United States Patent

Hori et al.

[15] **3,695,017**

[45] **Oct. 3, 1972**

[54] **AUTOMATIC YARN PIECING APPARATUS FOR SPINDLELESS SPINNING MACHINE**

[72] Inventors: **Kiyokazu Hori; Tatsuo Kose; Kazuo Ochi,** all of Wakayama, Japan

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

[22] Filed: **March 11, 1970**

[21] Appl. No.: **18,596**

[30] **Foreign Application Priority Data**

Mar. 15, 1969 Japan 44/19943
Dec. 16, 1969 Japan.....44/101514
Dec. 19, 1969 Japan.....44/102821

[52] **U.S. Cl.**.....**57/34 R,** 57/58.95, 57/91

[51] **Int. Cl.**.....**D01h 15/00**

[58] **Field of Search**.....57/34 R, 58.89–58.95, 57/81

[56] **References Cited**

UNITED STATES PATENTS

3,128,590	4/1964	Escursell-Prat	57/34 R
3,411,281	11/1968	Guido et al.	57/34 R
3,511,041	5/1970	Korikoysky et al.	57/34 R
3,540,200	11/1970	Tsukumo et al.	57/34 R

Primary Examiner—John Petrakes
Attorney—Waters, Roditi, Schwartz & Nissen

[57] **ABSTRACT**

An automatic yarn piecing apparatus for use with an spindleless spinning machine of the type having a plurality of spinning units each of which spins fiber materials into a yarn and deliver the thus-formed yarn to be taken up on a bobbin. The apparatus travels along the front face of the spinning machine and stops at the position of a particular spinning unit wherein yarn breakage has occurred, to automatically piece the broken yarn by the cooperation of various means in such a manner that the broken yarn is withdrawn from the yarn package on the bobbin, gripped and cut to form a new cut end of the yarn while simultaneously removing the snarl from the yarn end, and then the cut end of the yarn is introduced into the rotary chamber of the spinning unit through the delivery outlet thereof to effect piecing of the yarn.

