

- [54] **AUTOMATIC DOFFING SYSTEM FOR A CIRCULAR KNITTING MACHINE**
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66/153
- [51] Int. Cl..... **D04b 15/88**
- [58] Field of Search..... 242/56 R, 66, 65;
66/149 R, 151, 152, 153; 139/1 R

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[57] **ABSTRACT**

An apparatus for continuously taking up the knitted fabric delivered from take-up rollers disposed below a rotating cylinder of a circular knitting machine. The take up machine is mounted on a turn table disposed outside the knitting machine. The revolutions of the turn table and the cylinder are synchronized. The knitted fabric is wound on a spindle positioned on the take-up means. An automatic doffing mechanism which is mounted on the turn table, and the automatic spindle supply mechanism arranged beside the turn table both operate to doff a full spindle and insert a fresh one while the needle cylinder is rotating.

11 Claims, 11 Drawing Figures

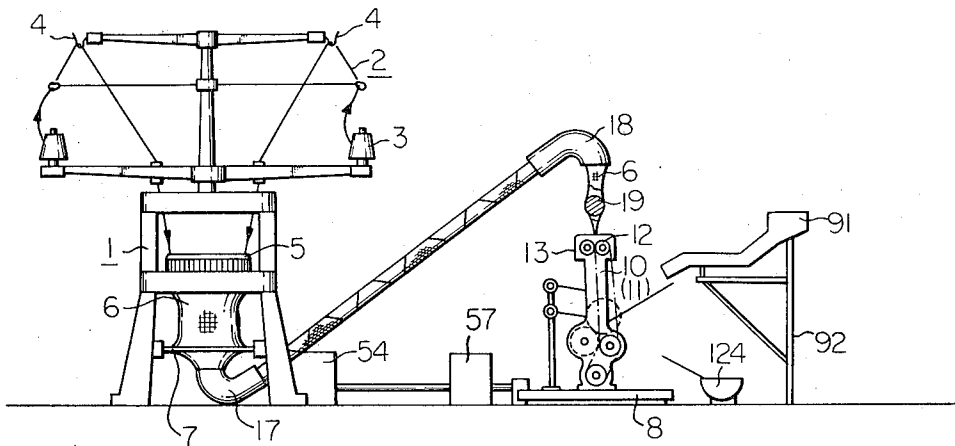


Fig. 1

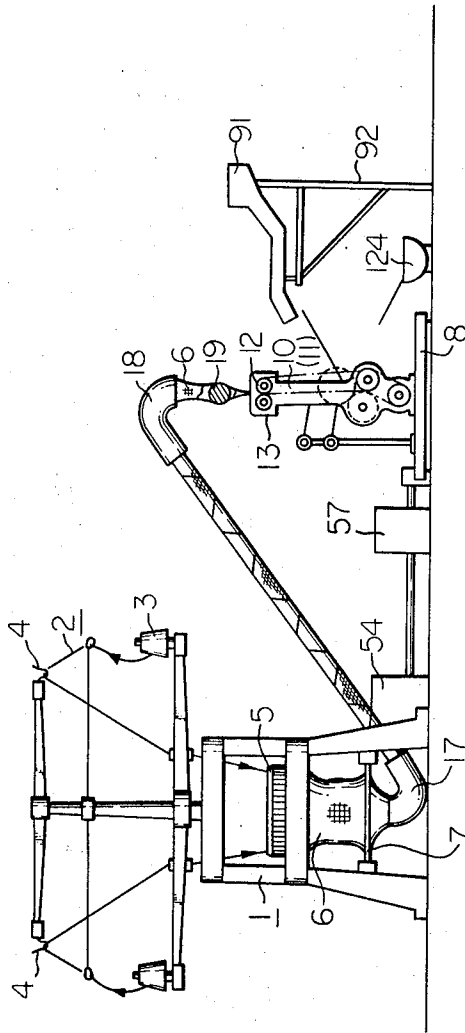
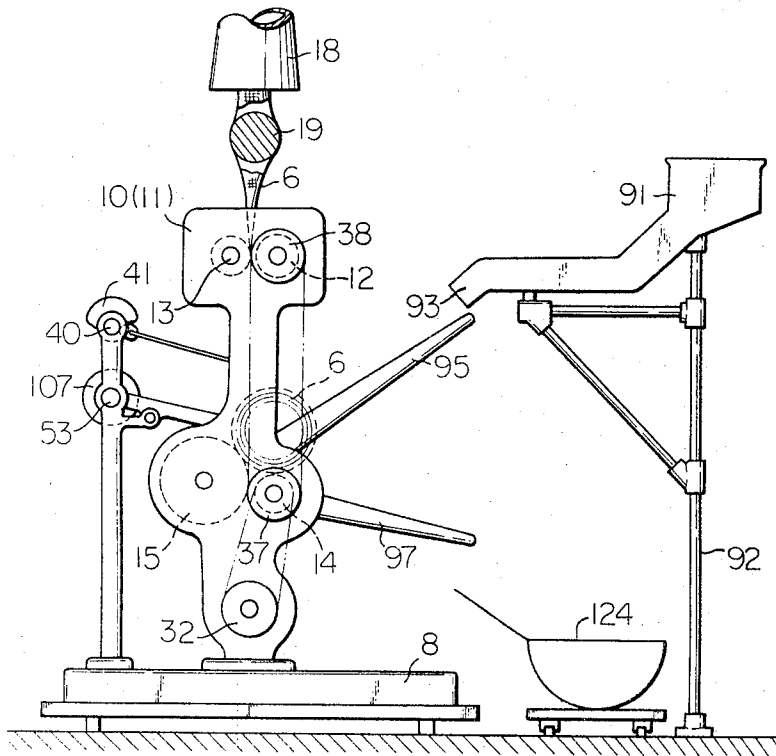


