United States Patent [19]

Wüst

[11] **3,856,222**

[45] **Dec. 24, 1974**

[54] **METHOD OF AUTOMATICALLY CHANGING WINDING TUBES AND WINDING APPARATUS FOR IMPLEMENTING THE AFORESAID METHOD AND IMPROVED SPOOL DOFFING MECHANISM**

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[73] Assignee: **Rieter Machine Work Ltd.,** Winterthur, Switzerland

[22] Filed: **Apr. 13, 1973**

[21] Appl. No.: **350,793**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 76,181, Sept. 28, 1970, abandoned.

[30] **Foreign Application Priority Data**

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Jan. 22, 1973	Switzerland	854/73
Feb. 2, 1973	Switzerland	1547/73

[52] **U.S. Cl.** ..... **242/18 A,** 242/18 PW, 242/41

[51] **Int. Cl.** **B65h 54/06**

[58] **Field of Search** ..... 242/18 A, 18 DD, 18 PW, 242/41

[56] **References Cited**

UNITED STATES PATENTS

3,001,732	9/1961	Hill, Jr. et al.	242/18 A
3,165,274	1/1965	DePriest	242/18 A UX
3,409,238	11/1968	Campbell et al.	242/18 A
3,559,901	2/1971	Schnetzer	242/18 A

FOREIGN PATENTS OR APPLICATIONS

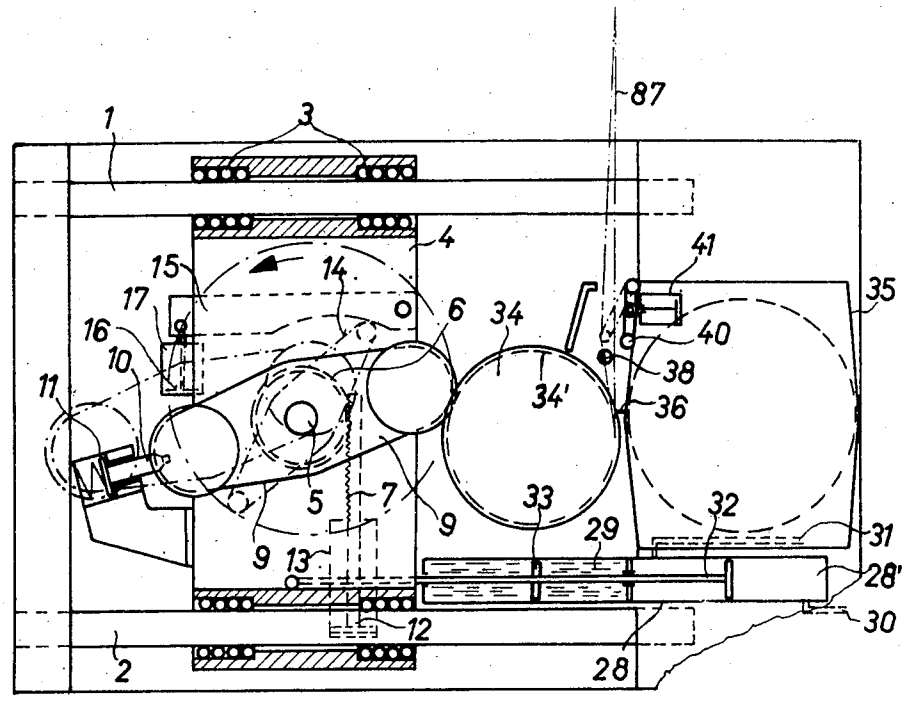
1,104,156	2/1968	Great Britain	242/18 A

Primary Examiner—Stanley N. Gilreath
Attorney, Agent, or Firm—Werner W. Kleeman

[57] **ABSTRACT**

A method of and apparatus for automatically changing two tubes, each placed upon a respective mandrel arranged on an arm member movable substantially parallel to its axis and rotatable such that said tubes alternatingly contact a friction drive drum for taking up an endless thread delivered at high speed in a winding device. The full package wound upon one of the tubes, during such time as the desired package size is reached, is rolled along the friction drive drum in the sense of an extension of the thread path on said friction drive drum and until the other tube which is empty contacts the friction drive drum. Due to its contact with the friction drive drum the empty tube is accelerated and the full package is lifted off the friction drive drum while the thread is still being wound thereon due to the inertia of the full package. The thread, in the meantime unthreaded from the thread traversing guide, and passing from the friction drive drum to the full package which has been lifted out of contact with the friction drive drum, passes through a rotating catching zone of the mandrel supporting the empty tube. Then the connecting thread between the full package and the empty tube is severed by means of the rotating catching zone, and a number of reserve wraps are placed onto the empty tube by axially moving such tube into a normal winding position while rolling such empty tube along the friction drive drum.

