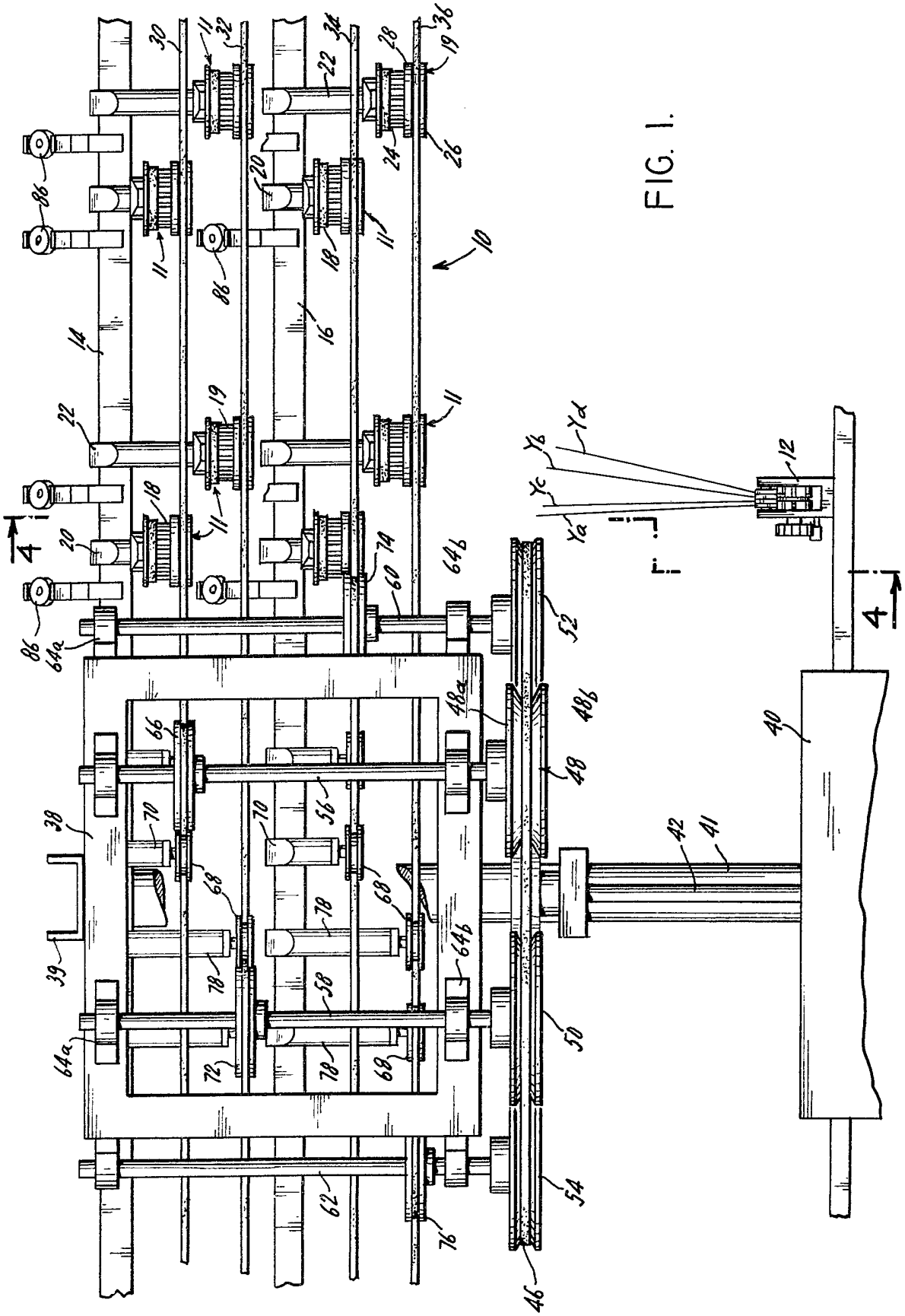
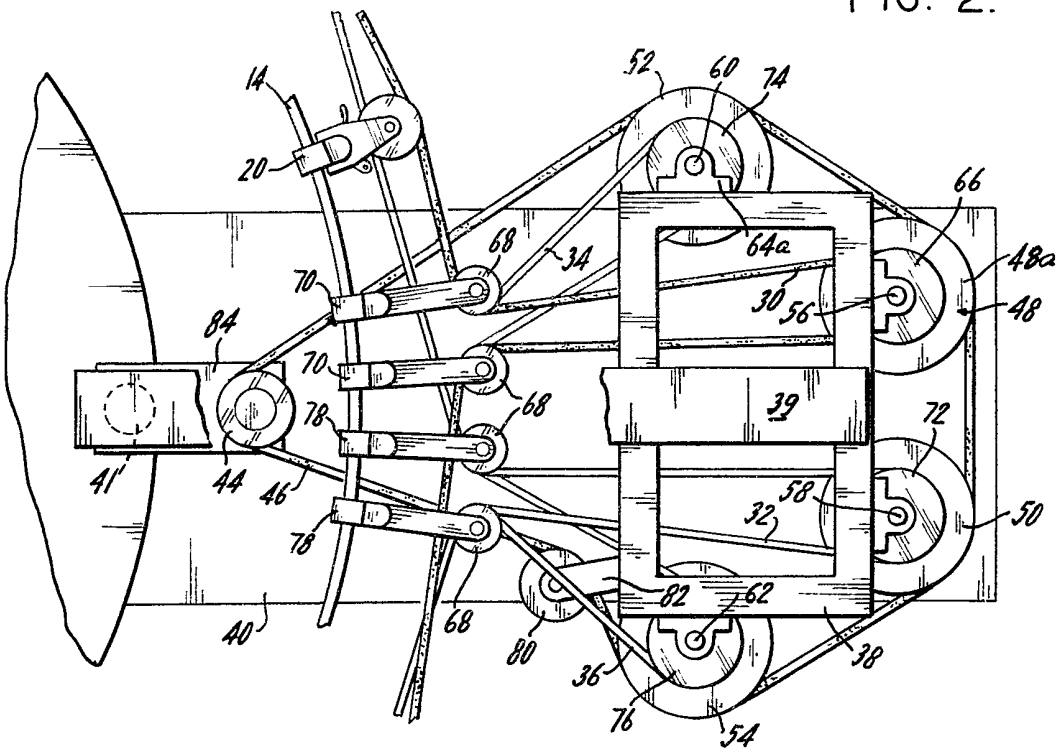

10
11
12
14
16
18
19
20
22
24
26
28
30
32
34
36
38
39
40
41
42
46
48
48a
48b
50
52
54
56
58
60
62
64a
64b
66
68
70
72
74
76
78
80
82
84
86
88
Ya
Yb
Yc
Yd
4
4

FIG. 1.

FIG. 2.