Fig. 2



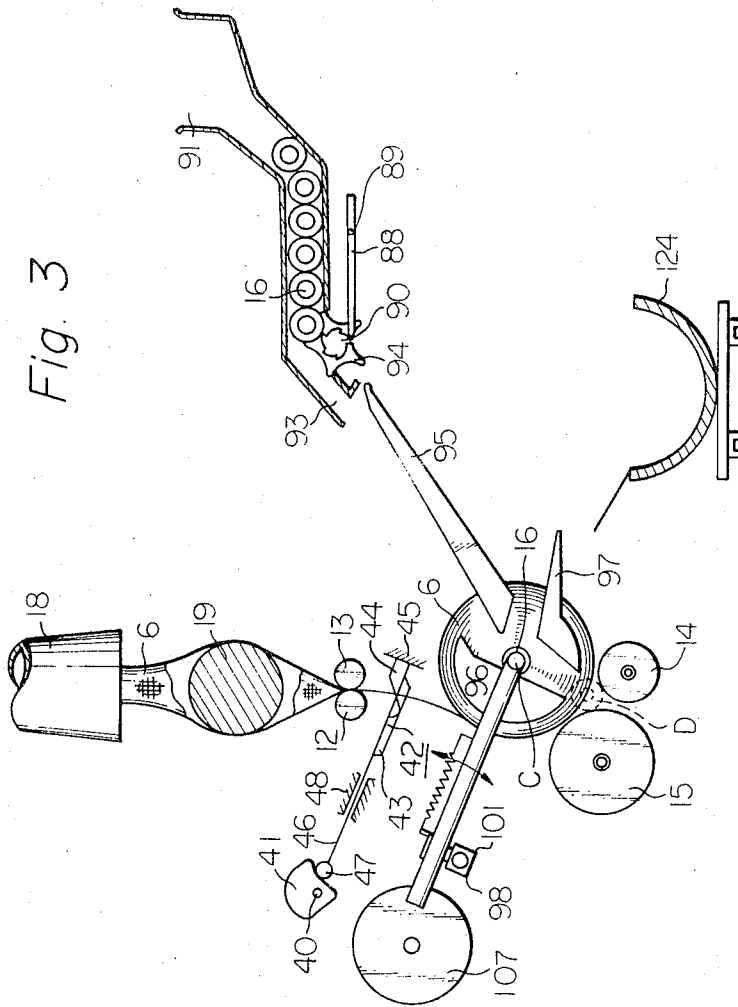


Fig. 5A

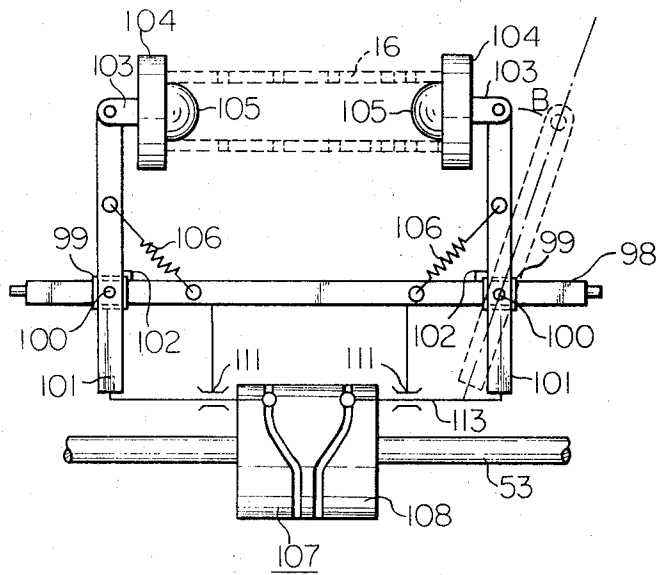


Fig. 5B

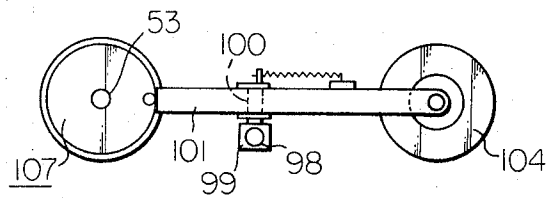


Fig. 5C

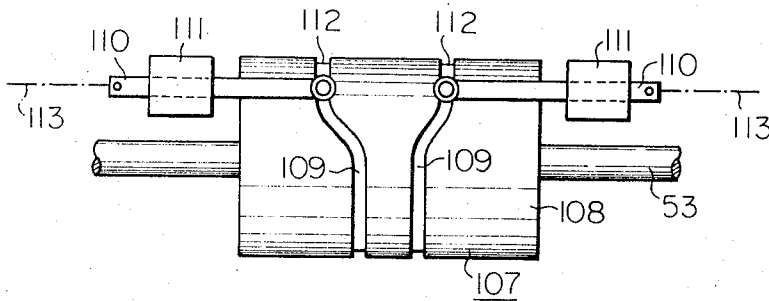


Fig. 5D

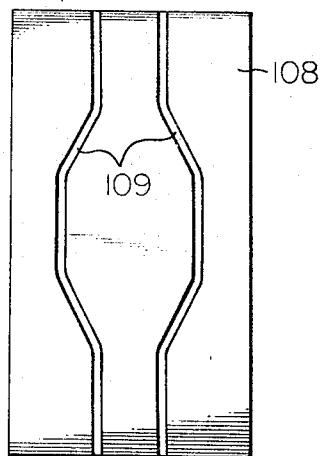


Fig. 6A

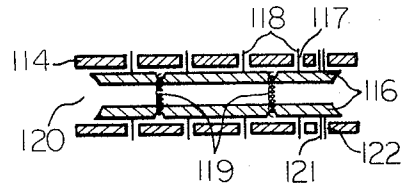


Fig. 6B

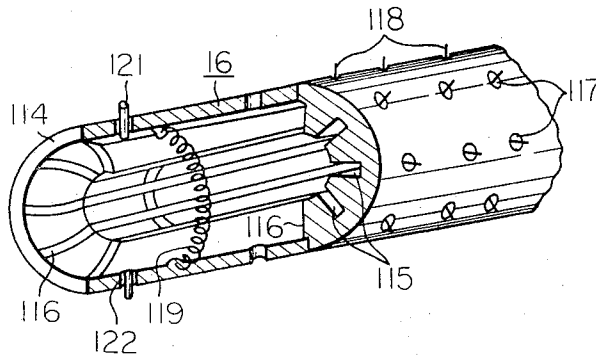
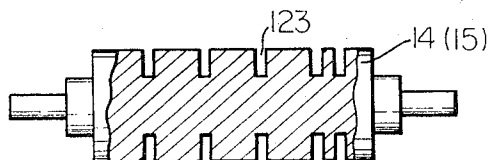


Fig. 7



AUTOMATIC DOFFING SYSTEM FOR A CIRCULAR KNITTING MACHINE

SUMMARY OF THE INVENTION

The present invention relates to an apparatus for taking up a continuous knitted fabric of the circular knitting machine.

It is well known that conventional circular knitting machines are classified as cam revolution type machines or cylinder revolution type machines. In the cam revolution type machine, as the cylinder is stationarily mounted, the winding mechanism is stationarily disposed below the knitting mechanism so that the doffing motion of the knitted fabric from the winding mechanism can be carried out very easily. However, as the yarn supply bobbins rotate it is difficult to use so-called large packaged yarn bobbins, and it is also very difficult to carry out the yarn piecing of a tail end of a previous bobbin with a leading end of a fresh bobbin. Further, it is difficult to adjust the yarn tension and feeding speed of the yarn, and to increase the number of yarn feeders. On the other hand, in the cylinder revolution type machine, the above-mentioned drawbacks of the cam revolution type machine do not exist. However, as the winding mechanism of the cylinder revolution type machine is disposed at a position below the knitting mechanism, the doffing operation is rather difficult in comparison with the cam revolution type knitting machine. Then, if it is required to produce a large size package of knitted fabric, the length of the legs which support the machine frame should be elongated. However, if the supporting legs are elongated, the level of the knitting station is changed to an elevated position so that manual operation of the machine becomes difficult and troublesome. Moreover, in addition to elongation, it is essential that these supporting legs be of sturdy construction.

The purpose of the present invention is to eliminate the above-mentioned drawbacks of conventional circular knitting machines, and more particularly, to provide a device for taking up a continuous knitted fabric of the cylinder revolving type circular knitting machine without stopping the knitting motion whereby the doffing operation can be carried out at any desired time.