4 Claims, 23 Drawing Figures

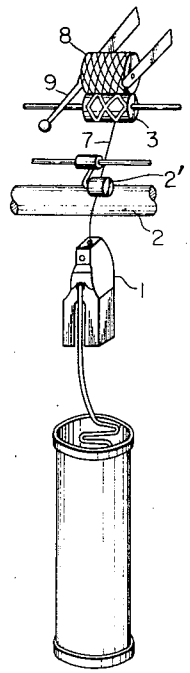


Fig. 1

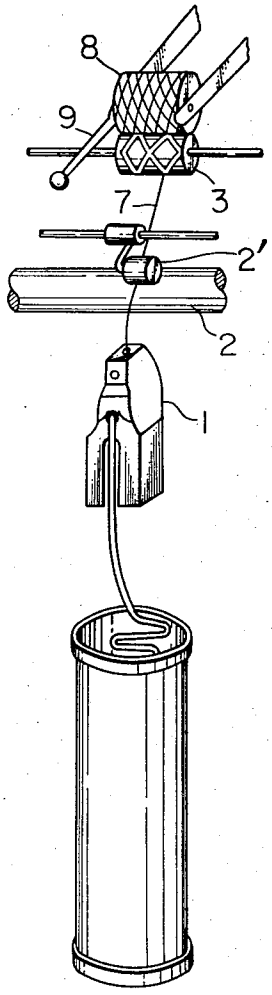


Fig. 2

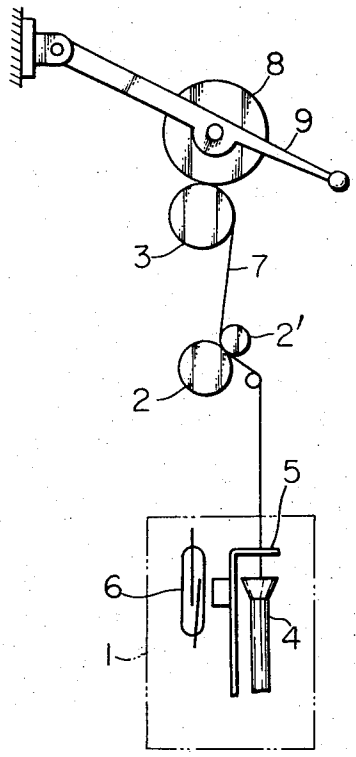


Fig. 3

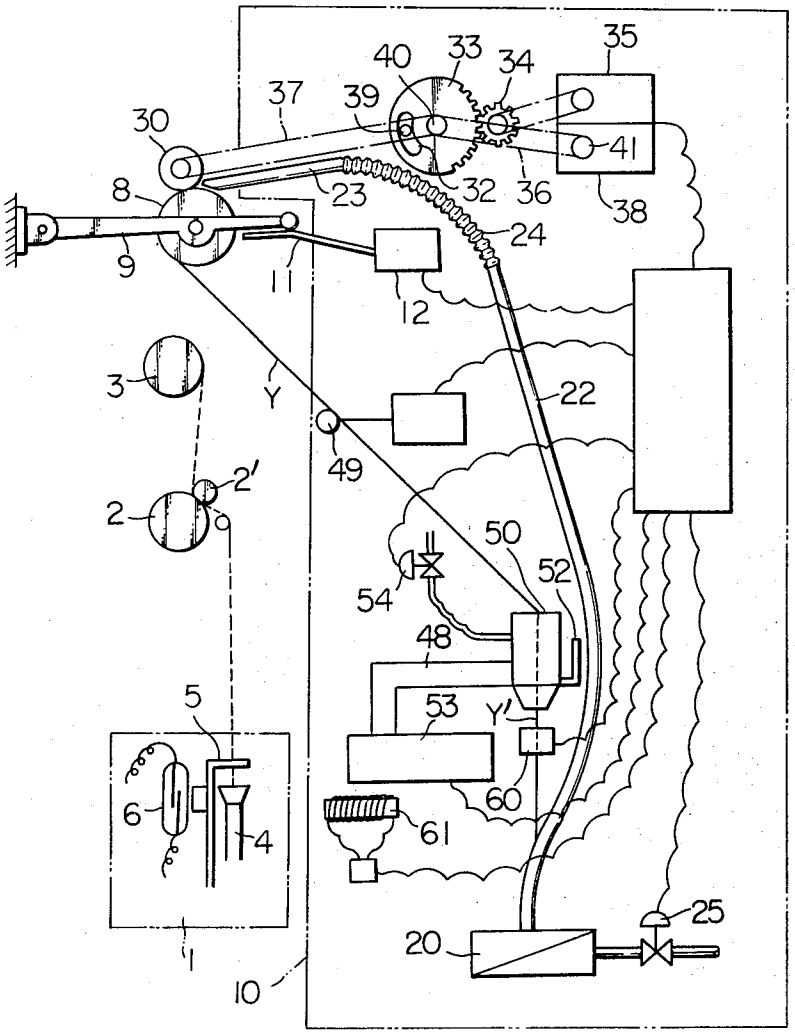

40
33
34
35
37
39
30
41
8
23
32
36
38
24
9
11
12
3
Y
22
49
2'
2
50
54
52
48
5
53
Y'
6
4
60
61
25
20
1
10

Fig. 4

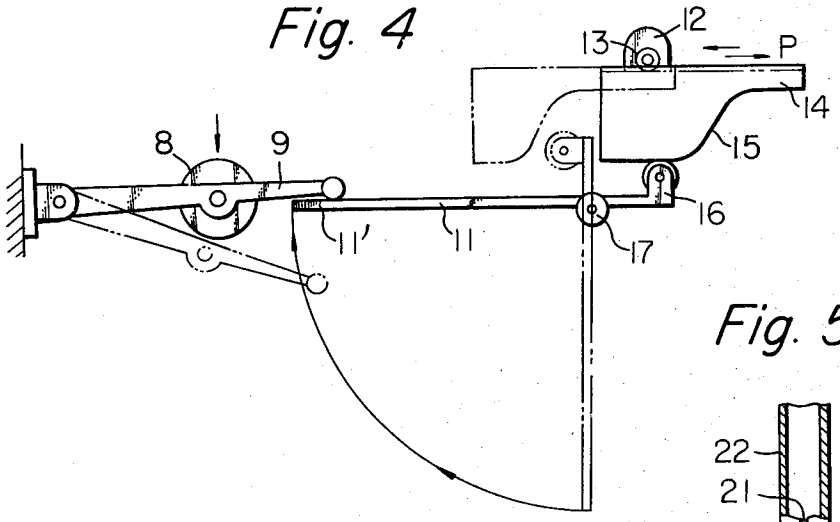


Fig. 5

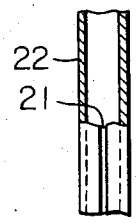


Fig. 6

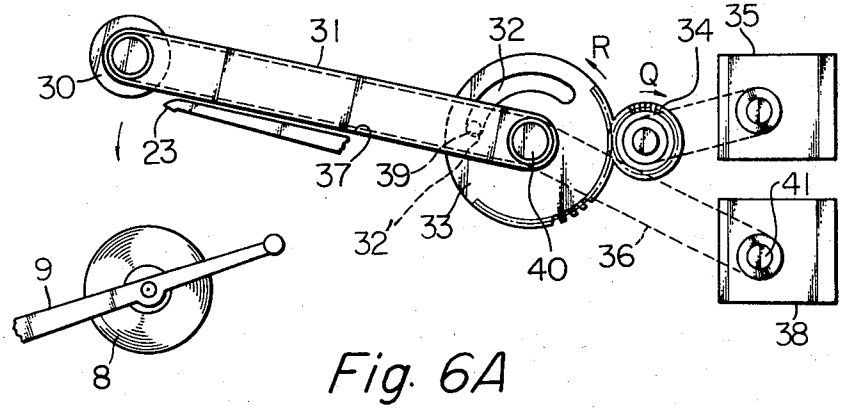


Fig. 6A

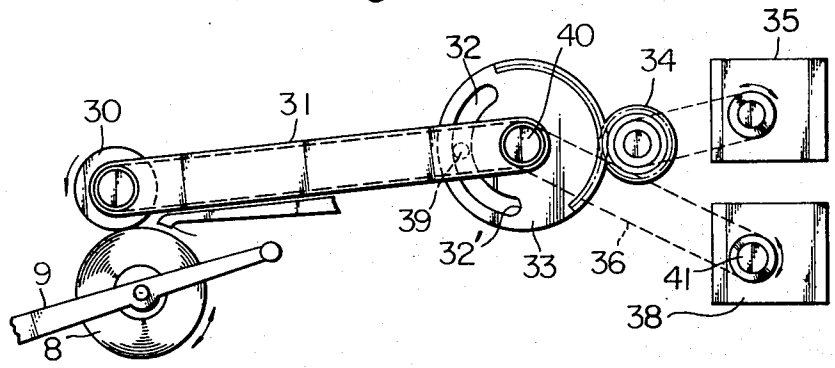


Fig. 7

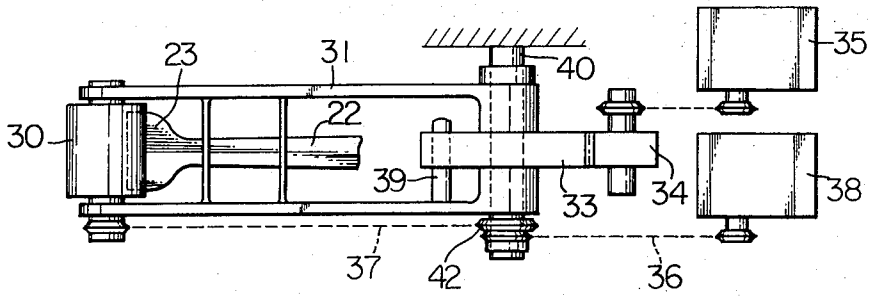


Fig. 8

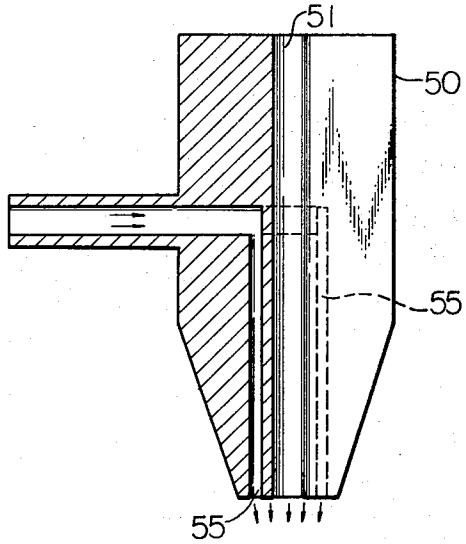


Fig. 9

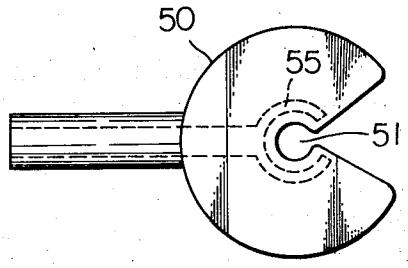


Fig. 10

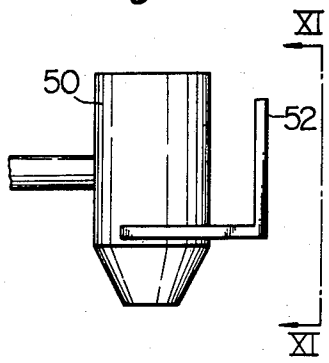


Fig. 11

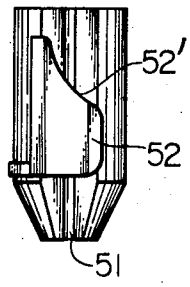


Fig. 12

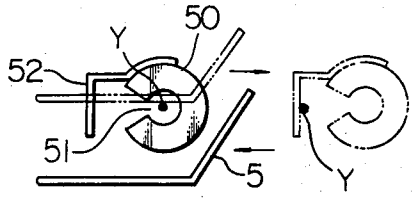


Fig. 13

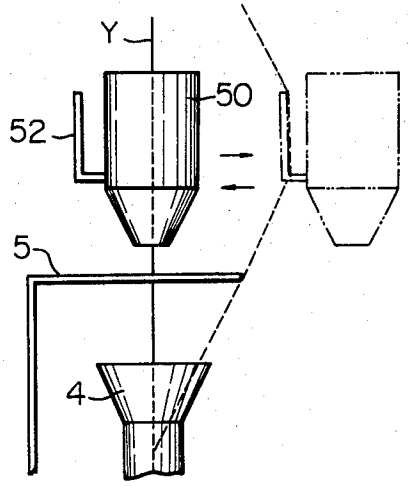


Fig. 14

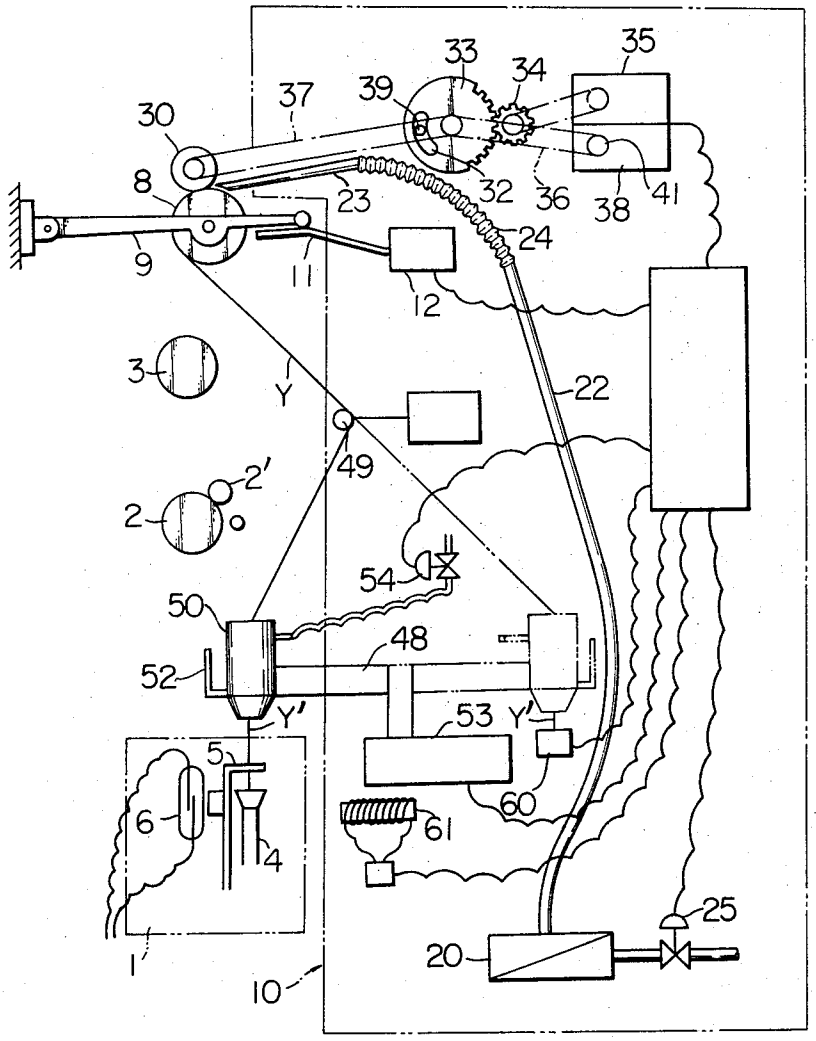

33
35
34
37
39
30
8
23
32
36
38
41
24
9
11
12
3
Y
22
49
2'
2
54
50
48
52
Y'
53
Y'
5
6
4
60
61
25
20
1'
10

Fig. 15

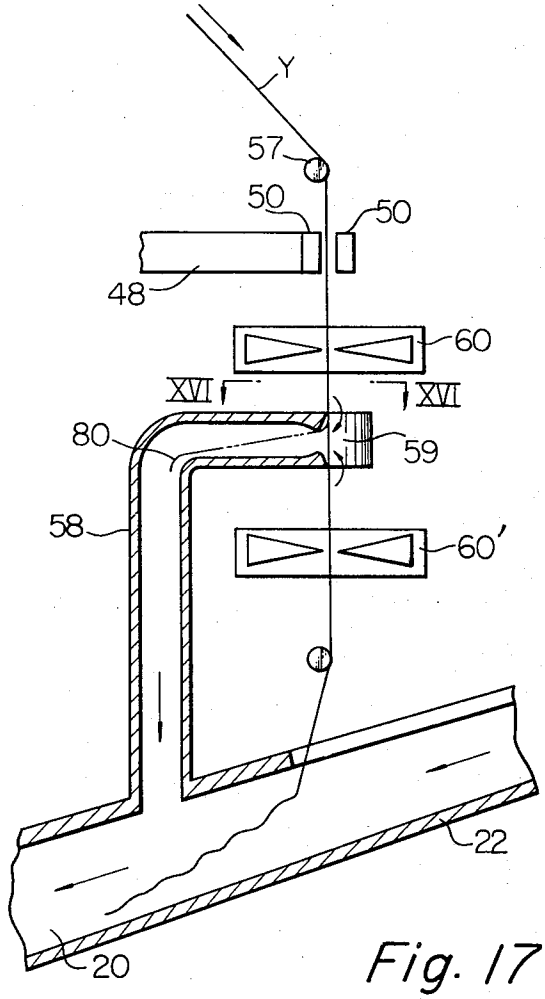


Fig. 16

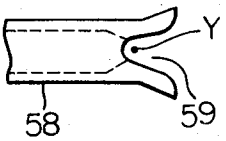


Fig. 17

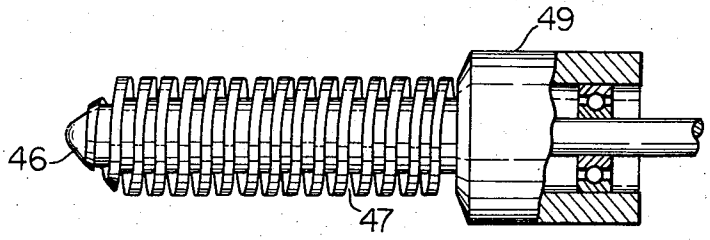


Fig. 18

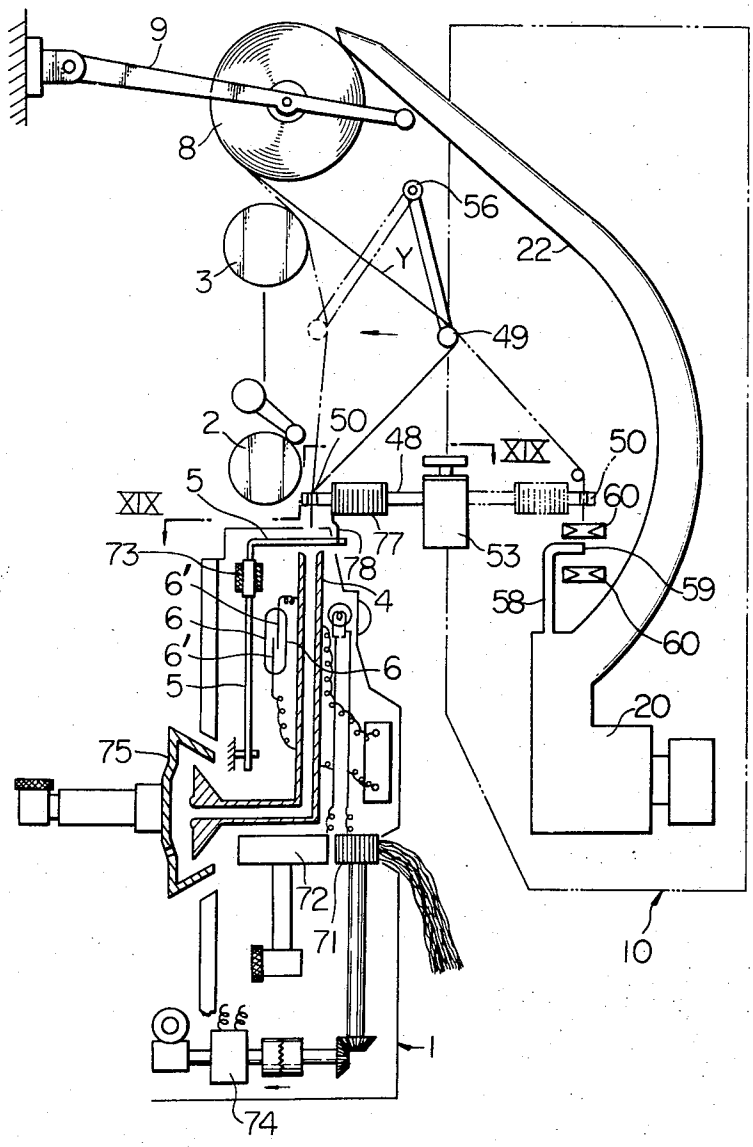

9
8
56
22
Y
3
49
2
50
48
XIX
50
5
XIX
60
73
77
53
78
59
6'
4
58
6
60
6'
6
5
20
75
72
71
10
1
74

Fig. 19

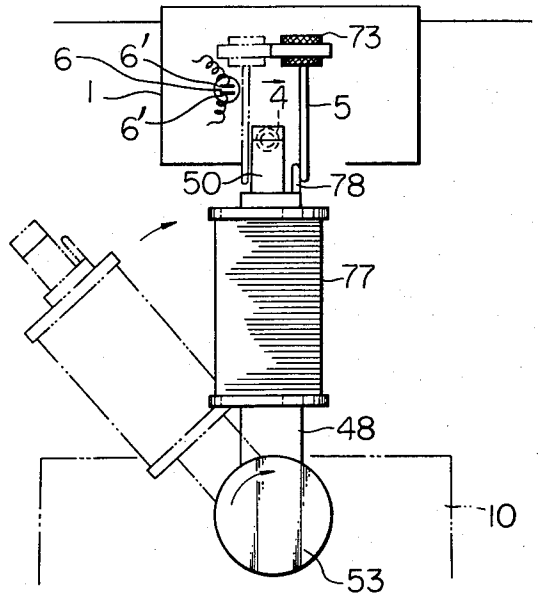

73
6
6'
1
4
5
6'
50
78
77
48
10
53

Fig. 20

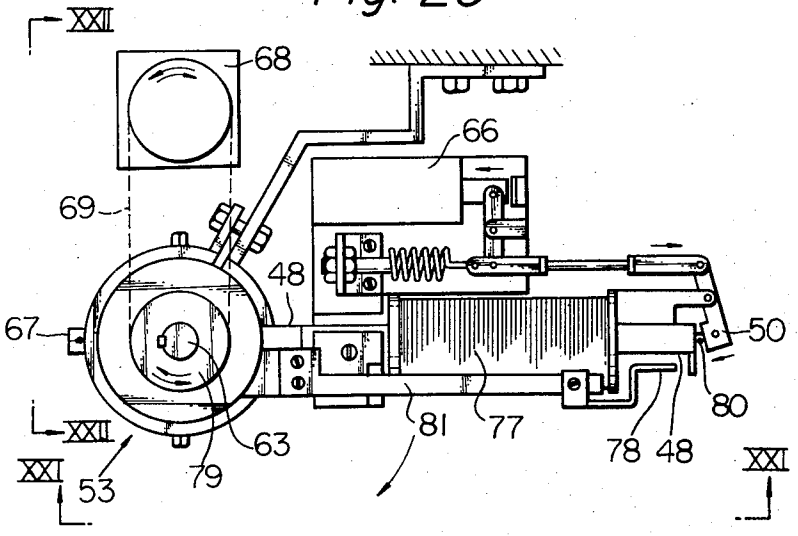

XXII
68
66
69
48
67
50
80
XXII
63
81
77
78
48
XXI
XXI
53
79

Fig. 21

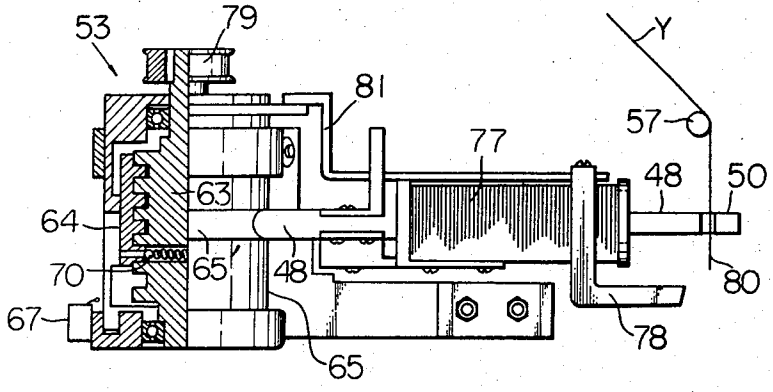
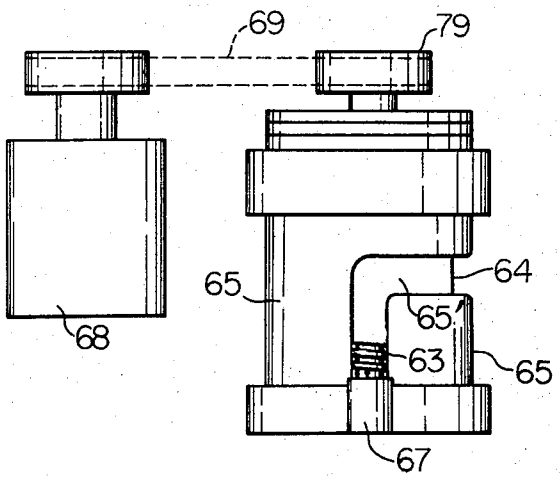

53
79
81
Y
57
77
48
50
63
64
65
70
48
80
67
78
65

Fig. 22


69
79
64
65
65
63
65
68
67

AUTOMATIC YARN PIECING APPARATUS FOR SPINDLELESS SPINNING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an automatic yarn piecing apparatus, and more particularly to an automatic yarn piecing apparatus adapted for use with an open end spinning machine or a break spinning machine having a plurality of spinning units, which travels along the front face of said spinning machine and is brought to a halt in front of the particular spinning unit wherein yarn breakage has occurred, to perform a yarn piecing operation, all automatically.