66 Claims, 28 Drawing Figures



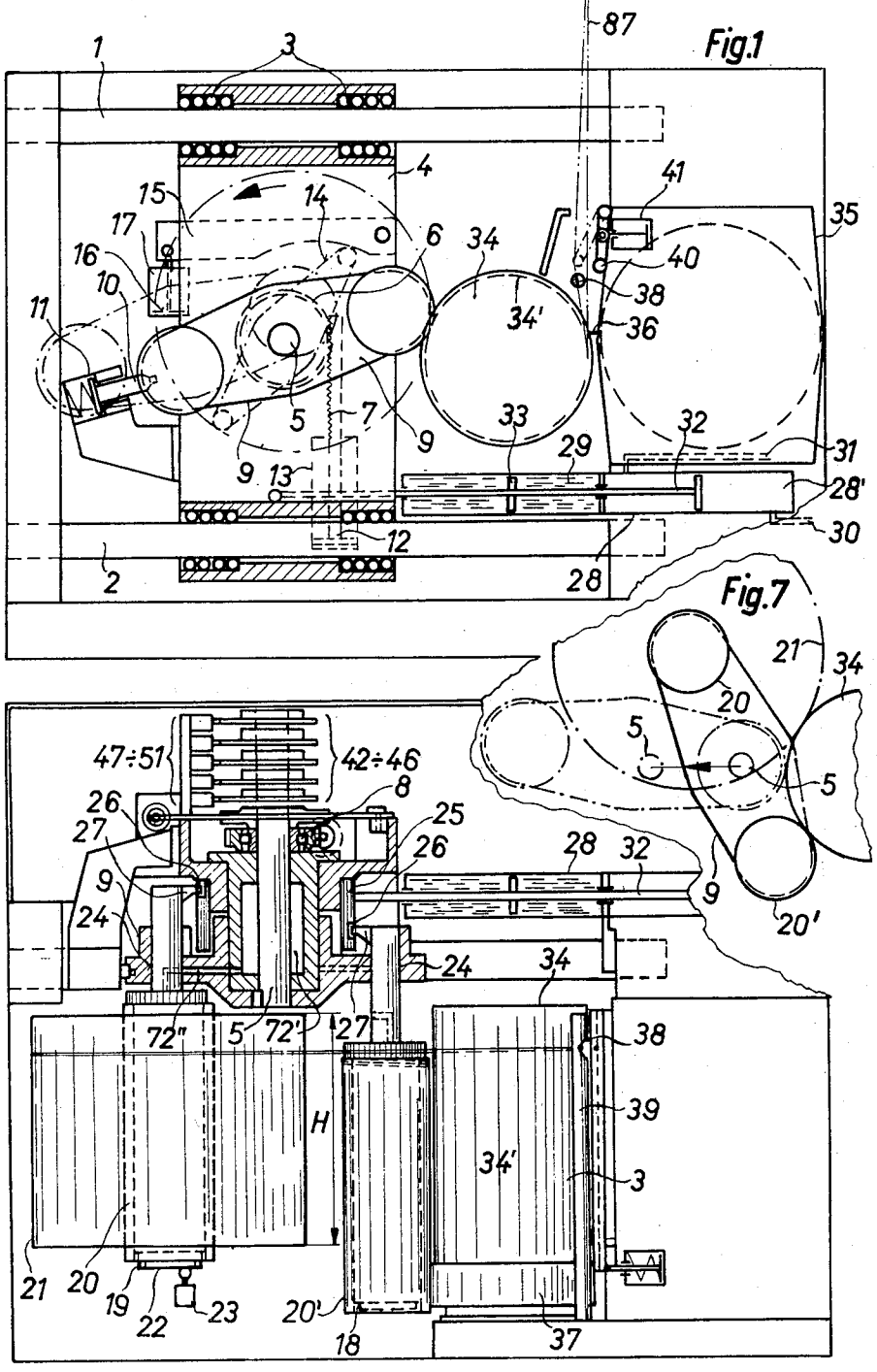


Fig.1

Fig.7

Fig. 2

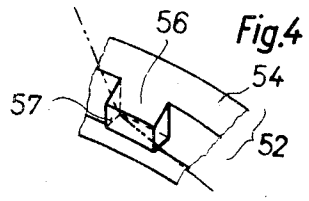


Fig.4

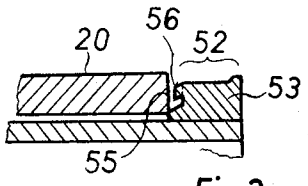


Fig.3

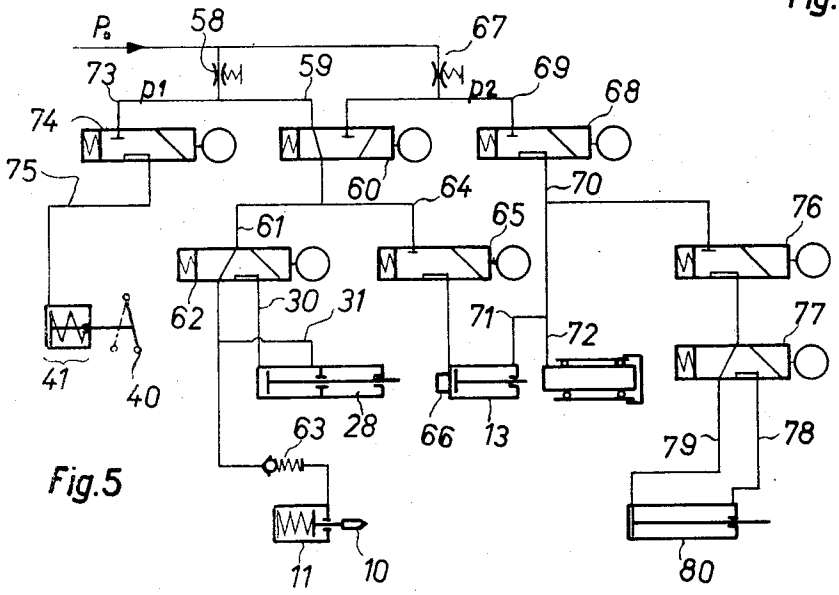


Fig.5

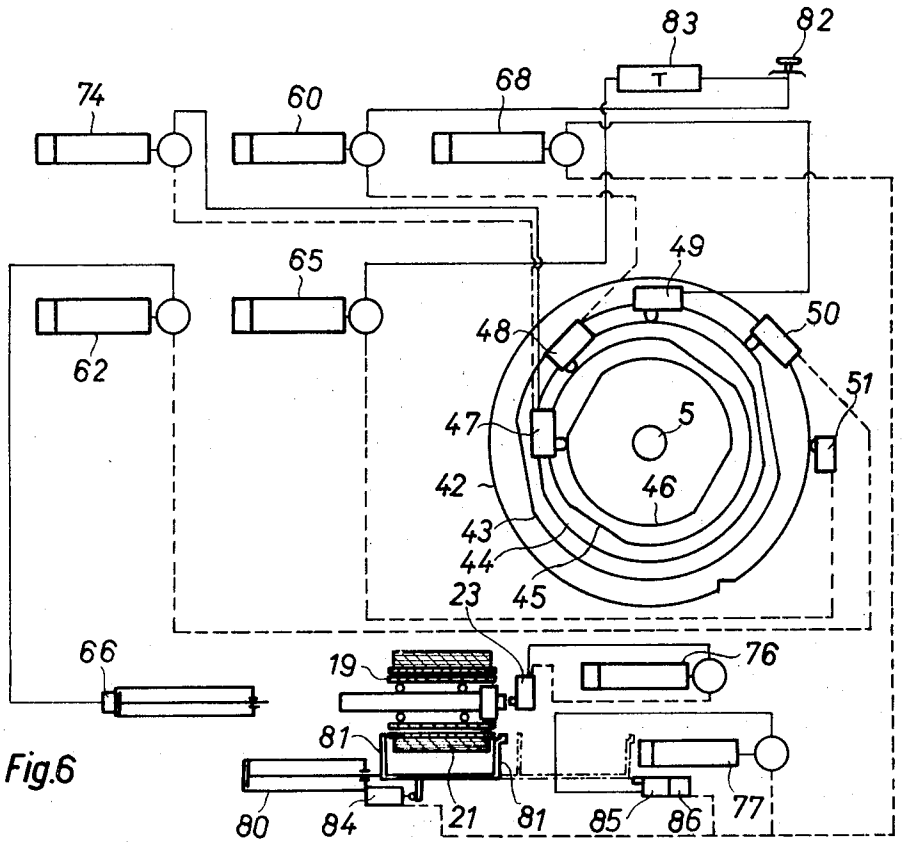

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Fig.6

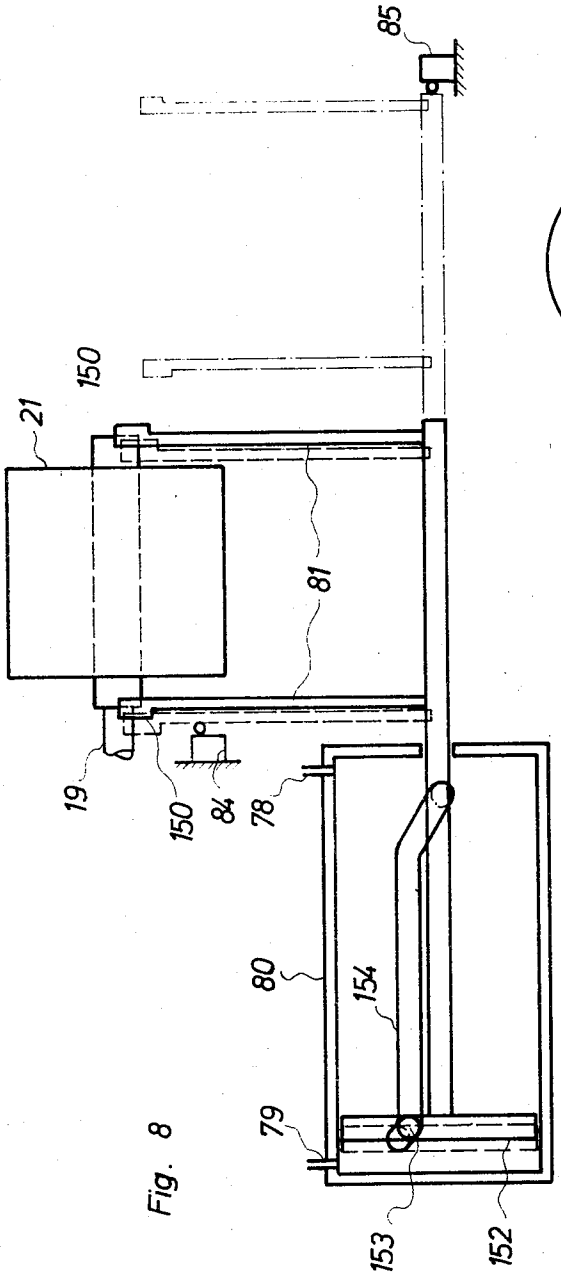


Fig. 8

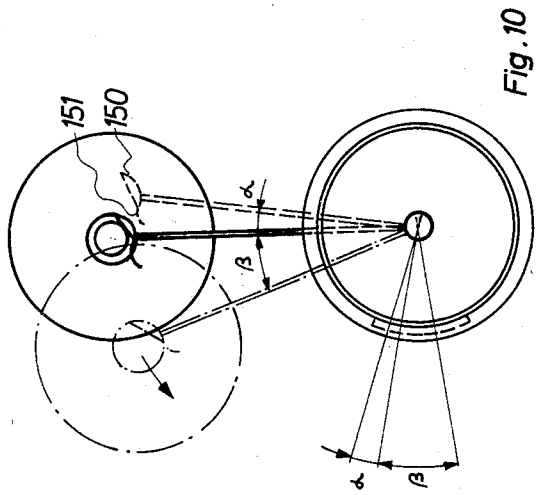


Fig. 10

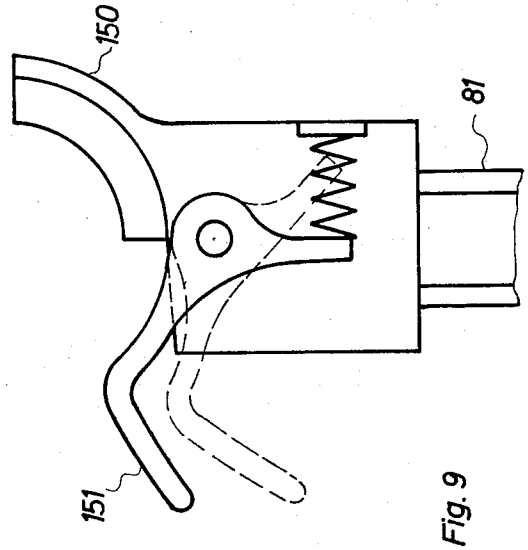


Fig. 9

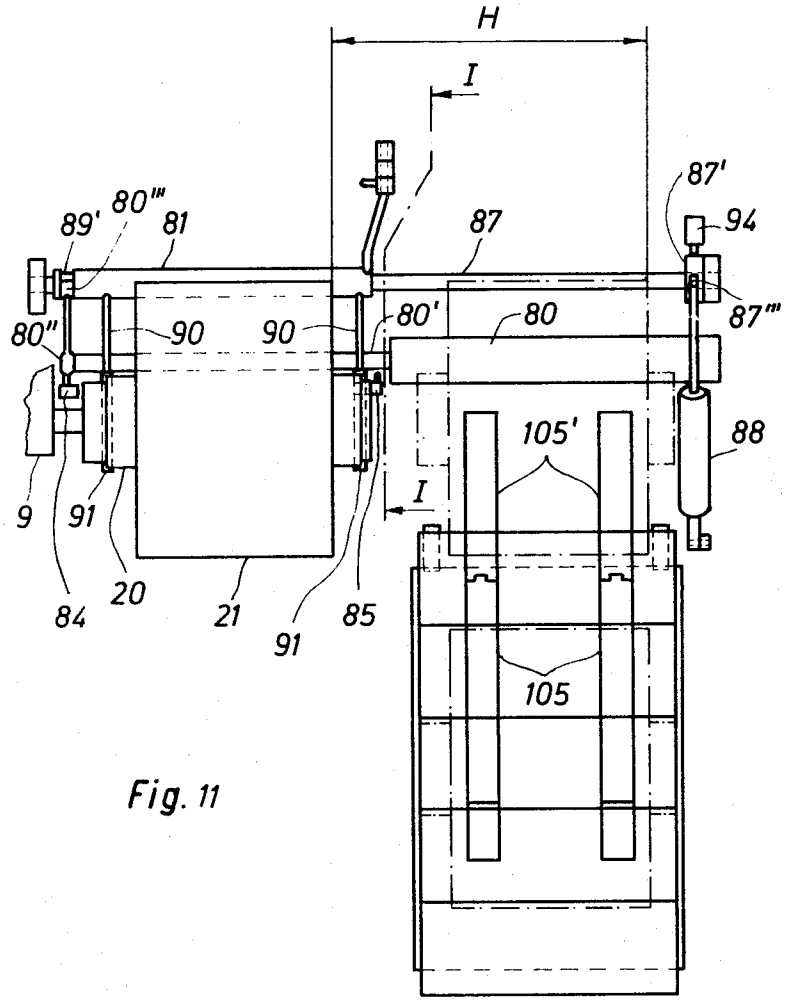


Fig. 11

Fig. 13

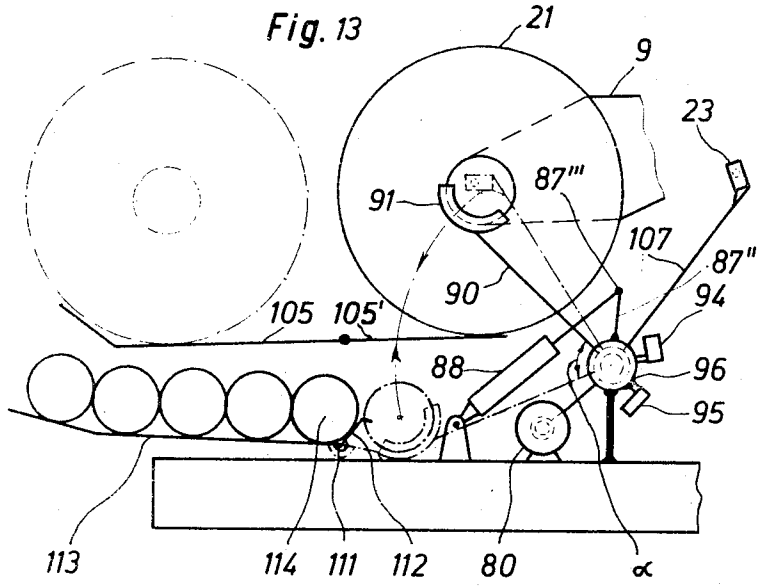
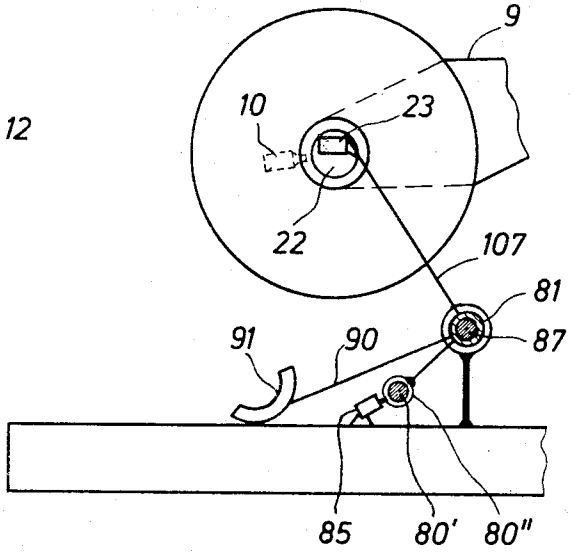

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Fig. 12


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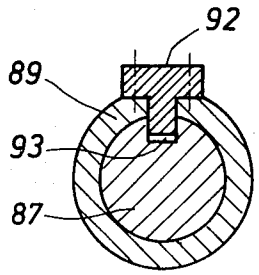