14
20
52
60
74
66
64a
48a
48
30
56
68
34
70
84
70
68
39
72
78
41
44
46
78
58
32
50
68
40
80
82
62
36
38
76
54

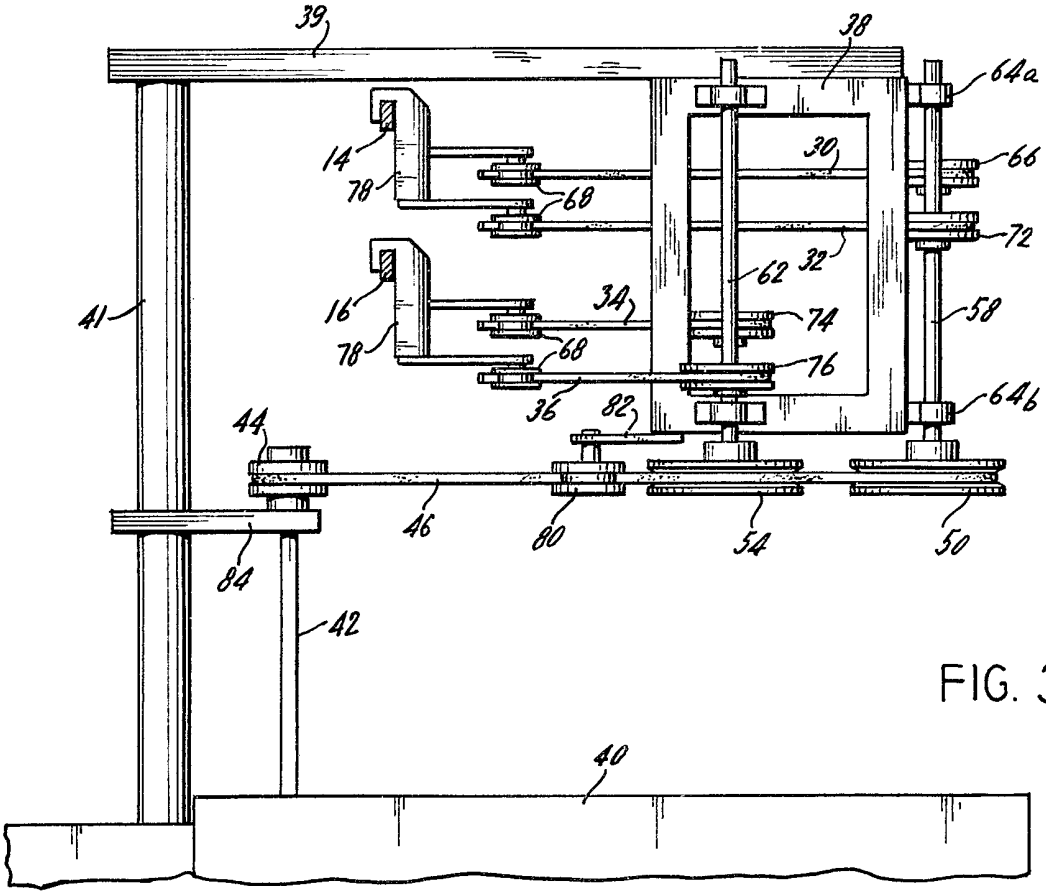

39
38
64a
14
78
30
66
68
72
32
62
16
34
74
58
41
78
68
76
36
82
64b
44
46
80
54
50
84
42
40

FIG. 3.

FIG. 4.

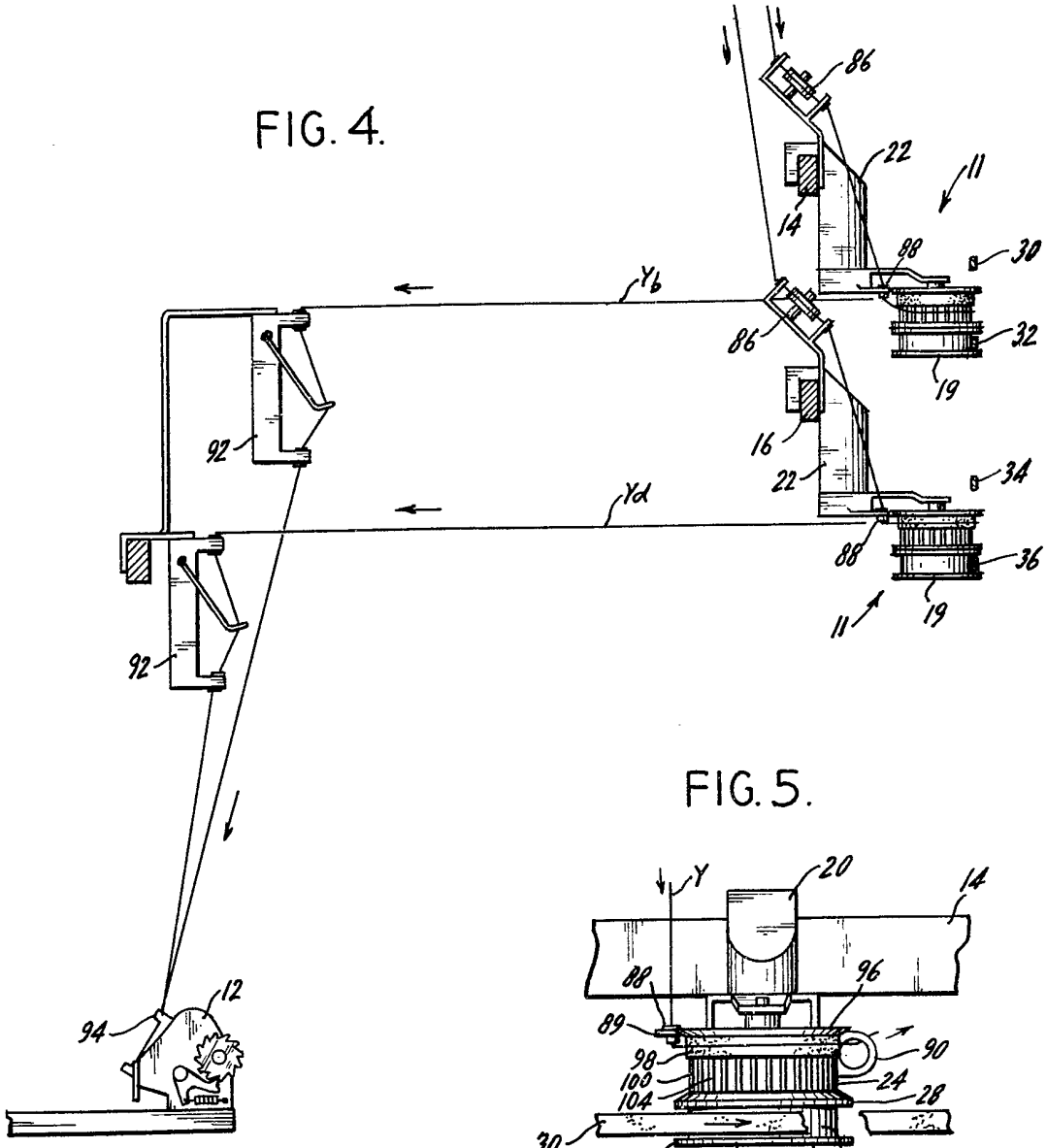


FIG. 5.