2. Description of the Prior Art

Recently, open end spinning machines of the type described have come into common use. These spinning machines are of a spindleless type which comprises a large number of spinning units arranged side-by-side in a single row and each having a rotatable spinning chamber operative under negative pressure, a feeder for feeding fiber materials into said chamber, a roller to open the fiber materials thus fed and a yarn delivery tube for delivering therethrough the yarn spun in said chamber to a take-up bobbin to form a package. The yarn delivery tube of each unit is provided at its outlet with a yarn feeler which is held in contact with the spun yarn, throughout the operation, to sense a breakage of the yarn. Upon sensing a yarn breakage, the feeler caused disengagement of a magnetic clutch connected directly with the fiber material feeder, thereby to interrupt the operation of said feeder. The spinning unit is also provided with means to indicate the yarn breakage.

In the past, an operation of piecing the yarn, upon occurrence of yarn breakage, has been performed manually by a patrolling operator at the spot of the particular spinning unit, of which the yarn breakage is indicated by the indicating means, and the automatization of the operation has been strongly desired.

SUMMARY OF THE INVENTION

The present invention contemplates the provision of an apparatus by which the yarn piecing operation, hitherto performed manually by an operator, can be accomplished mechanically automatically. The apparatus according to the present invention is so designed that it constantly travels along the front face of the associated spinning machine and, upon sensing a signal from a spinning unit, indicating the occurrence of yarn breakage, stops in front of said spinning unit to perform the yarn piecing operation.