Fig. 14

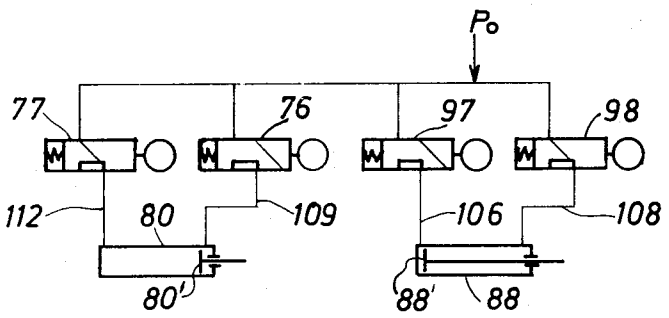


Fig. 15

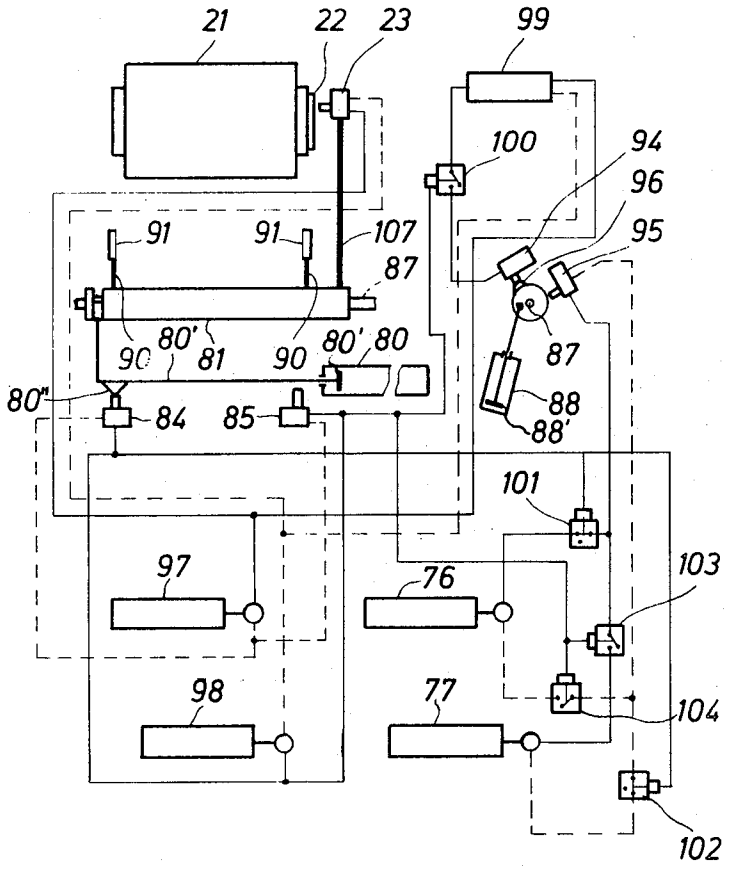

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Fig. 16

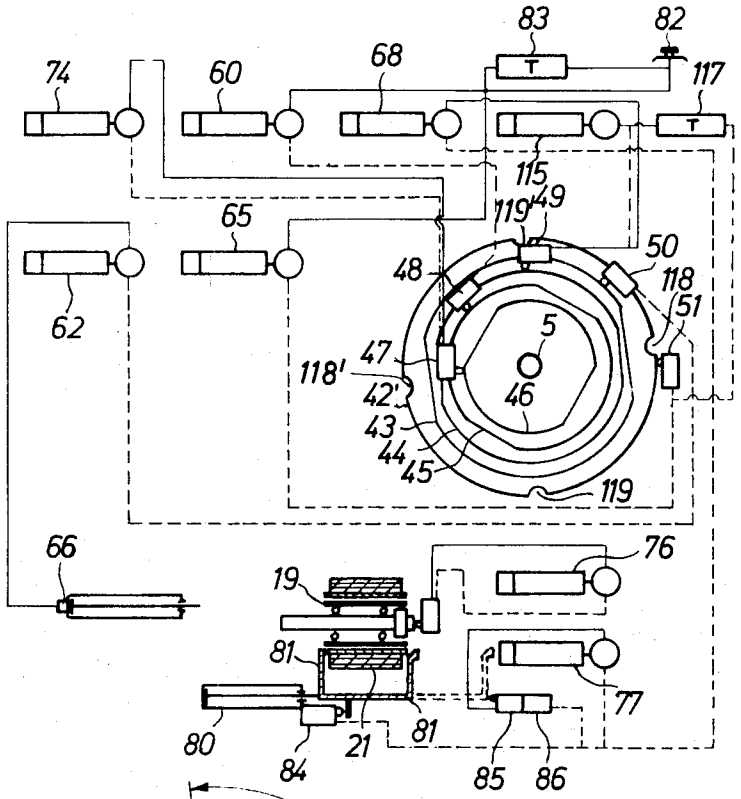

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Fig. 18

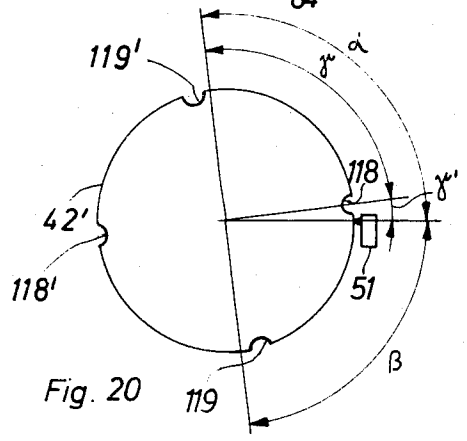

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Fig. 20

Fig. 19

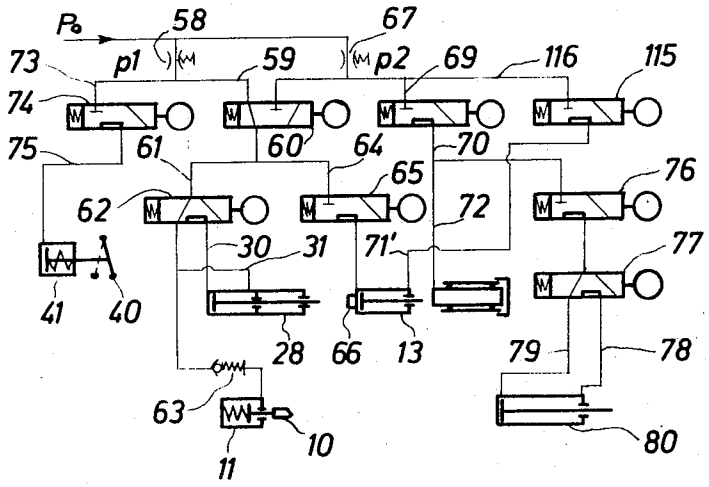
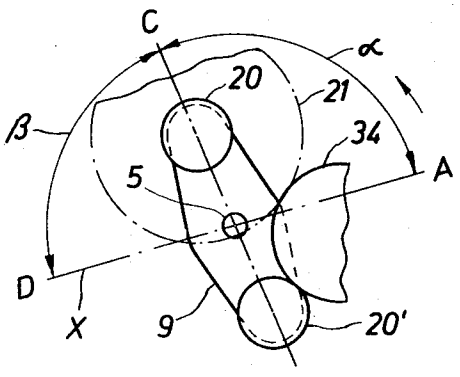

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Fig. 17


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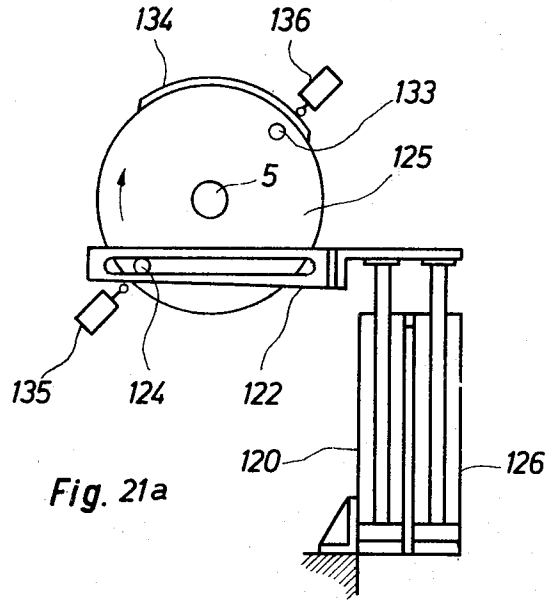