FIG. 6.

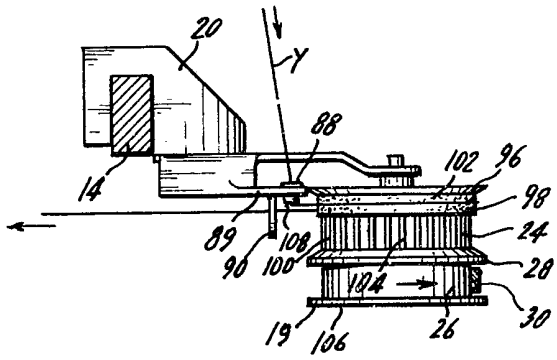
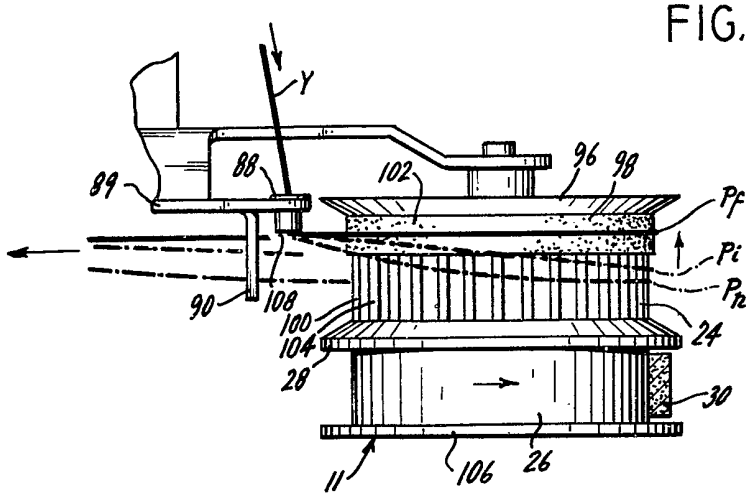


FIG. 7.



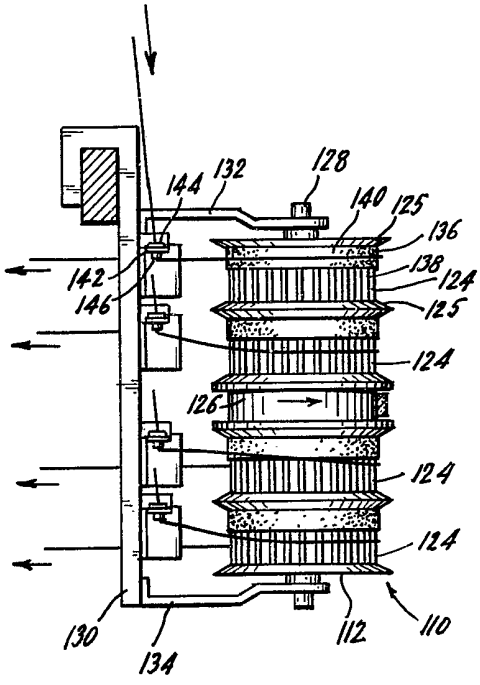


FIG. 8.

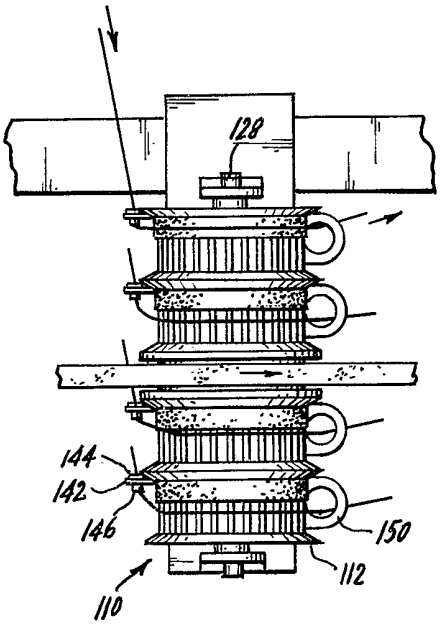


FIG. 9.

SPECIFICATION

Self actuating yarn feed and drive belt arrangement for circular knitting machines

The present invention relates to yarn feed devices for use in conjunction with circular knitting machines and to drive means for such yarn feed devices. More particularly, the invention is directed to a self actuating yarn feed device for use in conjunction with a circular knitting machine requiring uniform or non-uniform rates of delivery of yarn to the various feeds or in conjunction with the knitting machine having striping boxes or similar means requiring selective, intermittent delivery of particular yarns during the knitting operation. The yarn feed device utilizes a feed wheel having an outer cylindrical surface that is divided into an upper high friction yarn advancing portion and a bottom, low friction yarn idling portion. Additionally, the present invention relates to a means of driving the yarn feed device incorporating a series of belts, each operable at a different speed for precisely feeding the appropriate quantity of a particular yarn to the associated yarn feed in the knitting area of the machine.

Positive yarn feed devices are well known in the knitting art. For example, the device disclosed in U.S. Patent No. 3,090,215 provides a positive yarn feed by the use of a feed wheel or roller associated with each yarn cone. A plurality of feed wheels are arranged in a circular array adjacent the yarn cones, and each feed wheel is powered by a rotating flat tape contacting the circumferential surface of the feed roller. Positive feed of the yarn is accomplished by passing the yarn between the outer cylindrical surface of the feed wheel and the inside surface of the flat tape. This device, however, does not have a provision for stopping a particular yarn feed and adds substantial difficulty to the initial set-up of the machine or the restart of a machine after there has been a pressoff. Most significantly, such device cannot be utilized on knitting machines having pattern wheels or striping boxes requiring non-uniform or intermittent yarn feed.

Improved yarn feed devices such as those disclosed in U.S. Patent Nos. 3,802,228; 3,418,831; 3,950,966 and 4,043,155 attempted to overcome the difficulties discussed above. The 3,802,228 patent discloses a positive yarn feed device that can be moved manually to an out-of-action position to allow the knitting machine to be set up or to manually by-pass certain feed devices at the appropriate intervals during the knitting operation. The device of the 3,651,668 patent also provides positive feed of yarn and contains provisions for directing the yarn to a non-feed position. However, there are no provisions for automatic operation between the feed and the non-feed position in either device.

The device disclosed in the 3,418,831 patent uses mechanical or electrical means to automatically operate the positive feed feature. However, both the electrical and the mechanical embodiments of this device are complex utilizing yarn guide brackets movable from a first yarn idling position to a second yarn advancing position, to direct the yarn between the surface of the feed wheel and the flat tape at the appropriate time.

