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(54) Apparatus and method for winding and doffing roll of knitted cloth on a circular knitting machine.

(57) An automatic winding and doffing apparatus of a circular knitting machine includes a winding unit that revolves synchronously with the cylinder of the circular knitting machine. The apparatus includes opposed winding apparatus frame arms. A fabric winding roll has one roll end pivotally mounted on one of the arms. A guide mechanism guides the knitted fabric to the winding roll. The fabric roll is stopped after a predetermined amount of fabric has been wound. A doffing apparatus doffs the fabric from the winding roll after a predetermined amount of fabric has been wound on the fabric roll. In preferred embodiment, the other winding roll end is freely supported by a turning lever pivotally mounted on the frame. Upon pivoting movement of the lever arm, the winding roller may be moved from a home, winding position to an unloading, doffing position in which the other end of the winding roller is removed from the support arm. A lock mechanism operatively connects to the turning lever for locking the turning lever in a position in which the turning lever supports the winding roller in the home, winding position and for unlocking the turning lever to allow the turning lever to pivot and disengage from the winding roller. Said lock mechanism includes a cam on which the turning lever abuts, and includes a motor operatively connected to the cam for rotating the cam for turning the lever arm.

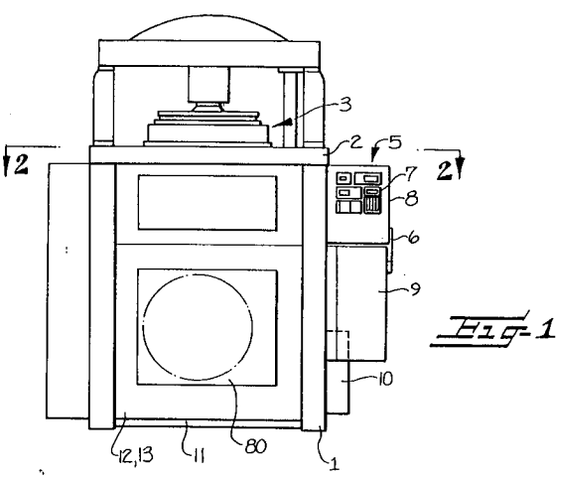

Fig-1

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Field of the Invention

This invention relates to an apparatus for automatic winding and doffing of knitted cloth on a circular knitting machine.

Background of the Invention

In conventional circular knitting machines, knitted cloth is flattened and wound on a winding roller supported by a winding unit. The winding unit revolves synchronously with the knitting machine cylinder and drives fabric delivery rolls through power transmission mechanisms which interconnect to the rotating winding unit. The knitted fabric then is wound into a flat sheet on the winding roll positioned beneath the delivery rolls. Typically, an operator manually unlocks the winding roll from a locked position relative to the frame arms of the machine frame, and removes the winding roll from the machine, together with the knitted fabric wound on the roll.

In recent years, technology advances have enabled circular knitting machines to operate at increased speeds, particularly in those knitting machines that knit fabrics in full body size. As a result of these speed increases, the knitted fabric is wound faster and doffed in shorter cycles, creating excess and difficult work for the machine operator.

Summary of the Invention

It is therefore an object of the present invention to provide an automatic winding and doffing apparatus and method for a circular knitting machine in which the winding and doffing steps are automatic for increasing efficiency and saving labor in delivery of the knitted fabric from the machine.

In accordance with the present invention, the claimed apparatus and method provides for more automated winding and doffing of the knitted cloth. The apparatus includes a winding unit revolving synchronously with the cylinder of the circular knitting machine. The winding unit is positioned below the cylinder and drives fabric delivery rolls through a power transmission mechanism interconnecting with the rotating winding unit.

A fabric winding roll is positioned between opposed frame arms of the machine and the roll winds the knitted cloth. The winding roll has two opposing ends and includes means for changing the diameter of the roll to allow a fabric wound thereon to be doffed from the roll. A plurality of combs are positioned on the surface of the roll. The combs are movable between a retracted position in which the combs are retacted and positioned below the surface of the roll to an extended position in which the combs project from the surface of the roll to engage the cloth and retain the cloth onto the winding roll.

One end of the winding roll is pivotally connected to one of the frame arms. Means guides the knitted fabric onto the winding roll at the start of fabric winding. The combs catch the knitted fabric and secure the knitted fabric to the winding roll. Means stops the winding roll after a predetermined amount of knitted fabric has been wound on the winding roll. Afterward, means cuts the knitted fabric and means doffs the knitted fabric in the direction of the roll axis.

In a preferred embodiment, a turning lever, pivotally mounted on the frame, supports the other free end of the winding roll so that the free end of the winding roll may be moved from a home, winding position to an unloading, doffing position in which the free end of the winding roller is moved away a support arm.

Locking means is operatively connected to the turning lever for locking the turning lever in a position in which the turning lever supports the winding roller in the home, winding position and for unlocking the turning lever to allow the turning lever to pivot and disengage from the winding roll.

A gate is positioned adjacent the winding unit between the frame arms for protecting and substantially covering the winding unit. Means automatically opens and closes the gate when doffing the knitted fabric from the winding roll. The winding roll includes two channel members dividing the surface of the winding roll into two half sections. Means moves the half sections relative to each other for changing the cross sectional size of the winding roll.

The winding roll includes guide channel members having holes. The half-section channel members engage the guide channel members and are guided along the holes. In a preferred embodiment, the locking means includes a cam on which the turning lever abuts, and includes motor means operatively connected to the cam for rotating the cam and turning the lever arm.

Brief Description of the Drawings

The foregoing and other objects, features and advantages of the present invention will become apparent from the following detailed description of the preferred embodiment of the invention, and from the drawings, in which:

Figure 1 is a front elevation view of the circular knitting machine in accordance with a preferred embodiment of the present invention;

Figure 2 is a plan view of the knitting machine taken along line 2-2 of Figure 1;

Figure 3 is a front elevation view of the winding unit of the present invention;
Figure 4 is a side elevation view of the winding unit taken along line 4-4 of Figure 3;
Figure 5 is a partial sectional view of the winding roll in accordance with the present invention;
Figure 6 is a sectional view of the winding roll taken along line 6-6 of Figure 5;
Figure 7 is a sectional view of the winding roll taken along line 7-7 of Figure 5;
Figure 8 is a diagrammatic, partial sectional view of the turning lever and the locking and unlocking mechanism for locking the free end of the winding roll with the turning lever;
Figure 9 is a sectional view of the lever arm taken along line 8-8 of Figure 8;
Figure 10 is a sectional view of the fabric guide apparatus taken along line 10-10 of Figure 3;
Figure 11 is a plan view of the winding unit taken along line 11-11 of Figure 3;
Figure 12 is a partial sectional view of a portion of the fabric doffing mechanism and the fabric cutting mechanism;
Figure 13 is a sectional view taken along line 13-13 of Figure 12;
Figure 14 is a plan view of a switch used for stopping the winding roll after a predetermined amount of fabric has been wound thereon;
Figure 15 is a side sectional view taken along line 15-15 of Figure 14;
Figure 16 is a front view of the gate opening mechanism in accordance with the present invention;
Figure 17 is a diagrammatic, sectional view taken along line 16-16 of Figure 15;
Figure 18 is a block diagram showing the signal transmission for controlling operation of the automatic winding and doffing apparatus of the present invention; and
Figures 19 and 20 are block diagrams showing operation of the automatic fabric winding apparatus in accordance with the present invention.

Detailed Description of the Preferred Embodiment

Referring now to Figure 1, there is illustrated a front elevational view of a circular knitting machine in accordance with the present invention. The circular knitting machine includes a knitting unit **3** mounted on a knitting bed **2** supported by legs **1**. The legs **1** include cross members **11** extending along the bottom. A winding unit **4** (Figure 3) and drive mechanism **5** are positioned below the knitting unit. The drive mechanism **5** includes a motor **6** having a motor converter **8** with a digital panel **7** for displaying operating characteristics of the motor **6**. Below the drive mechanism **5**, an AC invertor motor control panel **9** (hereinafter referred to as "ACI motor control panel") and automatic doffer control panel **10** are positioned.

Gates **12**, **13** are secured between the legs **1**. As illustrated, the gates are divided vertically in two sections, forming an upper gate, which can be opened and closed by hand, and a lower gate portion, which forms a window that can be automatically opened and closed for removing the cylindrically wound fabric positioned on the winding unit **4**.

A rotatable ring gear **14** is contained in the knitting bed as shown in Figure 3. The knitting machine frame includes winding frame arms **16**, **17** that rotate synchronously with the ring gear **14** through two connecting rods **15** connected at the bottom of the gearing **14**. The winding frame arms **16**, **17**, are formed integral with each other and are fixed on the bottom frame **17'**. One of the frame arms **16** is semi-circular in shape to allow the fabric wound into a cylindrical package to be removed in a horizontal direction relative to the machine (Figure 10).

During knitting, the knitted fabric **18** is delivered from the knitting unit **4** by at least two lines of delivery rolls **19**, **20**, and then wound on the winding roll **21**. A contactless switch KSI positioned on the bottom of the bed **2** detects the knitting machine speed, i.e., number of revolutions.

Referring now to Figures **3** and **4**, the drive mechanism **5** of the winding unit **4** will be described in greater detail. The winding unit **4** rotates and drives the delivery rolls **19**, **20** through a power transmission mechanism connected to the frame arms **16**, **17**. The power transmission mechanism includes a first bevel gear mechanism **22** that rotates as the winding unit **4** rotates. The mechanism includes a first belt **23**, a second variable speed pulley **24**, and a worm **25** that rotates the delivery roll **19**. A spur gear **26** rotates the delivery roll **20**, and a third belt **27** rotates the winding roll **21**.

