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[11] **3,561,688**

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[73] Assignee **Toyo Rayon Kabushiki Kaisha Chuo-ku, Tokyo, Japan**
Continuation-in-part of application Ser. No. 427,739, Jan. 25, 1965.

[54] **YARN TRANSFER METHOD IN THE WINDUP OPERATION**
10 Claims, 22 Drawing Figs.

[52] **U.S. Cl.** **242/18**
[51] **Int. Cl.** **B65h 54/02**
[50] **Field of Search** 242/18A, 18, 18DD, 25A, 19; 57/34, 157

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Primary Examiner—Stanley N. Gilreath
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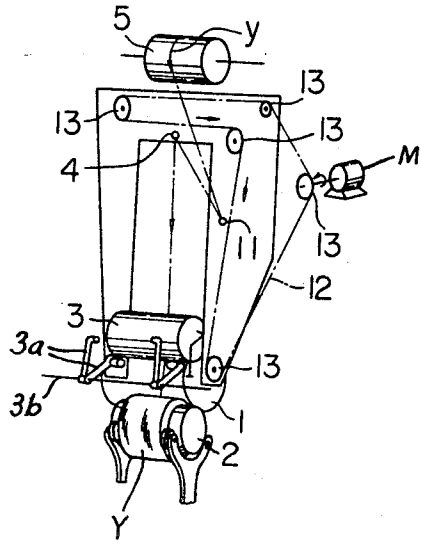
ABSTRACT: A method and apparatus for continuously winding yarn on a succession of bobbins. The apparatus has a travelling yarn guide mounted on a flexible member such as a chain or belt extending in a loop. The flexible member is driven in one or the other directions around the path of the loop. This crosses the path of the yarn coming from a yarn source and extending to a transversing guide for guiding yarn back and forth across the bobbin. The path of the flexible member also crosses the adjacent ends of the bobbin which have yarn catching means thereon. As the travelling guide moves along the path of the flexible member, it picks up the yarn and moves it so that it moves past the end of an empty bobbin and when the bobbin rotates, it picks up the thus moved yarn.