The devices of U.S. Patent Nos. 3,950,966 and 4,043,155 utilize the combination of a weighted arm and friction devices on the yarn itself to move the yarn from a feed to a non-feed position. Such devices, however, require substantial time to set up as both the amount of friction and the position of the counterweights must be precisely adjusted on each individual yarn feed. During operation of the knitting machine, when yarn is drawn off the cones the tension and the surface friction of the yarn entering the feed device may vary thereby requiring readjustment of both the counterweights and the friction devices for continued proper operation. Otherwise, there may be overfeed of yarn or "hunting" of the weighted arm resulting in failure of the positive feed device to remain fully activated.

Although the devices of the 3,950,966 and 4,043,155 patents direct the yarn between the cylindrical surface of the feed wheel and the tape when in the feed position, there is a commercially available feed device incorporating a feed wheel having high and low friction portions of its cylindrical surface. However, such device uses a spring controlled arm to move the yarn from the feed to the non-feed position. Such device is unsatisfactory for the same reasons as the devices disclosed in patent Nos. 3,950,966 and 4,043,155. These devices all utilize preset and constant parameters (e.g., the force exerted by a counterbalance or a spring; friction on the surface of yarn) to respond to variations inherent in the knitting process such as tension on the yarn wound on the cone or non-uniformity of the surface of yarns.

Yarn feed drive means utilizing drive belts in various planes corresponding to the heights of the various feed wheels are known. However, such devices utilize either a plurality of drive belts driven at the same respective circumferential speeds, as in U.S. Patent No. 3,785,176, or utilize relatively complex and expensive driving wheels having variable circumferences against which the flat tape rotates, as in U.S. Patent No. 3,243,091.

Broadly, it is an object of the present invention to provide an improved apparatus for positive feed of yarn which eliminates one or more of the aforesaid shortcomings of the prior art.

Specifically, it is within the contemplation of the present invention to provide improved positive yarn feeding apparatus which incorporates a plurality of feed wheels. Each feed wheel has an outer cylindrical surface, the top portion of which is covered with a high friction material and the bottom portion of which is of low friction material, such as polished steel. A fixed yarn inlet guide directs the yarn along the top, high friction surface of the feed wheel. When tension is placed upon

the yarn as a result of demand for yarn by the needles, the high friction surface of the rotating feed wheel draws yarn at the appropriate speed. The feed wheel is caused to rotate by one of two or more drive belts each of which are located in a different horizontal plane. Each drive belt can be rotated at a different circumferential speed relative to the other drive belts by virtue of the drive means assembly of the present invention.

It is a primary object of the present invention to provide a yarn feed apparatus that is capable of responding substantially instantaneously to both demand and non-demand of yarn.

It is a further object of the present invention to provide a yarn feed apparatus that is self actuating yet can be used in conjunction with knitting machines requiring uniform, non-uniform or intermittent yarn feed in conjunction with pattern wheels, striper boxes or the like without requiring modifications to the yarn feed structure.

It is a further object of the present invention to provide a yarn feed device which has few moving parts and requires little or no adjustment for different yarns.

It is a further object of the present invention to provide a yarn feed device that is self-actuating and need not be manually moved from the non-feed to the feed position or from the feed to the non-feed position in order to set up the machine or to restart the machine after a yarn breaks thereby resulting in higher production from each machine.

It is a further object of the present invention to provide a yarn feed apparatus that can be easily fit on existing knitting machines.

It is a further object of the present invention to provide a yarn feed apparatus that can supply different selections of yarn at different respective speeds of feed relative to the other yarns.

It is a still further object of the present invention to provide a means of varying the speed of either one or more yarns utilizing readily available economical components such as a variable speed V-belt pulley.

In accordance with an illustrative embodiment demonstrating objects and features of the present invention, there is provided a positive yarn feed device for a knitting machine comprising a mounting frame, a feed wheel mounted on said frame for rotation about a vertical axis. The feed wheel has an outer cylindrical surface that is divided into an upper segment and a lower segment by a medial plane perpendicular to the vertical axis. The upper segment of the cylindrical surface has a relatively high friction surface and the lower segment has a relatively low friction surface. Means are provided for rotating the feed wheel. A fixed yarn guide means is mounted on the frame in operative relationship to the feed wheel and a yarn inlet guide is mounted in the fixed yarn guide means. The yarn inlet guide has a bottom exit surface defining an exit plane which is above the medial plane of the roller whereby yarn exiting from the yarn inlet guide in the fixed yarn guide means is delivered to the upper segment of the feed wheel.

The present invention also provides drive means for the plurality of positive yarn feed devices on a knitting machine having multiple feeds which comprises a support frame and a first plurality of yarn feed wheels rotatably mounted on a bracket attached to the support frame in a first common horizontal plane. A second plurality of feed wheels are rotatably mounted on a bracket attached to the support frame in a second common horizontal plane. A first drive means is associated with the first plurality of yarn feed wheels and a second drive means associated with the second plurality of yarn feed wheels. Means for propelling the first drive means and the second drive means comprise a drive frame having a first vertical shaft rotatably mounted in the drive frame with the first variable speed driven pulley journaled at one end thereof and an output pulley journaled at the other end wherein the output pulley rotates in the first, common horizontal plane responsive to rotation of the first variable speed driven pully. A second vertical shaft is rotatably mounted in the drive frame having a second variable speed driven pulley journaled at one end thereof in a plane common to the first variable speed driven pulley and an output pulley journaled at the second end wherein the output pulley rotates in the second common horizontal plane responsive to rotation of the second variable speed driven pulley. The drive shaft and a drive pulley journaled to the drive shaft in a plane common to the first and second variable speed driven pulleys are provided along with means for connecting the drive pulley to the first and second variable speed driven pulley. Means are provided for rotating the drive shaft.

The above brief description, as well as further objects, features and advantages of the present invention, will be more fully appreciated by reference to the following detailed description of the presently preferred, illustrative embodiment according to the present invention, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevational view of the improved yarn feed drive means of the present invention, shown in conjunction with a portion of a circular knitting machine, wherein some components of the machine are shown schematically;

FIG. 2 is a plan view of the drive portion of the machine, with portions of the support structure cut away for clarity;

FIG. 3 is a side elevational view taken from the left of FIG. 1, with portions of the circular knitting machine broken away;

FIG. 4 is a sectional view taken substantially along the line 4—4 of FIG. 1 in the direction of the arrows showing the relative position of the feed wheel assemblies and a striper box.

FIG. 5 is an end elevational view showing the details of a feed wheel assembly of the present invention;

FIG. 6 is a side elevational view of the feed wheel taken from the left of FIG. 5;

FIG. 7 is a side elevational view of the feed

wheel assembly of the present invention in a larger scale showing the position of the yarn on the feed wheel in the various conditions;

FIG. 8 is a side elevational view of an alternate embodiment of a feed wheel assembly of the present invention; and,

FIG. 9 is an end elevational view of the alternate embodiment of FIG. 8.