Referring now to Figures 5 through 7, the winding roll **21** is shown in grater detail. The winding roll is rotatably supported at one end by a bearing fitted into the frame arm **17**. The other end of the winding roll is free. During winding of knitted fabric, the free end of the winding roll is in contact with the tip of a turning lever **28**. As will be described later in detail, the turning lever **28** is released from the winding roll **21** when the fabric wound on the winding roll is removed.

As shown in Figure 5, the winding roll **21** is shaped in a square configured hollow member, formed from rectangular channel members **21**, which divide the surface of the roll into two half sections. Short stub shafts **29**, **30** are fixed at the ends of the hollow cylinder, and a bearing **31** is

mounted on the outer side of the short stub shaft **29**. A spring **33** is positioned between a mounting collar **32** and the periphery of the bearing **31**. A rectangular, elongated shaft **34** is positioned on the inner side opposite the short stub shafts **29**, **30** and formed integral with the body. Guide holes **34a**, **34a** are positioned in the shaft **34** and are inclined toward the upper right side at two positions along the same direction. Other guide holes **34b**, **34b** are inclined to the lower right side along the same direction as the asymmetrical, opposing surface.

Combs **35** are positioned along the winding roll 21, preferably along four areas of the roll, and extend outward from the winding roll **21**. The combs **35** project from the roll, catch the tip of the fabric suspended from the knitting unit, and cause the fabric to remain secured to the winding roll **21**. When the fabric is to be doffed from the winding roll **21**, the combs **35** are retracted into the winding roll **21**.

The guide holes **34a**, **34b** engage pins **35a** secured to each comb **35**. Each comb **35** is guided by a guide plate **21c** secured on each of the channel members **21a**, **21b**. The channel members **21a**, **21b** include holes **21c** into which the combs **35** extend.

Small channel members **21e**, **21f** are secured on the inside of the channel members **21a** and **21b**. The small channel members **21e**, horizontal guide holes **21g** and inclining guide holes **21h** are bored to incline toward the lower right side along the same direction to each other. Channel members **21f**, horizontal guide holes **21j** and inclined guide holes **21k** are inclined toward the lower right side along the same direction. Pins **34c** extend through the elongate shaft **34** and extend into horizontal and inclining holes.

When the channel members **21a**, **21b** are moved in the direction of the illustrated arrow in opposition to the force supplied by the spring **33**, the combs are withdrawn from the surface of the winding roll along the inclining guide holes **34a**, **34b**, and, as a result, the cross-sectional size of the winding roll decreases. Thus, the knitted fabric is easily removed from the winding roll in the direction of the roll axis. After the fabric wound on the winding roll is removed, the winding roll is restored to the initial position in which the combs **35** project from the roll surface to prepare for subsequent winding of the knitted fabric.

Referring now to Figure 8, the turning lever supporting the free end of the winding roll **21** is illustrated in greater detail, together with the lever locking mechanism **37**, which locks and unlocks the turning lever. The turning lever **28** is mounted on the frame by a pin **36** positioned in a recess formed on the frame arm **16**. The forward portion of the turning lever **28** includes a cut-away, concave portion **28a**, which supports the free end of the winding roll **21**. The other end of the turning lever **28** includes an inclined portion **28b**. A spring **28c** is fixed between the winding frame arm **16** and the turning lever **28** to bias the lever arm.

The locking mechanism **27** is positioned on the lower end of the lever arm **28**. The locking mechanism **37** includes a cam **38** on which the turning lever **28** abuts. A collar **40** aids in supporting the cam **38** and a geared motor **39**, which is operatively connected to the cam **38**. The cam **38** is positioned at 90 degrees relative to a sensor plate **41**. When the cam 38 is rotated vertically, and turned into a position as shown by the double-dash line, knitted fabric is in position to be doffed. The cam **38** and collar **40** are positioned in a support box **42**. Two contactless switches **KS11** and **KS12** are positioned in the support box. The support box is mounted to a base plate.

Referring now to Figure 10, there is illustrated a side view of the fabric guide mechanism **43**. The fabric guide mechanism is positioned above the frame arms **16**, **17**, and includes a fabric guide plate **44** and spring **45** for pressing the guide plate **44** onto the knitted fabric. The fabric guide plate **44** is rotatably fixed to arms **46** horizontally extending from the frame arms **16**, **17**. The fabric guide plate **44** presses against the forward end of the knitted fabric at the start of the winding, while pressing and stabilizing the wound fabric as the roll of knitted fabric diametrically enlarges. The guide plate **44** accurately moves while touching the knitted fabric in opposition to the biasing force of the spring **45** as the diameter of the wound knitted fabric roll increases.

Referring now to Figure 12, the fabric doffing mechanism includes a doffing plate **49** for pressing the side of the knitted wound fabric on the winding roll **21**. A movable block **50** includes a female screw portion fixed to the doffing plate **49** and integral therewith. Screws **51** mesh with the movable block **50**. A motor **52** drives the screw **51**.

Two guide bars **53** are in parallel with the screw **51** and are inserted into support frame members **54**. The movable block **50** is displaceable between support frame members **54**. A sprocket wheel **55** is secured onto one end of the screw **51** beyond the outer side of the support frame **54**. The sprocket wheel is driven by a motor **52** secured to another sprocket wheel **56** through a chain mechanism. The motor **52** is connected to a motor support frame **57** positioned on the side of the support frame **54**.

A channel configured cover **58** and angle members **59** are fixed onto the sides of the support frame members **54** at upper and lower portions. Both side ends of the cover **58** and angle members **59** are shielded, such as by resilient rubber plates

60, positioned above and below the entrance to prevent fibers from entering. The arms **50a** on both sides of the movable block **50** extend upward beyond the rubber plate **60**. A vertical plate **50b** is fixed on the arms **58**. The doffing plate **49** is connected to the vertical plate **50b** and the forward end of the doffing plate extends within the vicinity of the winding roll **21** (Figure 4).

A sensor plate **50c** is connected to the side end portion of the movable block. A contactless switch **KS13** detects the positional base point of the movable block **50**. A contactless switch **KS14** for detecting the most extended use displacement of the block **50** is fixed opposite to the sensor plates **50c**.

Referring now to Figure 11, there is illustrated in greater detail the fabric cutting mechanism **48** in accordance with the present invention. The fabric cutting mechanism 48 is positioned outside the fabric doffing mechanism **47**, and includes a circular cutter portion **61** and a cutter displacement and driving mechanism **62**. The circular cutter portion **61** includes a motor **62a** on which a circular cutter **62b** is fixed (Figures 4 and 11). The circular cutter **62b** includes a cover **63** for protecting the cutter and minimizing chance of injury. The cover **63** is supported on a bent, upright stand **64** so that the cutter member **61** is positioned close to the knitted fabric. The stand **64** is supported on the cutter displacement and driving portion **62**, which includes a movable member **65**, transmission wire belt mechanism **66**, rail member **69** and a motor **67** for moving these components.

A mounting support block **68** is connected to the upper side of the bottom portion of the movable member **65** and is integral therewith. The block **68** includes pulley rollers **70** positioned at both sides so that the rail member **69** is displaceable. A power supply brush **71** is connected to the cutter portion, and a motor **67** is fixed to the rail member **69**. Wheel **73**, **74** are positioned on the rail member **69** and a pulley belt or wire **75** extends therearound. The pulley wheels **73**, **74** are connected to the motor **67** and the rail member **69**.

Rotation of the pulley wheel **73** drives pulley wheel **74** and displaces the mounting support block **68** connected to the pulley wire **75**, as well as the movable block **65**. A sensor plate **65c** is connected to the side end of the movable member **65**. A contactless switch **KS3** detects the positional base point of the movable member **65**. A contactless switch **KS4** detects the terminal point of displacement of the member fixed opposite the sensor plate **65c**.

Referring now to Figure 14, a plan view showing a contactless switch for stopping the winding roll and detecting the knitted fabric is illustrated. The contactless switch **KS2** allows stopping of the winding roll at a fixed position. The contactless switch is connected to the side of the box **82** at a position in close proximity to the winding unit **4**. A sensor plate **83** is connected to the bottom of the winding unit **45**. A micro switch **KS17** is contained in a containment box secured to the base plate.

Referring now to Figure 16 and 17, details of the gate opening and closing mechanism **76** are illustrated. The gate opening and closing mechanism **76** includes a transmission motor. Below the window portion **80**, pulley wheels **77** are positioned and a pulley wire **78** extends between and around the pulley wheels.

A motor **78** is fixed on one of the pulley wheels **77**, a transparent slide **81** is connected to the pulley wire. The slide **81** moves as the pulley wire moves right and left. The slide **81** is larger in size than the window portion **80** and is supported by guide rollers **82** positioned on right and left corners. A dash line drawn in the window portion of Figure 16 indicates a knitting fabric wound on the winding roll **21**. The fabric is doffed to a position shown in Figure 2 across from the window portion **80** when pushed by the doffing mechanism **47**. Afterward, the doffed fabric is conveyed by a cart, belt conveyor or the like to a position for subsequent processing.

A sensor plate is integrally fixed to the slide **81** and positioned on the lower end of the slide **81**. On the plate, contactless switches **KS7** and **KS8** are fixed for detecting the positional base point of the plate **83** and the terminal point of displacement.

Referring now to Figure 18, a block diagram illustrating the signal transmission route for controlling the automatic winding and doffing mechanism is illustrated. Referring to the drawing, a console of the digital panel mechanism **7** comprises a 10-key pad into which preset values and motor speed control values for the knitting machine are input. The digital panel includes function keys, monitors and trouble shooting lamps. A central processing unit (hereinafter referred to as "CPU") (not shown) performs processing in accordance with the pre-input sequence control program. The CPU is positioned in the digital panel **7**.

The digital panel is connected to the ACI motor control panel **9** and the auto doffer control panel **10**. ACI control panel **9** and auto doffer control panel **10** are connected to each other. The ACI motor control panel **9** is connected to the motor **M** of the knitting machine for controlling the machine.