The automatic yarn piecing apparatus of the invention, which is adapted for use with an open end spinning machine of the type described, comprises package holder push-up means for disengaging a package of the spinning machine from a take-up drum, rotating means for rotating the thus disengaged package in the winding or rewinding direction, yarn end drawing means for drawing the broken yarn end from the package under suction communicating with a source of suction and having a longitudinal continuous slit formed in the wall of that portion thereof which is curved toward the spinning machine, yarn end gripping means adapted to grip the drawn yarn outside of said yarn end drawing means and carry the gripped yarn to a position above the yarn delivery tube of the spinning unit, and yarn cutting means for cutting the yarn at a location below the yarn gripping means. The automatic yarn piecing apparatus constructed as described above operates in the following manner: Namely, when the yarn is broken in one of the spinning units of the spinning machine, the package is disengaged from the winding drum by the action of the package holder push-up means and rotated in the rewinding direction to release the yarn. Simultaneously, the broken yarn end is drawn by the yarn drawing means and thus the intermediate portion of the yarn slips out through the slit of the yarn drawing means and is held taut at an angle to the line connecting the package with the particular spinning unit of the spinning machine, with the broken yarn end being gripped by the gripping means. The yarn end is then cut by the yarn cutting means to form an introducing yarn end and thereafter the cut yarn end, being gripped by the yarn gripping means, is moved to a position above the outlet of the yarn delivery tube of said spinning unit. Then, the package is rotated in the rewinding direction and the gripped yarn is introduced into the delivery tube, whereupon the spinning chamber is rotated and the cut yarn is pieced with the yarn, spun in said spinning chamber, at the collecting surface of the chamber. Upon completion of the piecing operation, the bobbin is rotated in the winding direction and the pieced yarn is continuously delivered from the spinning unit.