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SHEET 1 OF 8

Fig. 1

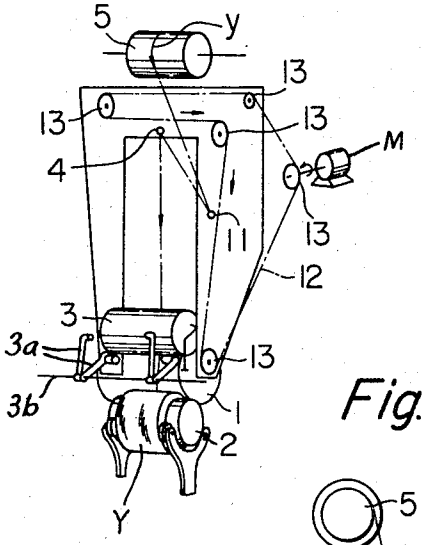

Fig. 3

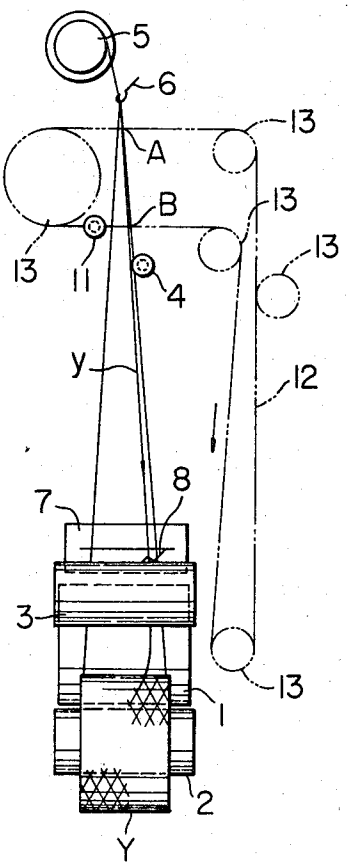

Fig. 2

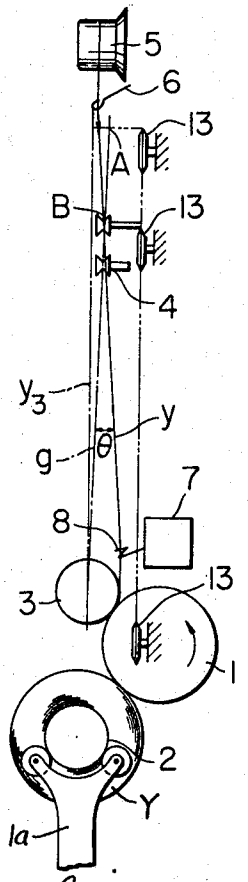

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Fig. 4

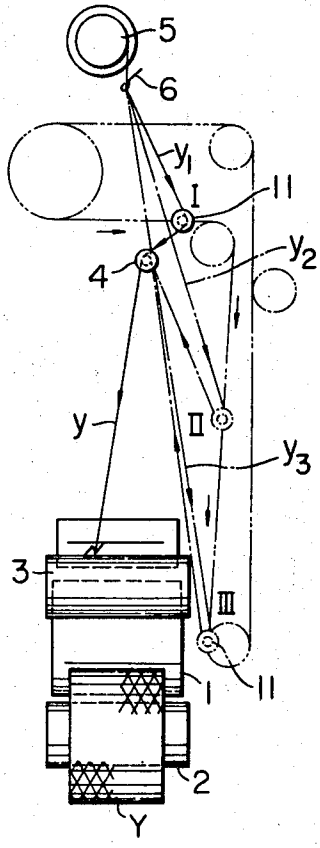

Fig. 6

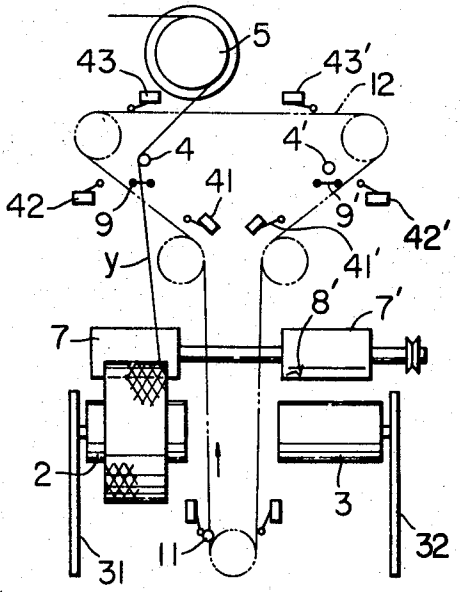

Fig. 5A

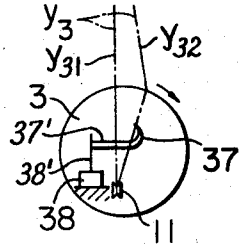

Fig. 5B

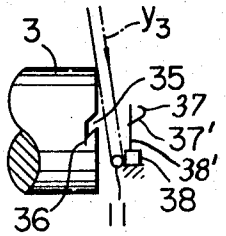

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Fig. 7

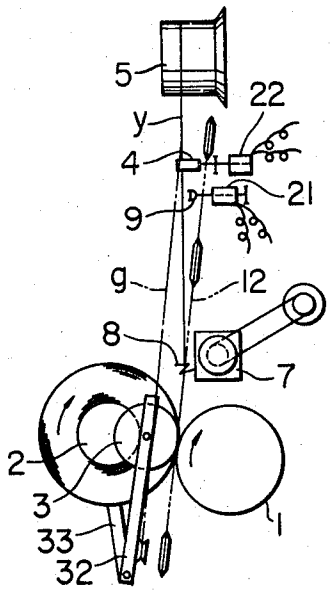

Fig. 8

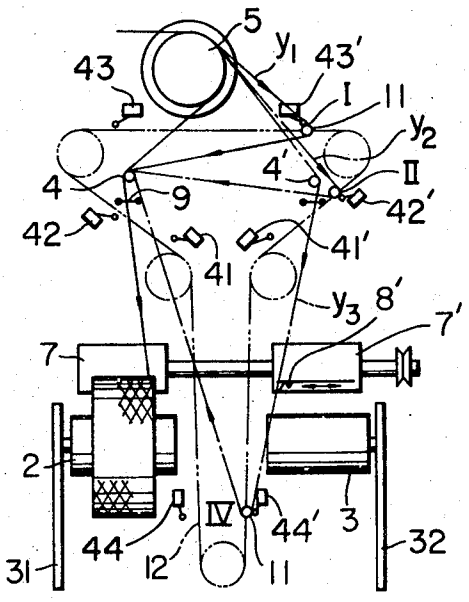

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Fig. 9

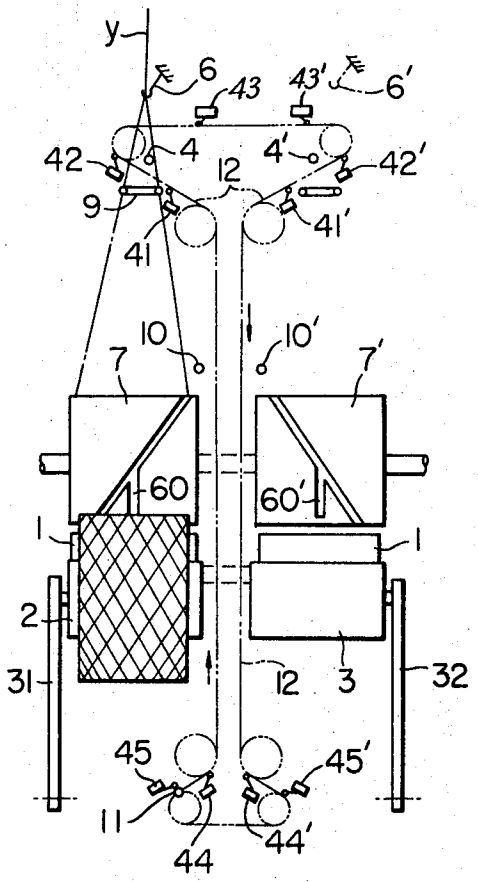

Fig. 10

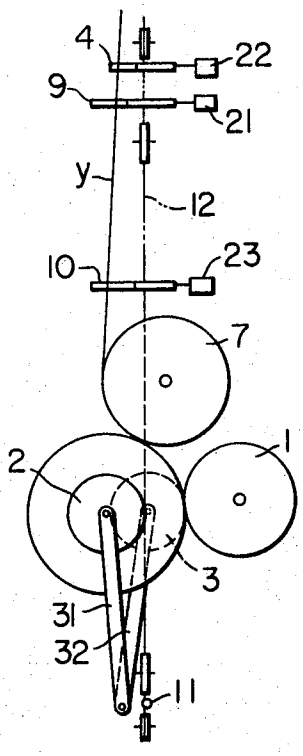

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Fig. 11A

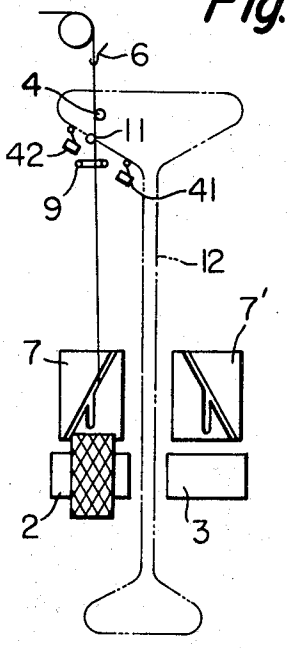

Fig. 11B

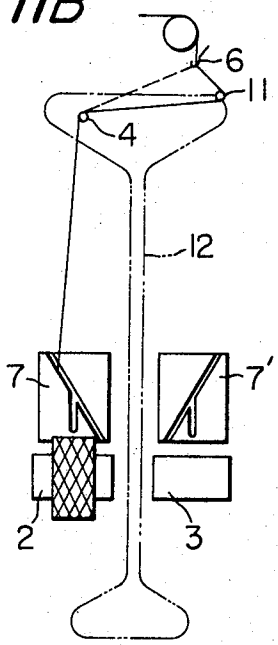

Fig. 11C

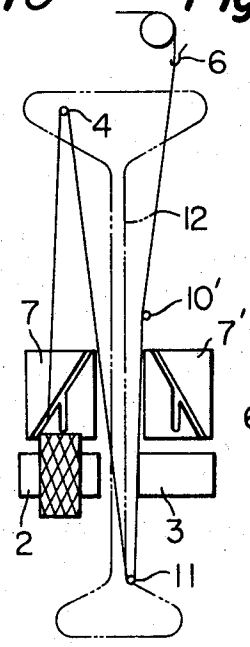

Fig. 11D

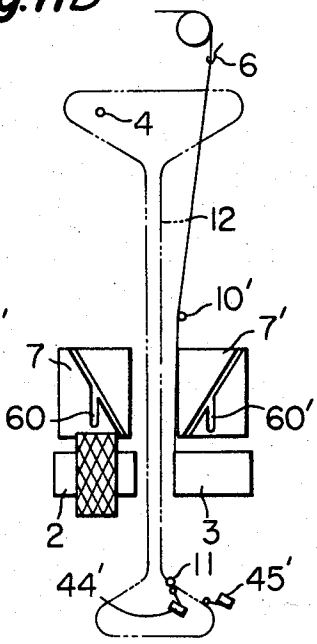

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Fig. 17

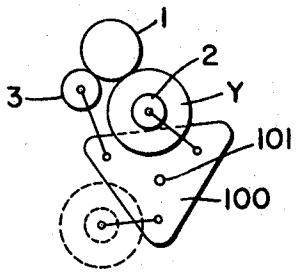

Fig. 12

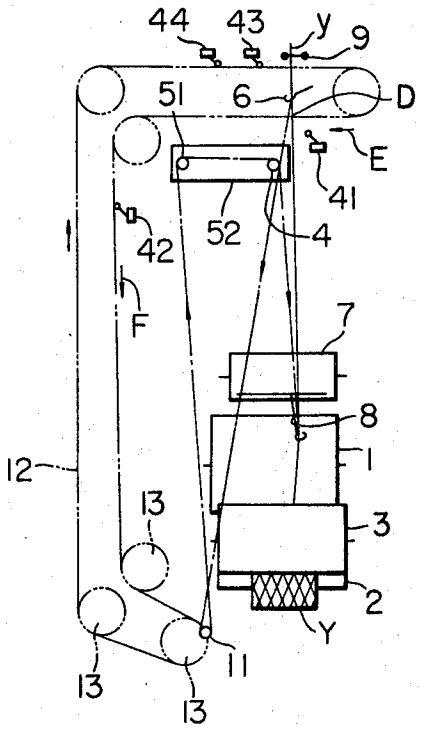

Fig. 13

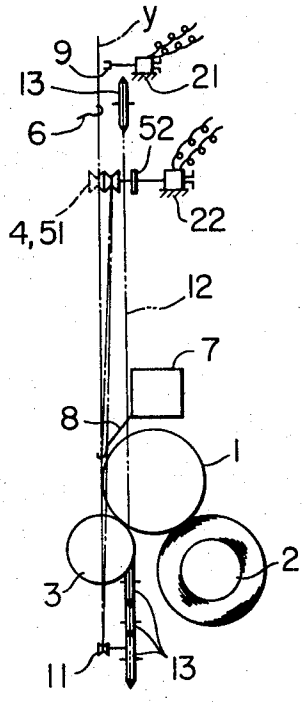

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Fig. 14A

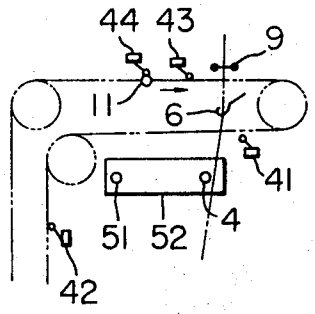


Fig. 14B

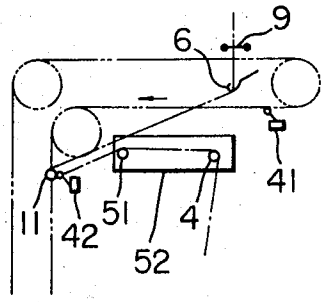
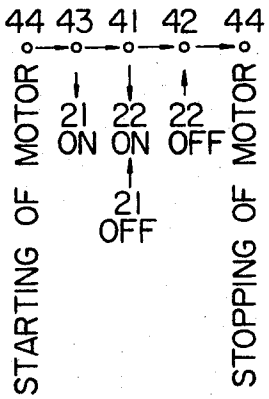


Fig. 15



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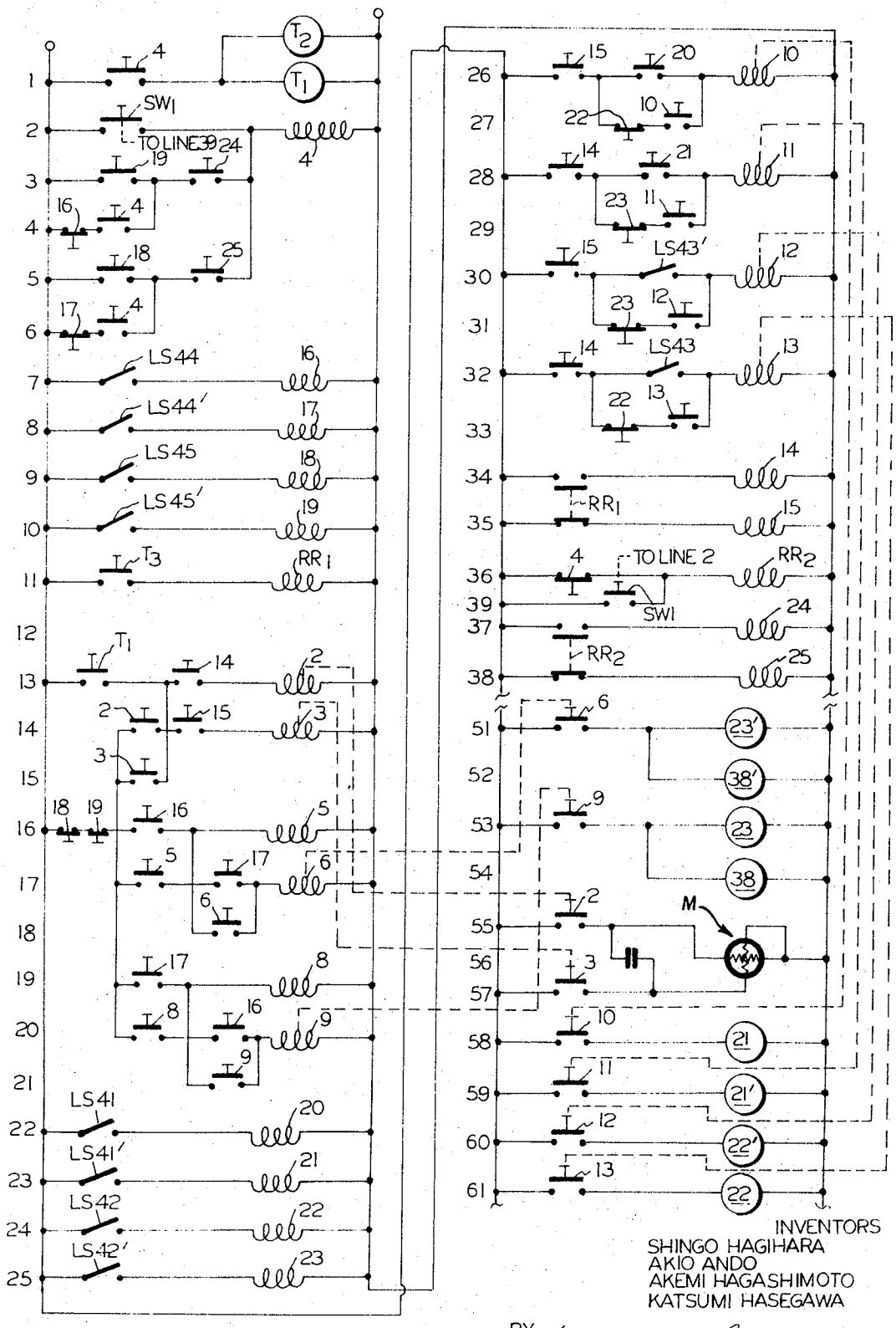

FIG.16

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YARN TRANSFER METHOD IN THE WINDUP OPERATION

This application is a continuation-in-part of application Ser. No. 427,739, filed Jan. 25, 1965, now abandoned.

This invention relates to a yarn transfer method carried out in the windup operation and to an apparatus therefor. More particularly, the invention relates to a yarn transfer method and apparatus therefor wherein the continuous windup of yarn is made possible by transferring the yarn from a full wound bobbin to an empty bobbin without interruption and moreover without waste of yarn.

With the increase in the production of textile fibers in recent years, the spinning and windup speeds of fibers are becoming increasingly higher, the speeds reaching as high as, say, 1000 to 2000 meters per minute. As a result, the operations incident to the windup of the yarn, particularly the yarn transfer operation, has encountered various difficulties.

