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Miyagawa et al.

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[45] **Mar. 25, 1975**

[54] **AUTOMATIC DOFFING SYSTEM FOR A CIRCULAR KNITTING MACHINE**

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[73] Assignee: **Toyo Boseki Kabushiki Kaisha,** Osaka, Japan

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[30] **Foreign Application Priority Data**

Aug. 9, 1973 Japan 48-88798

[52] **U.S. Cl.** ..... **66/151,** 242/56 R, 242/66, 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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Primary Examiner—W. C. Reynolds
Assistant Examiner—A. M. Falik

[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

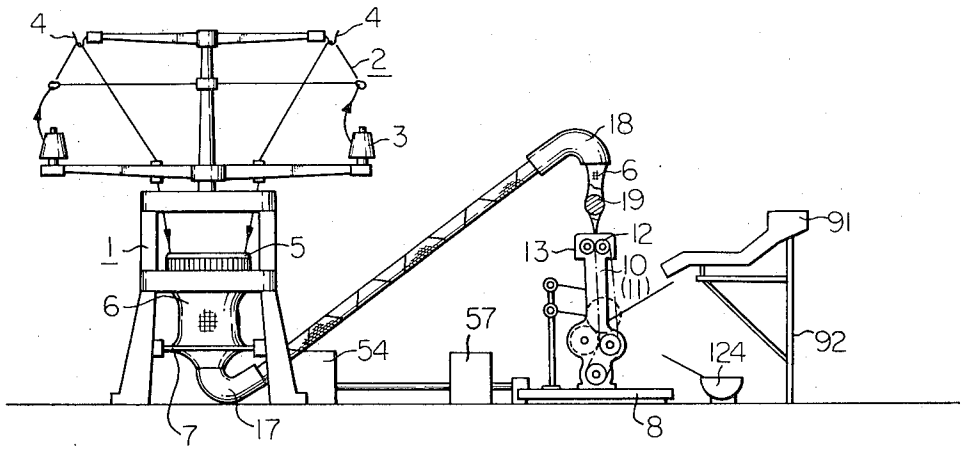


Fig. 1

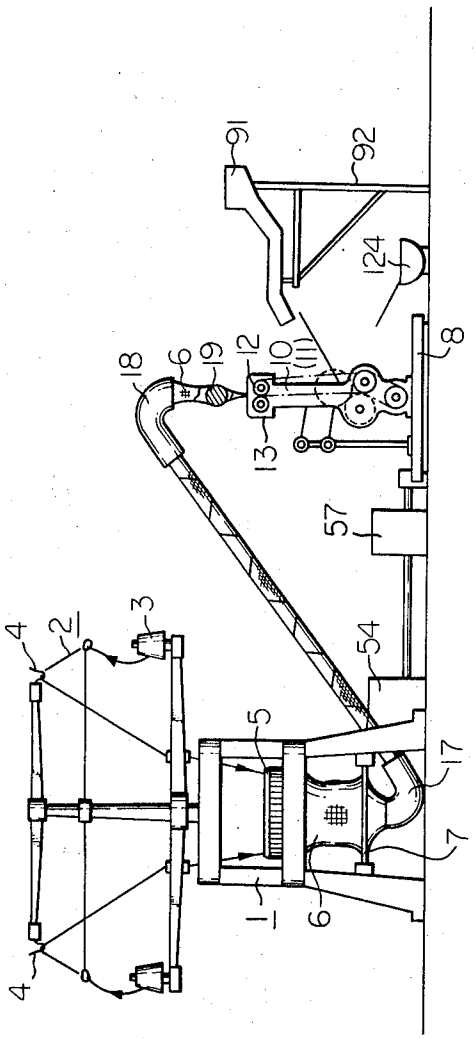


Fig. 2

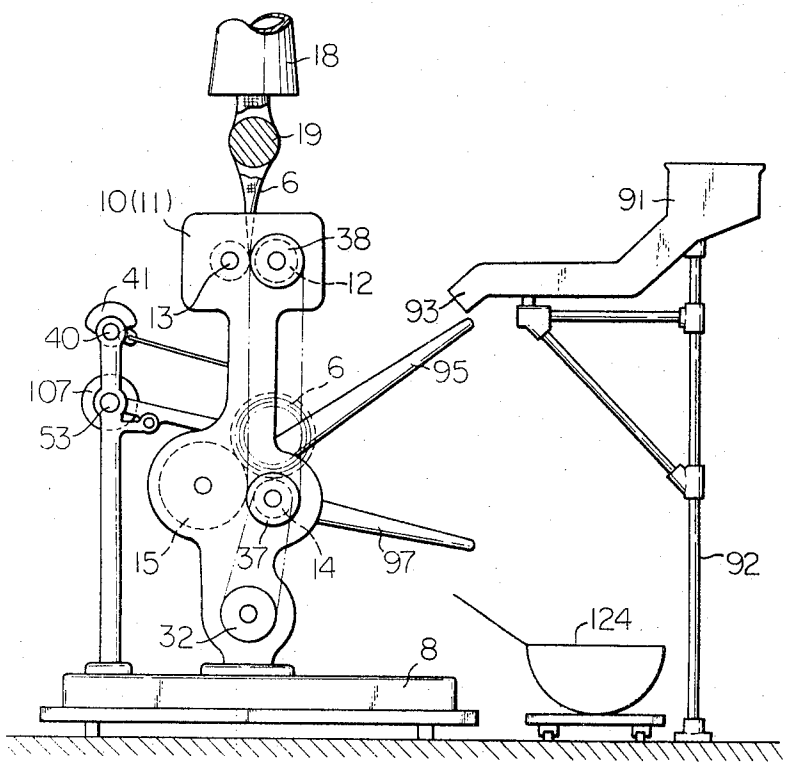
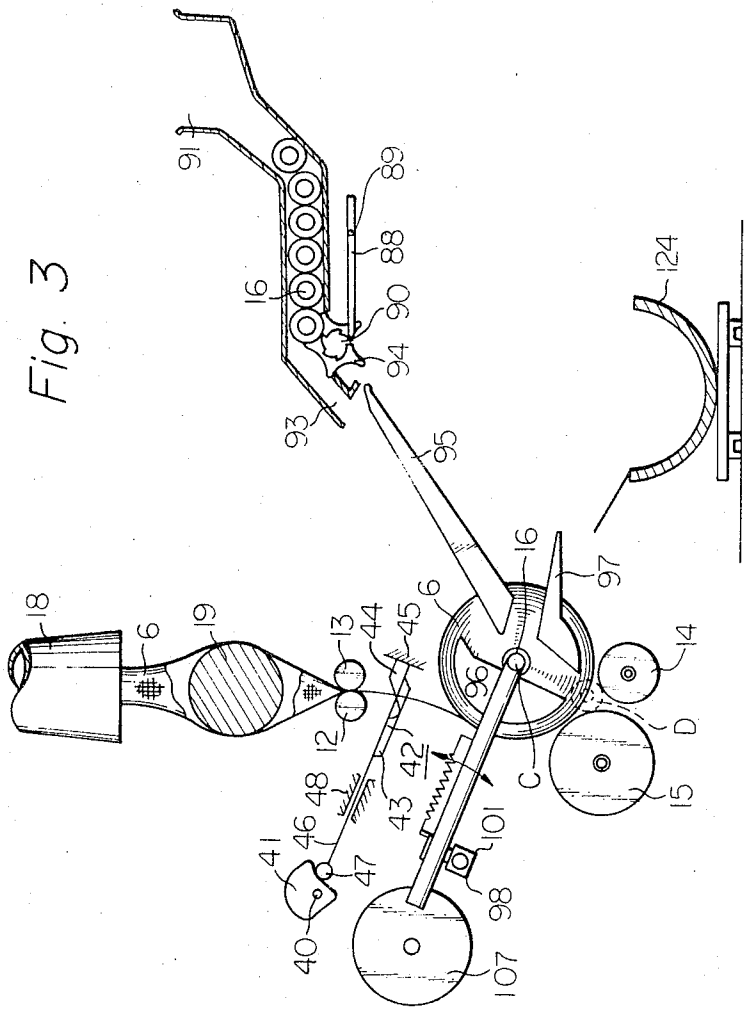