An object of the present invention, therefore, is to provide an automatic yarn piecing apparatus which is capable of readily piecing a broken yarn without requiring manual labor.

Another object of the invention is to provide an automatic yarn piecing apparatus of the character described, wherein two vertically spaced cutters are provided below the yarn gripping means and further snarl eliminating means is provided which has one end communicating with a source of suction, with the other end open at a location between said two cutters for sucking the cut yarn end thereinto under suction and thereby eliminating the snarl of the yarn.

Still another object of the invention is to provide an automatic yarn piecing apparatus of the character described, wherein yarn guiding means is provided which consists of a roller rotatably mounted on a cantilever pivotable toward the spinning machine, and having a screw-thread formed in the peripheral surface thereof.

In some spinning machines, a feeler for sensing the breakage of yarn is pivotally mounted on the outlet of each yarn delivery tube and said feeler is provided with a permanent magnet, so that when the yarn is broken, said feeler is caused to make a pivotal movement and the contacts of a switch which energizes a magnetic clutch for operating a feeder are brought into contact with each other under the influence of the magnetic force of said permanent magnet. In this case, the apparatus of the invention may advantageously be constructed such that the contacts of the switch are maintained in the closed position, until the normal spinning operation is resumed, under the influence of the magnetic field of an electromagnet which is provided on the yarn gripping means at a location adjacent a gripper thereof for gripping the cut end of the yarn, and is

excited when said gripping means has been shifted to above the outlet of the delivery tube.

These objects and features of the present invention will be more fully understood by reading the following detailed description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one of spinning units of an open end spinning machine;

FIG. 2 is a fragmentary side view of one unit of the spinning machine;

FIG. 3 is a side view of a main part of a yarn piecing apparatus according to the present invention, in relation with the open end spinning unit;

FIG. 4 is a side view, partially omitted, of a package holder pushup mechanism;

FIG. 5 is a front view, partially cut away, of a suction pipe;

FIGS. 6, 6*a* and 7 are views of a package rewinding mechanism, in which FIGS. 6 and 6*a* are front views and FIG. 7 is a plan view;

FIGS. 8 – 11 are schematic views of a gripping body, in which FIG. 8 is a longitudinal sectional view; FIG. 9 is a plan view; FIG. 10 is a side view of the gripper but including a yarn handling means; and FIG. 11 is another side view of the gripper taken along the line XI—XI of FIG. 10;

FIGS. 12 and 13 are a plan view and a side view respectively illustrating a yarn handling operation

FIG. 14 is a sectional side view, similar to FIG. 3, for the purpose of explaining an operation of displacing the gripping body and piecing a yarn;

FIG. 15 is a partially broken away schematic side view of a snarl eliminating mechanism;

FIG. 16 is a partial plan view taken along the line XVI—XVI of FIG. 15;

FIG. 17 is a front view, partially in section, of a yarn guiding means;

FIG. 18 is a side view of another yarn piecing apparatus having feed roller controlling means and the spinning machine;

FIG. 19 is a plan view taken along the line XIX—XIX of FIG. 18;

FIG. 20 is a plan view of another form of the yarn gripping assembly;

FIG. 21 is a front view looking in the direction of XXI—XXI of FIG. 20; and

FIG. 22 is a side view, partially in section, looking in the direction of XXII—XXII of FIG. 21.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A spindleless spinning machine or open end spinning machine to which the present invention is applied, comprises a plurality of spinning units arranged in a row at the front portion of the spinning machine. Each spinning unit is generally indicated by numeral 1 in FIGS. 1 and 2. The spinning unit spins fiber materials, or a silver fed from a can, into a yarn 7, which is taken up on a package 8 by means of a winding drum or traversing roll 3 through a pair of delivery rolls 2, 2', said package 8 being supported by a pair of holders 9. Each unit includes a cup-shaped spinning chamber or rotor 75 rotating at a high speed, a yarn delivering tube 4, a yarn breakage sensing feeler 5 and a lead switch 6 which is opened or closed by a feeler action to start or stop the fiber material feed roller. One of the delivery rollers 2' having a smaller inner diameter is provided with a V-shaped notch in the surface at one end thereof, which serves to catch the yarn 7 and automatically guide the same into the nip of the rollers 2, 2', as is well known. The winding drum 3 has grooves formed in the peripheral surface thereof to traverse the yarn, and the yarn thus traversed is taken up on the package 8 supported by the bobbin holder 9. The package holder 9 is pivotable about a pivot on the frame of the spinning machine, so as to urge the package 8 against the drum 3.

The automatic yarn piecing machine of the present invention is generally indicated by numeral 10 and comprises the following mechanisms.

1. Package Holder Push-Up Mechanism

The package holder push-up mechanism serves to disengage the yarn winding package 8 (hereinafter referred to simply as package) from the peripheral surface of the traversing roll 3, which package is rotating in engagement with said traversing roll above the spinning unit 1, and includes a push-up arm 11 and a driving source 12 to cause a pivotal movement of said arm.

Referring to FIG. 4, the arm 11 is pivotable about a pivot 17 and carries a roller at its right hand end 16 as viewed in the Figure. Above the arm 11 is provided a rack-pinion mechanism supported by means not shown (the pinion being indicated by numeral 13) and a cam lever 14 is fixed to the underside of said rack. When the pinion 13 is driven from a motor 12, the rack and the cam are moved in the direction of the arrow P from a position indicated by the phantom line to a position indicated by the full line. In this case, a curved surface 15 of the cam abuts against the roller at the right hand end 16 of the arm 11, causing the same to pivot from a position indicated by the phantom line to a position indicated by the full line. As a result, the left hand end 11' of the arm is shifted from a position indicated by the phantom line to a position indicated by the full line. Thus, the package 8 is disengaged from the traversing roll 3.

2. Yarn Broken End Drawing Mechanism

This mechanism comprises a sucking source 20 adapted to be opened and closed by a magnet valve 25, a pipe 22 connected to said sucking source 20, a nozzle 23 having a nozzle inlet extending in the widthwise direction of the package 8 and a flexible pipe 24 connecting said nozzle with said pipe. The assembly of the pipe 22, the pipe 24 and the nozzle 23 has a longitudinal slit 21 formed in that side of the wall thereof which faces the spinning machine (FIG. 5). The nozzle 23 is movable toward the package, in co-operation with a package rotating mechanism to be described later, to get the nozzle opening close to the peripheral surface of the pushed-up package.

The mechanism operates in the following manner: Namely, when the package is rotated in a rewinding direction by the package rotating mechanism, the broken end of the yarn on the surface of the package is sucked into the nozzle and drawn into the sucking source 20 through the pipes 24 and 22. In this case, the yarn tends to travel in the shortest distance, so that it

moves to the outside of the pipe through the slit **21**, as indicated by symbol Y in FIG. **5**. This technique is well known in the art of winding machine and will not be described in further detail. A crescent-shaped pipe **22**, shown in FIG. **18**, may be used in lieu of the pipes **22**, **23** and **24**, providing that said crescent-shaped pipe is tiltable toward the package during operation.

3. Package Rotating Mechanism

This mechanism serves to rotate the package **8**, which has been pushed up by the push-up mechanism and thereby disengaged from the peripheral surface of the winding drum **3**, in a rewinding direction to assist in drawing of the yarn end, to reverse the yarn from the package for piecing and to rotate the package in a winding direction to wind the yarn temporarily.

A rewinding roller **30** in engagement with the peripheral surface of the package is rotatably suppoted at the opposed ends of a forked holder **31** which is pivotally mounted on a pivot shaft **40** at the other end. A pin **39** projects inwardly from one of the arms of said holder and is received in an arcuate groove **32** of a main gear **33** which is fixedly mounted on the pivot shaft **40**, said groove being concentric with said pivot shaft. The main gear **33** is in meshing engagement with a gear **34** which is driven from a drive source **35** through a chain. The roller **30** is driven by a drive transmitted thereto from another drive source **38** through a shaft **41**, a chain **36**, two sprockets **42** mounted on the shaft **40** and a chain **37**.