The operation of transferring the yarn from a full wound bobbin to a fresh empty bobbin in the operation of winding up onto a bobbin a textile fiber delivered continuously from the spinning operation was hitherto principally done manually. In performing this operation, the windup operation had to be interrupted. In addition, not only was the time required for the interruption of considerable length, but also considerable waste of yarn occurred during the transfer operation. Further, since the transfer was handled individually by the workers, the amount wound varied for each spindle, and the manner in which the operation itself was carried out differed greatly, depending upon the skill of the worker. Further, even when the windup operation was interr ed, there was some danger involved in carrying out the yarn transfer operation in a winder operated at such high speeds as previously noted.

In recent years, although studies have been made for finding a method of continuously winding up the yarn being y, from spinning operations and the like, no good continuous windup method has as yet appeared. This is ascribable to fact that yarn transfer operation during the exchange of the bobbins is a highly complicated operation.

For instance, the operation in which the yarn is wound up on a bobbin and then, when the bobbin has become full, the yarn is transferred to a new bobbin encounters the difficulty that the yarn package becomes inferior. Further, it frequently occurs that either the yarn gets wound up on the drive roll instead of being wound up as desired on the new windup bobbin, or the yarn transferred to the new bobbin is not traversed as it should be, or a long period of time is required for the yarn to return to its normal traversing actions after the transfer operation. And these undesirable tendencies become worse as the windup speed becomes higher.

An object of the present invention is to provide a method by which the transfer of a yarn from a full wound bobbin to a fresh empty bobbin can be carried out smoothly without interrupting the windup of the yarn.

Another object of this invention is to provide a reliable yarn transfer method wherein in carrying out the transfer of the yarn there is no waste at all of the yarn and further the yarn package is not deformed in the least until completion of the yarn transfer.