Fig. 21a

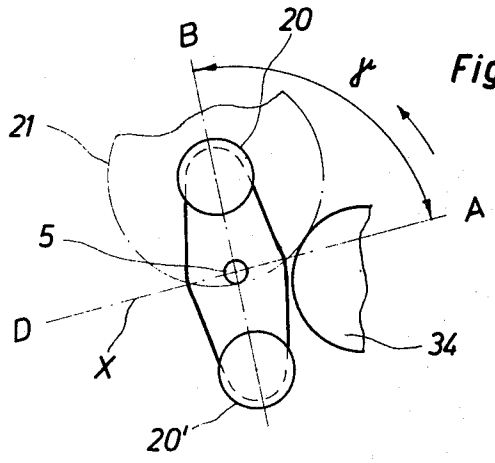


Fig. 17a

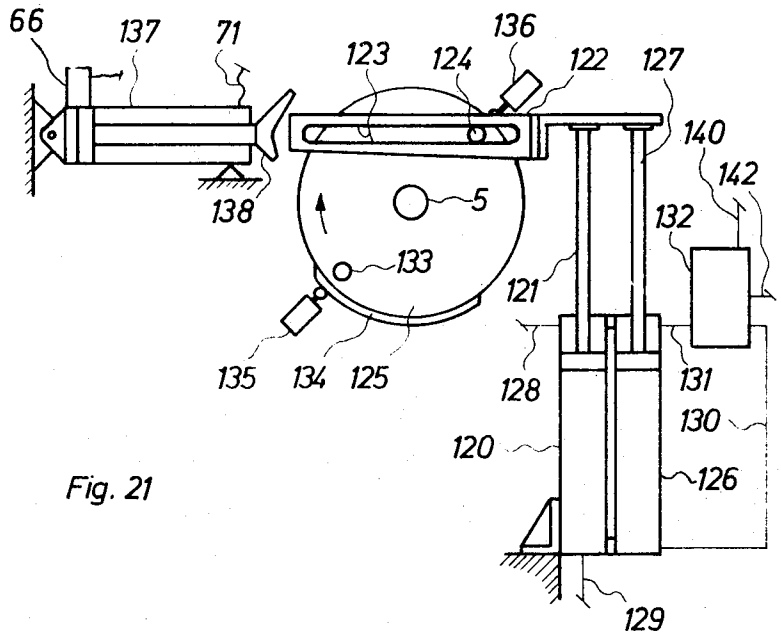

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Fig. 21

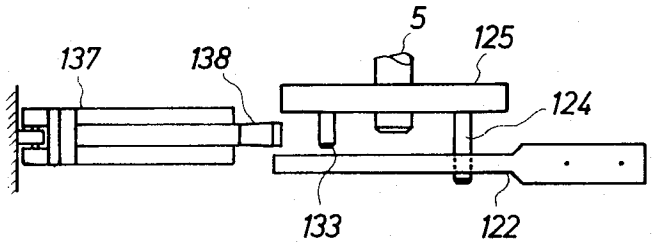

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Fig. 22

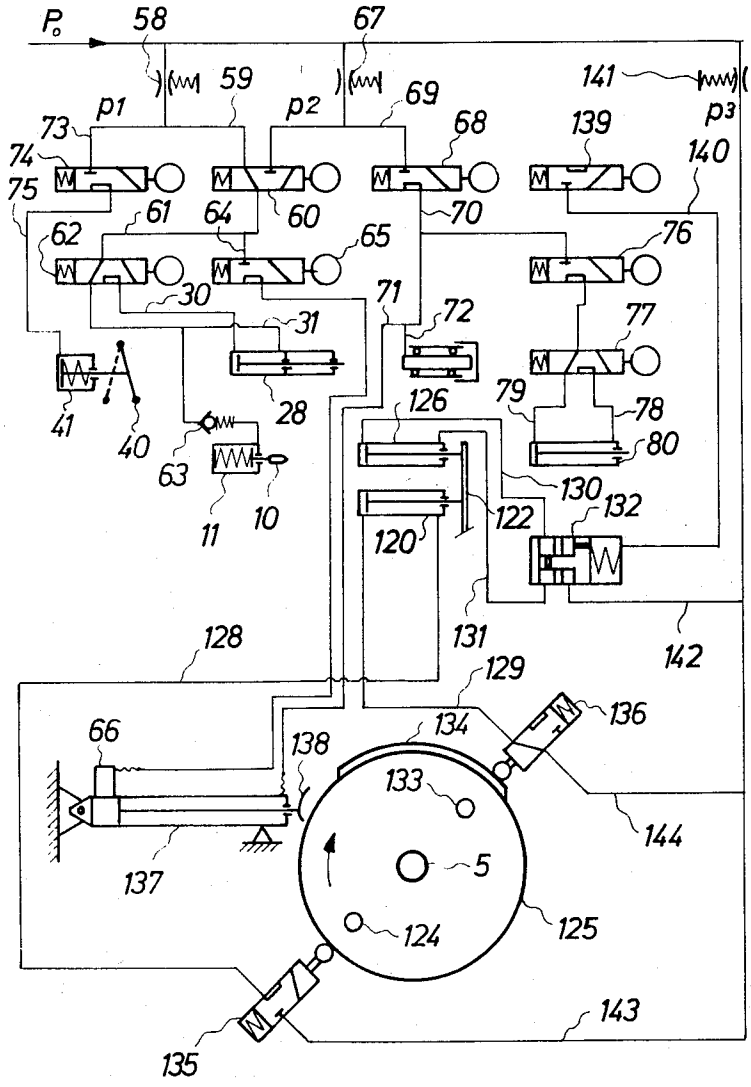

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Fig. 23

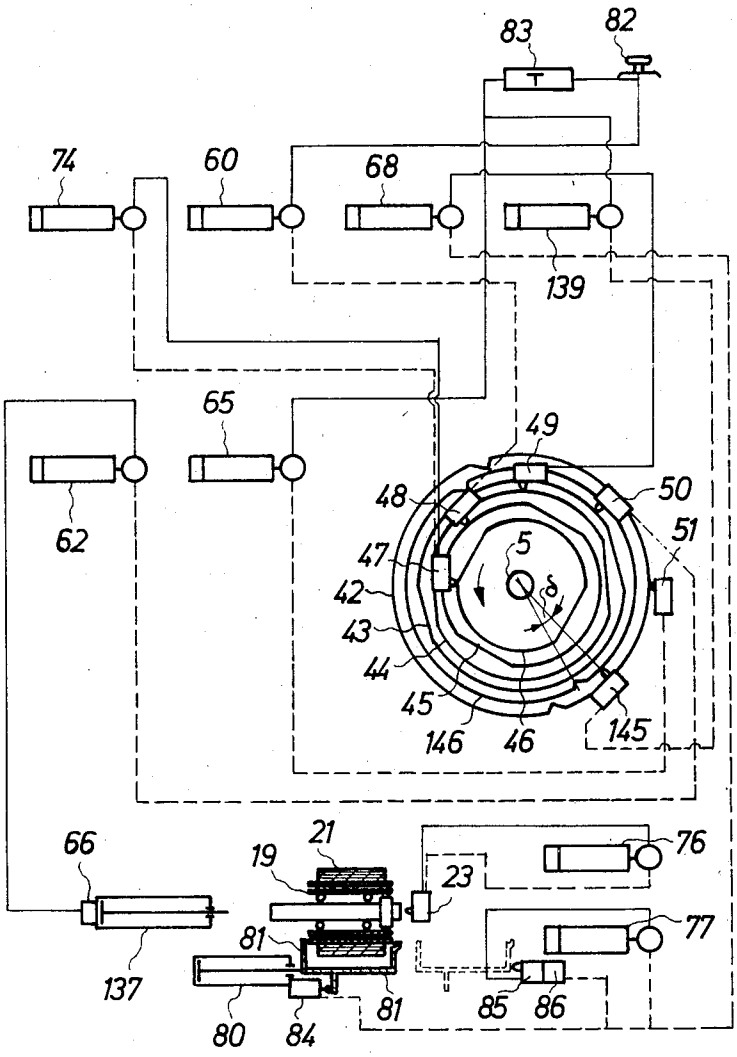

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Fig. 26

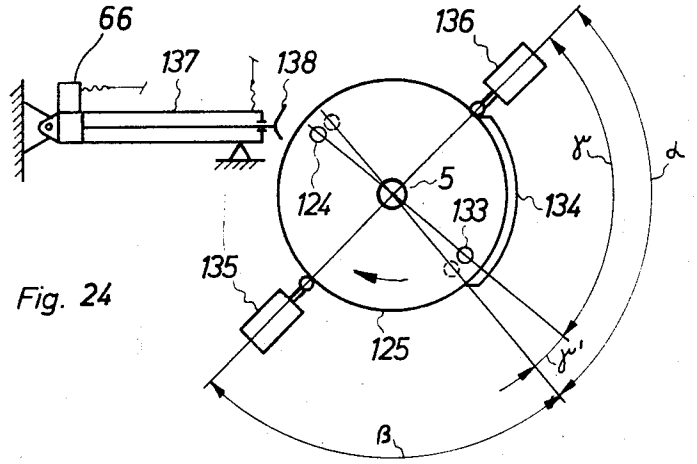

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Fig. 24

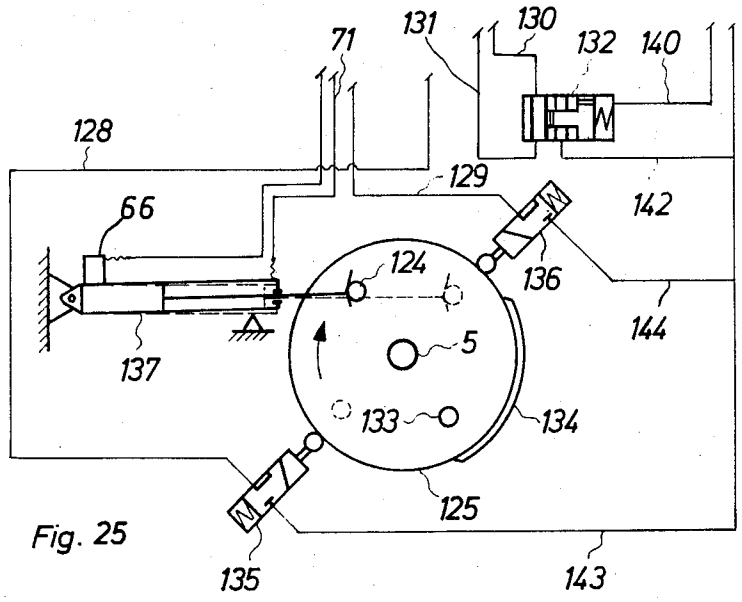

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Fig. 25

METHOD OF AUTOMATICALLY CHANGING WINDING TUBES AND WINDING APPARATUS FOR IMPLEMENTING THE AFORESAID METHOD AND IMPROVED SPOOL DOFFING MECHANISM

CROSS-REFERENCE TO RELATED CASE

This is a continuation-in-part application of my commonly assigned, copending U.S. application Ser. No. 76,181, filed Sept. 28, 1970, and entitled "Method Of Automatically Changing Winding Tubes And Winding Apparatus For Implementing The Aforesaid Method" now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to an improved method of automatically changing tubes taking up endless filaments and further pertains to an improved winding apparatus for implementing the aforesaid method. The method techniques and apparatus structure of the invention are especially suitable for use in spin-draw-winding in the man-made or synthetic fiber manufacturing industry. The invention also is concerned with an improved construction of spool doffing mechanism.

The prior art is already acquainted with the technique of lifting the full wound package off the drive drum for the purpose of changing the spool and to automatically pivot an arm supporting two spools. With this procedure the empty tube or sleeve is placed in rotation by manually pressing it against the friction drive drum for a short period of time, then lifting it off again for a short period of time, so that the thread or yarn can be manually wrapped several times around the empty tube. The winding process is thereupon started by again placing the empty tube onto the friction drive drum and by simultaneously threading the traversing thread guide, whereupon the connecting thread to the full package is torn off.

This technique possesses the notable drawback that automatic operation is not possible, resulting in operational difficulties at high processing speeds, inasmuch as manual operations can be no longer attained with sufficient precision and speed. A further disadvantage is that during the acceleration or speed-up time of the empty tube the full package must be already lifted off the friction drive drum, so that during a relatively long time interval thread is taken up by the undriven package, the speed of rotation of which decreases. As a result, the tension in the thread or yarn up to the location of the above-situated delivery element sharply decreases, greatly increasing the danger of lap formation at the delivery element. This phenomenon is particularly pronounced in the event a spool change operation must be effected for any reason during the initial stage of the package formation, during which time the inertia of the package is still extremely small. A still further disadvantage is that as the thread is unthreaded from the traversing guide, which occurs immediately after lifting the package, the thread tension considerably drops and cannot be compensated. Furthermore this device does not permit formation of a thread reserve.

SUMMARY OF THE INVENTION

Hence, there is a real need in the art for an improved technique of automatically changing the winding tubes as well as for improved winding apparatus for implementing such technique or method without encountering the aforementioned drawbacks of the prior art. With this in mind a primary objective of the present invention is to provide an improved method of changing winding tubes and an improved winding apparatus for this purpose which effectively fulfills the existing need and is not associated with the aforementioned drawbacks prevailing in the state-of-the art.

Another essential objective of the present invention not only constitutes the effective elimination of the aforementioned drawbacks of the prior art techniques and apparatus structure, but additionally aims at fully automating the process of spool change while at the same time achieving thread transfer from a full package to an empty tube held in readiness without generating any thread waste and while maintaining the normal winding speeds.

Still a further objective of the present invention is to realize spool change operation in such manner that the still traversing thread or yarn contacting the friction drive drum does not cause the formation of irregular or otherwise disturbing layers at the full package, nor cause damage to the thread, nor cause the formation of bulges at the full package due to prolonged winding without traversing the thread.

Another object of this invention is to control the contact pressure of the full wound package against the friction drive drum during the spool change operation up to the moment of lifting off such package from the friction drive drum, in other words, to maintain the contact pressure as constant as possible.

In connection with the last-stated object of the invention a further objective of the present invention is to compensate changes in thread tension during the spool change operation by appropriately selecting the magnitude of the circumferential speeds of the thread guiding elements.

A further object of the invention is the provision of a spool doffing mechanism which is of relatively simple construction and design yet extremely efficient and reliable in operation.

Now, in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the method for automatically changing two tubes each placed on a mandrel arranged on an arm movable parallel to its axis and rotatable such that such tubes alternatingly contact a friction drive drum for taking up in a winding device an endless thread delivered at high speed, is achieved by undertaking the steps of rolling the full package wound onto the tube, as the desired package size is reached, along the friction drum in the sense of an extension of the thread path on this drive drum until the empty tube is accelerated by the friction drive drum due to contact of such empty tube with the friction drive drum. Then the full package is lifted off the drive drum, thread still being wound onto this full package owing to the inertia of the full package. The thread passing from the friction drive drum to the full package which has been lifted off the drive drum and which thread in the meantime has been unthreaded from the traversing guide, is deflected through a rotating catching zone of the mandrel supporting the empty tube. The connecting thread between the full package and the empty tube is subsequently severed by the rotating catching zone, and a number of reserve wraps are placed upon the empty tube by axially moving the tube

into its normal winding position while rolling the tube along the friction drive drum.

The just-explained method aspects of the invention are successfully achieved through the use of a winding apparatus of the invention incorporating a friction drive drum for driving two tubes which are alternatingly brought into contact with such friction drive drum. These tubes are each placed upon a respective mandrel which can be braked and detached and which by means of a rotatable- and arrestable arm can be rotated through 180° in each instance into the spool- and tube change position, respectively. Furthermore, means are provided for generating and transmitting a contact pressure to the supporting arm in such a manner that the mandrels are supported so as to be axially movable at the supporting arm and this axial movement is determined by the momentary position of the supporting arm.