Referring now to the drawings and specifically to FIG. 1, there is provided an improved yarn feed device in accordance with the present invention for use in conjunction with a circular knitting machine. The preferred embodiment of the present invention is shown in conjunction with a knitting machine utilizing a striper box 12 and four alternately fed yarns Ya, Yb, Yc and Yd at each striper box. A typical machine may contain thirty two (32) striper boxes and one hundred and twenty eight (128) yarns and associated yarn feed assemblies. The present invention contains provisions whereby the speed at which each of the yarns is fed can be varied relative to the other yarns to compensate for variations in the yarn or the yarn supply requirements of a particular pattern.

The yarn feed structure 10 of the present invention includes a plurality of feed wheel assemblies 11 mounted from fixed rings 14, 16 supported above the primary knitting elements (not shown) of a circular knitting machine, and typically beneath the cones of yarn (also not shown). In the conventional manner, a striper box 12 is associated with each feed, and where the striper box 12 utilizes four different colored yarns Ya, Yb, Yc and Yd, each yarn is advanced by a separate feed wheel assembly 11. In order to facilitate the installation of four feed wheel assemblies 11 each feed wheel assembly is suspended from either fixed ring 14 or 16 by alternating short brackets 20 and long brackets 22. Each feed wheel assembly is comprised of a feed wheel or roller 18, 19 rotatably mounted from short and long brackets 20, 22, respectively. The other components comprising the feed wheel assembly 11 are discussed more fully below with reference to FIGS. 4 through 7.

A plurality of feed wheels 18 suspended from short brackets 20 mounted on fixed ring 14 around the circumference of fixed ring 14 define a first horizontal plane of rotation, and the plurality of feed wheels 19 suspended from long brackets 22 mounted on the fixed ring 14 define a second horizontal plane of rotation below the first horizontal plane of rotation. Similarly, the plurality of feed wheels 18 suspended from the short brackets 20 mounted on the fixed ring 16 define a third horizontal plane of rotation below the second horizontal plane of rotation and the plurality of feed wheels 19 suspended from the long brackets 22 mounted on the fixed rings 16 define a fourth horizontal plane of rotation below the third horizontal plane of rotation.

Each feed wheel 18, 19 is separated into an upper yarn engaging portion 24 and a lower driving portion 26 by a central flange 28. A first feed belt 30 extends around the circumference of fixed ring 14 in engagement with the surface of lower driving portion 26 of each feed wheel 18 mounted from fixed ring 14 in the first horizontal plane of rotation. A second feed belt 32 engages the surface of the corresponding lower driving portion 26 of feed wheels 19 extending from fixed rings 14 in the second horizontal plane of rotation. In a similar manner, a third feed belt 34 engages the surface of lower driving portion 26 of feed wheels 18 extending from fixed ring 16 and a fourth feed belt 36 engages the circumference of lower driving portion 26 of feed wheels 19 extending from fixed ring 16 in the third and fourth horizontal planes of rotation, respectively. Feed belts 30, 32, 34, 36 are shown to be of flat belt construction, although it should be understood that feed belts of any suitable construction such as "V" belts, round belts and the like can be utilized. In fact, as more fully described below, substantially any type of flexible drive means including chains, notched belts and the like can be utilized in conjunction with the feed wheel assemblies 11 without departing from the scope of the present invention. Since the feed belt does not come into contact with the yarn, it is even possible to use a chain or other drive belt requiring lubrication since the lubricant would not contaminate the yarn. Even more significantly, the same feed belt can be used to drive feed wheels furnishing yarns of different color or fiber without the feed belt contaminating the different yarns since the feed belt, at no time contacts the yarn.

Referring to FIGS. 2 and 3, there is provided a drive frame 38 cantilevered radially outward from the center of the circular knitting machine by an upper main support 39 mounted to support column 41, generally in the area of the circular knitting machine drive motor housing 40. Main drive shaft 42 extends upwardly from drive motor housing 40 and is rotated by a variable speed drive (not shown). Main drive pulley 44 is journaled to main drive shaft 42 and main drive belt 46, which is of a "V" belt construction in the preferred embodiment, is rotated by main drive pulley 44. Main drive belt 46 couples main drive pulley 44 to a quartet of variable pulleys, each of which is associated with means for driving the first, second, third and fourth feed belts 30, 32, 34, 36, respectively. The first, second, third, and fourth variable pulleys 48, 50, 52, 54 are each mounted to one end of corresponding jack shafts 56, 58, 60 and 62 in a plane of rotation common to the plane of rotation of main drive pulley 44. Each jack shaft is suspended in a substantially vertical orientation by upper and lower bearing assemblies 64a, 64b mounted to drive frame 38.

In accordance with the present invention, each feed belt 30, 32, 34 and 36 can be driven at a different peripheral speed relative to the other belts.

For the sake of illustration, the rotation of first feed belt 30 will be described. Main drive pulley 44 is connected to the first variable pulley 48 by the main drive belt 46. First variable pulley 48 is

journaled to one end of the first jack shaft 56 and the first feed belt pulley 66 is located along the length of first jack shaft 56 and journaled thereto at the height of the first horizontal plane of rotation. A pair of idler pulleys 68, 68, are rotatably mounted from idler brackets 70, 70 extending from fixed ring 14. In order to change the speed of rotation of first feed belt 30 relative to the speed of rotation of main drive shaft 42, upper and lower flanges 48a and 48b of first variable pulley 48 are moved axially relative to each other, thereby changing the radial distance at which the main drive belt 46 engages the first variable pulley 48. When flanges 48a and 48b are moved closer together, the effective diameter of first variable pulley 48 is increased resulting in a decrease speed of rotation of first jack shaft 56 relative to main drive shaft 42. Conversely, by moving flanges 48a and 48b further apart, main drive belt 46 engages first variable pulley 48 at a shorter rate of distance resulting in higher speed of rotation of first jack shaft 56 and corresponding increase in the perpendicular speed of first feed belt 30.

Second jack shaft 58 contains second variable pulley 50 and second feed belt pulley 72 journaled thereto. Second drive belt pulley 72 is located axially along the length of second jack shaft 58 in the second horizontal plane of rotation in substantial alignment with the lower driving portion 26 of feed wheels 19 extending from long brackets 22 mounted on fixed ring 14. Second feed belt 32 is directed over idler pulleys 68 rotatably mounted from low brackets 78 extending from fixed ring 14. The third jackshaft 60 contains corresponding third variable pulley 52 and third feed belt pulley 74 axially located in the third horizontal plane of rotation; and fourth jack shaft 62 contains fourth variable pulley 54 and fourth feed belt pulley 76 axially located in the fourth horizontal plane of rotation. Proper tension is maintained on third and fourth feed belts 34, 36 by idler pulleys 68, 68 mounted to either high bracket 70 or low bracket 78 suspended from fixed ring 16.

As described above with specific reference to first jack shaft 56 and its associated first variable pulley 48 and first feed belt pulley 66, each of the second, third and fourth variable pulleys 50, 52, 54 are likewise adjustable by axial movement of their respective flanges. Drive belt idler pulley 80 is rotatably mounted on swing arm 82 extending from the bottom of drive frame 38 whereby the position of drive belt idler pulley 80 can be varied to maintain the proper tension on main drive belt 46 to assure that there will be no slippage. The substantially vertical position of main drive shaft 42 is maintained by support collar 84 extending substantially horizontally from support column 41.