Still another object of the invention is to provide a yarn transfer method which can be applied readily to the conventional windup apparatus and by which the yarn transfer necessary during the winding up of a yarn can be automated.

A further object of the present invention is the provision of an apparatus by which the hereinbefore described method is carried out.

These objects are achieved by a yarn transfer method carried out in the windup step which is characterized by driving simultaneously a windup bobbin and an empty bobbin, hooking the yarn being wound with a traveling guide at a point between the yarn feed source and a fixed guide disposed upstream of the windup bobbin presently being wound when the latter has become full, conducting the thus hooked yarn to an end of the empty bobbin, severing the yarn by effecting the seizure of the yarn by means of a yarn catch provided at said

end, thereby effecting the transfer of the yarn from the full wound bobbin to the empty bobbin.

The present invention comprehends as the windup drum not only a windup drum which is not axially mounted, but is merely held between other rollers, but also the ordinary bobbins which rotate by being axially mounted. However, in either case it is necessary that they wind up a yarn by their rotation at a surface speed corresponding to the yarn forwarding speed. This drive system may be either a surface drive system or a spindle drive system, and in the case of the former this drive system includes not only the instance where the bobbin being wound up and the empty bobbin are disposed radially of a single drive roll, but also the instance where the bobbin being wound up and the empty bobbin are juxtaposed axially of the drive roll, and the instance where the bobbin being wound up and the empty bobbin are respectively driven by a plurality of drive rolls.

However, in order to automate the entire yarn transfer operation of this invention, these bobbins are desirably driven by a surface drive system, and by so doing there is an advantage in fitting and removing of the fully wound bobbin and the empty bobbin. And the yarn feed source as defined in this invention contains the entire forwarding structure such as yarn delivery rollers and forwarding guides.

For carrying out the transfer operation smoothly, it is preferred in this invention that the traveling guide be attached to a loop-shaped flexible member which is rotatable in the desired direction. In order to guide the yarn to the end of an empty bobbin by hooking the yarn with the traveling guide between the yarn feed source and a fixed guide disposed upstream of the windup bobbin, it is preferred that the traveling guide attached to the flexible member be caused to hook the yarn by traveling across the path that the yarn takes when it is being normally wound up and then moved so that the transfer distance is shortened as much as possible to guide the yarn to the end of the empty bobbin.

Further, the foregoing fixed guide can be provided between the yarn feed source and the windup mechanism, in the normal yarn guide plane (the plane including the yarn path during the normal windup, i.e. when the yarn transfer operation is not being carried out), and it need not necessarily function as a guide during the normal windup operation. The essential point is that it suffices if it functions as a fixed guide for guiding the yarn during the period from the start of the transfer operation to the completion thereof.

The foregoing normal yarn guide plane and the moving plane of the traveling guide either (1) intersect at a certain angle at the place where the traveling guide hooks the yarn, i.e., at a place intermediate of the yarn feed source and the fixed guide; (2) are identical; or (3) are proximate and parallel to each other. On the other hand, the moving plane of the traveling guide must be adjusted such that the yarn path between the yarn feed source and the travelling traveling guide is in a position such as to at least contact the end of the empty bobbin to which the yarn is to be transferred or in a position very close to this position. The former relative position of the moving plane is best employed when the yarn is fine, whereas the latter is used when the yarn is thick. For instance, in the latter case, the yarn is caused to contact the end of the empty bobbin by means of a yarn presser and severing means, and the yarn caught in the yarn catch provided in the end of the windup bobbin is severed by said severing means.

When the relative positions of the normal yarn guide plane and the moving plane of the traveling guide are in the relation indicated in the preceeding paragraph under item (1), it is possible to make said angle large, and thus prevent the contact of the traveling guide with the yarn guide plane at places other than said intersecting portion. On the other hand, when said angle is small and the relative positions are as indicated under items (2) and (3), it si is preferred to prevent the traveling guide from making contact with the normal yarn path at places other than the intersecting portion when it comes near to the yarn path, by moving the fixed guide to-and-fro with

respect to the yarn guide plane or by pushing out the yarn path by means of, say, a suitable means such as pushout guide, and it being particularly preferred that these moving positions of the traveling guide.

Further, according to the invention, other fixed guides besides the previously mentioned fixed guide can be provided, it being possible to control the yarn path more closely by providing another fixed guide in the yarn path between the yarn feed source and the traveling guide or between the traveling guide and the previously mentioned yarn guide. By so doing, it is possible to control the yarn paths passing the traveling guide and let only one yarn path approach the edge of the empty bobbin. All or part of these fixed or pushout guides are preferably moved to-and-fro with respect to the yarn guide plane, the movements being cooperatively effected in accordance with moving positions of the traveling guide. The yarn transfer operation can thus be carried out still more smoothly.

For a better understanding of this invention, reference is made to accompanying drawings, wherein:

FIG. 1 is a schematic drawing illustrating the application of the transfer method of the invention;

FIG. 2 is a side view showing one embodiment of the present invention, the locus of the yarn resulting from the movement of the traveling guide being illustrated;

FIGS. 3 and 4 are front views of an embodiment having a similar arrangement to that shown in FIG. 2 and are for illustrating the changes in the yarn path which occur in concomitance with the movement of the traveling guide;

FIGS. 5A and 5B are side and front views, respectively, illustrating the relationship between the windup bobbin and the yarn presser and severing means which can be used as an accessory in the present invention;

FIG. 6 is a front view showing another embodiment of the invention involving dual windup means;

FIG. 7 is a side view of the embodiment as shown in FIG. 6;

FIG. 8 illustrates the changes in the yarn path that takes place in concomitance with movement of the traveling guide in the embodiment shown in FIGS. 6 and 7;

FIGS. 9 and 10 are front and side views, respectively, illustrating another embodiment of the dual method of windup to which the present invention has been applied:

FIGS. 11A to 11D are diagrams illustrating the yarn transfer operation in the arrangement shown in FIGS. 9 and 10;

FIGS. 12 and 13 are front and side views, respectively, of still another embodiment of the invention in which two fixed guides are used which cooperatively move with the movement of the traveling guide;

FIGS. 14A and 14B are diagrams illustrating the movements of the traveling guide and the fixed guides in the arrangement shown in FIGS. 12 and 13.

FIG. 15 is a diagram illustrating the operational sequence of means such as a timer which is used as an accessory in the invention;

FIG. 16 is a schematic circuit diagram of a control circuit for the embodiment of FIGS. 9 and 10; and

FIG. 17 is an illustration of a mechanism for transferring the bobbins in the embodiment of FIGS. 12 and 13.

The embodiments of the invention will be described hereinafter with reference to the accompanying drawings.

FIG. 1 is a schematic view illustrating an instance of the application of the transfer method of the present invention in winding up a yarn. Yarn *y* delivered from yarn feed source 5, after passing neighborhood of fixed guide 4, is wound up as yarn layer Y onto windup bobbin 2 which is surface driven by drive roll 1. Windup bobbin 2 is supported in place against drive roll 1 by a suitable support structure 1*a*. Support 1*a* comprises two Y-shaped bodies which have small rollers on the ends thereof. The rollers contact and support bobbin 2. Supports 1*a* are supported by suitable means such as a spring mounting, to thereby give as the windup bobbin becomes wound with yarn. Support structure 1*a* is similar to that disclosed in U.S. Pat. No. 3,370,798. Now, when windup bobbin 2 becomes almost full, an empty bobbin 3, supported on the arms of an empty bobbin holder 3*a* and held in contact with drive roll 1, starts its preparatory rotation. Then a traveling guide 11 hooks yarn *y* intermediate of the yarn feed source 5 and fixed guide 4 and starts traveling in the direction of the arrow. Traveling guide 11 is preferably provided on a flexible member 12, for example, a chain or belt, the latter being loop-shaped and mounted about pulleys 13 and driven by motor M, and which determines the direction in which the traveling guide proceeds. When the traveling guide proceeds to the bottom, yarn *y* is guided to the end of empty bobbin 3 where, by coming into contact with a yarn catch provided in the end of the bobbin, it is severed and transferred to the fresh bobbin 3. Thereafter, the filled bobbin 2 is removed by automatic means, not shown. The fresh bobbin 3 is lowered into the position formerly operated by full bobbin 2 by rotating holder 3*a* around shaft 3*b*. The fresh bobbin 3 moves off the arms of the holder 3*a* and holder 3*a* is returned to its initial position, ready to receive the next fresh bobbin. This cycle is continuously repeated.