The invention also deals with a method of, and apparatus for, the automatic doffing or changing of a tube seated upon one of the mandrels which contemplates engaging a full tube defining a package by means of a gripper rocked towards the full tube out of a rest position and in a direction essentially perpendicular to the axial direction of the mandrel into a package change position, withdrawing the package from the mandrel by carrying out a movement of the gripper away from the mandrel and essentially parallel with respect to the axial direction of the mandrel until reaching a predetermined position, and thereafter releasing the package by carrying out an opposite pivotal movement of the gripper.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. **1** is a side or elevational view of the tube change apparatus of the invention in normal winding position;

FIG. **2** is a top plan view, partly in section, of the apparatus of FIG. **1**, showing the position of the structural components thereof immediately before thread transfer occurs;

FIG. **3** is a cross-sectional view showing a detail of the thread catching zone of the mandrel;

FIG. **4** is a perspective view illustrating details of the thread catching zone of the mandrel;

FIG. **5** is a schematic circuit diagram of electropneumatic control of the inventive winding apparatus;

FIG. **6** is an electrical circuit diagram of the inventive winding apparatus;

FIG. **7** is a schematic view illustrating the position of the tubes in the thread severing position;

FIG. **8** is a schematic elevational view, partly in cross-section, showing details of a possible construction of spool doffing mechanism for use with the apparatus of FIG. **1**;

FIG. **9** is an enlarged view showing details of a portion of the spool doffing mechanism of FIG. **8**;

FIG. **10** is a cross-sectional view of the spool doffing mechanism depicted in FIG. **8**, taken substantially along the line A—A thereof;

FIG. **11** is a plan view of a further embodiment of spool doffing mechanism with the full spool or tube still located upon the mandrel;

FIG. **12** is a cross-sectional view of the mechanism of FIG. **11** taken substantially along the line I—I thereof;

FIG. **13** is a schematic elevational view of the spool doffing mechanism of FIG. **11**;

FIG. **14** is a cross-sectional view showing a detail thereof;

FIG. **15** is a pneumatic circuit diagram of the control for the spool doffing mechanism of FIG. **11**;

FIG. **16** is an electrical circuit diagram of the control for the spool doffing mechanism of FIG. **11**;

FIG. **17** is a schematic view of a variant operation of the arrangement of FIG. **7** depicting application of the full bobbin and the empty tube at the friction drum;

FIG. **17***a* is a schematic illustration of the construction of FIG. **17** showing contact of the full spool at the friction drum and approaching contact of the empty tube at such friction drum;

FIG. **18** is a modified electrical circuit diagram for the winding apparatus;

FIG. **19** is a circuit diagram of a modified electropneumatic control for the winding apparatus;

FIG. **20** is a schematic representation of the course of movement of the cam disk through 180°;

FIG. **21** is an elevational view of the rotating mechanism for the arm in a semi-schematic illustration in a position in which the full spool or bobbin is located at position D of FIGS. **17** and **17***a*;

FIG. **21***a* is a fragmentary view of the rotating mechanism depicted in FIG. **21** in a position where the full spool is located at position A of FIGS. **17** and **17***a*;

FIG. **22** is a plan view of the rotating mechanism depicted in FIG. **21**;

FIG. **23** is a pneumatic circuit diagram wherein the position of the rotating mechanism corresponds to that shown in FIG. **21***a*;

FIG. **24** is a schematic illustration of the disk which is part of the rotating mechanism and in a position where the full spool is located at position B of FIG. **17***a*;

FIG. **25** illustrates a portion of the pneumatic circuit diagram depicted in FIG. **23** with the disk which is part of the rotating mechanism in a position in which the full spool is located at position C of FIG. **17**; and

FIG. **26** is an electrical circuit diagram.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings and, in particular, referring to FIGS. **1** and **2** illustrating a preferred embodiment of inventive winding apparatus, it will be seen that such comprises a platform **4** which is slidably arranged upon roller bearings **3** at the parallely extending horizontal rail members **1** and **2** fixed to the machine frame F. Platform member **4** supports a rotatable shaft **5** capable of being rotated in counterclockwise direction through the action of a gear **6** and a meshing gear rack **7**. When the gear **6** is driven in clockwise direction it rotates without transmitting its rotational movement owing to the action of a free-wheeling clutch **8**, best recognized by referring to FIG. **2**. An arm member **9** is rigidly connected with the rotatable shaft **5**. Further, an arresting pin member **10** protrudes into the area of the arm member **9**, this pin **10** being retractable through

the action of a cylinder **11** so as to permit rotation of such arm **9.** Rack member **7** actually constitutes an extension of a piston rod **12** which can be reciprocated up and down by cylinder **13** arranged upon platform **4.** The entire arrangement just-described constitutes the revolving or rotating mechanism for rotating the arm **9.**

A further arm member **14** is likewise rigidly connected to the shaft **5.** During such time as the shaft **5** is rotated this arm **14** progressively displaces or pushes a suitably shaped dampening or damping lever **15,** pivotably mounted at the platform **4,** towards the outside and against the resistance of a piston member **16** slidably arranged within an oil-filled cylinder **17.** As a result, the arm member **9** is braked during such time as the cylinder **13** is activated, that is, this arm is indirectly connected with a dampening device **15, 16, 17,** which, depending upon the position of such arm, prevents it from rotating too fast.

As best observed by referring to FIG. **2,** mandrels **18** and **19** are seated upon the ends of the arm **9,** these mandrels **18** and **19** serving to receive tubes or sleeves **20'** and **20,** respectively, onto which there is wound the thread package or spool **21.** These mandrels **18** and **19** can be pneumatically loosened and braked and in their loosened or released position are provided with a piston member **22** protruding at the free end of the loosened mandrel, as indicated in FIG. **2** for the mandrel **19.** Mechanism suitable for this purpose is well known to those versed in the art, as evidenced for instance from the apparatus structure of Swiss Pat. No. 443,993, corresponding to U.S. Pat. No. 3,495,781 of the assignee of this application, and also assignee's further U.S. Pat. No. 3,554,455, incorporated herein by reference, so that further description thereof can be dispensed with. The piston member **22** activates a terminal or contacting switch **23** which, in turn, activates the package and tube change mechanism to be described in greater detail hereinafter in conjunction with FIGS. **6** and **8–10.**

Furthermore, these mandrels **18** and **19** are each supported so as to be axially slidable in a respective bore **24** of the arm member **9,** these bores **24** being configured and dimensioned to provide a sliding fit. The mentioned axial movement or displacement is undertaken through the action of a ring-shaped cam **25** provided with grooves **26** into which extend appropriate extensions **27** provided at the mandrels **18, 19.** During rotation of the shaft member **5** there is thus performed a predetermined axial movement of the mandrels **18** and **19.** The platform member **4** is similarly displaced along the rails **1** and **2** through the action of a suitable piston-cylinder drive arrangement. The cylinder **28** thereof is partitioned so as to provide both a pneumatic work cylinder **28'** and an oil-filled dampening cylinder **29.** Work cylinder **28'** may be conveniently operated through the provision of ducts or conduits **30** and **31** commuhicating with opposite faces of the piston **32***a* slidably arranged within work cylinder **28'.** Furthermore, within the oil-filled cylinder **29** there is mounted upon the piston rod **32** a further piston or disk **33,** this piston or disk **33** permitting, by means of non-illustrated suitable valves, oil to only pass to a limited extent, thereby dampening the movement of the piston rod **32.** Moreover, these valves are selected such that they permit a greater passage or throughflow of oil during such time as the platform **4** moves towards the outside, resulting in outward platform movement being faster than inward platform movement. The dampening cylinder **29** is additionally advantageously employed for slowing down the almost impactlike movement of the piston rod **32** brought about by the pneumatic system and further serves to suppress vibrations which may be brought about through untrue or eccentric movement of the package **21** contacting the friction drive drum **34.** The package **21** which is to be wound contacts the friction drive drum **34** with a predetermined contact pressure when the platform **4** is displaced towards the right of FIG. **1** through the action of the piston rod **32.** Additionally, the winding apparatus of the invention possesses a thread traversing guide arrangement **35** which horizontally traverses back and forth a thread guide **36** through a traverse distance or stroke H along the friction drive drum **34.**

Inasmuch as the drive mchanism for the thread traversing guide arrangement **35** and the friction drive drum **34** is conventional, and many different systems suitable for the purposes of the invention are already part of the prior art, any further description thereof can be dispensed with, particularly since such details are not important for understanding the underlying concepts of the invention. What is however worthy of mention in this context is that the friction drive drum **34** is provided with an acceleration or entrainment rim **37,** the diameter of which exceeds the diameter of the drive drum **34** by about 1 to 3 percent. This acceleration rim **37** serves to contact and accelerate the tube **20'** to a speed above the circumferential speed of the thread contacting surface **34'** during such time as the tube is moved out or displaced into its thread transfer position. Additionally, an abrasion-resistant rod **39** provided with a lateral notch **38** as best observed by referring to FIG. **2,** is arranged in the converging space or area formed by the friction drive drum **34** and the thread traversing guide arrangement **35,** the mentioned notch **38** being located within the region of the traverse distance H, as shown.

In the same area there is pivotably arranged above the rod **39** a further rod member **40.** Rod member **40** possesses good thread sliding properties and can be tilted from a rest position into a pivoted or thread transfer position shown in phantom lines in FIG. **1.** Cams **42** to **46** are furthermore provided upon the shaft member **5,** each such cam operating a terminal or contact switch **47** through **51,** respectively, utilized for the control of the operation of the individual elements during spool change.

Continuing, it will be understood that the thread catching zone **52,** shown in particular detail in FIGS. **3** and **4,** and provided on the mandrels **18** and **19** is equipped with a tightly fitting steel ring **53.** The outside diameter of this steel ring **53** is slightly less than the diameter of the tube **20,** so that there is avoided damage to the friction drive drum **34** and the somewhat higher rotational speed of the tube is compensated. Ring member **53** under consideration is provided with a surface **54** which is conically inclined towards the inside, leaving a clearance of about 0.05 to 0.1 mm. towards the face **55** of the tube **20** placed upon the associated mandrel. Uniformly distributed along the circumference of this conical surface **54** are the teeth **56** which are inclined towards the tube face **55** and provided with a sharp inside edge. The clearance between the teeth

56 and the confronting tube face or surface 55 is sufficiently large to enable the thread to enter.

The circuit diagram of FIG. 5 of the electropneumatic control arrangement depicts the valves in their positions during the normal winding operation when building up the thread package, and this control arrangement is constructed and designed to operate as follows:

A pressure limiting valve 58 is supplied with air at a pressure p_0 from a non-illustrated compressed air source, delivering such pressurized air at a pressure p_1 via a conduit or duct 59 to an electromagnetic valve 60. Electromagnetic valve 60 in turn is flow connected via a further duct or conduit 61, an electromagnetic valve 62, a blocking or stop-valve 63 closed at the pressure p_1 but opened at a higher pressure p_2, with the cylinder 11 of the previously discussed arresting pin member 10. In the description to follow all of the electromagnetic valves will be conveniently briefly referred to as simply valves. A conduit or duct 64 communicates in flow relationship a valve 65 with the heretofore discussed cylinder 13 of the likewise heretofore discussed revolving or rotating mechanism serving to rotate the arm member 9. Furthermore, cylinder 13 is equipped with a pressure sensor 66 which responds upon attaining the pressure p_2 in the cylinder 13 and closes the electrical circuit of FIG. 6 which will be more fully discussed shortly hereinafter. Incidentally, the pressure sensor 66 has been illustrated in the electrical circuitry diagram of FIG. 6 for purposes of clarity. Continuing, valve 60 is operated through the agency of a further pressure limiting valve 67 serving to reduce the pressure p_0 to the pressure value p_2 which, however, is higher than the pressure p_1. By the same token, valve 68 receives air at a pressure p_2 by means of the conduit or duct 69. A further conduit 70 communicating with the valve 68 delivers air to a conduit 71 and to a conduit 72 for the purpose of pneumatically loosening the tube and braking the mandrels 18 and 19, respectively. Although not specifically illustrated in the drawings, the chamber 72' appearing in FIG. 2 is furnished with pressurized air via the duct 72 which communicates by means of the channel or throughpassage opening 72'' with the interior of the mandrel 19, shown just located in its changing position for the full package 21. The supply of pressurized or compressed air to the other mandrel 18 on which there is placed the empty tube is stopped or blocked. A conduit 73 branches off of the conduit 59 and communicates with a valve 74. Valve 74 is connected via the conduit 75 with the cylinder-piston arrangement 41 serving to tilt or pivot the rod member 40. Furthermore, duct or conduit 70 additionally supplies valve 76 and 77, and through the agency of the further conduits 78 and 79, respectively, delivers fluid medium to the cylinder 80 of a spool doffing or changing mechanism shown schematically by way of example in FIG. 6 and in greater detail in FIGS. 8, 9 and 10. This spool doffing or change mechanism embodies a displaceable and pivotable spool and tube gripping element 81, which can be outwardly displaced through the action of the cylinder 80, this gripping element serving to withdraw the full package 21 off the mandrel 19 (FIGS. 6 and 8) and subsequently pushing an empty tube held in preparedness onto such mandrel 19. As best seen by referring to FIGS. 8 to 10 the tube gripping element 81 possesses for such purposes the shoes or segments 150 equipped with a lever 151 which can be deflected against spring pressure, and which allows for the introduction and application of the tube gripping element 81 against the ends of the tube. The cylinder 80 accommodates the piston 152 which is equipped with a cam follower 153 engaging with a guide groove or cam 154, cam following 153 being guided by guide groove or cam 154. The guide groove 154 is curved at its ends as shown in order to bring about the previously explained pivoting or rocking movement of the tube gripping element 81.