According to the present invention, a turn table is disposed beside the circular knitting machine in such a manner that the revolution of the turn table is synchronized with and in the same direction as the revolution of the cylinder, and the take-up device is mounted on the turn table. This take-up device is provided with an automatic doffing mechanism which includes an automatic device for supplying spindles to the take-up device. The knitted fabric delivered from the knitting mechanism is firstly carried toward a bottom portion of the knitting machine and is then carried to the take-up device disposed on the turn table. The package of the knitted fabric formed on the spindle can be easily doffed from the take-up device and, upon completion of the doffing operation, a fresh spindle is automatically fed to the winding station of the take-up device. In the present invention, a spindle having a special construction is utilized so as to pick up a leading end of the knitted fabric easily. Further, to carry out the doffing operation without stopping the knitting operation, a particular mechanism for compensating or eliminating the difference between the number of revolutions of

the cylinder and that of the turn table due to the doffing operation is provided. Consequently, in the device for taking up the knitted fabric of the circular knitting machine according to the present invention, the knitted fabric delivered from a pair of withdrawing rollers is carried to the take-up device on the turn table, and after winding a predetermined length of the knitted fabric on a spindle, the turn table is stopped while the knitting operation is carried out; the doffing operation of a package and the feeding operation of a fresh spindle to the take-up device are carried out rapidly; the difference between the number of revolutions of the cylinder and the turn table during the period of stopping the turn table is rapidly compensated for by the above-mentioned compensation device, so that any twist in the knitted fabric between the withdrawing rollers and the take-up mechanism can be completely eliminated automatically.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a schematic front view of a circular knitting machine equipped with an apparatus for taking-up a continuous knitted fabric according to the present invention;

FIG. 2 is a front view of the take-up device, shown in FIG. 1, provided with an automatic spindle supply device;

FIG. 3 is a schematic front view, partly in section of a main portion of the take-up device provided with the spindle supply device shown in FIG. 2;

FIG. 4 is a schematic gear diagram of the take-up device shown in FIG. 2;

FIG. 5A is a schematic plan view of a main portion of the spindle supply device shown in FIG. 2;

FIG. 5B is a side view of a part of the spindle supply device shown in FIG. 2;

FIG. 5C is a schematic front view of the cam means for actuating the spindle supply device according to the present invention;

FIG. 5D is a spread-out diagram of the cam means shown in FIG. 5C;

FIG. 6A is a cross-sectional view of a spindle utilized for the device according to the present invention;

FIG. 6B is a perspective view, with part of the cover portion removed, of the spindle shown in FIG. 6A;

FIG. 7 is a longitudinal cross sectional view of a take-up roller utilized for the device according to the present invention.