FIGS. 2 and 3 are side and front views, respectively, of an arrangement of one embodiment of the invention. In the FIGS., yarn *y* delivered from yarn feed source 5, after passing through delivery guide 6 and traversed by means of traverse guide 8 of traverse mechanism 7, is wound up as yarn layer Y onto windup bobbin 2, which is surface driven by drive roll 1. Drive roll 1 also simultaneously drives an empty bobbin 3. Traveling guide 11 is mounted on a flexible member 12 which is controlled by means of guides and drive pulley 13 as to the path over which it proceeds. The path of flexible member 12, i.e., the path over which traveling guide 11 proceeds, has a bent configuration such that the locus of yarn *y*, i.e., the plane through which the yarn is traversed during normal windup, is traveled across and moreover is such that the yarn hooked by traveling guide 11 is guided to the end of empty bobbin 3 that is being driven. The setup is such that, while as seen from the front, the locus of the traveling guide 11 resulting from the movement of the loop-shaped flexible member appears to intersect the locus of yarn *y*, at points A and B, the plane of the locus of the traveling guide 11 is at an angle Θ to the locus of yarn *y*, which causes traveling guide 11 to hook yarn *y* at B but not at A. This is clearly seen in FIG. 2, where the normal yarn guide plane of yarn *y* and them the moving plane *g* of the traveling guide intersect at point B at angle Θ. On the other hand, fixed guide 4 is disposed in a relative position such that the normal yarn locus of yarn *y* does not pass through fixed guide 4.

Now, when windup bobbin 2 becomes full, timer means, described hereinafter, is actuated to drive the flexible member driving motor M, and traveling guide 11 in the position shown in FIG. 3 being moved by flexible member 12 travels in the direction of the arrow and hooks yarn *y* at point B. When traveling guide 11 travels and comes to point I of FIG. 4, the yarn path becomes i y_1. At this time, the yarn from the yarn feed source by passing via the delivery guide, moving guide, fixed guide 4 and traverse guide in the sequence given is wound up on windup bobbin 2. The traveling guide proceeds to travel about in the direction of the arrow, passing point II (the yarn path becomes y_2 at this time) and thence arrives at point III (the yarn path becomes y_3 at this time). Since the yarn path (e.g. y_1, y_2 and y_3) passes through the several guides in the foregoing order during the time the yarn shifts its position while being held by traveling guide 11, the yarn at all times passes through the fixed guide and is thereafter traversed by the traverse guide. Hence, no abnormalities in the traversing of the yarn of deficiencies in the form of the yarn package occur during the period in which these operations are carried out.

Next, the method of severing the yarn and winding the severed end onto an empty bobbin will be described. When traveling guide 11 arrives at position III in FIG. 4, the yarn path becomes y_3 as shown in FIGS. 2 and 4. At this position, the yarn comes into contact with the end of empty bobbin 3

and slips into incised portion 35 (see FIG. 5) in the end of the bobbin where it is severed by the resulting shock. Then while its end is being held in the incised portion, the yarn gets wound onto the fresh empty bobbin. Thus the windup on the fresh bobbin is carried out.

When the yarn is thick, instead of doing as hereinabove described, a yarn presser and serving mechanism, as shown in FIG. 5, can be used. In this case, traveling guide 11 is brought to a stop at a place close to position III in FIG. 4, i.e., at a place where the yarn comes very close (y_3) to the end of the empty bobbin. Now, when a sing signal enters rotary solenoid 38 at this time from an actuating means described hereinafter, such as a limit switch such as 44 or 44' of FIGS. 6—8, shaft 38' is rotated to swing knife 37 in a horizontal plane. This knife is hooked-shaped, for instance, and is provided with an edge and only its tip. Accordingly, as seen in FIGS. 5A and 5B, when the knife 37 is made to swing horizontally by the rotary solenoid 38, yarn $y_3$1 is urged against the end of bobbin 3 by means of a nonedged portion 37' of the knife 37. As the bobbin 3 rotates, the yarn $y_3$1 is pushed into recess 35 and is rotated in the direction of the rotation of the bobbin 3. The yarn in this state is shown by reference $y_3$2. The displaced yarn $y_3$2 is caused by its rotation to be pressed against the edge portion of the knife 37 and is severed and then forced into slot 36 whereby it is held by the bobbin.

The yarn which has been thus wound onto a fresh windup bobbin 3 automatically returns to the center by means of the tension of the yarn and is hooked by traverse guide 8 into which the yarn automatically slips, no matter from what direction it comes so as to be traversed normally while the windup of the yarn continues.

FIGS. 6 to 8 illustrate the application of the present invention to the dual windup method, a method in which two windup bobbins are arranged along side each other. In FIGS. 6 and 7, yarn yis delivered by means of yarn delivery roll 5 and is wound up as a yarn layer Y onto windup bobbin 2 while being traversed by means of traverse guide 8 of traverse device 7 via fixed guide 4. When windup bobbin 2 becomes full, an empty bobbin 3 fitted on a supporting mechanism 32 provided symmetrically of windup bobbin 2 is pressed against the drive roll 1 and driven by surface drive (see FIG. 7).

On the other hand, the flexible member 12 equipped with traveling guide 11, when seen from the front, is provided in a loop shape as shown in FIG. 6, whereas, when seen from the side, is provided so that the moving plane of the traveling guide is a plane *g* as shown in FIG. 7.

When empty bobbin 3 starts to be driven, flexible member 12 starts to travel around in its circuit and traveling guide 11 which was at the position shown in FIG. 6 starts to travel in the direction of the arrow. At this time when windup bobbin 2 on the left is full, flexible member 12 proceeds to go around in the clockwise direction, but when windup bobbin 3 on the right is full, it goes around in the counterclockwise direction. Then when traveling guide 11 contacts limit switch 41, a normally retracted pushout guide 9 lunges forward by means of the agency of a solenoid 21 and shoves the yarn *y* forward. Since moving guide 11 passes below this yarn, yarn *y* is not hooked by the traveling guide at this point. Then when traveling guide 11 contacts limit switch 42, the solenoid is deenergized and pushout guide 9 retracts to return yarn *y* to its former position. Traveling guide 11 continues its travel and contacts limit switch 43 (no action takes place here when the traveling guide is moving clockwise), after which yarn *y* is hooked by traveling guide 11 between delivery roll 5 and fixed guide 4 and then the traveling guide arrives at point I in FIG. 8. At this point, traveling guide 11 contacts limit switch 43' which operates electromagnetic solenoid 22 whereby another normally extended fixed guide 4' is made to recede. The path of the yarn at this time is indicated by y_1, it passing from the delivery roll to traverse guide 8 via the traveling guide and fixed guide 4. When traveling guide 11 proceeds with the course of the yarn in this state and arrives at point II in FIG. 8 where it contacts limit switch 42' to move it in one direction, fixed guide 4', which has been in a retracted position, reverts to its former position. The state of the yarn path at this time is shown by y_2, only the upper one of the two yarn paths I hooked by traveling guide 11 passing through fixed guide 4'. Traveling guide 11 continues to proceed in this state and contacts limit switch 41', but without any action taking place when the traveling guide is moving clockwise and arrives at point IV in FIG. 8. At this point, the yarn path is indicated by y_3, the yarn passing from the roll to the traverse guide via fixed guide 4', traveling guide 11 and fixed guide 4, in the order given. When the traveling guide is transferred to below point IV, the yarn comes into contact with the end of empty bobbin 3 where it is severed by the incised portion provided in the end of the bobbin and simultaneously becomes wound onto the bobbin, the transferred yarn *y* automatically slipping into traverse guide 8' by which it is traversed normally and wound up onto the bobbin.