The electrical circuitry employed in the winding apparatus of the present invention will now be described in conjunction with the illustration of FIG. 6. A switch 82, initiating the spool change operation and activated manually or automatically as a function of another parameter, such as for instance package size, thread length taken-up or winding time, is electrically connected via a pre-settable timing relay 83 with the heretofore discussed valve 65. As also shown in FIG. 7 this switch 82 is likewise directly connected with the valve 60. Furthermore, the terminal switches 47 to 51 are each connected with one of the valves 74, 60, 68, 62, 65. The position of the cams 42 to 46 depicted in FIG. 6 corresponds to the position assumed by the shaft member 5 at the start of its rotation through the action of the gear rack 7. The pressure sensing means or sensor 66 is operatively connected with the valve 62. The limit or terminal switch 84 controls operation of the valves 77 and 68, whereas the terminal or limit switch 23 acts upon valve 76. The terminal or limit switch 85 is activated when the gripping element 81 moves outwards and through the agency of the timing relay 86 switches the valve 77. In the circuit diagram of FIG. 6, all of the electrical connections used for the switching operations starting from the operating position are shown in full or solid lines, whereas the electrical connections employed for resetting are indicated with broken or phantom lines.

Having now had the benefit of the foregoing description of the inventive winding apparatus its operation now will be considered and is as follows:

A. Normal Operation:

The endless thread 87 (FIG. 1) delivered by a conventional non-illustrated drawing arrangement, and which may be a single thread or a strand consisting of single threads, is delivered at high speed, approximately 3,000 meters per minute, and after having been traversed by the thread guide 36 of the thread traversing guide arrangement 35 arrives at the friction drive drum 34. From this location such thread is payed-up onto the package 21. During the winding operation the package diameter increases in the usual fashion to a maximum diameter, corresponding to the desired package weight. By virtue of the increasing package diameter the arrested arm member 9 together with the platform 4 moves out parallel into the position indicated in phantom lines in FIG. 1 and against the contact pressure transmitted by the piston rod 32.

B. Spool Change:

The spool change operation is undertaken as follows: As the desired package weight is reached, the switch 82 is closed. Closing of this switch 82 causes switch-over of the valve 60 to the higher pressure p_2 and via the conduit 61 and the further valve 63 the arresting pin 10 is retracted in the cylinder 11. Now the arm member 9 is free to pivot. At the same time the conduit 31 serves to increase the pressure in the cylinder 28 to the pres-

sure value p_2, causing displacement of the platform **4** towards the right while the full package **21** rolls upon the friction drive drum **34** and the shaft member **5** rotates. The increased force transmitted by the piston rod **32** is employed to compensate the weight of the heavy full package **21** and also to overcome the braking effect exerted by the arm **14** and the dampening lever **15.** This braking effect is used for maintaining a controlled motion, and this can be realized by switching or setting the lever **15** and by suitably selecting the dampening cylinder **17.** Also in this manner there is maintained the contact pressure of the full package **21** against the friction drive drum **34,** and simultaneously also avoiding too rapid pivotal movement of the arm member **9.**

This pivotal motion of the arm member **9** then continues until the empty tube **20'** contacts the acceleration or entrainment ring member **37** of this friction drive drum **34.** It is here mentioned that in the meantime the mandrel **18** of the empty tube **20'** has been moved axially outwards by the cam member **25.** At this moment both the full package **21** as well as the tube **20'** simultaneously contact the friction drive drum **34,** the braking effect of the dampening arrangement ceasing inasmuch as the arm member **9** no longer pivots. The empty tube **20'** is now accelerated to a circumferential speed which exceeds the speed of the surface of the friction drive drum by 1 to 3 percent, which it will be recalled is the amount of the larger selected diameter of the acceleration ring **37.** The previously increased contact pressure acting upon the platform member **4** is now also useful inasmuch as both the full package **21** and the tube **20'** are now in contact with the friction drive drum **34** and the contact pressure of both such full spool and empty tube must correspond to the normal operating-contact pressure, since the full spool or package **21** continues to windup thread and no change in the density of the last layers wound onto the package should occur. At the same time, as the switch **82** is actuated, the timing relay **83** begins to operate in such a manner that only after the empty tube **20'** is placed against the friction drive drum **34** and is accelerated is the valve **65** actuated. The conduit **64** and the cylinder **13** are then furnished with pressurized medium at a pressure p_2, and piston rod **12** and gear rack **7** begin to raise or lift and cause the shaft **5** and its arm member **9** to again rotate in the counterclockwise direction. This causes the empty tube or sleeve **20'** to roll along the friction drive drum **34** in an upward direction and the full package or spool **21** is lifted-off.

The rotational movement from the position in which both spools, i.e., package and empty tube contact the friction drive drum **34,** as indicated in FIG. **7** in full or solid lines, into the position indicated with phantom lines, is assisted by switching the contact pressure transmitted by the piston rod **32** in that the pressure sensor **66,** after the pressure p_2 is reached in the cylinder **13,** switches the valve **60** and the conduit **30** serves to displace the disk or piston member **33** in the opposite direction. The outward movement of the piston rod **32** can be controlled thorugh suitable selection of the dimensions of the cylinders **13** and **28,** such that at all times the tube **20'** is never lifted-off. When the tube **20'** reaches its labile or unstable dead-center position, that is, a position where the center of the tube **20'** is located at a plane containing the center of both the shaft **5** and the friction drive drum **34** (phantom-line position depicted in FIG. **7**), then, the cam member **43** activates the limit or terminal switch **50** and thus resets the valve **62** into the position indicated in FIG. **5,** namely the idle or rest position, which causes direction of the contact pressure of the piston rod **32** acting upon the platform **4** again towards the right-hand side. The position of the cam disks **42** to **46** shown in FIG. **6** corresponds to the position of the arm member **9** during such time as the tube **20'** contacts the friction drive drum **34** (cf., FIG. **7**). Somewhat after the switch **50** has been activated the switch **47** is closed, causing switching of the valve **74** and the piston-cylinder arrangement **41.** Consequently, the thread traversing motion is suppressed, that is, due to deflection of the rod member **40** the thread **87** is placed into the notch **38** provided at the rod member **39.** In this regard comparison should be made of the thread path indicated with phantom lines in FIG. **1.** During further rotation of the arm member **9** the wrapping angle of the thread passing onto the full package **21** has also increased at the cylindrical catch zone **52** of the mandrel **18.** The wrapping angle must be large enough so that the thread quickly and reliably is brought beneath at least one of the teeth **56.** Hence, this wrapping angle is dependent upon the diameter of the mandrel as well as upon the distribution or gauging of such teeth. The rotational movement of arm member **9** now continues and the cam **25** now displaces the mandrel **18** back in the direction of the nornal operating position. As a result, the thread arrives at the region of the conical teeth **56** and moves along the end face or surface **55** towards the inside below such teeth, resulting in a sharp deflection of the thread portion extended towards the full package **21** and causing cutting or severing of the thread at the sharp edge **57** (FIG. **4**).

Through continued axial movement of the mandrel **18** a few reserve wraps are now also placed onto the tube **20'** until the normal operating position is attained. After the flattened portion of the cam disk **46** has moved past the switch **47** this switch **47** switches the valve **74** back into the position shown in FIG. **5,** whereupon the piston and cylinder arrangement **41** retracts the rod member **40.** The thread thus leaves the notch **38** and is automatically threaded into the thread guide **36** of the thread traversing guide arrangement **35.** As a result, the winding operation performed with the normal stroke or traverse width H of thread onto the empty tube **20'** which has now completely reached its retracted position, can be started. To this end, the contact pressure of this tube **20'** against the friction drive drum **34** must correspond to the normal contact pressure, that is to say, cylinder **28** must again be supplied with compressed or pressurized air at the pressure p_1. In order to bring this about, shortly prior to or upon termination of the rotation of the arm member **9,** the switch **48** is activated by the cam disk **45** and the valve **60** is again switched to the position depicted in FIG. **5.** Consequently, the throttle or pressure limiting vlave **63** is also again subjected to the reduced pressure p_1, that is, it shuts off the supply to the cylinder **11** and causes the arresting pin **10** to move outwards which, in turn, brings about blocking or arresting of the arm member **9** which has just passed. The normal winding position is therefore again reached. Shortly prior to the time that the normal winding position has been established the switch **51** of the cam disk **42** switches the valve **65** back into the position shown in FIG. **5.** Thus the supply of compressed air via the conduit **64** to the cylinder **13**

is interrupted and movement of the rack **7** is terminated. The switch **49** is activated by the cam disk **44** at such time as the valve **65** is switched and valve **68** is switched, that is, the conduit **70** as well as the conduits **71** and **72** are supplied with compressed air at the pressure p_2. On the one hand, this causes return of the gear rack **7** into its starting position and, on the other hand, by means of the conduit **72** the compartment **72'** of FIG. **2** is supplied with pressure so that in the operating position of the arm member **9** that mandrel which supports the full package **21** actuates by means of the throughflow passage **72''** the pneumatic brake- and sleeve release mechanism (not shown) located within the mandrel. Due to the loosening or release of the tube holding mechanism the piston **22** is moved outwards and the terminal or limit switch **23** is actuated which, in turn, switches the valve **76** and moves the piston **152** from the dotted-line position of FIG. **8** into the phantom-line position. Consequently the tube gripping element **81** initially pivots through a predetermined angle α out of its pivoted position into a vertical position in which the shoes or segments **150** bear against the ends of the full tube. The subsequent linear trajectory of the tube gripping element **81** is initiated until the tube is stripped from the associated mandrel. Then there is carried out pivoting of the tube gripping element **81** through the angle β into the phantom-line ejection position. In this position the full tube presses the lever **151** downwardly owing to its inherent weight and the ejection or removal of the full tube occurs. After there has been applied the empty tube, either manually or by any suitable non-illustrated charging mechanism, the tube gripping element **81** returns back into the starting position by virtue of the action of the terminal switch **85,** timing relay **86** and valve **77.** As a result the empty tube is now placed upon the mandrel **19.** Upon reaching the starting position the terminal switch **84** simultaneously actuates the valves **77** and **68,** so that such again return into the position depicted in FIG. **5.** Now the spool doffing or change operation has been completed: as soon as the switch **82** is again actuated the entire cycle begins anew.