In the disengaged state of the package **8** from the winding drum **3**, the mechanism is in the position shown in FIG. **6**, in which the pin **39** is resting on one end **32'** of the arcuate groove **32** of the main gear **33**. Then, as the gear **34** is rotated in the direction of the arrow Q, rotating the main gear **33** in the direction of the arrow R, the winding roller **30** is allowed to move downward under its own weight along with the holder **31** pivoted on the shaft **40**, until it engages the peripheral surface of the package **8** (FIG. **6***a*). The main gear **33** is rotated through a predetermined angle, despite of the stoppage of the rewinding roller **30**. Thus, the pin **39** of the holder **31** is disengaged from the end **32'** of the arcuate groove **32** in the main gear **33** and held in an optional position within said groove. It will, therefore, be seen that a pressure corresponding to the weights of the holder **31** and the rewinding roller **30** only acts on the package **8**. Such being the construction, the rewinding roller **30** can positively be brought into contact with the peripheral surface of the package **8** under a predetermined pressure, owing to the presence of the arcuate groove **32**, even if the diameter of the yarn wound on the package **8** is inconsistent. It is also possible to always locate the nozzle **23** of the aforesaid yarn drawing mechanism provided on the holder **31**, in a position slightly spaced from the peripheral surface of the package **8**. After stoppage of the main gear **33** upon rotation through the predetermined angle, the rewinding roller **30** is rotated in the yarn rewinding direction from the drive source **38** through the chains **36**, **37**, and at the same time the valve **25** is opened to act the sucking force of the sucking source **20** in said nozzle **23**, whereby the yarn end is drawn from the package **8** and held in the position shown by symbol Y in FIG. **3**, as stated previously. The drive source **38** is designed to rotate the rewinding roller **30** in a winding or rewinding direction according to a predetermined program, thereby to feed the yarn end into the delivering tube **4** of the spinning unit **1**, as will be described later, or to draw the pieced yarn as required.

4. Yarn Gripping Mechanism

This mechanism serves to grip the yarn Y which has been drawn by the yarn drawing mechanism, and after the yarn is cut on the sucking source side by a cutting mechanism to be described later, carry the cut yarn end to a position upwardly of the delivery tube **4** of the spinning unit **1** while holding the same. In an embodiments shown in FIGS. **8 – 11** a gripping body or catcher **50** is an assembly consisting of a cylinder and a frusto-conical body, and that side of the assembly facing the slit **21** of the pipe **22** is longitudinally open in a V-shape (FIG. **9**). The bottom of the V-shaped opening is in communication with a longitudinal through-hole or channel **51**. The gripping body **50** is at least provided at its lower end with a yarn end holding means for preventing the yarn end, cut by the yarn cutting mechanism to be described later, from returning upwardly and to positively hold the yarn end along the hole **51**. The yarn holding means, as shown in FIG. **9**, consists of fluid passage **55** surrounding a portion of the peripheral surface of the channel **51**, within the gripping body, and communicating with a conduit connected to said body **50** on the opposite side to the V-shaped opening, said fluid passage extending through the frusto-conical body to open to the outside at the bottom of said frusto-conical body. The conduit is connected to a valve **54** through a flexible pipe. With such arrangement, when compressed air is supplied into the passage **55** through the valve **54**, the air flows in said passage in a direction toward the cut end of the yarn to hold the yarn end within the body **50**.

A yarn handling plate **52** is fixed to the V-shaped opening side of the gripping body **50** with a space interval therebetween. The yarn handling plate **52**, as shown in FIG. **11**, has a curved edge **52'** on one side thereof for guiding the yarn. When the yarn Y moves outward through the slit **23**, it abuts against the plate **52**, since the yarn Y is held taut, it moves along the curved edge **52'** of said plate and received in the hole **51**.

Furthermore, this mechanism makes a pivotal movement from a position adjacent the tube **22**, shown in FIG. **3**, to a position adjacent the spinning unit, shown in FIG. **14**, while holding the end of the yarn Y. When an inverted L-shaped arm **48**, carrying the gripping body **50**, rotates 180° by the drive of a drive means **53**, after the yarn is cut at a portion Y' by a cutter to be described later, the body **50** takes a position indicated by the full line shown in FIG. **14**. If the roller **30** is rotated in the rewinding direction in this state, the yarn Y is introduced into the delivery tube **4** from the outlet end of said tube, and thus the piecing is accomplished. The arm **48** is also movable perpendicularly toward the spinning unit by a means known in the art, provided in the drive means **53**, though not apparent in the drawing. By such movement of the arm **48**, the body **50** upon completion of the piecing operation is moved from a full line position to a phantom line position shown in FIGS. **12** and **13**. In this case, the yarn Y moves out of the hole **51** but is prevented from leaving the hole by the yarn handling plate **52**. However, since

the yarn is held taut between the spinning chamber and the rollers **2**, **2'**, it parts from the plate **52** along the curved edge **52'** and trails along the outside surface of the feeler **5** upon passing around the flexed end of said feeler. The feeler is, therefore, shifted from the full line position to the phantom line position under the tension of the yarn to start sensing the yarn.

5. Yarn Cutting Mechanism

This mechanism is generally indicated by numeral **60** and serves to cut the yarn, being gripped by the aforesaid gripping mechanism, at its lower portion or a portion Y' at a location a predetermined distance spaced below the lower end of the body **50**, and thereby to provide a predetermined length of the yarn depending from the lower end of said gripping body **50**. It is important that the yarn cutting position below the gripping mechanism is selected in such a manner that when the gripping body **50** is displaced to above the yarn drawing tube **4** of the spinning unit **1**, while gripping the yarn end, the length of the yarn depending from the lower end of the gripping body **50** becomes substantially equal to the distance between the lower end of said gripping body **50** and the upper end (outlet) of the yarn drawing tube **4**. The cutting mechanism may be of any type, as long as it reliably cut the yarn at a predetermined time according to an improved type of the mechanism will be described later.

6. Operation

While the automatic yarn piecing apparatus comprising the above-described mechanisms constantly is travelling along the front side of an open end spinning machine, a yarn breakage occurs in the spinning machine. Upon occurrence of a yarn breakage, the yarn piecing apparatus stops in front of a particular spinning unit indicating the yarn breakage. First of all, the package holder push-up mechanism is actuated, with the motor **12** energized, and the rack is moved by the pinion **13** in the direction of the arrow P and the curved surface **15** of the cam is brought into abutment against the roller at the right end extremity of the arm **11**, thereby causing the arm to make a pivotal movement. Consequently, the holder **9** is moved upward to a predetermined position by the left hand end **11'** of the arm and hence the package **8** is disengaged from the peripheral surface of the drum **3**. Successively thereafter, the drum rotating mechanism and the yarn drawing mechanism are actuated.

Namely, the main gear **33** is rotated through a predetermined angle by the gear **34** which is rotated according to the predetermined program, and thus the rewinding roller **30** and the yarn end suction nozzle **23** move downwardly toward the peripheral surface of the elevated package **8**. When the rewinding roller **30** engages the package **8**, the opening of the nozzle **23** is held in a position slightly spaced from the peripheral surface of said package. Thereafter, the automatic valve **25** is opened and the suction of the sucking source **20** is acted in the nozzle **23** through the pipe **22**. Concurrently, the rewinding roller **30** is driven through the drive shaft **41** and the chains **36**, **37** in a direction to rewind the yarn for the drawing of the cut end of the yarn. After the yarn Y has been drawn for a predetermined period, it slips out through the slit **21** of the pipe **22** and is held taut along the shortest distance between the sucking source **20** and the package **8**.