The auto doffer control panel **10** has the following components connected thereto: 1) contactless switches **KS7** (base point) and **KS8** (terminal point) for confirming positions of the gate opening and closing; 2) gate opening-closing motor **M1**; 3) contactless switches **KS3** (base point) and **KS4** - (terminal point) for confirming a position of the

fabric cutting device **48**; 4) fabric cutter displacing motor **M2** and cutter motor **M3**; 5) contactless switches **KS13** (base point) and **KS14** (terminal point) for confirming a position of the fabric doffing device; 6) motor **M4** for displacing the fabric doffing device; 7) contactless switches **KS11** (base point) and **KS12** (terminal point) to confirm a locking-unlocking position for locking and unlocking the winding roll; 8) motor **5** for locking and unlocking the winding roll; and 9) contactless switch **KS2** for confirming stop of the winding unit at a fixed position. These mechanisms and components transmit signals detected thereby to the auto doffer control panel.

When the mechanisms connected to the auto doffer control panel **10** are operational, corresponding signals indicating that the doffer is in operation are transmitted to the digital panel device **7**.

When operational trouble occurs in the mechanisms connected to the auto doffer control panel **10** and in the yarn feeding system, signals enabling the doffer to halt (wait) operation are transmitted from the digital panel device **7** to mechanisms connected to the auto doffer control panel **10**.

The ACI motor control panel **9** transmits to the auto doffer control panel 10 signals obtained from mechanisms connected to the auto doffer control panel **10**, indicating that the knitting machine is rotating.

Signals from the contactless switch **KS1**, indicating the speed and number-of-revolutions of the knitting machine, are transmitted to the CPU of the digital panel device **7**. The output side of the CPU is connected to the motor **M** of the knitting machine through the ACT motor control panel **9**.

Signals from the contactless switch **KS1** control the speed of the motor **M** of the knitting machine, for example, three steps as normal, medium, and low modes with the ROM incorporated into the ACI motor control panel **9** and programmed beforehand. The contactless switch **KS1** is connected to the auto doffer control panel **1O** through the digital panel device **7**.

When the number of detected revolutions of the knitting machine reaches a preset value, stop signals are transmitted to the ACI motor control panel **9** through the digital panel device **7**. The stop signals transmitted to the ACI motor control panel **9** are transmitted as retardation signals to the motor **M** connected to the output side of the ACI motor control panel **9** to stop the knitting machine at a fixed position after driving at low speed.

When the knitting machine is stopped, the contactless switch **KS2** detects the fixed stop position of the winding unit. Fixed position stop signals are transmitted to the auto doffer control panel **10**. The fixed position stop signals of the winding unit **4** transmitted to the auto doffer control panel **10** are in turn transmitted to a mechanism connected to the output side of the panel **10** and then further transmitted to the mechanism after completion of an operation of one mechanism performed in the order of desired operations.

A microswitch **KS17**, for confirming that the fabric is wound on the winding roll **21**, is connected to the digital panel **7**. The switch **KS17** operates when winding of the fabric on the winding roll **21** fails. At that time stop signals are transmitted to the digital panel **7** to stop the motor **M** connected through the ACI motor control panel **9**, as well as the other mechanisms connected to the auto doffer control panel **10**.

An operation panel **84** enables full automatic operation and allows a series of mechanisms to automatically operate, and operate in semi-automatic operation, as well as to allow each mechanism to operate independently from the others when wrong operation is caused, and manual operation is fixed to the auto doffer control panel **10**.

A detailed description of operations of the automatic fabric winding mechanism of this invention on the circular knitting machine will now be made with reference to a flow chart shown in Figure 19. The reference numbers **N100** to **N200** represent steps in the flow chart.

When the knitting machine is started, a preset counter of the digital panel **7** begins counting, and the contactless switch **KS1** inputs the signals indicative of the number of revolutions of the knitting machine into the central processing unit ("CPU" hereafter) (not shown) of the digital panel **7**. An accumulated value of the number of revolutions is calculated for comparison with a sequence process algorithm inputted beforehand. (N step **100**).

In the N step **101**, the number of revolutions of the knitting machine is compared with a preset value to determine if the number of revolutions has reached that value. When the number of revolutions reaches the preset value, the motor is retarded according to an instruction of the motor control panel, placing the knitting machine in the low speed driving mode (N step **102**). When the number of revolutions is under the preset value, the knitting machine continues operating.

In the N step **103**, the winding unit has reached the fixed stop position. Contactless switch **KS2** determines the fixed stop position.

In the N step **104**, if the winding unit reaches the fixed position, the knitting machine is stopped. If the winding unit has not reached the fixed position, the machine is driven at low speed until the unit reaches the fixed position.

In the N step **105**, the switch **KS18** compares the diameter of the fabric package with a standard value of 200 mm.

If the diameter of the fabric package is more than 200 mm, the operation is shifted to the N step **106** in which the contactless switch **kS2** determines the fabric package is in the fixed position. When the diameter is less than 200 mm, the operation is checked with the semi-auto mode. If the winding unit in not in the fixed position error is implied, and the operator performs checking.

In the N step **107**, when the winding unit is stopped in the fixed position, the geared motor **5** of the lever locking and unlocking mechanism **37** is driven. Thus, the cam **38** fitted onto the shaft of the geared motor **5** turns by 90° in the vertical direction and abuts on the turning lever **28** for turning the lever and releasing the free end of the winding roll **21**.

In the N step **108**, the contactless switch **KS12** determines the position in which the turning lever **28** turns for locking and unlocking the winding roll **21**.

When the turning lever **28** has been turned to the fixed position, the operation is shifted to the N step **109** and the geared motor **M5** is stopped. Driving of the geared motor **M5** continues if the turning lever **28** has not turned to the fixed position.

After the geared motor **M5** has stopped, operations in the N steps **110** through **113** for opening the gate **12**, and the N steps **114** through **117** for driving the cutter motor **62** of the fabric cutting device **48** and the cutter displacing motor **52** proceed simultaneously.

In the N step **110**, determinations are made as to whether the contactless switch **KS2** for stopping the winding unit **4** at the fixed position is operative and the switch **KS12** for locking-unlocking the winding roll **21** is operative.

When the contactless switch **K2** for stopping the winding unit **4** at the fixed position, and, the **KS12** switch for locking-unlocking the winding roll **12** are operative, the motor **M1** for opening and closing the gate **12** is driven for opening the window of the gate **12**. (N step **111**) A contrary result implies error and the operator performs checking.

In the N step **112**, the contactless switch **KS8** determines whether the gate has been opened. If the gate has been opened, the operation is shifted to the N step **113** in which the gate opening-closing motor **M1** is stopped. If the gate has not been opened, the gate opening-closing motor **M1** continues rotating until the gate is opened.

In the N step **114**, the determinations are made whether the contactless switch **KS2** for stopping the winding unit **4** at the fixed position is operable, and whether the **KS12** for locking-unlocking the winding roll **21** is operable.

When the contactless switches **KS2** (fixed position stopping of the winding unit **4**) and the **KS12** - (for locking-unlocking of the winding roll **21**) are determined operable, the cutter motor **M3** and cutter displacing motor **M2** are enabled. If the switched are not operable, error is implied and the operator checks for error. In the N step **116**, a determination as to whether the fabric cutting mechanism **48** has reached the terminal point is made.

In the N step **117**, if the fabric cutting mechanism **48** has reached the terminus, the cutter displacing motor **M2** stops; otherwise, the cutter displacing motor **M2** continues operation.

In the N step **118** the cutter displacing motor **M2** rotates in the reverse direction to return the cutter to the initial base position (N step **119**) if the contactless switch **KS2** for the fixed position stop of the winding unit **4**, and the **KS12** for locking unlocking of the winding roll **21** are determined to be in operation; otherwise, error is implied and the operator performs checking.

In the N step **120**, if the cutter has returned to its initial base position, the cutter displacing motor **M2** is stopped (N step **121**); otherwise, the cutter displacing motor **M2** continues operation.

In the N step **119**, when the contactless switch **KS2** for the fixed position stop of the winding unit **4** and the **KS12** for opening and closing the gate **12** are in operation, the step is shifted to the N step **123** in which the motor for doffing the fabric is driven to push the fabric on the winding roll **21** outside of the machine so that the fabric may be doffed.

In the N step **124**, if the fabric doffing position **47** is at the terminal position, the fabric doffing motor **M4** is stopped (N step **125**); otherwise, the fabric doffing motor **M4** is stopped.

In the N step **126**, if the winding unit is in the fixed, stop position, and the gate **12** is opened for the fixed position stop of the winding unit **4**, the fabric doffing motor is rotated in the reverse direction and the fabric doffing mechanism **47** returns to the initial base position (N step **127**); otherwise, error is implied and the operator performs checking.

In the N step **128**, if the fabric doffing mechanism **47** has returned to the initial base position as determined by the switch **KS13**, the motor for the fabric doffing device **47** is stopped (N step **129**); otherwise, driving of the motor for the fabric doffing device **47** continues.

In the N step **130**, the switch **KS 13** determines whether the motor **M4** for fabric doffing has terminated. If that motor is off, the motor **M1** for opening and closing the gate **12** is rotated in the reverse

direction so that the gate **12** is displaced to the initial closure position; otherwise, error is implied and the operator performs checking.

In the N step **132**, if the gate has been closed, the motor **M1** for opening and closing the gate **12** is stopped.

In the N step **134**, if the doffing device **47** and cutter are in fixed stop positions as determined by the switch **KS13** (confirming the base point of the mechanism **47**) and **KS3** (confirming the base point of the cutter), the motor **M5** for actuating a locking-unlocking cam **38** for the winding roll **21** is rotated in the reverse direction and the winding roll **21** is turned and locked by the turning lever **28** (N step **135**); otherwise, error is implied and the operator performs checking.