The present invention allows each plurality of feed wheel assemblies 11 corresponding to a particular yarn to be fed at constant rates of feed different than the rates of feed of the other pluralities of yarn feed wheels due primarily to stitch construction. This feature is also advantageous when there are differences in the respective yarns due to different dyes, finishes, size and fiber types.

The construction of the drive frame assembly of the present invention enables this invention to be utilized on a large variety of circular knitting machines from the coarser eight cut machines to the finer thirty-two cut machines without substantial modification. Further, the drive assembly utilizes readily available parts which, with the exception of the variable pulleys, are commonly used in the knitting industry. By virtue of the wide range of adjustments possible with the variable pulleys, the present invention can be used in conjunction with machines set up for substantially any type of stitch such as looping stitches requiring more yarn, or tight stitches requiring the feed of substantially less yarn.

The self actuating positive yarn feed aspect of the present invention is best shown by reference to FIGS. 4 through 7. In particular, FIG. 4 shows a pair of feed wheel assemblies 11 each comprising a feed wheel 19, rotatably mounted from a long bracket 22, mounted on fixed rings 14, 16. In operation, yarn Yb is directed to the top feed wheel assembly 11 mounted to a fixed ring 14 from a yarn storage cone (not shown) through a conventional friction device 86. However, in the present invention pre-friction is not critical. Yarn Yb is next led through yarn inlet guide 88 mounted in a fixed yarn guide 89 and wrapped around the cylindrical surface of upper yarn engaging portion 24 of feed wheel 19. Yarn Yb exits from the feed wheel assembly 11 through the yarn outlet guide 90 (best shown in FIG. 5), is passed through to a conventional stop motion assembly 92, and is fed to an appropriate yarn finger 94 within striper box 12.

The lower feed wheel assembly 11, suspended from fixed ring 16, is used to feed yarn Yd from the yarn cone to the appropriate yarn finger 94 in striper box 12. As is more fully described below, upper feed wheel assembly 11 is shown with the yarn Yb in the non-feed position, while lower feed wheel assembly 11 is in the feed position with yarn Yd being caused to advance by contact with the upper yarn engaging portion 24 of feed wheel 19. In such case, yarn finger 94d is activated to allow knitting of yarn Yd.

Feed wheel 18 rotatably mounted from short bracket 20 is shown in enlarged scale in FIG. 5. For clarity, short bracket 20 will be described as being mounted to a segment of fixed ring 14 so that the feed wheel assembly 11 is driven by first feed belt 30. It should be understood that FIG. 5 could also refer to a feed wheel assembly 11 suspended from fixed ring 16 and driven by third feed belt 34.

As shown in FIG. 5, feed wheel 18 is constructed of upper yarn engaging portion 24 and lower driving portion 26 separated by central flange 28. The upper yarn engaging portion 24 of feed wheel 18 is defined by the central flange 28 and top flange 96 of feed wheel 18. In accordance with the present invention, upper yarn engaging

portion 24 is further divided into a yarn drive surface 98 and a yarn idle surface 100 on each side of a medial plane through the upper yarn engaging portion 24 perpendicular to the axis of rotation of feed wheel 18. The yarn drive surface 98 contains a relatively high friction material for example, a band of rubber 102 such as Silicone, butyl, neoprene and the like. The friction between the high friction surface and yarn Y causes yarn Y to be drawn at a linear speed substantially identical to the circumferential speed of the rotating feed wheel 18. Yarn idle surface 100 of upper yarn engaging portion 24 of feed wheel 18 is constructed of a material having a low coefficient friction such as polished metal rods 104 or a smooth, polished cylindrical surface. When the yarn Y is in contact with yarn idle surface 100 of feed wheel 18, 19, the low friction between the yarn and the yarn idle surface allows the yarn to remain in contact with the rotating feed wheel without having the yarn advance.

Lower driving portion 26 of feed wheel 18 is defined by the central flange 28 and the bottom flange 106 of feed wheel 18. The cylindrical surface of lower driving portion 26 is adapted to be engaged by first feed tape 30 contacting a portion of the circumference of lower driving portion 26. The circumferential speed of the surface of the rotating feed wheel 18 is substantially equal to the peripheral speed of rotation of first feed tape 30.

In accordance with the present invention, yarn inlet guide 88 mounted in the fixed yarn guide 89 has a bottom exit surface 108 which defines a substantially horizontal exit plane. The exit plane is above the medial plane dividing the upper yarn engaging portion 24 of feed wheel 18 into the yarn drive surface 98 and the yarn idle surface 100. In such case, the yarn Y, when driven by the feed wheel assembly 11 exits from the yarn inlet guide 88 in an orientation substantially coplanar to the exit plane. As shown in FIG. 6 as the feed wheel 18 is caused to rotate in the direction shown by the arrow, yarn Y is drawn through yarn inlet guide 88 across bottom exit surface 108 and onto the forming yarn drive surface 98 of upper yarn engaging portion 24 of feed wheel 18. As feed wheel 18 continues to rotate, the yarn is fed in the direction shown by the arrows.

FIG. 7 depicts yarn Y in the feed position Pf, the non-feed position Pn and an intermediate position Pi. In normal operation, yarn Y at each feed wheel assembly 11 is either in the feed position Pf or the non-feed position Pn. The intermediate orientation Pi is assumed for a short period of time while the yarn Y is traveling from the non-feed position Pn to the feed position Pf. Specifically, when yarn Y is called for by the appropriate yarn finger in a striper box or by the needles responsive to the operation of a pattern wheel, cam or similar device, tension is applied to yarn Y thereby tightening yarn Y around upper yarn engaging portion 24. By virtue to the fact that yarn Y is led onto the upper yarn engaging portion 24 of feed wheel 18 through the yarn inlet guide 88 having a bottom exit surface 108 at a height above the medial plane of feed wheel 18, tension on yarn Y causes the yarn to move from the non-feed position Pn to the intermediate position Pi. When the yarn Y is in the intermediate position Pi, yarn Y engages the surface of the high friction surface and, due to the relatively high friction between the yarn Y and the high friction surface, yarn Y is drawn along the high friction surface. Substantially instantaneously yarn Y moves upwardly as shown by the arrow and assumes the yarn feed position Pf. As long as there is tension on yarn Y resulting from the knitting of that yarn, the friction between the yarn and the high friction surface will result in positive feed of the yarn.

When there is no longer a demand for yarn Y due to the change of yarn fingers in the striper box or changing demand caused by a pattern wheel or cam, a tensile force is no longer exerted on yarn Y and the force of the yarn Y against the high friction surface is substantially minimized resulting in the yarn Y moving downwardly out of engagement with the high friction surface into the yarn idle surface 100 of the upper yarn engaging portion 24 of feed wheel 18 into the non-feed position designated Pn. Although it is necessary for the operation of the present invention that the bottom exit surface 108 of the yarn inlet guide 88 is above the medial plane of the upper yarn engaging portion 24, the vertical orientation of yarn outlet guide relative to the medial plane is not critical. It has been found that the yarn feed device of the present invention will generally operate with the yarn outlet guide located either above, below or at the medial plane.