Then, the yarn gripping mechanism is set in motion. Namely, the drawn yarn Y is positively and easily introduced into the hole **51** of the gripping body **50** through the V-shaped opening and into the cutting mechanism **60**. Then, the yarn holding means is actuated and the cutting mechanism **60** is actuated concurrently, to cut the drawn yarn Y, and the lower length of the cut yarn is sucked into the sucking source **20**, while the upper length of the same depends downwardly in a predetermined length from the lower end of the gripping body **50**, while being gripped by said gripping body. Thereafter, the yarn gripping body **50** is rotated through an angle of about 180° by the drive of the driving source **53** to locate the yarn end Y' in a position immediately above the delivery tube **4** of the spinning unit **1**. In the spinning unit **1**, a negative pressure is produced in the delivery tube **4** by the high speed rotation of the cup-shaped spinning chamber and a sucking phenomenone appears at the outlet of said tube. Therefore, the yarn end Y' position immediately above the delivery tube **4** can be easily introduced into said delivery tube. Upon completion of the rotation of the gripping body **50**, with the yarn end Y' being located above the delivery tube **4**, the rewinding roller **30** is again rotated to rotate the package **8** in a direction to rewind the yarn and synchronously the yarn gripping force of the gripping body **50** is released, so that the yarn Y is drawn into the delivery tube **4**. (The yarn gripping force is not necessarily released where use is made of a compressed air for holding the yarn end.)

The length of the yarn introduced into the delivery tube or the length of the yarn rewound from the package **8** is previously determined in consideration of the distance from the outlet of said delivery tube to the spinning chamber, and is limited by the angle of rotation of the rewinding roller **30**. The yarn end introduced into the delivery tube **4** passes through said tube under the suction of the chamber or the spinning rotor and reaches the fiber condensing surface of the spinning rotor. Then, Then, an electromagnet **61** provided in the body **10** of the yarn piecing apparatus is energized to actuate the lead switch **6** by the magnetic force thereof, which lead switch **6** is provided in the spinning unit **1**. Thus, the spinning unit **1** is drivingly connected with a power source, whereupon a feed roller (not shown) in the spinning unit is rotated to supply the fibers to the spinning unit. After passage of a short time sufficient for the fibers thus supplied to be pieced with the yarn end already introduced in said spinning unit, the rewinding roller **30** is rotated in a reverse direction or a direction to wind the yarn and thereby the yarn, pieced in the spinning unit, is drawn out of said spinning unit. The yarn drawing speed or the rotational speed of the rewinding roller **30** is substantially equal to the peripheral speed of the winding drum **3**.

When the new yarn has continuously been drawn upon completion of the yarn piecing in the manner described, the arm **11** holding the holder **9** in the elevated position is lowered, while keeping the package **8** rotating in engagement with the rewinding roller **30**, and the package **8** is returned to rest on the traversing roller **3**, under the biasing force of the holder **9** or the own weights of the rewinding roller **30** and the holder **31**, while continuing the winding operation. Thereafter,

the package 8 is driven by the traversing roller 3 to take up the yarn. The yarn gripping mechanism is shifted a short distance toward the pipe 22 by the displacement of the arm 48 along the drive means 53, during the period of return movement of the package 8, whereby the yarn slips away through the hole 51. In this case, the feeler 5 returns to its normal yarn sensing position, so that a permanent magnet mounted on the feeler holds the lead switch 6 in the state of connection. Thus, the electromagnet 61 is deenergized. In the drawings, reference numeral 49 designates a movable threaded rod by which the yarn, extending between the gripping body 50 and the package 8, is prevented from being brought into contact with the traversing roller 3 or the delivery rollers 2, 2' in the process of the yarn piecing operation. Details of the rod 49 will be explained later with the reference to FIGS. 17 and 18. This rod also serves to return the engaging yarn toward the delivery roller 2, 2' upon completion of the piecing operation and is mounted on a pivotable arm. The yarn released from the rod 49 upon pivotal movement of the latter and being delivered is placed on the smaller diameter delivery roller 2' and shifted to one end of said roller by the traversing action of the transverse roller 3. In this case, the yarn is automatically taken into the nip of the roller 2, 2' by the action of the notch in said roller 2'.

In the embodiment described above, the lead switch 6 which is operated by the magnetic force of the electromagnet in the body of the piecing apparatus, is provided in the spinning unit to rotate the feed roller in said spinning unit, in the yarn piecing operation, but alternatively the feed roller may be driven by providing a mechanical means on the body of the piecing apparatus, which is adapted to set up the lying yarn breakage sensing feeler 5.

Further, the present invention may be practiced by replacing any one of the mechanisms described above with one or more of improved mechanisms which will be described hereinafter:

7. Snarl Eliminating Mechanism

The yarn spun by the open end spinning machine is so closely twisted that when the yarn is drawn from the package upon occurrence of yarn breakage, it tends to be kinked by the untwisting force of the yarn and a snarling phenomenone. The kinked yarn cannot be accurately located at the outlet of the delivery tube. Thus, it is recommendable to provide a snarl eliminating mechanism along with the cutting mechanism.

The snarl eliminating mechanism is exemplified in FIGS. 15 and 16. Namely, two vertically spaced cutters 60, 60' are provided below the position in which the yarn Y drawn by the gripper or catcher 50 will be located for introduction into the delivery tube 4, and a pipe 58 in communication with the sucking source 20 is provided, with its open end 59 located adjacent the path of the yarn between said two cutters. By so doing, the yarn end drawn from the nozzle 23 of the suction pipe 22 and slipped out from said suction pipe through the slit formed therein, as described previously, is located between the upper and lower cutters 60, 60' by being led by the yarn handling rod 49 and a guide rod 57 spaced above the upper cutter 60 and passing through the catcher 50. Thereafter air is sucked through the pipe 58, located between the upper cutter 60 and the lower cutter 60' to suck the yarn through the open end 59 of said pipe. Successively thereafter, the lower cutter 60' is actuated to cut the yarn. Upon cutting the yarn, the upper cut end 80 of the yarn connected to the package 8 is set free and sucked into the pipe 58 through the open end 59 thereof under suction. In this case, the yarn Y is untwisted in a very short period of time after the yarn is cut by the cutter 60', wherein the cut end 80 of the yarn is moved upwardly and sucked into the open end 59 of the pipe 58, and thereby the twist of the yarn is eliminated which is the cause of snarl. The yarn is further untwisted while it is trapped in the open end 59 of the pipe 58 in the free state. The catcher 50 is actuated after the snarl phenomenone or the shrinking phenomenone of the drawn yarn from the package has been eliminated in the manner described. In this way, a predetermined length of the yarn end 22, depending from the catcher 50, can more easily be introduced into the delivery tube 4.

8. Improved Yarn Gripping Mechanism

Besides the yarn gripping mechanism of the type described above, which makes use of air stream for holding the yarn end, the following improved type is available. In the improved type, as shown in FIGS. 20 – 22, the catcher 50 provided at one end of the arm 48 consists of a pair of pivotable levers adapted to grip the yarn therebetween. The drive means 53 comprises an externally threaded shaft 63 journaled in a bearing, provided in a frame to which the other one 81 of the catcher supporting arms is connected, and a bearing provided in a base; an annular cylinder 64 having an internal thread in meshing engagement with the external thread of said shaft 63; and a stationary guide 65 provided along the outer peripheral surface of said cylinder 64. The shaft 63 is driven from a motor 68 through a belt 69 and a pulley 79 connected thereto. The frame integral with the catcher 50 is secured to the cylinder 64 on the side opposite to said catcher. Therefore, the catcher 50 rotates around the shaft 63 incident to rotation of the cylinder 64. The cylinder 64 also has the stationary guide 65 fixed to the outer surface thereof, which is mounted on the base. In the outer peripheral surface of the stationary guide 65 is formed an inverted L-shaped guide groove 65', into which one end of the arm 48 is slidably fitted. The arm 48 is provided with a solenoid 66 by the action of which the catcher 50 is opened and closed. The solenoid is actuated after actuation of the lower cutter 60', with a predetermined time lag, and deenergized when a limit switch 67 on the base is actuated by the arm 48.