When the yarn is thick, traveling guide 11 stops at points IV by the action of limit switch 44' disposed at this point, and the yarn is severed by the knife illustrated in FIG. 5 and transferred to the fresh windup bobbin 3.

FIGS. 9—11 illustrate another embodiment of the invention using the dual windup method. In FIGS. 9 and 10, yarn *y* delivered from the yarn feed source is wound up via delivery guide 6 while being traversed by means of rotary traverse roll 7, the actions during the normal windup being identical to that of the embodiment shown in FIGS. 6—8. When windup bobbin 2 becomes full, an empty bobbin 3 starts to rotate by coming into contact with drive roll 1. At this time, traveling guide 11, which was stopped at the position of limit switch 45, starts moving in the direction of the arrow as a result of the movement of flexible member 12. The contact with limit switch 44 produces no control action. When traveling guide 11 contacts limit switch 41 and actuates, it, yarn pushout guide 9 is pushed forward by means of solenoid 21. In consequence, yarn *y* is pushed upwardly and traveling guide 11 passes thereunder. This state is shown in FIG. 11A. Next, when traveling guide 11 actuates limit switch 42, (') the pushout guide 9 recedes to its former position; and (2) the frame (not shown) which supports yarn delivery guide 6 shifts to point 6' in FIG. 9. At this time, the yarn path, as shown by the dotted line in FIG. 11B, follows the sequence of yarn delivery guide, guide 4 and rotary traverse roller 7. Traveling guide 11, upon continuing its travel, intersects the yarn path between yarn delivery guide 6 and guide 4, where it hooks the yarn and arrives at the position shown in FIG. 11B. When the yarn guide 11 actuates limit switch 43, no control action occurs. When it actuates limit switch 43', fixed guide 4' is drawn back by means of solenoid for yarn guide 4'. The traveling yarn guide next actuates limit switch 42' which deenergizes the solenoid for yarn guide 4' and it returns to its forward position. Actuation of limit switch 41' causes no control action. When traveling guide 11 moves to the point indicated in FIG. 11C, the yarn path follows the sequence of yarn delivery guide 6, fixed guide 10', traveling guide 11, guide 4 and the rotary traverse roller 7. When traveling guide 11 proceeds still further from the state shown in FIG. 11C, the yarn contacts the end of empty bobbin 3, becomes caught in the incised portion or yarn catch to be severed and wound on the fresh bobbin 3. This state is shown in FIG. 11D. The yarn transferred to fresh bobbin 3 passing through guide 10' is wound up onto windup bobbin 3 directly below guide 10'. It is necessary for the windup bobbin to be so disposed that its ends are located inwardly of the guides 10 and 10'. When the yarn is thick, the traveling guide stops at the position shown in FIG. 11C and the yarn is transferred to the fresh windup bobbin 3 by the means described in connection with FIG. 5. The aforesaid guides 10 and 10' control the yarn path still more closely to ensure that the yarn in the path between yarn delivery guide 6 and traveling guide 11 is not severed by becoming caught in the stringing up opening 60' of the rotary traverse 7.

By the use of another guide 10' such as this, there is the further advantage that the transfer tail can be formed on the

bobbin without fail. Considerable difficulty is experienced in picking up this transfer tail by the ordinary yarn transferring method or yarn stringing up method. However, by employing the present embodiment, this operation can be carried out automatically.

When traveling guide **11** then proceeds further around its circuit and contacts limit switches **44'** and **45'**, solenoid **23** is actuated to retract guide **10** or **10'**, with the consequence that yarn *y* is disengaged from guide **10** or **10'** and gets caught in the yarn stringing up opening **60** or **60'** to be traversed normally. On the other hand, the traveling guide stops at this point.

A circuit diagram for the circuit for driving the flexible member **12** of FIGS. **9** and **10** is shown in FIG. **16**. All relay switches are shown in their normal position, i.e. the position to which they move when the corresponding relay coil is deenergized. The description of the circuit and its operation will be started with the apparatus set to wind yarn on a bobbin in the lefthand portion of the apparatus of FIG. **9**. The circuit is connected across lines from a power source (not shown). The switch RR_2 between lines **37** and **38** of circuit is in the upper position so that relay coil **24** is energized and relay coil **25** is deenergized, and relay switch **24** in line **3** is closed and relay switch **25** in line **5** of the circuit is open. Switch RR_1 between lines **34** and **35** is also in the lowered position so that relay coil **14** is deenergized, thus opening relay switches **14** in lines **13**, **28**, and **32** of the circuit, while relay coil **15** in line **35** is energized and relay switches **15** in lines **14**, **26** and **30** of the circuit are closed.

Timer T_1 in line **1** is actuated by pushing switch SW_1 in line **2** to the closed position. This energizes relay coil **4** in line **2** and closes relay switch **4** in line **1** so as to energize the timer T_1. Relay coil **4** also closes relay switches **4** in lines **4** and **6** for the purpose of holding relay **4** energized. It also closes relay switch **4** in line **36** and energizes relay coil RR_2 in order to switch relay switch RR_2 of lines **37** and **38** to the lower position. This deenergizes relay coil **24** and energizes relay coil **25**, which in turn allows relay switch **24** in line **3** to open, and causes relay switch **25** in line **5** to close, thus holding relay coil **4** energized.

After the time set on the timer T_1 has passed, a timer contact T_1 in line **13** is closed, thus completing a circuit through closed relay switch **15**, whereby relay coil **3** is energized and relay switches **3** in lines **15** and **57** are closed. Relay switch **3** in line **15** is a holding switch for holding the relay coil **3** energized, and relay switch **3** in line **57** energizes the motor M in line **56** for driving the flexible member **12** clockwise in FIG. **9**.

The traveling guide **11** on flexible member **12** first engages and momentarily closes limit switch **44**, which temporarily energizes relay coil **16** and in line **7** to close relay switch **16** in line **16**. This energizes relay coil **5**, which in turn closes relay switch **5** in line **17**. However, since relay switch **17** in line **17** is open, because relay coil **17** in line **8** is not energized, no control action occurs.

The traveling guide **11** next momentarily closes limit switch **41** and energizes relay coil **20** in line **22** which in turn closes relay switch **20** in line **26**. Since relay switch **15** is closed, relay coil **10** is energized to close relay switch **10** in line **27** for holding relay coil **10**, and relay switch **10** in line **58** for actuating solenoid **21**. Solenoid **21** moves guide **9** forward, thus moving the yarn forward. The traveling guide **11** next strikes and momentarily closes limit switch **42**, which energizes relay coil **22** in line **24**. This opens normally closed relay switches **22** in line **27** and line **33** so that relay coil **10** is deenergized due to the interruption of the holding circuit. As a result, the solenoid **21** is deenergized and yarn guide **9** is drawn back to its original position. During this time the solenoid **22** for yarn guide **4** is not actuated.

Traveling guide **11** next strikes limit switch **43**, in line **32** but no relays are energized because relay switch **14** in line **32**, which is in the circuit with limit switch **43** and relay coil **13**, is open.