DETAILED EXPLANATION OF THE INVENTION

Referring to FIGS. 1, 2 and 3, in the cylinder revolution type circular knitting machine 1, a creel 2 is stationarily mounted on the upper portion of the knitting machine 1, a plurality of yarns are supplied to a knitting mechanism 5 from the respective cones 3 via the respective yarn guides 4, and a knitted fabric 6 is delivered downward from the bottom portion of the knitting mechanism 5 by means of a pair of withdrawing rollers 7. A turn table 8 is disposed outside the circular knitting machine 1. This turn table 8 is preferably arranged in the horizontal condition so as to turn about a vertical shaft 25 thereof. However, the turn table 8 may be disposed in an inclined condition or vertical condition so as to turn about an inclined axis or a horizontal axis thereof. In any of the above-mentioned cases, the rotation of the turn table 8 is synchronized with that of the cylinder of the circular knitting machine 1. A pair of

upright frames 10, 11 are rigidly mounted on the turn table 8 and a pair of horizontal grip rollers 12, 13 and a pair of horizontal take-up rollers 14, 15 are rotatably supported between the frames 10 and 11. A curved cylindrical guide 17 is disposed below the withdrawing rollers 7 of the knitting mechanism 5 and another curved cylindrical guide 18 is disposed above the take-up device mounted on the turn table 8. The knitted fabric delivered from the withdrawing rollers 7 is carried through the cylindrical guides 17 and 18, and the grip rollers 12, 13, and then wound on a winding spindle 16 which is supported by the take-up rollers 14, 15. The spindle 16, together with the knitted fabric wound thereon, is taken off the take-up rollers 14, 15 when the doffing operation is carried out. However, it is also permissible to convey the knitted fabric 6 into a reserve box disposed below the take-up rollers 14, 15 and not wind it into a package on the spindle 16.

When the knitted fabric 6 is carried in the curved cylindrical guide 17, the fabric 6 is deformed into a rope shape and carried along an incline between the curved guides 17 and 18 while maintaining the rope form. The above-mentioned passage may be surrounded by an inclined conduit supported by the above-mentioned guides 17 and 18. As the cylinder is rotating in the circular knitting machine 1 and the turn table 8 is synchronously rotating in the same direction, a number of twists are imparted to the knitted fabric 6 in rope form in the above-mentioned passage between the guides 17 and 18. However, the above-mentioned twists are so-called false twists, and the knitted fabric 6 can be easily spread out. In the embodiment shown in these drawings, a spreading out rod 19 is disposed in the knitted fabric 6 at a position between the guide 18 and the nip point of the grip rollers 12 and 13, so that the knitted fabric 6 in rope form is spread out before the fabric 6 is fed to the grip rollers 12, 13. The knitted fabric 6 delivered from the grip rollers 12, 13 is wound on a spindle 16 supported on the take-up rollers 14, 15.

Referring to FIG. 4, showing a diagram of the gears turning the turn table 8 and a part of the mechanism for supplying spindles 16, the turn table 8 is provided with an external toothed wheel 9 formed at a lower edge portion thereof, and the turn table 8 is supported on a plurality of rolls 20 disposed between the turn table 8 and the floor to permit the turntable to rotate about a vertical center axis. The external toothed wheel 9 engages a pinion 23 secured to a vertical shaft 24. The turn table 8 is driven by means of a gear train composed of a pair of bevel gears 21, 22, wherein the bevel gear 21 is driven by a driving mechanism of the circular knitting machine 1 which is hereinafter illustrated in detail.

The vertical shaft 25 loosely passes through a central axis portion of the turn table 8, and a horizontal gear 26 is secured at a top portion of the shaft 25. A vertical shaft 27 is mounted on the turn table 8 and a horizontal gear 28 secured to the shaft 27 meshes with the horizontal gear 26 so that shaft 27 is driven. A gear train for driving the take-up roller 14 comprises a bevel gear 29 secured to the shaft 27, a bevel gear 31 secured to a horizontal shaft 30 mounted on the turn table 8 and meshed with the bevel gear 29, a sprocket wheel 32 rigidly mounted to the horizontal shaft 30, a sprocket wheel 34 mounted on an extended portion of the take-up roller 14, and an endless chain 33 for transmitting the driving power from the sprocket wheel 32 to the

sprocket wheel 34. The take-up roller 15 is driven by a pair of pinion wheels 35, 36 which are rigidly mounted on the shafts of the take-up rollers 14, 15, respectively in a meshing condition with each other.

The grip roller 12 is driven by a driving gear train composed of a sprocket wheel 37 rigidly mounted on an extended shaft of the take-up roller 14 and a sprocket wheel 39 rigidly mounted on an extended shaft of the grip roller 12 and an endless chain 38 which transmits the driving power from the sprocket wheel 37 to the sprocket wheel 39. The endless chain 38 is tensioned by a conventional tension roller (not shown). The other grip roller 13 is driven by a pressure contact with the grip roller 12. The surface speed of the grip roller 12 can be relatively changed to the surface speed of the take-up rollers 14, 15 by changing the gear ratios between the sprocket wheel 37 and the sprocket wheel 39. Consequently, if the surface speed of the grip roller 12 is relatively faster than the surface speed of the take-up rollers 14, 15, a soft package can be produced.

A cam means 41 is mounted on a shaft 40 disposed below the grip rollers 12, 13 and a cutter 42 (see FIG. 3) is actuated by this cam 41. The cutter 42 comprises a pair of scissors 43, 44. The scissor 43 is urged towards a stationary scissor 44 mounted on a bracket 45 supported by the frames 10 and 11 when the cam 41 is turned and the scissor 43 is positioned apart from the scissor 44 during the taking up operation. When blade 43 is displaced toward blade 44, the knitted fabric is separated by the shearing action created by these blades. The scissor 43 is secured to an end of a lever 46 and a small roll 47 is turnably mounted at another end of the lever 46 in such a way that the roll 47 is always in contact with a cam surface of the cam 41 by means of a helical spring (not shown). The motion of the lever 46 is guided by a sliding guide 48 mounted on brackets secured to the frames 10 and 11. The shaft 40, whereon the cam 41 is secured, is driven by a gear box 52 through a gear train composed of a shaft 51, a bevel gear 50 secured to the shaft 51, and a bevel gear 49 mounted on the shaft 40 and meshed with the bevel gear 50. A shaft 53 is also driven by the gear box 52.