The entire system generating the movement of the arm supporting the mandrels is advantageously operated by pneumatic means inasmuch as such type means insure for a minimum of inertia, and accordingly, mechanical movements follow the pulses of the program control device very quickly. This is of advantage since thread transfer at high winding speeds and without interruption of the thread delivery can be brought about within a very short period of time, that is, within fractions of a second.

Continuing further, it is here mentioned that a preferred construction of spool doffing mechanism, in other words a full tube unloading and empty tube charging mechanism and its control has been depicted in FIGS. **11** to **16** inclusive and again embodies a tube gripping element **81** which can be actuated by the cylinder **80,** the tube gripping element **81** being displaceably seated upon a shaft **87.** The gripper or gripper element **81** comprises a tubular portion **89** and two arms **90** secured thereat, each of which is provided with a shoe or bucket segment **91.** Furthermore, as best seen by referring to FIG. **14** a groove block, which is connected with the tubular portion **89,** is guided in a longitudinal groove **93** provided at the shaft **87.** Near one end of the shaft **87** there is provided a ring **87'** which is fixedly connected with the shaft **87.** At the ring **87'** there is provided an arm **87''** to which there is connected a hinge or pivot joint **87'''**, as best seen by referring to FIG. **13.** The piston (not visible) of a pivotably mounted cylinder **88** is coupled with the hinge joint **87'''**, and by means of the aforementioned cylinder **88** the shaft **87** can be rocked through the angle α (FIG. **13**), whereby the gripper element **81** is pivotably entrained by means of the groove block **92** engaging in the groove **93** (FIG. **14**). In both end or terminal positions of this pivotal range α a respective terminal switch **94** and **95** is actuated by means of a cam **96** (FIGS. **13** and **16**) which rotates together with the shaft **87.** In the showing of FIG. **11** only the terminal switch **94** has been depicted. An arm **80''**, coupled with the piston arrangement **80'** of the cylinder **80,** engages by means of a bifurcated or forked portion **80'''** belonging to the arm **80''** in an annular groove **89'** (FIG. **11**) provided at the tubular portion **89** (FIG. **14**). Additionally, in the one terminal position of the piston arrangement **80'** the arm **80''** actuates the terminal switch **84** and in the other terminal position the terminal switch **85.**

FIG. **15** schematically illustrates a modification of the pneumatic control depicted in FIG. **5,** wherein only the differences have been shown and will be considered. Apart from the valves **76** and **77** respectively for actuating the cylinder **80** there is additionally provided a respective valve **97** and **98** for actuating the cylinder **88.** The valves have been illustrated in a position corresponding to the rest- or starting position of the gripper element **81** depicted in FIG. **12.** Furthermore, the valves **76, 77, 97** and **98** are directly supplied by a suitable pressure source at the pressure p_0. The electrical components and connections are described in conjunction with FIG. **16.**

Generally, those electrical connections employed for shifting the valves **76, 77** and **97, 98** respectively out of the starting position depicted in FIG. **15** have been shown in full lines and those electrical connections for resetting the valves have been shown in broken lines. The terminal switch **23** which is actuated by the piston member **22** (FIG. **16**) actuates the valves **97** and **98** which also can be actuated by the terminal switches **84** and **85** as well as by a timing relay **99.** The terminal switch **94** places the timing relay **99** into position whereas the terminal switch **95** actuates the valves **76** and **77.** In the connection line from the terminal switch **94** to the timing relay **99** there is mounted a self-opening electromagnetic switch **100** which is actuated by the terminal switch **85.** In the lines connected with the valves **76** and **77** there are mounted the respective self-opening electromagnetic switches **101** and **102** and **103** and **104** respectively. The actual terminal swtich **84** closes the switches **101** and **102,** whereas the actuated terminal switch **85** closes the switches **100, 103** and **104.**

After the arm member **9** (FIG. **11**) has again been brought into its operating- or tube change position and fixed by the arresting bolt **10,** then in the manner already previously described, the terminal switch **23** is actuated by the piston member **22.** Such actuates the valve **97** in such a manner that a conduit or line **106** which connects the valve **97** and the cylinder **88** (FIG. **15**) is placed under pressure. At the same time the valve **98** is reset by the terminal switch **23,** so that a conduit **108** which connects the valve **98** and the cylinder **88** is without pressure. As a result, the piston of the

cylinder **88** is displaced and thus turns or rotates the shaft **84** and therefore the gripper element **81** through the angle α. Simultaneous with the movement of the gripper element **81** the terminal switch **23,** which is secured to arm **107,** is brought out of the position depicted in FIG. **12** into the position depicted in FIG. **13.** On the other hand, due to the rotation of the gripper element **81** the arms **90** secured thereto and therefore the bucket segment or shoes **91** are brought into such position at the tube **20** of the full bobbin **21** that such gripper shoes **91** engage the tube **20.** Together with the rotation of the shaft **87** the cam **96** is rotated from the location of the terminal switch **94** to the location of the terminal switch **95.** The thus activated terminal switch **95** actuates, on the one hand, the valve **76** in such a manner that a conduit **109** which connects the valve **76** and the cylinder **80** is pressurized. At the same time the terminal switch **95** actuates the valve **77** so that a conduit **110** which connects the valve **77** and the cylinder **80** is relieved of pressure. As a result, the piston arrangement **80'** of the cylinder **80** is displaced through the stroke of length H (FIG. **11**). Due to this displacement the spool or package **21** is brought into position over a pair of roll-off rails **105.** At the same time, in this terminal position of the piston arrangement **80'**, the terminal switch **85** is actuated which, in turn, closes the switches **100, 103** and **104** as well as bringing the valves **97** and **98** respectively into the position depicted in FIG. **15.** The piston or piston arrangement **88'** of the cylinder **88** is thus again brought back into the position depicted in FIG. **15,** whereby the shaft **87** and therefore the gripper element **81** as well as the cam **96** are again rocked back through the angle α. The cam **96** again thereby actuates the terminal switch **94** which, in turn, places into operation the timing relay **99.** Due to this downward rocking the spool or package **21** is deposited upon the roll-off rails **105,** upon which it rolls into the final position depicted in phantom lines in FIG. **13.**

Likewise owing to the downward rocking of the gripper element **81** and therefore the shoes or buckets **91** into the phantom-line position depicted in FIG. **13** a flap member **112,** which is upwardly urged by a spring **111,** is downwardly pressed by the shoes or buckets **91** in such a way that a tube **114** retained in ready supply upon the rails **113** rolls into the shoes **91.** Thereafter, the timing relay **99** which has been set for the duration of such tube charging operation actuates the valves **97** and **98** in such a manner that the connection line or conduit **106** is subjected to an overpressure and the connection line or conduit **108** is vented. Consequently, due to the action of the piston **88'** of the cylinder **88** the shaft **87** and therefore the gripper element **81** and the shoes **91** respectively are again upwardly rotated through the angle α together with one of the empty tubes **114.** The tube **114** which is raised during this rotational movement in turn upwardly raises two tiltable members or components **105'** of the roll-off rails **105** to such an extent that it can rock or pivot therepast. After completion of this rotation through the angle α the terminal switch **95** is again activated and in turn actuates the valves **76** and **77** such that the conduit **110** is now subjected to the pressure p_o and the conduit **109** is vented, so that the piston **80'** of the cylinder **80** is again retracted by the stroke length H. Due to this movement the empty tube **114** is pushed into one of the clamping mandrels **18** or **19** (FIG. **2**). Due to the retraction of the piston **80'** of the cylinder **80** into the position depicted in FIG. **15** the terminal switch **84** is again actuated and the terminal switch **85** released. Due to the release of the terminal switch **85** the switches **100, 103** and **104,** previously closed by such terminal switch, are again opened and owing to actuation of the terminal switch **84** the switches **101** and **102** are again closed. The terminal switch **84** likewise actuates the valves **97** and **98** in such a manner that the conduit **108** is subjected to an excess pressure and the conduit **106** is without pressure, so that the piston **88'** in the cylinder **88** is again shifted back into the position depicted in FIGS. **15** and **16.** Consequently the shaft **87** and therefore the gripper element **81** is again brought back into the starting or basic position depicted in FIG. **11.** At the same time the terminal switch **23** is again rocked into the position in front of the piston **22** as depicted in FIG. **11** so that the apparatus is ready for the next spool doffing and tube charging operation. Instead of the cylinders **80** and **88** it would be possible to employ other means which would carry out the same functions, such as for instance a spindle driven by a motor instead of the cylinder **80** and a transmission coupled with the shaft **87** and driven by a motor instead of the cylinder **88.**

At this point there will be considered in conjunction with FIGS. **17** to **20** an additional possibility for carrying out rotation of the arm member **9** out of the position depicted in FIG. **1** and the basic- or wind-up position depicted by the line X of FIG. **17,** that is to say, to rock the full spool or package **21** out of the position depicted by reference character A in FIGS. **17** and **17***a* through an angle α (FIGS. **17** and **20**) into the position depicted by reference character C (FIG. **17**) in which the full spool or package **21** and the empty tube **20'** simultaneously bear against the friction drive drum **34.** In this case the full spool **21** seated upon the arm **9** initially carries out a pivotal or rocking movement through an angle γ (FIGS. **17***a* and **20**) into the position depicted by reference character B (FIG. **17***a*), i.e., shifts until shortly prior to achieving contact of the empty tube **20'** with the friction drive drum **34** owing to the action of the cylinder **13** and rack **7,** whereas there occurs during the second phase of operation the remaining rocking or pivotal movement through the angle γ' (FIG. **20**), that is, from the position B (FIG. **17***a*) into the position C (FIG. **17***a*) by means of the already previously explained contact force which prevails between the full package and the friction drive drum.

The elements required for achieving such and the modifications of the system to realize the same reside in the features that the valve **65** (FIG. **18**) parallel to the connection with the timing relay **83** is also directly connected with switch **82,** that for the return of the rack **7** (FIG. **1**) there is provided an additional valve **115** (FIGS. **18** and **19**) actuated by the switch **49** and which, on the one hand, is connected by a conduit **116** (FIG. **19**) with the conduit **69** and, on the other hand, via a conduit **71'** with the cylinder **13,** and further, switch **51** additionally places into operation a timing relay **117** which likewise actuates the valve **115.** Furthermore, a cam disk **42'** possesses the respective switching grooves **118** and **119** which serve to actuate the switch **51.**

During change of the spool, and after the switch **82** is closed, the arresting bolt **10** is retracted and the arm member **9** is therefore released for rotation, the valve

65 (FIGS. 18 and 19 and therefore the cylinder 13 actuated, so that the rack 7 (FIG. 1) rotates the arm member 9 through the angle γ (FIGS. 17*a* and 20). Simultaneous with the actuation of the cylinder 13 the pressure in the cylinder 28 is increased to the value p_2 via the conduit 31, so that the carriage, as already previously discussed, with rolling-off of the full bobbin 21 and rotation of the shaft 5, moves towards the right. After pivoting of the arm member 9 through the angle α the switching groove 118 provided at the cam disk 42' actuates the switch 51 (FIGS. 18 and 20) so that, on the one hand, the valve 65 is reset into the position depicted in FIG. 19 and, on the other hand, the valve 115, after expiration of the time set at the timing relay 117, is actuated in such a manner that the conduit 71' is subjected to pressure, so that the rack 7 is again retracted back into the starting position depicted in FIG. 1. The course of movement with respect to the rotation of the shaft 5 and the rolling-off of the full spool or package 21 over the friction roller 34 is carried out in a controlled manner by means of the braking action exerted by the arm 14 (FIG. 1) and the damping lever 15.

The remaining operations until reaching the starting- or wind-up position respectively of the arm member 9, that is to say, until reaching the position D (FIGS. 17 and 17*a*) of the full package 21 while rotating the arm member through the angle β (FIGS. 17 and 20), that is to say, until the bolt 10 again fixes the arm member in position, correspond to the already described operations discussed in conjunction with FIGS. 1 to 7.