In the N step **136**, the fabric retention confirming switch **KS11** determines whether the turning lever **28** for locking-unlocking of the winding roll locks the winding roll.

In the N step 137, if the turning lever **28** is retaining the winding roll, other mechanisms and components are sensed to determine whether they are stopped: the driving part for displacing the cutter; the closure of the gate **12**; the locking of the winding roll by the locking-unlocking cam **38**; and whether the fabric doffing device is stopped or performed in base positions. If the above mechanisms are stopped, the knitting machine is started again; otherwise, error is implied, and the operator performs checking.

The invention provides the benefits and advantage of relieving the knitting machine operator of heavy labor normally associated with conveyance of the knitted fabric roll, and enables an increase in knitting machine operation.

The foregoing embodiments are to be considered illustrative, rather than restrictive of the invention and those modifications which come within the meaning and range of equivalents of the claims are to be included therein.

Claims

1. An apparatus for automatic winding and doffing of knitted cloth on a circular knitting machine having a winding unit **4** disposed below the cylinder and revolving synchronously with the cylinder, and which drives fabric delivery rolls through a power transmission mechanism interconnected to the rotating winding unit and being characterized by:

a frame having opposed winding apparatus frame arms **16**, **17**;

a fabric winding roll **21** for winding knitted cloth, said winding roll having two opposed ends, and including means for changing the diameter of the roll to allow a fabric wound thereon to be doffed therefrom, and including comb means **35** positioned on the surface of the roll and movable from a retracted position below the surface to an extended position projecting from the surface of the roll for engaging the cloth and retaining the cloth onto the winding roll;

means pivotally connecting one end of the winding roll to one of the frame arms;

means for guiding **43** fabric to the winding roll at the start of fabric winding;

means for stopping the fabric winding roll after a predetermined amount of fabric has been wound on the winding roll;

means for cutting **48** the fabric after fabric winding; and

fabric doffing means **47** for doffing the fabric from the winding roll in the direction of the roll axis after a fixed length of fabric has been wound on the fabric roll.

2. An apparatus according to Claim 1 including a gate **12** positioned adjacent the winding unit between the frame arms for protecting and substantially covering the winding unit, and including means for automatically opening and closing the gate when doffing the knitted fabric from the winding roll.

3. An apparatus according to Claim 1 wherein the winding roll includes two channel members **21a**, **21b** dividing the surface of the winding roll into two half sections, and including means for moving the half-sections relative to each other for changing the cross sectional size of the winding roll.

4. An apparatus according to Claim 1 wherein one of the frame arms is substantially C-shaped and bent in the direction along which the fabric is doffed.

5. An apparatus according to Claim 1 wherein the fabric cutting means is positioned apart from the winding unit.

6. An apparatus for automatic winding and doffing of knitted cloth on a circular knitting machine having a winding unit **4** disposed below the cylinder and revolving synchronously with the cylinder, and which drives fabric delivery rolls through a power transmission mechanism interconnecting to the rotating winding unit and being characterized by:

a frame having opposed winding apparatus frame arms **16**, **17**;

a fabric winding roll **21** for winding knitted cloth, said winding roll having two opposed

ends, and including means for changing the diameter of the roll to allow a fabric wound **35** thereon to be doffed therefrom, and including comb means positioned on the surface of the roll and movable from a retracted position below the surface to an extended position projecting from the surface of the roll for engaging the cloth and retaining the cloth onto the winding roll;

means pivotally connecting one end of the winding roll to one of the support arms;

a pivotally mounted turning lever **28** supporting the other end of the winding roll so that the other end of the winding roll may be moved from a home, winding position to an unloading, doffing position;

means for guiding **43** fabric to the winding roll at the start of fabric winding;

means for stopping the fabric winding roll after a predetermined amount of fabric has been wound;

means for cutting **48** the fabric after fabric winding; and

fabric doffing means **47** for doffing the fabric from the winding roll in the direction of the roll axis, said doffing means including a doffing plate for pressing the side of a wound fabric roll from the winding roll.

7. An apparatus according to Claim 6, and further including locking means **37** operatively connected to the turning lever for locking the turning lever in a position in which the turning lever supports the winding roll in the home, winding position and for unlocking the turning lever to allow the turning lever to pivot and disengage from the winding roller, said locking means including a cam on which the turning lever abuts, and including motor means operatively connected to the cam for rotating the cam for turning the lever arm.

8. A fabric winding roll **21** for use in knitting machines in which the fabric winding roll has two opposed ends and is positioned between opposed winding apparatus frame arms, **16**, **17** and being characterized by

means adapted for pivotally connecting one end of the winding roll to one of the frame arms so that the winding roll may be moved from a home, winding position to an unloading, doffing position in which the other end of the winding roller is removed from the other frame arm;

means for changing the cross-sectional size of the winding roller; and

a plurality of combs **35** positioned on the surface of the winding roll, and wherein the combs are movable between an extended position in which combs project from the winding roll for grasping knitted fabric and retaining the knitted fabric onto the winding roll, and a withdrawn position in which the combs are positioned below the surface of the winding roll.

9. A fabric winding roll according to Claim 8 wherein the winding roll includes two channel members **21a**, **21b** dividing the winding roll into two half-sections, and including means for moving the half-sections relative to each other for changing the cross-sectional size of the winding roll.

10. A fabric winding roll according to Claim 9 wherein the channel members **21a**, **21b** of the winding roll include guide channel members having holes, and wherein the half-section channel members engage the guide channel members and are guided along the holes when the cross-sectional size of the winding roll is changed.

11. A method of automatically winding and doffing knitted fabric on a circular knitting machine and being characterized by the steps of

guiding the knitted fabric to a winding roll positioned between opposed winding apparatus frame arms,

catching the fabric on the winding roll by engaging the guided fabric onto a plurality of combs that are positioned on the winding roll and that extend beyond the peripheral surface of the winding roll,

winding the fabric onto the winding roll,

detecting the length of fabric wound onto the winding roll,

reducing the cross-sectional size of the winding roll,

doffing the fabric from the winding roll, and

opening a gate which covers and protects the winding roll to allow the knitted fabric to be doffed outside the machine.