A main driving motor 54 is mounted on the machine frame of the circular knitting machine 1. A small pulley 58 is rigidly mounted on a shaft 59 of the motor 54. A horizontal shaft 55 is rotatably supported by supporting means (not shown) mounted on the machine frame. Another horizontal shaft 56 is rotatably supported by another supporting means (not shown) mounted on the machine frame in such a way that these two horizontal shafts 55 and 56 extend along a common horizontal axis separately, but are connected to each other by way of a conventional magnetic clutch 57. A large pulley 60 rigidly mounted on the shaft 55 and an endless belt 61 transmit the driving power of the pulley 58 to the pulley 60. A pair of gears 64, 65 are rigidly mounted on the shaft 55 wherein the gear 64 is a gear for driving the turn table 8 at normal operation speed while the gear 65 is utilized for driving the turn table 8 at a higher speed than the normal driving speed of the turn table 8 for a predetermined time just after completion of the spindle supply motion. A horizontal shaft 62 is rotatably supported by a supporting means (not shown) mounted on the machine frame and a hollow shaft 63 is slidably mounted on the shaft 62 in spline engagement. At the end of the shaft 62, the bevel gear 21 is rigidly mounted thereon. A pair of gears 66 and 67 are

rigidly mounted on the hollow shaft 63 with an intervening space therebetween in such a condition that the hollow shaft 63 is capable of being displaced and positioned at two positions wherein the gear 64 meshes with the gear 66, the gear 65 meshes with the gear 67 respectively. The above-mentioned positioning of these gears 66, 67 is carried out by a control mechanism composed of a magnetic clutch 69 provided with a plunger 70 and a grooved pulley 68 rigidly mounted on the shaft 63 in such a way that the plunger 70 engages therewith. In other words, the plunger 70 is positioned at two positions corresponding to the above-mentioned A and B positions by the action of the magnetic clutch 69. On the shaft 56, a measuring wheel 71 is rigidly mounted so as to detect the number of rotations of the shaft 56.

The power transmission mechanism to the gear box 52 is hereinafter explained in detail. A sprocket wheel 76 is rigidly mounted on the shaft 56. A horizontal shaft 79 is rotatably supported by bracket means (not shown) secured to the machine frame, and a sprocket wheel 78 is rigidly mounted to the horizontal shaft 79. The driving force of the sprocket wheel 76 is transmitted to the sprocket wheel 78 by an endless chain 77. A hollow horizontal shaft 74 is slidably mounted on the shaft 79 by a so-called spline engagement so that the shaft 74 is capable of turning with the shaft 79 and of sliding along the longitudinal axis thereof. A pair of conical shaped cams 80 and 81 are rigidly mounted on the shaft 74 and one of the elements of clutch means 75 is rigidly mounted at a free end of the hollow shaft 74. The above-mentioned cams 80 and 81 are provided with outwardly projected conical surfaces respectively as shown in FIG. 4. A cam actuation solenoid 82 is disposed below the shaft 74 at a position where a roller 84 mounted on a shaft of the solenoid 82 can work against the conical cam surface of the cam 80 when the solenoid 82 is actuated, while another cam actuation solenoid 83 is disposed above the shaft 74 at a position where a roller 85 mounted on a shaft of the solenoid 83 can work against the conical cam surface of the cam 81 when the solenoid 83 is actuated. A horizontal shaft 73 is turnably supported by bracket means (not shown) mounted on the machine frame in such a way that the shaft 79 and the shaft 73 have a common axial line. The gear box 52 transmits the driving power of the shaft 73 to the horizontal shaft 53, and an output shaft 51 of the gear box 52 is provided with the bevel gear 50 rigidly mounted on the shaft 51 as already described. Consequently, the shafts 53 and 40 are turned when the shaft 73 is driven. Another element of the clutch means 75 is rigidly mounted on a free end of the shaft 73, and the two elements of the clutch means 75 are alternately engaged or disengaged according to the alternate motion of the solenoid 82 or solenoid 83. That is, when the solenoid 82 is actuated, so as to push the roller 84 upward, the roller 84 urges the cam surface of the conical cam 80 and consequently, the hollow shaft 74 is displaced toward the gear box 52 and when the solenoid 82 is deactivated or de-energized, the roller 84 is returned to its rest position. On the other hand, when the solenoid 83 is actuated so as to push the roller 85 downward, the roller 85 urges the conical surface of the cam 81 and, consequently, the hollow shaft 74 is displaced toward the sprocket wheel 78. According to the above-mentioned sliding motion of the horizontal hollow shaft 74, the elements of the clutch means 75

are engaged or disengaged so that the driving power of the shaft 79 is either transmitted or not transmitted to the horizontal shaft 73.

The spindle supply device attached to the take-up device according to the present invention comprises a spindle container 91 supported by a supporting member 92 rigidly mounted on the floor, a control means for regulating the spindle supply motion at an output aperture 93 of the container 91 and a plurality of guide plates 95, 96 and 97. (FIGS. 3 and 4). The above-mentioned control means comprises a control wheel 94 provided with a star shaped lateral cross section, and a ratchet wheel 90 rigidly mounted on a shaft of the control wheel 94; a lever 88, provided with a pawl (not shown) formed at a leading free end thereof and turnably supported by a pivot 89, and a connecting wire 87 which connects a rear end of the lever 88 to a top end of a solenoid shaft 86 of the solenoid 83. Consequently, when the solenoid 83 is actuated, the solenoid shaft 86 is pulled downward so that the rear end of the lever 88 is pulled downward. According to the above-mentioned motion, the lever 88 is turned clockwise (in FIG. 4) and the pawl of the lever 88 actuates the ratchet wheel 90 so that the ratchet wheel 90 is turned one tooth angle about the shaft thereof. By this turning of the ratchet wheel 90, a fresh spindle 16 is displaced toward the outlet aperture 93 of the container 91. After a fresh spindle 16 is displaced to the outlet aperture 93 of the container 91, the spindle 16 rolls on the guide plates 95 and 97 toward a supporting position D (FIG. 3) formed by the take-up rollers 14, 15.