Traveling guide **11** next strikes and momentarily closes limit switch **43'**, thus energizing relay coil **12** in line **30**, relay switch **15** being closed. Relay coil **12** closes relay switches **12** in line **31** and **60**, the relay switch **12** in line **31** completing a holding circuit for relay coil **12** and the relay switch **12** in line **60** energizing solenoid **22'** to draw yarn guide **4'** back. The traveling guide **11** next momentarily strikes and closes limit switch **42''**, energizing relay coil **23** in line **25**, which in turn opens normally closed relay switch **23** in lines **29** and **31**, thus breaking the holding circuit for relay coil **12**. When relay switch **12** in line **60** is opened, solenoid **22'** is deenergized and yarn guide **4'** is returned to its forward position.

Traveling guide **11** next strikes and momentarily closes limit switch **41'** and energizes relay coil **21** of line **23**. This closes relay switch **21** in line **28**, but because switch **14** is open, relay coil **11** is not energized.

The traveling guide **11** next strikes and momentarily closes limit switch **44'** energizing relay coil **17** in line **8** for opening normally closed relay switch **17** in line **6** and closing relay switches **17** in lines **17** and **19**. Opening of relay switch **17** in line **6** breaks the holding circuit to relay coil **4**, thus deenergizing it so that normally closed switch **4** in line **36**, which has been held open by relay coil **4**, is allowed to close, thus energizing relay coil RR_2 in line **36** so as to permit switch RR_2 between lines **37** and **38** to move to the upper position. This energizes relay coil **24** and deenergizes relay coil **25**. As a result, the timers T_1 and relay T_2 are reset. At the same time, since relay coil **5** in line **16** is still energized and relay switch **5** in line **17** is still closed, relay coil **6** is energized, closing relay switch **6** in line **51** to energize solenoids **23'** and **38'**. The guide **10'** is drawn backward and the knife **37'** is operated one cycle to cut the yarn. Traveling guide **11** finally strikes and momentarily closes limit switch **45'** and energizes relay coil **19** in line **10**. This closes normally open relay switch **19** in line **3** and opens normally closed relay switch **19** in line **16**. Since the relay coil **24** in line **37** is now energized, relay switch **24** in line **3** is closed and the relay coil **4** of line **2** is energized. The timer T_1 is thus actuated and begins to run. Three seconds later, Three seconds later, delay relay T_2 is actuated and changes switch RR_1 so that relay coil **14** in line **34** is energized and relay coil **15** in line **15** is deenergized. The opening of relay switch **19** in line **16** deenergizes relays **2**, **3**, **5**, **6**, **8** and **9** due to the interruption of the holding circuits therefor.

After a lapse of time necessary for the bobbin on the right hand side of the machine to be filled, the timer contact T_1 is closed, and since relay coil **14** in line **34** is energized to close relay switch **14** in line **13**, relay coil **2** is energized, closing relay switch **2** of line **14** and relay switch **2** in line **55**. This causes motor M to rotate in the opposite direction to drive the flexible member **12** in the opposite direction. The traveling guide **11** strikes the limit switches in the opposite sequence, and the various relays, etc. are closed in reverse sequence, thus operating the yarn guides and knife **38** so as to transfer the yarn back to the bobbin on the left hand side of the apparatus. In this operation, the limit switches which were inactive during the transfer from left to right will be active due to switches **14** being closed, and the corresponding limit switches will be inactive due to switches **15** being open.

It will be apparent to those skilled in the art that this circuit can, by the omission of appropriate switches and relays, be adapted to control the less complicated embodiment of FIGS. **1**—**4** and **6**—**8**.

FIGS. **12** and **13** illustrate another embodiment of the invention. In this embodiment, the present invention has been applied to a winder conventionally employed hitherto in the spinning and winding up of synthetic fibers, the application having been made without requiring major alterations in the essential part of said winder. It comprises providing in the yarn guide device a traveling guide provided on a loop-shaped flexible member and a fixed guide in the plane through which the yarn is conducted from the delivery roll to the windup bobbin and by causing said fixed guide to make to-and-fro sliding movements with respect to the moving plane of the traveling

guide to permit the yarn being delivered to take an optional course.

In FIGS. 12 and 13, reference numeral 1 indicates the drive roller; 3, the empty bobbin which has been readied for winding the yarn; 2, the windup bobbin being wound; 52, the fixed guide attaching plate; 4 and 51, the guides attached to attaching plate 52; 22, the device for moving the attaching plate; 7, the traverse mechanism; 8, the traverse guide fitted to the traverse mechanism; 11, the traveling guide; 12, the loop-shaped flexible member such as a chain or belt; 13, the guide and drive pulleys for effecting the travel of flexible member 12; 41, 42, 43, 44, the limit switches; 21 and 22, the solenoids; 9, the pushout guide; and 6, the yarn delivery guide.

Normally when yarn *y* is being wound up on windup bobbin 2, the yarn which proceeds via guide 6 is wound up on bobbin 2 via traverse guide 8 fitted to the traverse mechanism 7. (See yarn indicated by the solid line in FIG. 12; as regards the relationship between the guides and yarn, see FIG. 14A).

Now, when windup bobbin 2 has become wound up with the required amount of yarn *y*, the motor (not shown) which drives the yarn transfer apparatus is started up as a result of the displacement of the windup bobbin supporting mechanism.

Traveling guide 11 fitted to flexible member 12 (usually a chain) travels in the direction of arrow E, and after hooking yarn *y* at point D, proceeds downwardly in the direction of arrow F. The yarn path becomes as shown with the dot-and-dash line in FIG. 12.

If fixed guides 4 and 51 project beyond the plane of travel of the yarn when the traveling guide is traveling, the yarn being shifted by traveling guide 11 is hooked by the foregoing fixed guides 4 and 51, with the consequence that the yarn path shown with the dot-and-dash line in FIG. 12 does not result. However, the present embodiment has effectively solved this defect.

As traveling guide 11 starts traveling around its course, it contacts limit switch 43, thereby actuating solenoid 21 of FIG. 13 to shove out yarn pushout guide 9. Traveling guide 11 passes under this yarn pushout guide 9 and thus below yarn *y*. Next, as limit switch 41 is operated and yarn pushout guide 9 is retracted, simultaneously solenoid 22 is actuated and plate 52 equipped with the two fixed guides 4 and 51 lunges forward from its normal position. At this time, yarn *y* conveyed by traveling guide 11, being hooked thereon is hooked by guide 4 and then guide 51 which have leaped forward before the yarn. Next, when traveling guide 11 arrives at the point where a yarn path shown in FIG. 14B is formed, since limit switch 42 is operated to deenergize 22, the guide 4 and 51 retract with the yarn being still hooked by these guides.

Thus, only the yarn which proceeds towards windup bobbin 2 passes through guides 4 and 51, while the yarn that comes to traveling guide 11 from delivery guide 6 does not get hooked by guides 4 and 51. The yarn path hereafter follows the sequence of delivery guide 6, traveling guide 11, guide 51, guide 4 and traverse guide 8.

When traveling guide 11 arrives at the point shown in FIG. 12, the yarn delivered from delivery roller or the spinning machine (both not shown) gets caught in the incised portion provided in the end of empty bobbin 3, which has already been given preparatory rotation to become severed by the inertia of the bobbin and transferred to the fresh windup bobbin 3. Traveling guide 11 still continues its travel until it stops at the point where limit switch 44 is operated.

When the yarn is thick in this case, the chain is stopped once before the yarn gets caught by empty bobbin 3 and the transfer of the yarn is accomplished by the yarn being severed by the action of the yarn presser and severing means shown in FIG. 5 while it simultaneously gets wound on empty bobbin 3.