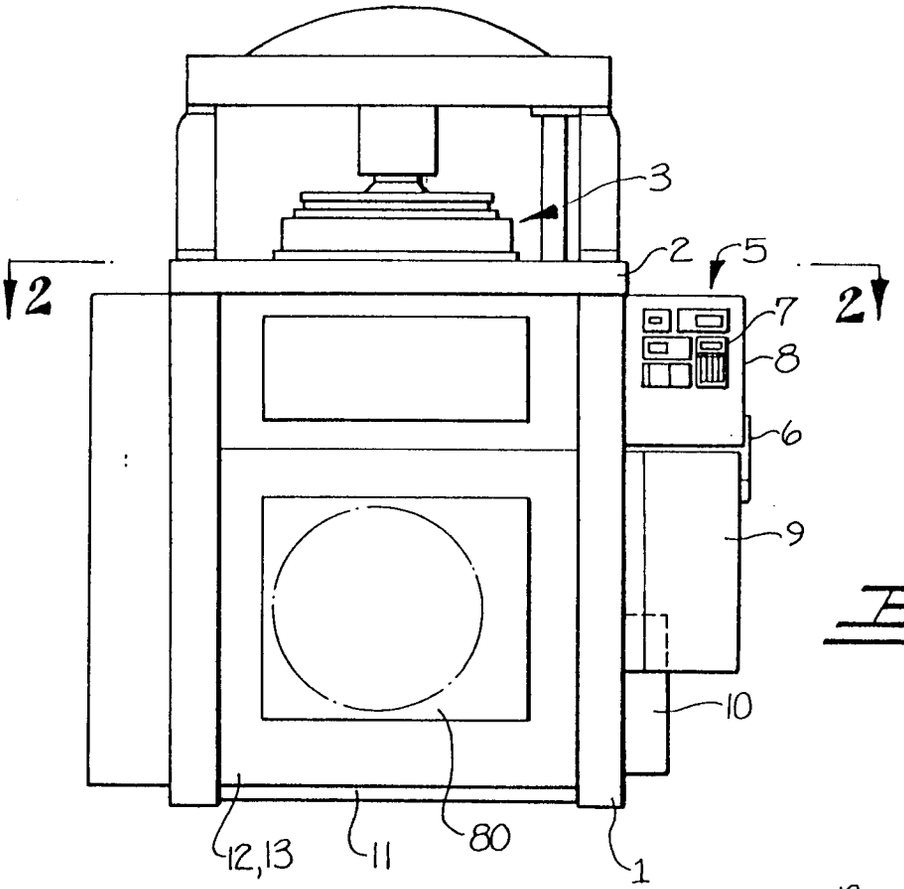

Fig-1

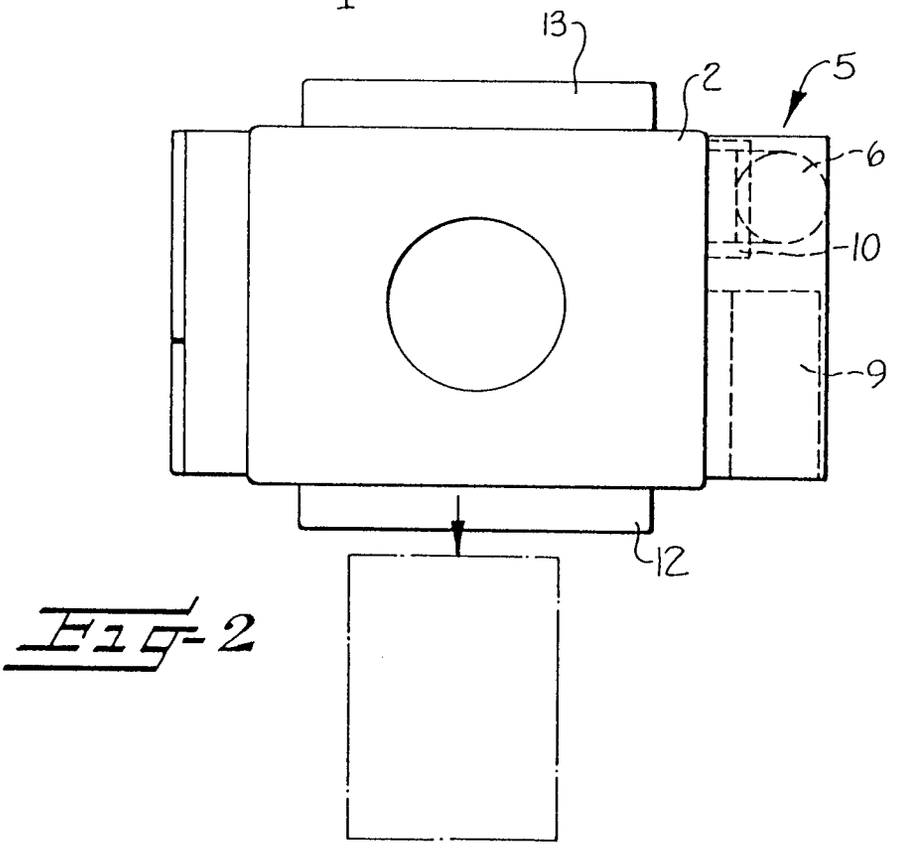

Fig-2

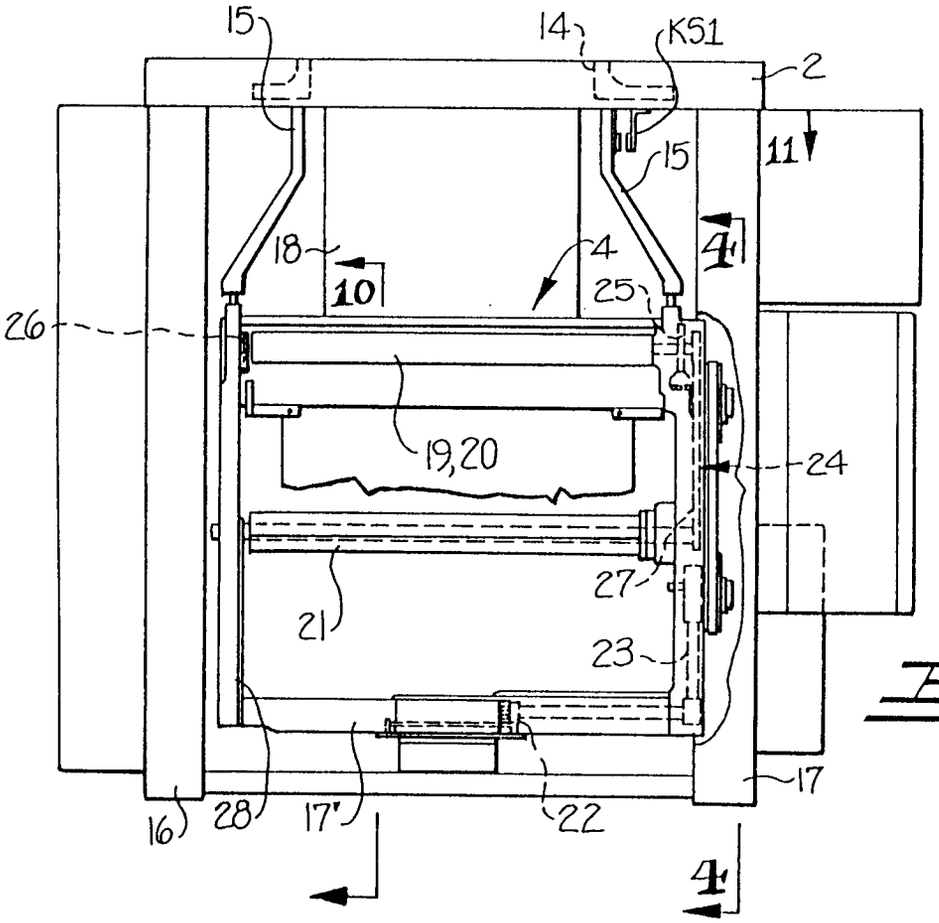
15
14
K51
2
11
15
18
10
4
4
25
26
19,20
24
27
21
23
17
16
28
17'
22
4