A control box 72 is mounted on the machine frame of the knitting machine so as to control the doffing operation and the spindle supply operation.

The control box 72 is provided with: a counting means for automatically counting the winding length of the knitted fabric; electric relays for actuating the solenoids 82, 83 and the magnetic clutch 57, and a timer for determining one cycle of the knitting operation.

A mechanism for holding the spindle 16 at the take-up position is shown in FIGS. 5A and 5B in detail. That is, a horizontal rod 98 is attached to the frame of the take-up device and a bracket 99 is turnably mounted on the horizontal rod 98 at each end thereof. A pivot shaft 100 is rigidly mounted on each bracket 99 and a holding arm 101 is turnably supported by the each pivot shaft 100. A pair of stoppers 102 are mounted on the horizontal rod 98 so as to define the working position of each holding arm 101 for supporting a spindle 16. Each arm 101 is provided with a horizontal shaft 103 at the top end thereof and a holding member 104 is turnably mounted on each horizontal shaft 103. Each holding member 104 is provided with a hemispherical jaw 105 projected toward the other holding member 104. Each arm 101 is always forced to urge the holding member 104 toward the other holding member 104 by a spring force created by a tension spring 106 connected to the arm 101 and the horizontal rod 98.

When a predetermined length of knitted fabric is produced so that a full packaged spindle 16 is positioned at position "C" shown in FIG. 3, the holding arms 101 are forced to turn toward direction B in FIG. 5A, so as to move from their holding position to their doffing position, which is shown by a dotted line in FIG. 5A. The above-mentioned turning motion is controlled by an action of a cylindrical cam means 107 mounted on the shaft 53. The cam means 107 comprises, as shown in

FIG. 5C; a cylinder 108 secured on the shaft 53; a pair of grooves 109 formed on the cylindrical surface of the cylinder 108; a pair of sliding rods 110 slidably supported by the respective brackets 111 mounted on the horizontal rod 98, and; a sliding pin 112 mounted on a free end of each sliding rod 110 at a position where each pin 112 is slidably engaged into the respective cam groove 109. A connecting strand 113 connects each sliding rod 110 to a bottom end portion of each holding arm 101 as shown in FIG. 5A. The shape of each cam groove 109 is represented in FIG. 5D in a spread out condition.

According to the above-mentioned turning motion of the holding arms 101, the full package spindle 16 is released from the hold of the holding members 104. In this condition, after taking off the full package spindle, the holding members 104 move to a position D shown in FIG. 3, which is a position defined by the take-up rollers 14, 15 based on their own weight. When the holding members 104 are displaced to position D, they are in an opened condition and, consequently, when a fresh spindle 16 is supplied to position D, it is possible to hold the fresh spindle 16 by the holding members 104 by turning them toward their own holding positions as shown in FIG. 5A.

To prevent undesirable slip of the knitted fabric on the spindle 16, the spindle 16 utilized for the present invention is provided with a particular construction as shown in FIGS. 6A and 6B. That is, the spindle 16 comprises an outer cylinder 114 provided with a plurality of radial grooves 115 extended along a longitudinal axis of the spindle 16 and a plurality of plates 116 slidably engaged in the respective radial grooves 115. A plurality of apertures 117 are formed on the shell of the spindle 16 along the respective radial grooves 115, and a plurality of pins 118 are mounted on each plate 116 at positions such that a pin 118 faces each aperture 117. The plates 116 are connected to each other by means of springs 119 so that the plates 116 are urged toward the central axis of the spindle 16. Both sides 120 of the spindle 16 are opened and both ends of the plates 116 are provided with a curved surface which coincides with the hemispherical surface of the hemispherical jaw 105 of the holding member 104. Consequently, when the holding members 104 hold the spindle 16, the hemispherical jaws 105 engage the two ends of the plates 116 so that the plates 116 are forced to displace toward the inside wall of the outer cylinder 114. According to the above-mentioned motion of the plates 116, the pins 118 are projected from the respective apertures 117. On the other hand, when the holding members 104 move away from the spindle 16, the plates 116 retreat to their rest positions so that the pins 118 are retracted into the outer cylinder 114. To prevent undesirable displacement of the plates 116, a guide rod 121 is mounted on each plate 116 at an end portion thereof and the guide rod 121 is always slidably engaged with the respective apertures 122 formed at the end portion of the outer cylinder 114. Further, to prevent any damage to the pins 118, when the pins 118 are projected from the respective apertures 117, the take-up rollers 14, 15 are provided with a plurality of grooves 123, as shown in FIG. 7, formed at positions corresponding to the arrangement of the pins 118.

After the knitted fabric is automatically cut, the cut end of the fabric 6 is delivered from the grip rollers 12, 13 toward the spindle 16 previously supplied to posi-

tion D on the take-up rollers 14, 15. Then the knitted fabric 6 is picked up by the plurality of pins 118 on the spindle 16 so that the end portion of the knitted fabric 6 is automatically wound on the spindle 16 without slip or other troubles such as failure to pick up the cut end of the knitted fabric 6.

When it is required to remove the full packaged knitted fabric from the spindle 16, as the pins 118 are retracted into the outer cylinder 114, there is no difficulty in carrying out the operation.

The doffing operation of the full packaged knitted fabric from the take-up device is hereinafter illustrated in detail.