Fig. 3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D
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Fig. 4

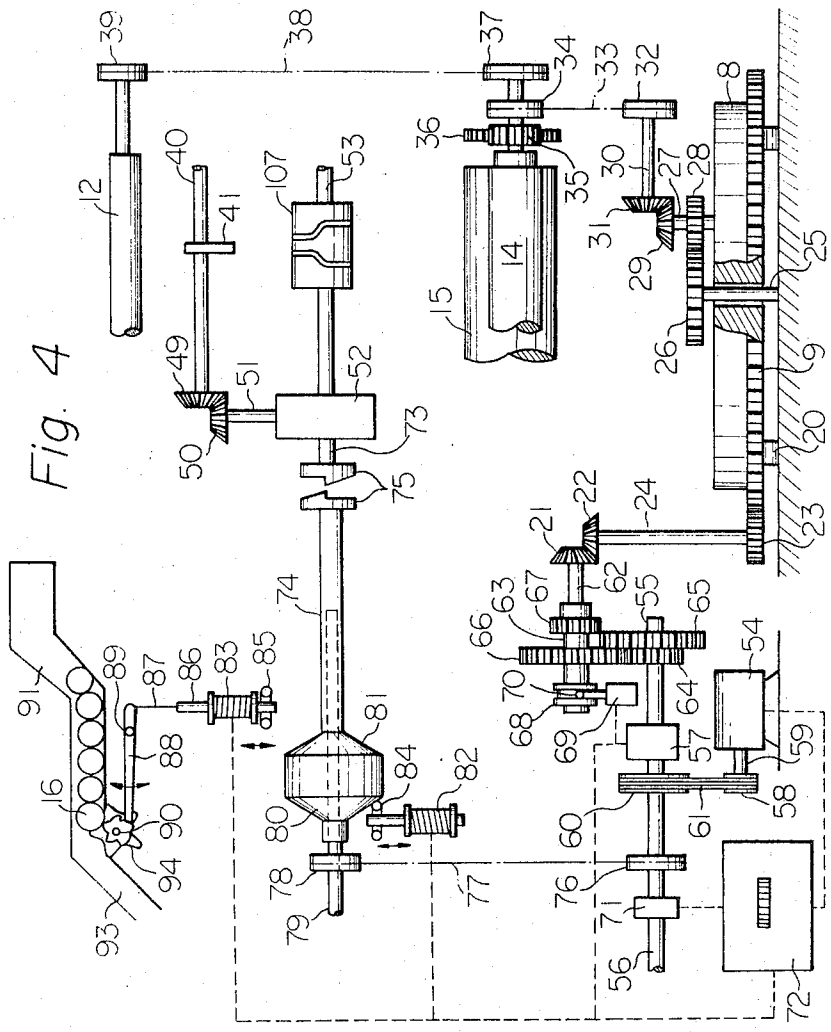
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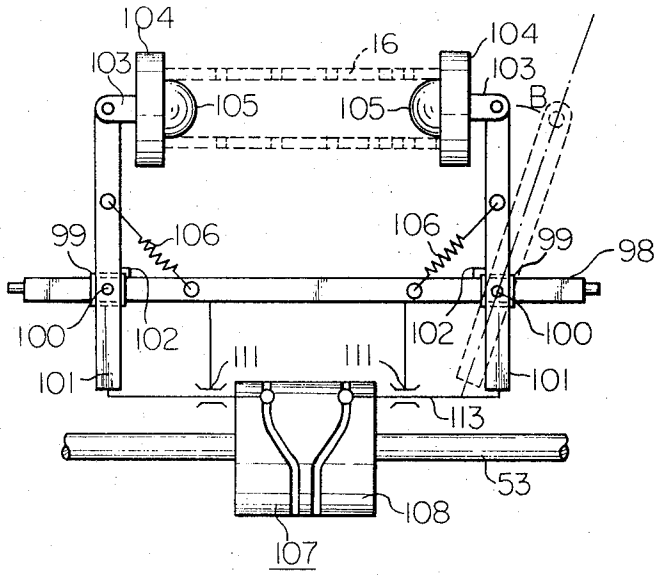
Fig. 5A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103
16
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105
105
B
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106
106
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102
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113
53
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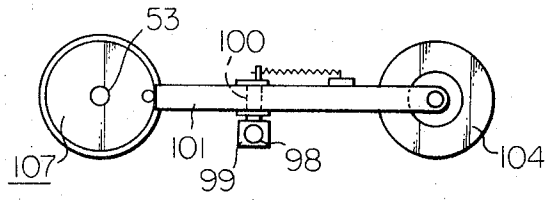
107