Fig-3

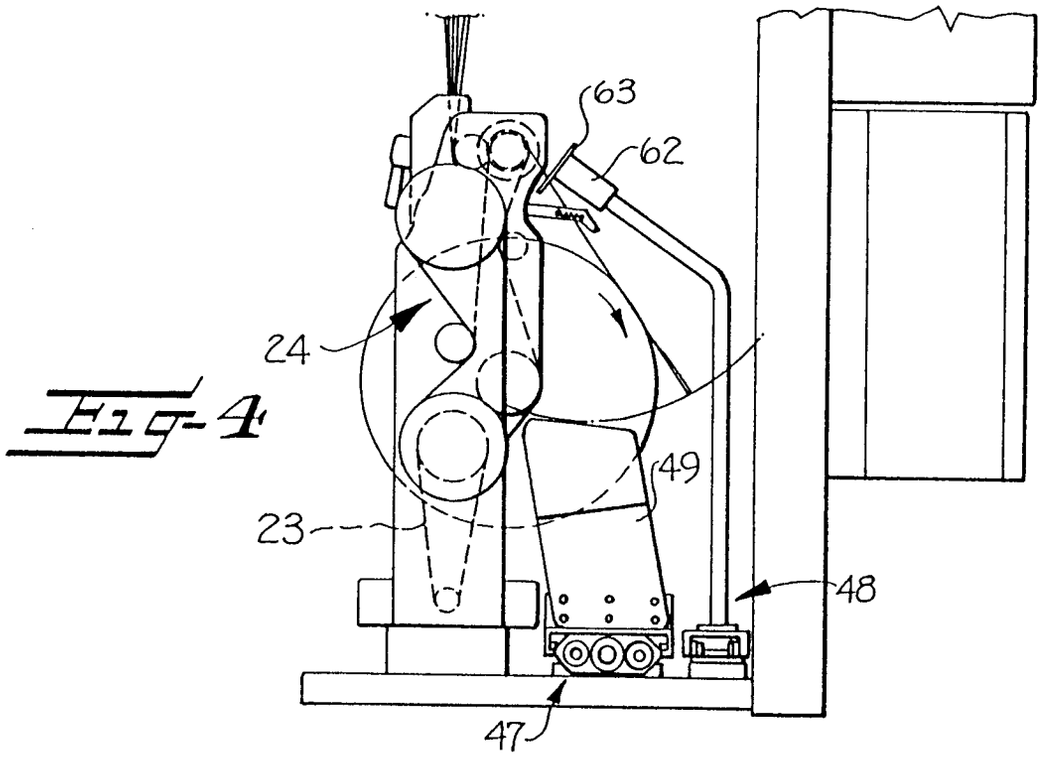
63
62
24
49
23
48
47

Fig-4

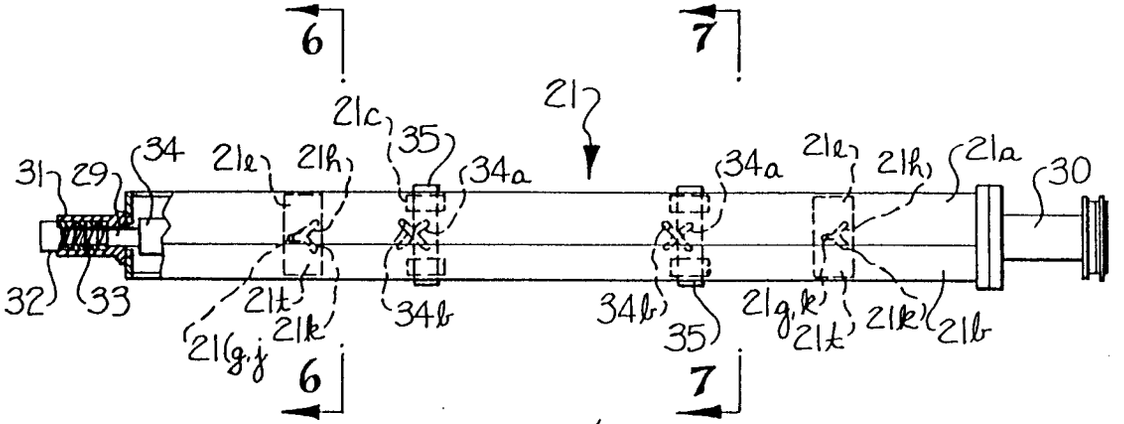

Fig-5

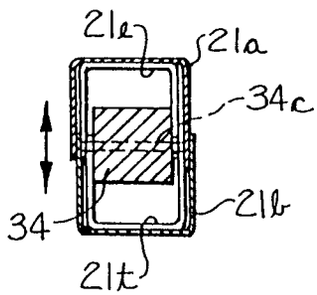

Fig-6

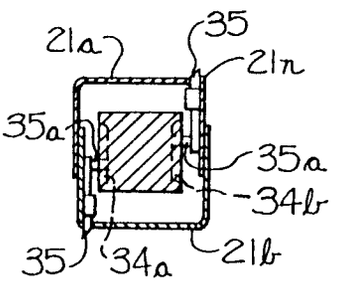

Fig-7

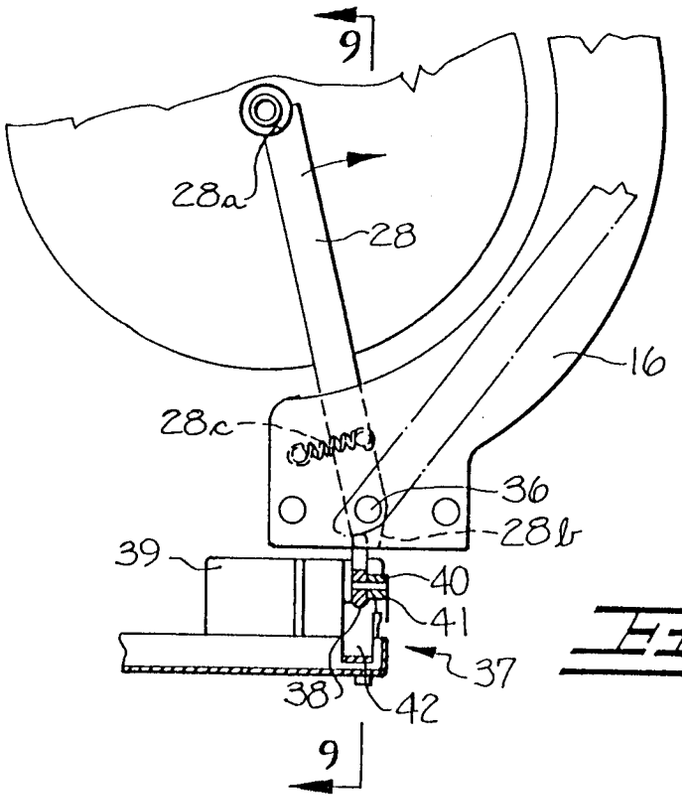

Fig-8

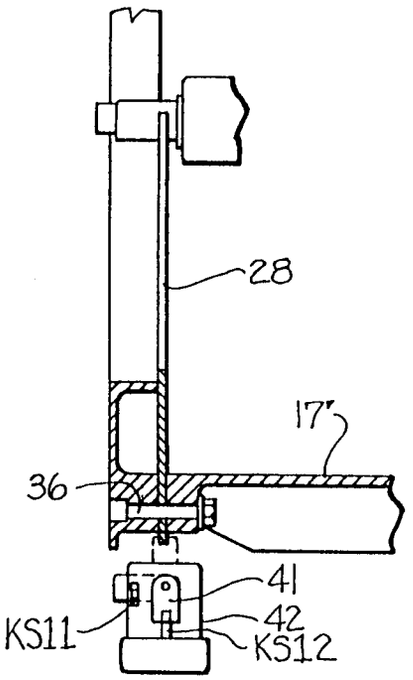

Fig-9

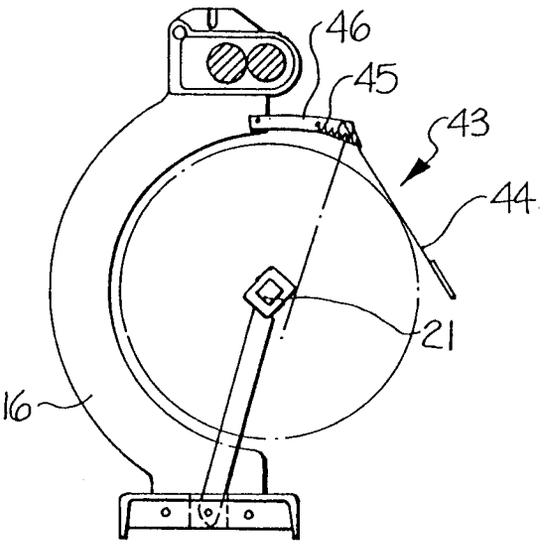

Fig-10

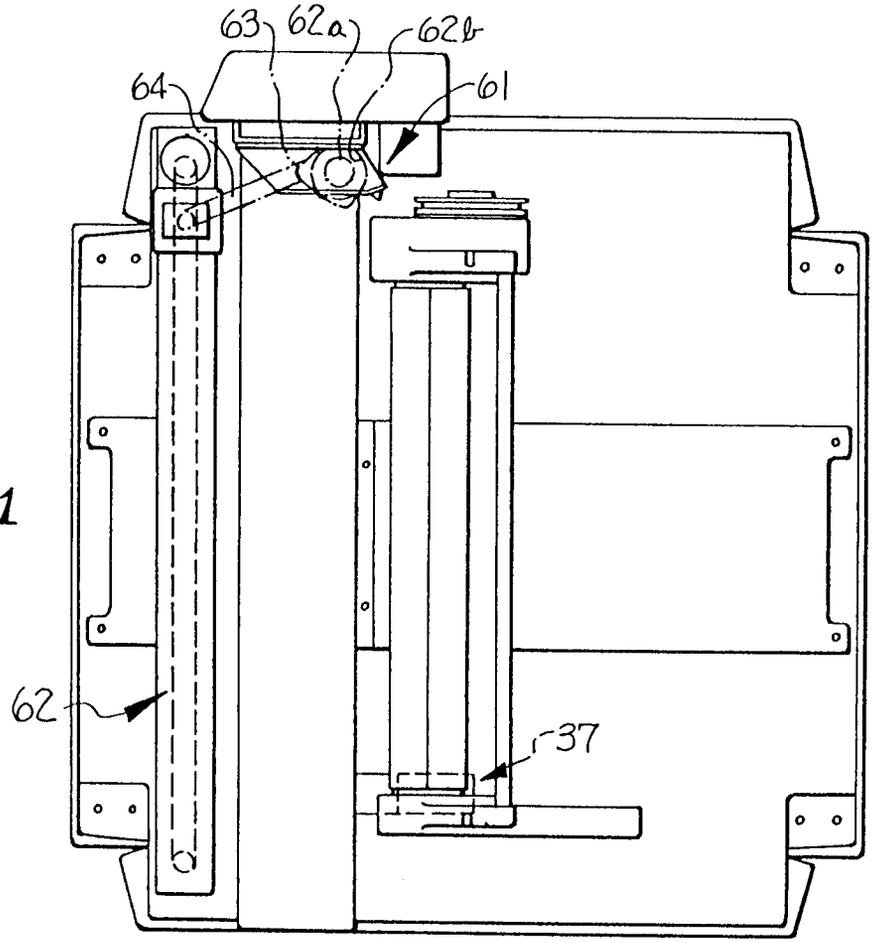

Fig-11

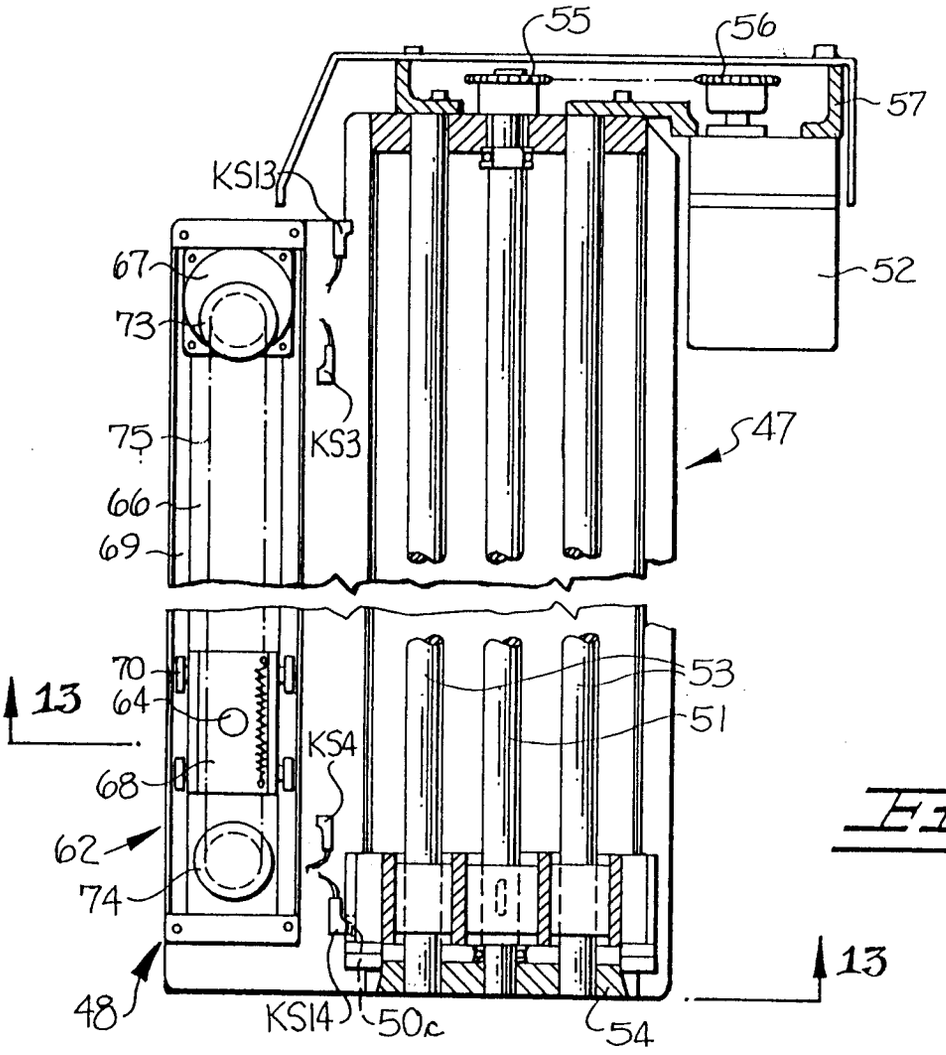
55
56
57
KS13
67
73
52
75
KS3
47
66
69
70
64
53
51
13
KS4
68
62
74
48
KS14
50c
54
13