Referring to FIGS. 2, 3 and 4, when an automatic counter (not shown) of the control box 72 detects that a predetermined length of the knitted fabric 6 has been wound on a spindle 16, based on the number of revolutions of the measuring roller 71, the control box 72 issues a control signal. As an automatic counter, any conventional counter such as a type of automatic hank meter mounted on the conventional ring spinning frame can be utilized. Based on the above-mentioned issuance of a control signal, the magnet clutch 57 is actuated so that the motion of the turn table 8 is stopped. When the turn table 8 is stopped, the control box 72 actuates the solenoid 82 so as to raise the roller 84. Upon contact of the roller 84 with the conical cam-surface of the cam 80, the hollow shaft 74 is displaced to the right hand side in FIG. 4, the elements of the clutch 75 engage each other, and then the gear box 52 is driven. Consequently, the shaft 40 is driven by way of the gear train composed of the shaft 51 and bevel gears 50 and 49. With the rotation of the shaft 40, the cam 41 is turned and, consequently, the movable scissor 43 is actuated so that the knitted fabric 6 is cut at a position between the grip rollers 12, 13 and the spindle 16.

The cam 41 and the cam means 107 are mounted on the respective shafts 40 and 53 with a predetermined phase difference so as to actuate the holding means 104 after completion of the cutting action of the cutter 42. Consequently, upon completion of the cutting motion of the knitted fabric 6, the cam means 107, is actuated.

According to the motion of the cam means 107 the holding arms 101 holding a spindle 16 are actuated as already illustrated, so that the spindle 16 is released from the grip of the holding members 104 and the full packaged roll of the knitted fabric 6 rolls on the guide plate 97 by its own weight and drops into a receiving box 124 (FIG. 2).

Upon completion of the above-mentioned motions, the control box 72 deactivates the solenoid 82, and actuates the solenoid 83. Upon actuation of the solenoid 83, the lever 88 is turned so that the ratchet wheel 90 is turned one tooth angle so that the control wheel 94 is turned for supplying a spindle 16 to the outlet aperture 93 of the container 91. Therefore, a fresh spindle 16 rolls on the guide plates 95 and 97 and is displaced to the position D (FIG. 3) on the take-up rollers 14, 15. During the above-mentioned spindle supply motion, the roller 85 is displaced downwardly by the motion of the solenoid 83, so that the conical surface of the cam 81 is urged by the downward motion of the roller 85 and, consequently, the hollow shaft 74 is displaced toward the sprocket wheel 78. According to the above-mentioned motion of the hollow shaft 74, the elements of the clutch means 75 are disengaged.

As described above, the doffing motion and fresh spindle supply motion are carried out in controlled condition according to the control action of the control box 72.

The above-mentioned control motion by the control box 72 is carried out by utilizing a combined arrangement of timer relays, however, this technology is well known in the present state of the art. The detailed illustration thereof is, therefore, omitted.

When it is required to carry out the doffing and spindle supply motion, the control box 72 issues a signal to the magnetic clutch 57 so as to disengage the shaft 55 from the shaft 56. Consequently the turn table 8 is stopped. The above-mentioned action of the control box 72 is initiated by an action of the automatic counter (not shown) in which the output of the measuring roller 71 is stored. The conventional non-contact switch can be utilized to detect the number of rotations of the measuring roller 71. During the above-mentioned doffing and spindle supply motion, the hollow shaft 63 is positioned at B position by the action of the solenoid 69 so that the turn table 8 is stopped. However the circular knitting machine 1 is continuously operated when the turn table 8 is stopped, and twists corresponding to the number of revolutions of the cylinder during the doffing and spindle supply motion are imparted to the knitted fabric between the guides 17 and 18. As the above-mentioned additional twists correspond to the number of rotations of the cylinder of the knitting machine while the turn table 8 is stopped, the above-mentioned number of rotations of the cylinder is measured by the measuring roller 71 and the output of the measuring roller 71 is transmitted to the control box 72. Upon completion of the doffing and spindle supply motion, the control box 72 issues a signal to actuate the solenoid 69 so as to displace the hollow shaft 63 so that the gear 55 is in mesh with gear 67 and to simultaneously actuate the magnetic clutch 57 so as to drive the shaft 55. Therefore, the turn table 8 is rotated at a speed higher than the normal running speed. According to the above-mentioned higher running of the turn table 8, the knitted fabric reserved during the doffing and spindle supply motion is quickly taken up while the above-mentioned twists imparted thereon are quickly reduced. In the control box 72, an automatic counting device (not shown) is mounted so as to count the reduction of the stored output of the measuring roller 71. When the automatic counting device counts the end of the above-mentioned reduction, the control box 72 issues a signal to actuate the solenoid 69 so as to displace the hollow shaft 63 to the position where the gear 64 meshes with the gear 66. Then the rotation speed of the turn table 8 is returned to its normal running condition. Consequently, normal knitting operation is carried out in the condition that the rotation of cylinder of the circular knitting machine 1 and the rotation of turn table 8 are synchronized with each other.

As mentioned above, the automatic doffing and spindle supplying motion according to the present invention creates many valuable results in the circular knitting machine of the cylinder revolution type. That is, a very large package can be produced with the take-up mechanism because of the utilization of the take-up device independently disposed outside the knitting machine; any defects of fabric construction mostly due to the discontinuous knitting operation can be effectively prevented so that the quality of the knitted fabric is im-

proved because of the non-stop operation of the knitting machine; a very high production efficiency can be attained because of the non-stop operation and easy doffing operation. Further, as the knitted fabric is uniformly taken up and wound on the spindle uniformly because the knitted fabric 6 is spread out after passing the guide 18.

Further, it is important to realize that the hardness of the package of the knitted fabric 6 can be easily changed by changing the gear ratio between the sprocket wheels 37 and 39.