In some instances, particularly when the period of non-feed of the yarn is very short, the yarn may remain above the medial plane. However, the lack of tension on the yarn will prevent the high friction surface from causing the yarn to be fed.

In order to obtain optimum operation of the present invention, yarn inlet guide 88 and yarn outlet guide 90 should be oriented relative to the cylindrical surface of feed wheel 18, 19 so that the yarn Y will engage a sufficient length of the circumference of the feed wheel to result in the feed of the yarn at a linear speed substantially identical to the circumferential speed of the rotary feed wheel. When yarns having different fibers are used, the orientation of the yarn inlet guide 88 and yarn outlet guide 90 relative to the feed wheel 18, 19 is varied so that the angle between the points of tangency of the yarn to the cylindrical surface of the feed wheel is changed. When the amount of friction between the high friction surface and the yarn is higher due to the nature of the yarn or the material comprising the friction surface, the angle between the points of tangency can be lowered and, conversely, when the amount of friction is lower, the angle may be increased to result in a larger length of the cylindrical surface engaged by the yarn.

FIG. 8 shows an alternate construction of a multi-yarn feed wheel assembly 110 having a multiple feed wheel 112 which takes the place of

four individual feed wheel assemblies 11. Multiple yarn feed wheel assembly 110 contains a plurality of yarn engaging portions 124 with a single driving portion 126 concentrically mounted on a common shaft 128 for rotation about the shaft 128 as a single unit.

Feed wheel assembly 110 includes a main support bracket 130 and upper and lower support arms 132, 134 cantilevered from the main support bracket 130 to support shaft 128 in a substantially vertical orientation. Each yarn engaging portion 124 is defined by two adjacent flanges 125, 125. Likewise, the driving portion 126, which can be located in the middle of the feed wheel assembly 110 as shown in FIGS. 8 and 9 or at any other position between any two yarn engaging portions 124 or at the top or bottom of the stack of yarn engaging portions. It should be understood that the multiple feed wheel 112 can be formed from a plurality of individual feed wheels journaled together or it can be fabricated as a unitary assembly. In either case, multiple feed wheel 112 rotates as a single unit.

Each yarn engaging portion 124 of multiple feed wheel 112 is separated into a yarn drive surface 136 and a yarn idle surface 138 on each side of a medial plane through the yarn engaging portion 124 perpendicular to the axis of shaft 128. The yarn drive surface 136 contains a relatively high friction surface such as a band of rubber 140 as in the embodiment of this invention. A fixed yarn guide 142 is associated with each yarn engaging portion 124 of the multiple feed wheel 112. In the embodiment of this invention shown in FIGS. 8 and 9, there are four fixed yarn guides 142. Each fixed yarn guide 142 has a yarn inlet guide 144 mounted therein with the axis of the yarn inlet guide 144 in a substantially vertical orientation. The bottom exit surface 146 of each yarn inlet guide 144 defines a substantially horizontal plane at a height above the medial plane of each corresponding yarn engaging portion 124. Each fixed yarn guide 142 also includes a yarn outlet guide 150. Yarn outlet guide 150 is located adjacent the yarn engaging portions 124 of multiple feed wheel 112, the specific orientation of the yarn outlet guide 150 relative to the medial plane is not critical.

In operation, multiple feed wheel 112 of multiple yarn feed wheel assembly 110 is rotated by a drive belt 148 in the direction shown by the arrow in FIG. 8. As best shown by the top-most yarn Ya in FIG. 9, when there is a demand for a particular yarn, the requirement for yarn at the needles puts the yarn under tension maintaining the yarn tightly against the high friction surface on yarn drive surface 136. As long as there is demand for the yarn, the self actuating action of the multiple yarn feed wheel assembly 110 will continue to deliver yarn. However, when there is no longer demand for that yarn, the tension on the yarn is released allowing the yarn to substantially instantaneously move downwardly off the high friction surface along the yarn drive surface 136, past the medial plane to assume a position on the yarn idle surface 138 as shown by the orientation of yarns Yb and Yd in FIGS. 8 and 9. Again, in some instances, the yarn will remain above the medial plane but the lack of tension on the yarn will prevent the high friction surface from causing the yarn to be fed.

The transition of the yarn from the idle or non-feed position to the drive or feed position is shown by yarn Yc in FIGS. 8 and 9. Specifically, in a manner similar to that described with reference to FIG. 7, yarn Yc in FIGS. 8 and 9 exits from bottom exit surface 146 of yarn inlet guide 144 at a height above the medial plane of the third yarn engaging portion 124 on multiple feed wheel 112. Since yarn Yc is now under tension, the engagement of yarn Yc with the lower corner of the band of rubber 140 causes yarn Yc to substantially instantaneously move onto the high friction surface and to ultimately assume the position shown at the top-most yarn engaging portion 124 of multiple feed wheel 112 shown in FIGS. 8 and 9. At substantially the same time, yarn Ya will move into the orientation shown for yarns Yb and Yd in FIGS. 8 and 9.

The use of the multiple yarn feed wheel assembly 110, allows a more compact arrangement for a self actuating multiple yarn feed device. Such device can be simply added to an existing circular knitting machine having a conventional single yarn feed and a single drive belt. When the multiple yarn feed assembly 110 is utilized, however, it is not possible to independently vary the speed of yarn feed of the individual yarns, however, this possible disadvantage is overcome by the simplicity of installation of the multiple yarn feed assembly 110 and the minimal amount of space required for such assembly.

Although not shown, it should be understood that the present invention can also be utilized with structure comprising multiple feed wheels having two or three or more than four yarn engaging portions 124 associated with a single yarn drive surface 130.

The self actuating feature of the present invention offers many advantages over prior art devices. Most significantly, this feature of the present invention causes the yarn to be fed on demand allowing the knitting of more uniform striped or Jacquard fabric having greater dimensional stability. This invention can be used in conjunction with striper boxes to allow the intermittent yet positive feed of the appropriate yarns in a random order responsive to the operation of the striper box. Likewise, the present invention can be used in conjunction with pattern wheels to produce Jacquard patterns requiring the non-uniform feed of yarn. It has been found that the appearance and the quality of the fabric are improved by the positive feed of yarn.

When automatic striping machines are used, it is necessary to remove needles in the area of the yarn changeover resulting in the formation of a vertical panel which is generally known as the selvage or seam. Whenever this seam area passes

over a feed, the fewer needles demand less yarn. Prior art yarn feed devices, however, typically continue to feed yarn at a constant rate or respond too slowly to the decrease in demand resulting in an overfeed of yarn to the needles in the seam area and downstream of the seam. Frequently, the overfed yarn will result in loose stitches often causing the latches of the needles in the seam area to fail to open making a hole or resulting in loose, non-uniform stitches in the material downstream of the seam. Significantly, the present invention is capable of responding to the decreased demand substantially instantaneously thereby avoiding the overfeeding problem.