Fig-12

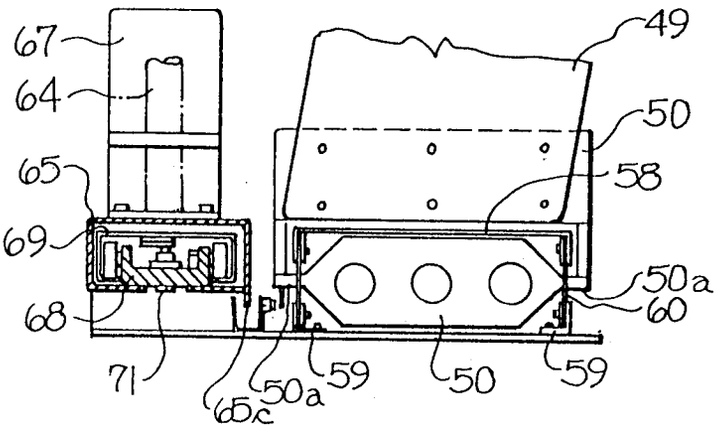
67
64
49
50
65
58
69
50a
60
68
71
65c
50a
59
50
59

Fig-13

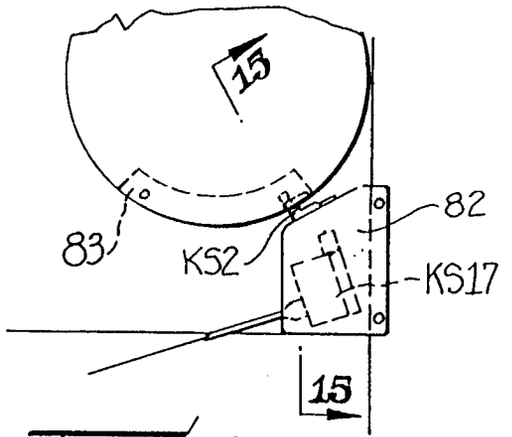

Fig-14

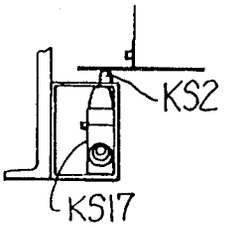

Fig-15

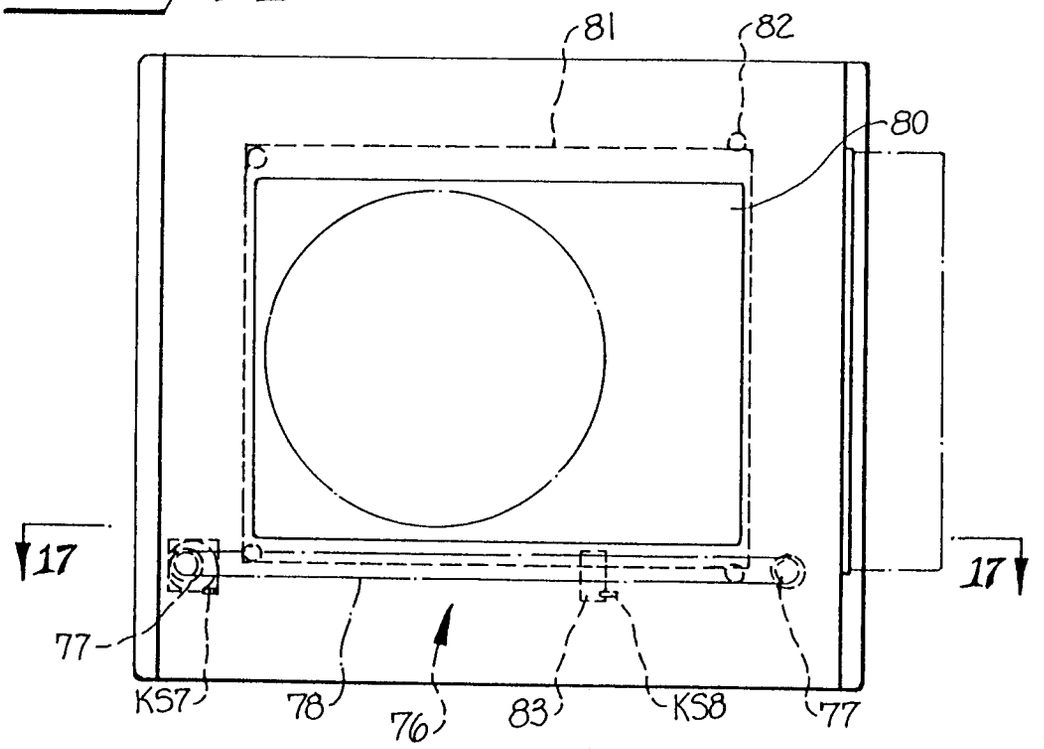

Fig-16

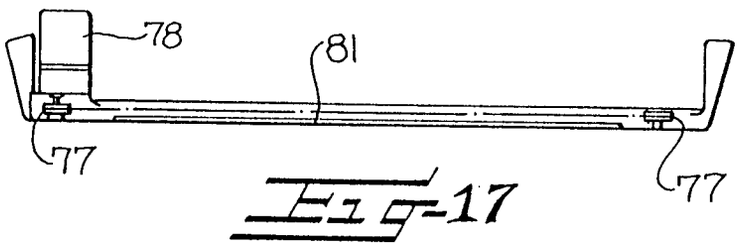

Fig-17

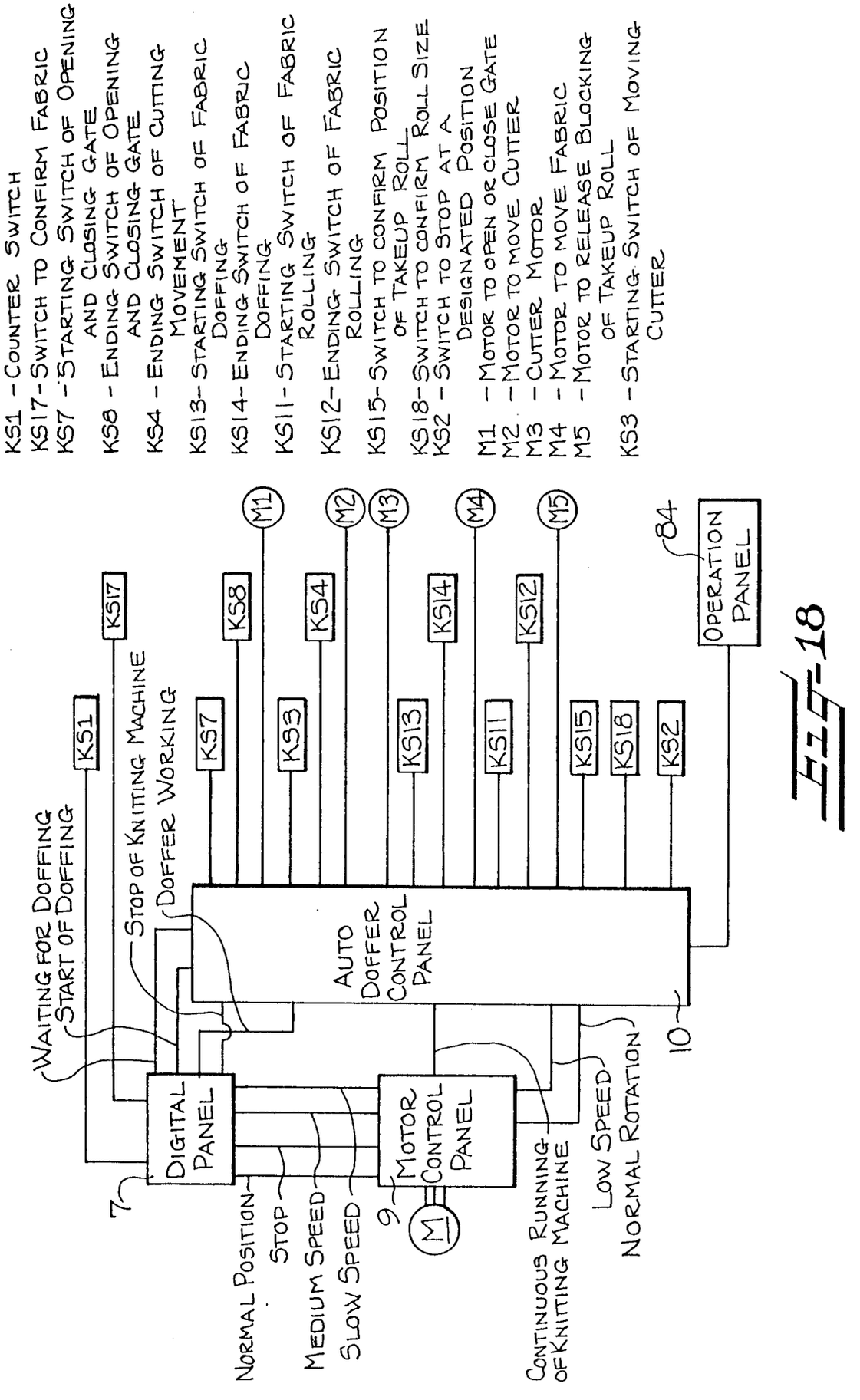
KS1 - Counter Switch
KS17- Switch to Confirm Fabric
KS7 - Starting Switch of Opening and Closing Gate
KS8 - Ending Switch of Opening and Closing Gate
KS4 - Ending Switch of Cutting Movement
KS13- Starting Switch of Fabric Doffing
KS14- Ending Switch of Fabric Doffing
KS11- Starting Switch of Fabric Rolling
KS12- Ending Switch of Fabric Rolling
KS15- Switch to Confirm Position of Takeup Roll
KS18- Switch to Confirm Roll Size
KS2 - Switch to Stop at a Designated Position
M1 - Motor to Open or Close Gate
M2 - Motor to Move Cutter
M3 - Cutter Motor
M4 - Motor to Move Fabric
M5 - Motor to Release Blocking of Takeup Roll
KS3 - Starting Switch of Moving Cutter
Waiting for Doffing
Start of Doffing
Stop of Knitting Machine
Doffer Working
Auto Doffer Control Panel
Digital Panel
Motor Control Panel
Normal Position
Stop
Medium Speed
Slow Speed
Continuous Running of Knitting Machine
Low Speed
Normal Rotation
Operation Panel
7
9
10
84
M
M1
M2
M3
M4
M5
KS1
KS17
KS7
KS8
KS3
KS4
KS13
KS14
KS11
KS12
KS15
KS18
KS2