What is claimed is:

1. In a circular knitting machine provided with a cylinder which is revolving in carrying out the knitting operation, and a pair of delivery rollers which are continuously downwardly delivering a continuous knitted fabric from a knitting mechanism, and a main driving motor for driving said knitting machine, an apparatus for continuously taking up said knitted fabric comprising,
 - a turn table disposed outside said knitting machine, a driving mechanism for driving said turn table so that its rotations are synchronized with and in the same direction as the rotations of said cylinder, during the normal knitting operation,
 - a take-up means mounted on said turn table and driven by the turning motion of said turn table for winding said knitted fabric on a spindle,
 - means for transporting said delivered knitted fabric from said delivery rollers to said take-up means, a mechanism for automatically doffing a fully packaged roll of said knitted fabric formed on said take-up means as said cylinder continues to revolve in carrying out the knitting operation, and means for automatically supplying a fresh spindle to said take-up means.
2. In a circular knitting machine provided with a cylinder which is revolving in carrying out the knitting operation, and a pair of delivery rollers which are continuously downwardly delivering a continuous knitted fabric from a knitting mechanism, and a main driving motor for driving said knitting machine, an apparatus for continuously taking up said knitted fabric comprising,
 - a turn table disposed outside said knitting machine, a driving mechanism for continuously driving said knitting machine at a constant running speed and for driving said turn table synchronously with the revolution of the cylinder in the same direction as said cylinder during the normal knitting operation, and for driving said turn table at a higher running speed than the normal running speed of said turntable for a predetermined time after completion of said doffing operation,
 - a take-up means mounted on said turn table and driven by the turning motion of said turn table for winding said knitted fabric on a spindle,
 - means for carrying said delivered knitted fabric from said delivery rollers to said take-up means and, a mechanism for automatically doffing a fully packaged roll of said knitted fabric formed on said take-up means as said cylinder continues to revolve in carrying out the knitting operation.
3. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 1, further comprising a control mechanism for controlling the sequential motions of elements

for carrying out doffing operation of a full package of knitted fabric formed on said take-up means.

4. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 3, further comprising a device for automatically supplying a fresh spindle to a take-up position on said take-up means.

5. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 1, wherein said doffing means is provided with a cutting means disposed at an upstream position before said take-up means.

6. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 1, wherein said turn table is provided with an external toothed wheel formed at a bottom edge thereof, and driving means comprising a main driving motor for driving said knitting machine, a gear train driven by said main driving motor, said external toothed wheel being driven by said main motor by way of said external toothed wheel driven by said gear train.

7. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 1, wherein said take-up means comprises a pair of upright supporting frames, a pair of take-up rollers rotatably supported by said supporting frames, a gear train for driving said take-up rollers, said gear train comprising a first stationary upright shaft loosely passing through an aperture formed at a center position of said turn table and a pinion gear secured to said stationary shaft, a second upright shaft turnably mounted on said turn table and a gear secured to said second upright shaft in engaging condition with said pinion gear, a component gear train for transmitting turning motion of said upright shaft to said take-up rollers.

8. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 7, further comprising means for spreading out said knitted fabric at an upstream position before said take-up rollers.

9. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 1, wherein said transporting means comprises a curved cylindrical guide rigidly disposed below said delivery rollers and another curved cylindrical guide rigidly mounted on a top portion of said take-up means.

10. An apparatus for continuously taking up a continuous knitted fabric of the circular knitting machine according to claim 1, wherein said mechanism for automatically doffing (means) a fully packaged rod comprises a horizontal rod mounted on said take-up means, a pair of brackets turnably mounted on said horizontal rod with the intervening distance therebetween being

slightly longer than the length of a spindle for winding said knitted fabric thereon, a pivot shaft secured to each of said brackets, a holding arm turnably supported by each pivot shaft, each of said holding arms provided with a turntable holding member, each of said holding members provided with hemispherical jaw projected toward the other holding member, for supporting a spindle on which said knitted fabric is wound, spring means for always pulling said hemispherical jaws toward each other, means for displacing said hemispherical jaws away from each other by turning said holding arms respectively, cam means for actuating said turning motion of said holding arms so as to displace said hemispherical jaws away from each other when a doffing operation is required, whereby said spindle held by said hemispherical jaws is released therefrom.

11. An apparatus for continuously taking up a continuously knitted fabric of the circular knitting machine according to claim 6, further comprising a control mechanism which comprises a magnetic clutch for connecting or alternatively interrupting gear means for transmitting the driving power of said main driving motor to said knitting machine, a first horizontal shaft turnably mounted on said take-up means, a sprocket wheel and chain driving mechanism for transmitting power of said gear means to said first horizontal shaft, a hollow horizontal shaft spline-engagement upon said horizontal shaft, a pair of conical cam means secured to said hollow horizontal shaft, a second horizontal shaft turnably mounted on said take-up means, a clutch means for connecting or alternately disconnecting said hollow horizontal shaft with said second horizontal shaft, a gear box driven by said second horizontal shaft, a third horizontal shaft driven by said gear box, a fourth horizontal shaft driven by said gear box, a cylindrical cam means mounted on said third horizontal shaft, a cam means mounted on said fourth horizontal shaft, a pair of solenoids for displacing said conical cam means along said first horizontal shaft toward either one of two directions, counting means for measuring the number of revolutions of said turn table, a control box involving a plurality of timing relays for actuating in a predetermined sequential timing said magnet clutch and said conical cam means, and said solenoids, said cylindrical cam means working to actuate said doffing means, said cam means working to actuate means for cutting the knitted fabric, when said solenoids work to said pair of conical cam means mounted on said hollow horizontal shaft, alternatively said hollow horizontal shaft being displaced for engaging and disengaging said clutch means with engagement of the latter resulting in said conical cam means working to actuate means which feeds a fresh spindle to said take-up means.

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