Full bobbin 2 may be replaced with a new bobbin 3 in any conventional manner. One structure for carrying out this operation is shown in FIG. 17. Bobbins 2 and 3 may be mounted by suitable arms on a structure, for instance of a triangular configuration, 100. Triangle 100 is revolvably mounted around a center point thereof 101. As bobbin 2 becomes full of yarn, the yarn is transferred to new bobbin 3 in the manner above described. When this transfer is completed, triangle 100 may be rotated in a clockwise manner by 120°. This will, of course, bring new bobbin 3 into the position formerly occupied by bobbin 2. Bobbin 2, on the other hand, will be moved to the position indicated by the dash lines in FIG. 17. At this point, it will be apparent that bobbin 2 may be removed and replaced by a further new empty bobbin. This operation is continued as the windup bobbins rotatively become full of yarn.

The roll of the guides 4 and 51 will be described. Guide 4 is for controlling the yarn to be wound up on the bobbin to ensure that the yarn is positioned centrally. On the other hand, the role of the other guide 51 is to keep separate the two lengths of yarn i.e., to hook only the yarn coming from above when stringing the yarn up to empty bobbin 3 and to ensure that the yarn which returns to guide 4 via traveling guide 11 does not get caught on the end of empty bobbin 2.

FIG. 15 is a diagram showing the sequence of action of the timer and limit switches. The hereinbefore described yarn hooking operations are carried out in accordance with this diagram. Referring to FIG. 15, starting of the motor moves the traveling guide until it strikes the limit switch 43, which energizes solenoid 21 so as to push the guide 9 out. The continued movement of the traveling yarn guide next actuates limit switch 41 to deenergize solenoid 21, thus retracting yarn guide 9, and at the same time energizes solenoid 22 to move yarn guides 4 and 51 out. Continued movement of the traveling yarn guide next actuates limit switch 42, which deenergizes solenoid 22 and causes withdrawal of guides 4 and 51 to their original positions. Continued movement then actuates limit switch 44 to stop the drive motor for the flexible member, and start a timer which turns the motor on when the bobbin is full.

For effecting the travel of the traveling guide in the hereinbefore described embodiments, the movement is accomplished by means of a flexible member such as a chain or belt. However, the present invention is not limited to such instances only, but the movement can be carried out by a rectilinear motion by means such as hydraulic cylinder or a curvilinear motion by the provision of the former with linkages.

Further, the transfer method of the present invention can also be practiced by merely combining the fixed and traveling guides in the yarn windup operation in specific relative positions. Further, automation can readily be carried out by employing a power source, such as hydraulic, pneumatic or electric, for driving the traveling guide. In addition, the apparatus has the advantages that it can be readily attached to the conventional winders and that the appearance of the yarn package during yarn transfer differs not a whit from that during the conventional windup operation.

In the explanation of the examples, all the drive systems for a windup roll were surface drive systems; however, it should be borne in mind that upon practicing this invention, these can be replaced by other drive systems, for instance, a spindle drive system is also possible.

We claim:

1. A method of continuously winding yarn, comprising the steps of guiding the yarn from a source thereof toward a windup bobbin position, winding the guided yarn on a windup bobbin at said position while traversing the yarn along the bobbin and simultaneously driving the windup bobbin and an empty bobbin, and when the windup bobbin has become full, engaging the yarn at a point between the yarn source and the point at which it is guided and drawing it tranversely of the direction of its movement and then across the end of the driven empty bobbin, guiding the yarn at additional points spaced from said first mentioned point for dividing the paths along which the yarn moves so that only a single length of the yarn approaches the end of the empty bobbin, and then engaging the yarn by the driven empty bobbin and severing the yarn, whereby the severed end of the yarn coming from the yarn source is engaged with and wound up on the empty bobbin,

and the severed end of the yarn extending to the fully wound up bobbin is wound onto the fully wound up bobbin.

2. The method as claimed in l claim 1 further comprising the step of shifting the yarn laterally of the path along which it normally runs between the yarn source and the windup bobbin for passing an engaging and drawing means for carrying out the engaging and drawing step past said yarn where it is desired not to engage and draw said yarn.

3. A yarn windup apparatus comprising means for rotatably supporting a plurality of windup bobbins, bobbins having yarn catching means on the ends thereof and supported in said supporting means, at least one traverse guide for guiding yarn back and forth along at least one bobbin in said bobbin supporting means, at least one yarn guide for guiding said yarn from a source of yarn to said traversing means, a traveling yarn guide, a flexible member extending in a loop and on which said traveling yarn guide is mounted, and drive means coupled to said flexible member for driving said flexible member, said flexible member extending in a path which crosses the path of the yarn coming to the said guide from the said yarn source transversely thereof and which extends past and adjacent the ends of the bobbins having the yarn catching means thereon, whereby when the flexible member is driven, the traveling yarn guide engages the yarn and draws it transversely and then past the end of an empty bobbin in the yarn sunporting means, and when the bobbins are rotatably driven, the yarn is picked up by an empty bobbin.

4. An apparatus as claimed in claim 3 and further comprising at least one drive roll engaged with said bobbins and simultaneously surface driving said bobbins.

5. An apparatus as claimed in claim 3 in which the said yarn guide and traverse guide cooperate to guide the yarn in one plane and the flexible member lies in a second plane, said planes being at an angle to each other and intersecting adjacent said point where said traveling yarn guide engages the yarn, whereby the traveling yarn guide will not engage the yarn at any other points.

6. An apparatus as claimed in claim 3 further comprising at least one movable yarn guide, and moving means on which said movable yarn guide is mounted, said moving means and movable yarn guide being mounted adjacent the path of said yarn and movable laterally of the path of said yarn and engageable with said yarn o for moving the yarn out of the path of the traveling yarn guide on said flexible member for permitting the traveling yarn guide to pass the yarn without engaging it.

7. An apparatus as claimed in claim 3 further comprising a yarn pressing and severing device adjacent the end of at least one empty bobbin in said bobbin supporting means and adjacent and movable into the path of the yarn drawn adjacent the end of the bobbin by said traveling yarn guide and movable to engage the yarn to move it into engagement with the yarn catching means on the empty bobbin and to sever the yarn.

8. An apparatus as claimed in claim 3 in which said bobbin supporting means supports two bobbins one at a higher level than the other and on an axis parallel to the other, the lower being the windup bobbin and the upper being an empty bobbin in position to become a windup bobbin, and said yarn guide is a single fixed yarn guide.

9. An apparatus as claimed in claim 3 in which said bobbin supporting means supports two bobbins side by side on the same axis and there are two yarn guides one above each bobbin, yarn guide moving means on which each of said yarn guides is mounted for moving said yarn guides transversely of the plane of the yarn, said flexible member extending in a closed loop above the bobbins and s downwardly between the bobbins, and actuating means coupled to said yarn guide moving means and positioned adjacent said flexible member and engaged by said traveling yarn guide for moving said yarn guides to permit said traveling yarn guide to move past said yarn without engaging it, and said flexible member drive means being reversible for driving said flexible member in either direction around said loop.

10 An apparatus as claimed in claim 3 in which said bobbin supporting means supports two bobbins on parallel axes, and said yarn guide is a fixed yarn guide, and further comprising two further yarn guides positioned side by side on a line generally parallel to the axis of the bobbins with at least one of the further yarn guides lying outside the ends of the bobbins, said flexible member extending in a path above the further yarn guides past the said at least one yarn guide and then downwardly past the end of the empty bobbin, further yarn guide moving means on which said further yarn guides are mounted and moving said further yarn guides transversely of the path along which said flexible member extends above said further yarn guides, and actuating means coupled to said further yarn guide moving means and positioned adjacent said flexible member and engaged by said traveling yarn guide for moving a said further yarn guides to permit the traveling yarn guide to move past the yarn without engaging it.