Fig-18

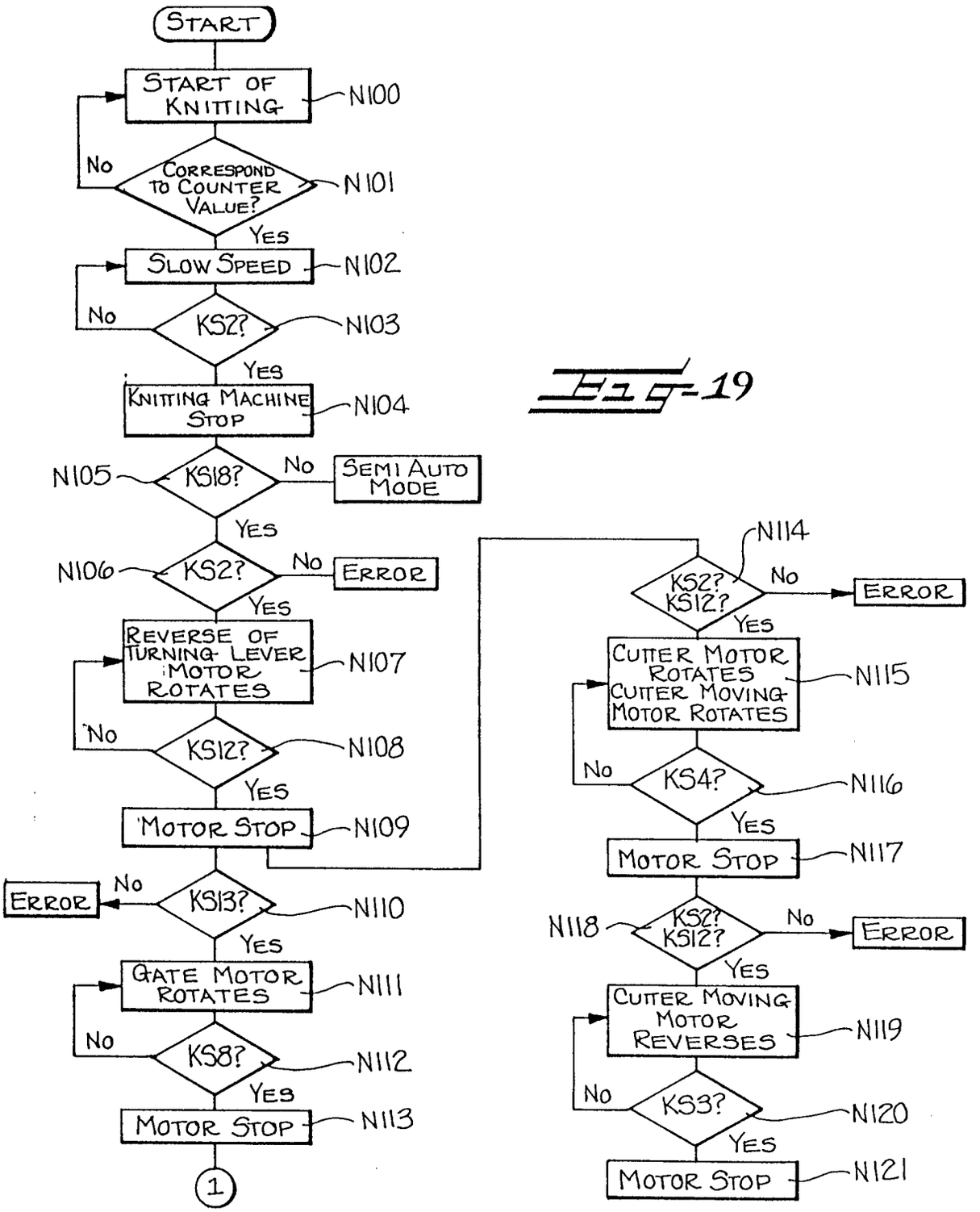
START
START OF KNITTING
N100
No
CORRESPOND TO COUNTER VALUE?
N101
Yes
SLOW SPEED
N102
No
KS2?
N103
Yes
KNITTING MACHINE STOP
N104
N105
KS18?
No
SEMI AUTO MODE
Yes
N106
KS2?
No
ERROR
Yes
REVERSE OF TURNING LEVER MOTOR ROTATES
N107
No
KS12?
N108
Yes
MOTOR STOP
N109
ERROR
No
KS13?
N110
Yes
GATE MOTOR ROTATES
N111
No
KS8?
N112
Yes
MOTOR STOP
N113
1
N114
KS2? KS12?
No
ERROR
Yes
CUTTER MOTOR ROTATES CUTTER MOVING MOTOR ROTATES
N115
No
KS4?
N116
Yes
MOTOR STOP
N117
N118
KS2? KS12?
No
ERROR
Yes
CUTTER MOVING MOTOR REVERSES
N119
No
KS3?
N120
Yes
MOTOR STOP
N121

Fig-19

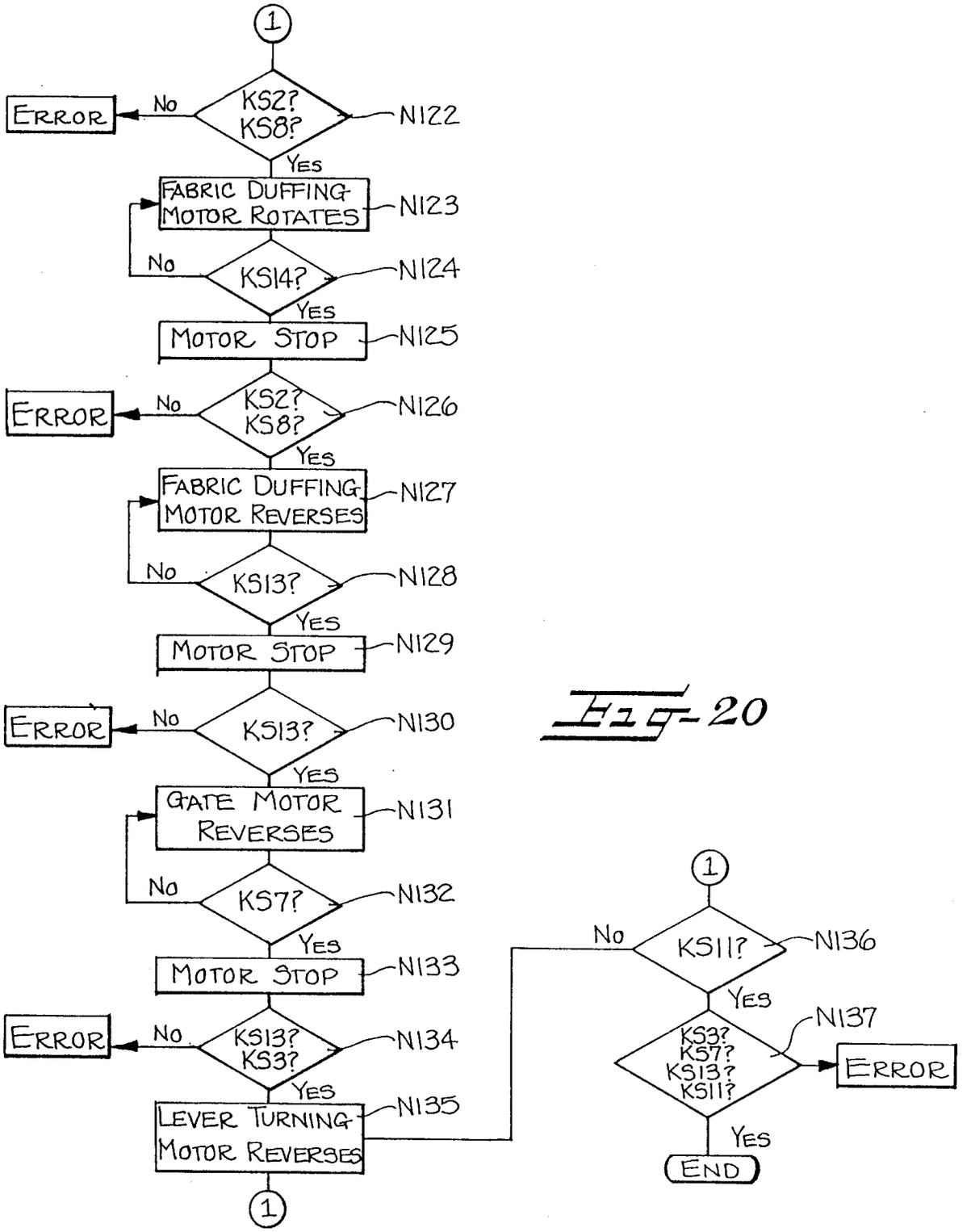
1
KS2?
KS8?
N122
No
ERROR
Yes
FABRIC DUFFING MOTOR ROTATES
N123
KS14?
N124
No
Yes
MOTOR STOP
N125
KS2?
KS8?
N126
No
ERROR
Yes
FABRIC DUFFING MOTOR REVERSES
N127
KS13?
N128
No
Yes
MOTOR STOP
N129
KS13?
N130
No
ERROR
Yes
GATE MOTOR REVERSES
N131
KS7?
N132
No
Yes
MOTOR STOP
N133
KS13?
KS3?
N134
No
ERROR
Yes
LEVER TURNING MOTOR REVERSES
N135
1
1
KS11?
N136
No
Yes
KS3?
KS7?
KS13?
KS11?
N137
ERROR
Yes
END

Fig-20