The shaft 63 is rotated in a clockwise direction as viewed in FIG. 20, by the motor 68, after the yarn Y is cut by the cutters 60, 60', the snarl is removed from the yarn by the snarl eliminating mechanism and then the yarn end 80 is held by the catcher 50. Since the shaft 63 and the cylinder 64 are operatively associated with each other by means of a ball stopper 70 shown in FIG. 21, the rotation of said shaft causes rotation of the cylinder 64 and the arm 81. During this rotation, one end of the arm 48 holds the yarn Y by means of the catcher 50, while the other end thereof slides in a horizontal portion of the groove 65' in the guide 65. Thus, the catcher is carried to a position above the outlet of the delivery tube 4. At this time, the other end of the arm 48 hits the corner of the groove 65' and the

arm **48** is not longer rotatable horizontally. However, since the shaft **63** keeps on rotating, the engagement between the shaft and the cylinder **64** by the stopper **70** is released. As the shaft **63** further rotates, the cylinder **64** is moved downward relative to the shaft, due to the engagement between the internal thread of said cylinder and the external thread of said shaft. The other end of the arm moves downward along with the cylinder and slides in a vertical portion of the groove **65'**. The yarn end **80** held by the catcher **50** is introduced into the delivery tube **4** through the outlet thereof and subject to piecing operation within the spinning chamber **75** as described previously.

9. Yarn Conducting Mechanism

This mechanism serves to guide the yarn, gripped by the yarn gripping mechanism and connected to the package, while regulating it in a manner corresponding to each operation preparatory to piecing and thereby to secure accurately the length of the yarn to be introduced into the delivery tube, and also to transfer the pieced yarn to the spinning machine smoothly, upon completion of the yarn piecing. According to the construction of this mechanism, a roller **49** having a spiral groove **47** is rotatably mounted, for example, on one side of an arm which is provided between the package **8** and the yarn delivery tube **4** and which is pivotable about a pivot **56**. When the yarn drawn from the package is gripped by the gripping mechanism, the roller **49** is in the solid line position shown in FIG. **18**, and the gripping mechanism is shifted from the phantom line position to the full line position, with the roller **49** being held in said position. As a result of this operation, the length of the yarn necessary for the introduction into the delivery tube **4** is reserved and the yarn Y is engaged around the groove **47** in the roller **49** in a taut condition. In introducing the yarn into the delivery tube **4**, the roller **49** is shifted from the solid line position to the phantom line position, adjacent the spinning unit, by a pivotal movement of the arm about the pivot **56**, whereby the length of the yarn previously reserved is used for the introduction of a predetermined length of the yarn into the delivery tube **4**. Upon completion of the piecing, the package **8** is rotated in a winding direction and the normal spinning operation is resumed. In this case, the roller **49** is caused to rotate under the tension of the travelling yarn and the point of engagement between the yarn and the roller **49** is shifted from the inner end to the free end **46** of the groove in the roller, under the influence of the spiral groove, and the yarn is automatically disengaged from the roller and shifted toward the spinning unit.

Such arrangement is advantageous in that the length of the yarn necessary for the introduction into the tube can be maintained with high accuracy, and also in that after completion of the piecing, the yarn introduced into the tube and the new yarn pieced thereto and continuously drawn from the tube can smoothly be engaged with the delivery rollers **2** and **2'** and the traverse drum **3** of the spinning machine until the normal condition of spinning operation is obtained.

10. Controlling Mechanism for Fiber Material Feed Roller of the Spinning Unit

In some of the spinning machine of the type described above, an arrangement is made such that when the yarn is broken, the yarn breakage sensing feeler **5**, provided above the outlet of the yarn delivery tube **4** of each spinning unit, is tilted from the full line position to the phantom line position (in FIG. **19**) to make the contacts **6'**, **6'** of the lead switch **6** on the delivery tube **4** under the action of a permanent magnet **73** provided on said feeler and thereby a magnetic clutch **74** is deenergized to stop the rotation of a fiber material feed roller **71**.

If, in this case, the feeler is set upright by the yarn gripper which is carried to a point above the delivery tube **4** for introducing the yarn end into the outlet of said tube, the magnetic force of the magnet **73** will not act on the contacts **6'**, **6'** and hence the clutch **74** will be energized to rotate the feed roller **71**. Under such condition, the fiber materials are fed to the unit to be opened therein and the opened fibers are supplied into the spinning chamber rotating at a high speed. However, the yarn is not drawn from the delivery tube for a considerably long time and the fibers are accumulated in the spinning chamber during said period, which can be a cause of trouble. It is, therefore, desirable that the rotation of the feed roller **71** be stopped until the broken yarn end is introduced into the spinning chamber through the delivery tube.

To this end, another electromagnet **77** is fixed on the arm **48** of the gripper and a pin **78** is connected to said magnet (FIGS. **19** and **20**). With such arrangement, when the arm **48** is operated to bring the yarn end, gripped by the gripper, to the yarn introducing position above the outlet of the delivery tube **4**, the pin **78** moves the feeler, so that the electromagnet **77** is energized and the electric connection of the contacts **6'**, **6'** can be maintained under the magnetic force produced by said magnet. Thus, it is possible to stop the rotation of the feed roller **71** until the yarn end introduced into the delivery tube **4** reaches the spinning chamber. By deenergizing the magnet **77** immediately before or after the yarn end reaches the collecting surface of the spinning chamber, the clutch **74** is excited to rotate the feed roller **71** and the spinning operation is resumed. Therefore, the piecing can be effected while drawing the yarn end.

We claim:

1. An automatic yarn piecing apparatus for a spindleless spinning machine including a plurality of spinning units, a spindleless rotary spinning chamber in each of said units for spinning fiber materials fed therein into a yarn and delivering the yarn thus formed therefrom through a delivery outlet in said unit to a yarn take-up package for winding thereon, a package holder for retaining said package, a yarn traversing roller on said holder for rotating said package; said apparatus being movable along a front face of said spinning machine and adapted to be stopped at the position of a particular spinning unit in which the yarn was broken for piecing the broken yarn, package holder push-up means for disengaging the yarn up package from the yarn traversing roller, means rotating the disengaged package in a yarn rewinding direction and subsequently in a winding direction, suction means for drawing the broken end of the yarn from the package during rewinding of the broken yarn end, said suction means including an elongated tube curved toward the spinning machine and communicating with a source of suction, said tube having a longitudinal slit formed in a wall

thereof for discharging a portion of said yarn therethrough, means for gripping said portion of the yarn exteriorly of said elongated tube, and means for cutting the yarn at a location below said gripping means, and means for horizontally displacing said gripping means to above said delivery outlet while gripping the yarn end for introducing said end into said spinning chamber for piecing the yarn.

2. An automatic yarn piecing apparatus as claimed in claim 1, wherein said yarn cutting means includes two vertically spaced sets of cutters disposed below said yarn gripping means, and yarn snarl removing means, said last-mentioned means including a suction tube having its free open end located at an intermediate point of the yarn path between said two sets of cutters.

3. An automatic yarn piecing apparatus as claimed in claim 1, comprising yarn guiding means mounted for pivotable motion toward the front face of the spinning machine, said guiding means guiding the yarn toward said spinning machines, a pivotable arm on said guiding means, and a roller rotatably mounted at the lower end of said pivotable arm, said roller having a screw-thread formed in the peripheral surface thereof.

4. An automatic yarn piecing apparatus as claimed in claim 1, comprising pivotable a yarn breakage sensing feeler in said spinning unit pivotally connected to the delivery outlet thereof, a fiber material feeding device, an electromagnetic clutch on said device disengageable in response to the pivotal movement of said sensing feeler from the original position thereof; said gripping means including an electromagnet maintaining said clutch in an open position when said feeler is returned to and retained in its original position.

* * * * *