Fig. 5B


53
100
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101
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Fig. 5C

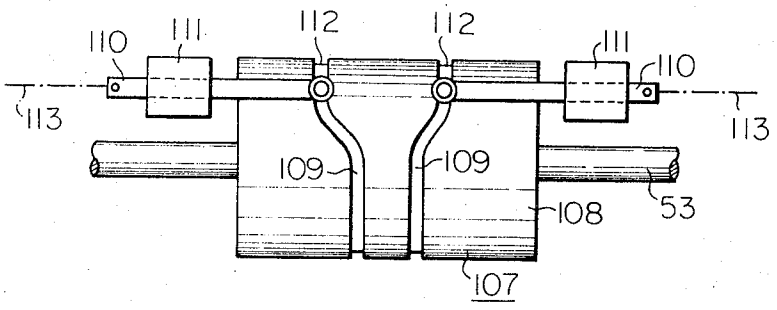


Fig. 5D

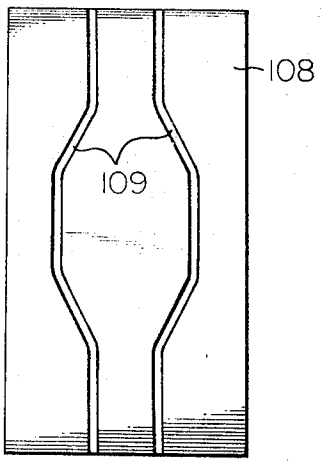


Fig. 6A

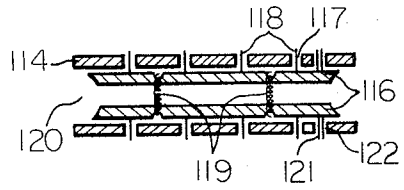


Fig. 6B

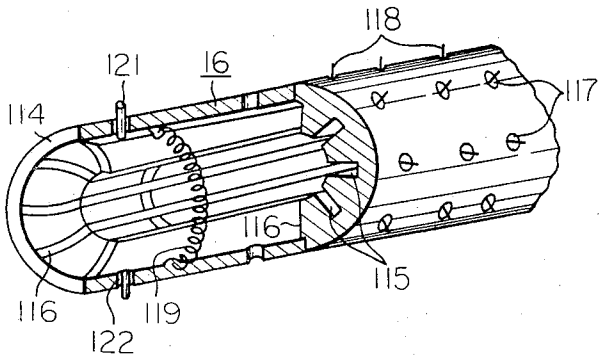
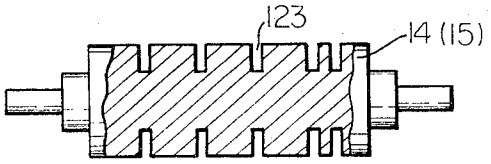


Fig. 7



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 vertial 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 position 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 improved 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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