Another advantage of the yarn feed device of the present invention is that when the machine is being set up initially or restarted after a pressoff or after one or more yarns have broken, there is no need for the operator to manually override the feed device. Specifically, since the yarn feed device of the present invention will not feed yarn unless there is tension on the yarn, when the knitting machine is operated by hand, excess yarn will not be fed needlessly which would otherwise be more susceptible to tangling and subsequently breaking. The elimination of this problem has been found to substantially increase the production of fabric on machines utilizing the present invention. Although some prior art yarn feed devices can be manually placed in a non-feed position to avoid these shortcomings, such devices introduce another potential problem. If the operator does not remember to restore each feed to the yarn feeding position the fabric produced will not be uniform.

The present yarn feed invention has few moving parts, and most significantly, the initial setup requires few, if any, adjustments. The significant spatial relationship between the bottom exit surface of the yarn inlet guide relative to the yarn engaging portion of the feed wheel is set and need not be readjusted.

The yarn feed device of the present invention smoothes out any inconsistencies in pre-tension or tension before the feed device resulting from variations in the winding of the yarn cone. Unlike many prior art yarn feed devices, such variations in pre-tension do not affect the operation of the feed device of the present invention, particularly in the seam, whether or not changeover occurs. In the present invention, as soon as there is demand for yarn at the needles, a preset minimum amount of tension is applied to the yarn by the needles and a preset rate of yarn will be delivered by the feed wheel to maintain a uniform level of tension. It has been found that for cotton or poly-cotton yarn knitting, a jersey stitch, a minimum 5 grams of tension on the yarn will result in positive yarn feed. The positive yarn feed is not affected by any changes in pre-tension.

A latitude of modification, change in substitution is intended in the foregoing disclosure and in some instances, some features of the invention will be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

CLAIMS

1. A positive yarn feed device for a knitting machine comprising a mounting frame, a feed wheel mounted on said frame for rotation about a vertical axis, said feed wheel divided into an upper segment and a lower segment by a medial plane perpendicular to said vertical axis wherein the upper segment has a relatively high friction surface and the lower segment has a relatively low friction surface, a fixed yarn guide means mounted on said frame in operative relationship to said feed wheel, and a yarn inlet guide in said fixed yarn guide means having a bottom exit surface defining an exit plane wherein said exit plane is above said medial plane of said feed wheel whereby yarn exiting from said yarn inlet guide in said fixed yarn guide means is directed to said upper segment of said feed wheel.

2. The device according to claim 1 further including a yarn outlet guide in said fixed yarn guide means wherein said yarn inlet guide and said yarn outlet guide are located at opposite sides of said feed wheel whereby the yarn will contact said feed wheel for a portion of the circumference of said feed wheel sufficient to cause the yarn to be advanced by said rotary feed wheel at a linear rate substantially the same as the circumferential speed of said rotating feed wheel.

3. The device according to claim 1 or 2 wherein said relatively high friction surface of said upper segment of said feed wheel is a band of rubber.

4. The device according to claim 1, 2 or 3 wherein said means for rotating said feed wheel comprises a driving portion concentrically mounted to said feed wheel rotatable about said vertical axis and a drive belt engaging said driving portion.

5. The device according to any one of the preceding claims wherein a plurality of feed wheels are each mounted on said frame with a corresponding plurality of fixed yarn guide means and a yarn inlet guide in each of said fixed yarn guides.

6. The device according to any one of the preceding claims wherein said feed wheel comprises a plurality of concentric feed portions each having an outer cylindrical surface extending axially between a pair of flanges, each of said feed wheel portions being divided into said upper segment and said lower segment.

7. A drive system for a plurality of yarn feed wheels on a circular knitting machine having multiple feeds comprising a support frame, a first plurality of yarn feed wheels rotatably mounted on a bracket attached to said support frame in a first common horizontal plane, a second plurality of feed wheels rotatably mounted on a bracket attached to said support frame in a second common horizontal plane, a first drive means associated with said first plurality of yarn feed wheels, a second drive means associated with said second plurality of yarn feed wheels, means

for propelling said first drive means and said second drive means comprising a drive frame, a first vertical shaft rotatably mounted in said drive frame having a first variable speed driven pulley journaled at a first end thereof and an ouput pulley journaled at the second end rotatable in said first common horizontal plane responsive to rotation of said first variable speed driven pulley and engageable with said first drive means, a second vertical shaft rotatably mounted in said drive frame having a second variable speed driven pulley journaled at a first end thereof in a plane common to said first variable speed driven pulley and an output pulley journaled at the second end rotatable in said second common horizontal plane responsive to rotation of said second variable speed driven pulley and engageable with said second drive means, a drive shaft and a drive pulley journaled to said drive shaft in a plane common to said first and said second variable speed driven pulleys, means for connecting said drive pulley to said first and said second variable speed driven pulleys, and means for rotating said drive shaft.

8. The drive system according to claim 7 wherein said first and said second variable speed driven pulley each have a first and a second outwardly diverging flange movable axially relative to each other and said means for connecting said drive pulley to said first and said second variable speed driven pulleys is a V-belt having engaging surfaces in engagement with said first and said second flanges of each of said first and said second variable speed pulleys at a radial distance whereby axial movement of said first and said second flanges closer together increases the radial distance and axial movement of said first and said second flanges further apart decreases the radial distance.

9. The drive system according to claim 7 or 8 wherein each of said yarn feed wheels has an outer cylindrical surface, said first drive means is a first drive belt in engaging relationship to said outer cylindrical surface of each of said yarn feed wheels in said first plurality of yarn feed wheels, and said second drive means is a second drive belt in engaging relationship to said outer cylindrical surface of each of said yarn feed wheels in said second plurality of yarn feed wheels.

10. The drive system according to claim 7, 8 or 9 wherein said first plurality of yarn feed wheels is rotatable at a first speed and said second plurality of yarn feed wheels is rotatable at a second speed.

11. The drive system according to any one of claims 7 to 10 further comprising a second support frame, and a third plurality of yarn feed wheels rotatably mounted on a bracket attached to said second support frame in a third common horizontal plane, a fourth plurality of yarn feed wheels rotatably mounted on a bracket attached to said second support frame in a fourth common horizontal plane, a third drive means associated with said third plurality of yarn feed wheels, a fourth drive means associated with said fourth plurality of yarn feed wheels and means for propelling said third drive means and said second drive means.

12. The drive system as recited in claim 1 wherein said means for propelling said first drive means and said second drive means are mounted outside the first plurality of yarn feed wheels.

13. A positive yarn feed device substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

14. A drive system for a plurality of yarn feed wheels substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

15. A positive yarn feed device for a knitting machine substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1981. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.