Continuing, it is here further indicated that according to the embodiment of FIGS. 21 to 26 there additionally exists the possibility of carrying out the rotation of the arm member 9 from the one basic- or wind-up position into the other position rotated through 180° at least partially by means of a lifting cylinder 120, at the piston or piston arrangement 121 of which there is connected a transversely extending member or traverse 122 having a guide track 123 for guiding a bolt 124 connected with a disk 125 seated upon the shaft 5. A braking or brake cylinder 126 is arranged parallel to the cylinder 120 and secured thereto.

This braking cylinder 126 has a piston or piston arrangement 127 which is likewise connected with the transverse 122. The cylinder 120 is coupled by the conduit 128 with a valve 135 and by a conduit 129 with a valve 136. The braking cylinder 126 is connected on the one hand via a conduit 130 and on the other hand via a conduit 131 with a throttle- and shunt valve 132. The shunt valve 132, in the position depicted in FIG. 23, operates as a throttle for a fluid medium flowing through the conduits 130 and 131. A further bolt 133 is connected with the disk 125 and relative to the axis of rotation of the shaft 5 is located in a position which is symmetrically opposite the bolt 124. A raised portion 134 provided partially at the periphery of the disk 125 actuates the valves 135 and 136 respectively (in FIG. 21 there is only partially visible the valve 136). Perpendicular to the arrangement of the cylinders 120 and 126 there is provided at the opposite side of the disk 125 a pivotably mounted cylinder 137, the piston 138 of which can be advanced at the region between the traverse 122 and the disk 125. A valve 139 is coupled by means of a conduit 140 with the shunt valve 132 (FIGS. 21, 23 and 25). Furthermore, a conduit 142 communicates the shunt valve 132 with a pressure reduction valve 141. The valve 135 is likewise connected with the pressure reduction valve 141 by a conduit 143 and the valve 136 by a conduit 144. Furthermore, the valve 139 is connected with the timing relay 83 and with a terminal switch 145 (FIG. 26). The terminal switch 145 is actuated by a cam disk 146.

Now for the purpose of changing the spools the following operations are performed:

As best seen by referring to FIG. 23, in the illustrated position the valve 136 is actuated by the raised portion 134, and specifically in such a way that there exists a flow connection between the conduits 144 and 129 and therefore the pressure p_3 prevails at the cylinder 120. Now if after attaining the desired package weight the switch 82 is closed and if in the manner previously described the valve 60 is switched-over or reversed to the higher pressure p_2 and via the conduit 61 and the valve 63 the arresting bolt 10 is retracted in the cylinder 11, then, as a result, the arm member 9 is freed for rotation. Owing to the aforementioned pressure p_3 the piston 121 and therefore the traverse 122 are displaced so that the disk 125 is rotated out of the position depicted in FIG. 21*a* by means of the bolt 124 which is guided at the guide track 123. This occurs for such length of time until the valve 136 is no longer actuated by the raised portion 134. As a result, the disk 125 carries out a rotation through the angle γ (FIGS. 17*a* and 24), that is to say, the arm member, during this rotation, is rotated out of the wind-up position into a position in which the empty tube 20' (FIG. 1) is brought to the region of the friction drive drum 34 whereas the full package 21 still bears against the friction drive drum 34. The remaining rotation of the arm member through the angle γ' (FIG. 24) until contact of the empty tube 20' and the full spool or package 21 against the friction drive drum 34 (FIG. 1) is generated by the already previously described contact force which prevails between the spool 21 and the friction drive drum 34. The sum of the angles γ and γ' correspond to the angle α (FIGS. 17 and 24). The empty tube 20', upon bearing against the friction drive drum 34 in the manner already explained, is accelerated thereby.

Upon expiration of the time which has been set at the timing relay 83 the valve 65 and at the same time the valve 139 are actuated. The valve 139 in turn actuates the shunt valve 132 in such a way that the aforementioned throttling between the conduits 130 and 131 is eliminated (FIG. 25). The valve 65 actuates the cylinder 137 so that the piston 138 upon reaching the bolt 124 (FIG. 25) rotates the drive disk 125 and therefore the shaft 5 and the arm member 9 respectively again into the position depicted in FIG. 21. The disk 125 then carries out a rotation through the angle β (FIGS. 17 and 24). Corresponding to the position depicted in FIG. 25 of the disk 125 the valve 136 at the beginning of such rotation is no longer actuated by the raised portion or cam 134 and the valve 135 is still not actuated, that is to say, the conduits 128 and 129 are relieved of pressure. The position of the cam disk 146 depicted in FIG. 26 corresponds to the position of the disk 125 depicted in FIG. 25, that is to say, at the beginning of the lifting of the full spool or package 21 from the friction drive drum 34. As best seen by referring to FIG. 26 the terminal switch 145, after the cam disk 146 has been rotated through the angle γ (FIG. 26) is actuated thereby, so that the valve 139 is again reset back into the starting position depicted in FIG. 23. As a result the

shunt valve **132** is again brought back into the position depicted in FIG. **23**, that is to say, it again works as a throttle. The angle δ (FIG. **26**) is smaller than the angle β. The bridging or by-passing of the aforementioned throttling has the purpose of rapidly carrying out the rotation of the arm member **9** at the beginning of the lifting of the full spool or package **21** until the already described takeover of the thread by the empty tube **20'**.

For the exchange of the full tube **20'** (not shown) for a new empty tube the operations are essentially the same, with the exception that now the valve **135** actuated by the raised portion or cam track **134** establishes a connection between the conduits **128** and **143** and therefore the pistons **121** and **127** and the traverse **122** are moved out of the position depicted in FIG. **21** to the position depicted in FIG. **23** and the disk **125** is rotated by means of the bolt **133** via the piston **138** through the angle β. The remaining components depicted in FIGS. **23** and **26** and which have been provided with the same reference characters as the corresponding components or elements of FIGS. **5** and **6** carry out the same functions as already previously described.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims. Accordingly,

What is claimed is:

1. A method of automatically changing two tubes, each of which have been positioned upon a respective mandrel arranged on a movable member and rotatable such that said tubes alternatingly contact a friction drive drum for taking up an endless thread delivered at high speed in a winding device, comprising the steps of rolling the full package wound upon one of the tubes during such time as the desired package size is reached along the friction drive drum in the sense of an extension of the thread path on said friction drive drum and until the other tube which is empty contacts the friction drive drum, prior to such contact of the other empty tube with the friction drive drum axially displacing the mandrel carrying the empty tube in the direction of its free end to bring a thread catching and severing zone within a thread traversing range, accelerating such empty tube due to its contact with the friction drive drum, lifting the full package off the friction drive drum while the thread is still being wound thereon due to the inertia of the full package, unthreading the thread from a thread traversing guide, deflecting the thread passing from the friction drive drum to the full package which has been lifted out of contact with the friction drive drum such that the deflected thread passes through said rotating catching and severing zone of the mandrel supporting the empty tube, thereafter catching and severing the connecting thread between the full package and the empty tube by means of the rotating catching and severing zone, and placing a number of reserve wraps onto the empty tube by axially moving such tube into a normal winding position while rolling such empty tube along the friction drive drum.

2. The method as defined in claim **1**, including the step of approximately maintaining the contact pressure of the full package against the friction drive drum during rolling motion of the full package along the friction drive drum until it is lifted off of said friction drive drum, this step of approximately maintaining such contact pressure being undertaken by braking the rotation of the member after it has been placed in a condition where it is able to rotate and by increasing the force urging a support for the member in the direction of the friction drive drum beyond the force existing during normal operation.

3. The method as defined in claim **2**, including the step of continuously maintaining the rolling motion of the full package upon the friction drive drum until the empty tube contacts such friction drive drum and the rotation of the member temporarily ceases, maintaining the increased force urging said support during the temporary contact with the drive drum of both the full package and the empty tube.

4. The method as defined in claim **3**, including the step of positively further rotating the member and thereby causing reverse movement of said support in a direction away from the friction drive drum.

5. The method as defined in claim **3**, further including the step of exerting a rotational moment upon the member which is independent of the contact pressure so that the empty tube rolls along the friction drive drum until assuming a labile dead-center position.

6. The method as defined in claim **5**, further including the step of again braking the rotational movement of the member after it has passed through said labile dead-center position in order to maintain the contact pressure.

7. The method as defined in claim **3**, including the step of doubling the force acting upon the member during at least such time as both the full package and the empty tube contact the friction drive drum in order to thereby approximately maintain the normal contact pressure.

8. The method as defined in claim **5**, further including the step of again reducing the force acting upon the member during such time that only the empty tube rolls along the friction drive drum.

9. The method as defined in claim **8**, wherein reduction of the force acting upon the member is effectuated by reversing the direction of such force so as to be directed away from the friction drive drum.

10. The method as defined in claim **9**, further including the step of again reversing the direction of the force acting upon the member so as to be in a direction towards the friction drive drum when the empty tube passes through said labile dead-center position, to thereby again increase such force.

11. The method as defined in claim **5**, wherein the thread is unthreaded from the thread traversing guide at the latest at such time that the empty tube reaches said labile dead-center position.

12. The method as defined in claim **1**, wherein the thread unthreaded from the thread traversing guide is deflected into the catching zone which is arranged within the normal traverse distance of such thread traversing guide, causing the thread to acquire a certain wrapping angle at the catching zone, and then axially moving the mandrel carrying the empty tube and equipped with catching means up to the location of the thread which is in its catching position, to thereby catch such thread.

13. The method as defined in claim **12**, wherein the step of severing the thread which is still connected to the full package is undertaken by deflecting the caught thread over a sharp edge.

14. The method ad defined in claim 1, including the step of generating a rolling motion of the full package at the friction drive driven until the empty tube reaches a position near the friction drive drum by exerting a rotational moment upon said movable member independent of the contact force between the full package and the friction drive drum, and generating the further rolling motion of the full package at the friction drive drum until contact of both the full package and empty tube against the friction drive drum by means of said contact force.

15. The method as defined in claim 1, further including the step of threading the thread back into the traversing thread guide after said number of reserve wraps have been placed upon the empty tube.

16. The method as defined in claim 1, further including the step of driving the empty tube at a slightly greater speed than the speed of the thread contacting surface of the friction drive drum at most until the thread is guided again into the thread traversing guide.

17. The method as defined in claim 6, including the step of carrying out rolling motion of the empty tube along the friction drive drum until the member is arrested in normal operating position and is no longer free to rotate.

18. The method as defined in claim 17, including the step of rendering ineffective the rotational moment acting on the member which is independent of the force acting on the member at the same time as the member is again arrested.

19. The method as defined in claim 18, including the step of establishing a braking readiness for the member upon termination of the rolling motion of the empty tube along the friction drive drum and upon reaching the normal winding position of such empty tube.

20. The method as defined in claim 8, further including the steps of continuing the rolling motion of the empty tube along the friction drive drum until the empty tube has passed said labile dead-center position and reached an arresting position, then arresting the empty tube so that it is no longer able to rotate, and wherein reduction of the force acting on the member to its normal operating level is at least undertaken shortly prior to or at the time at which said member is arrested.

21. The method as defined in claim 20, wherein reduction of the force acting upon the member to its normal operating level is undertaken at the moment at which said member is arrested.

22. The method as defined in claim 1, including the steps of braking the full package at the moment of severing the thread thereof, and thereafter loosening the tube of the full package at its associated mandrel.

23. The method as defined in claim 22, further including the step of moving the full package off its associated mandrel at such time as the tube is loosened from such mandrel.

24. The method as defined in claim 23, further including the step of placing a new empty tube onto the mandrel from which the full package has been removed upon termination of such removal of the full package and while taking into account the loading time for the new empty tube.

25. The method as defined in claim 1, wherein prior to contact of the empty tube with the friction drive drum the empty tube supporting mandrel is axially displaced out of its normal winding position to such extent that the catching zone is positioned within the normal traverse path of the thread, and the mandrel is axially moved back into normal winding position upon the severing of the thread.

26. The method as defined in claim 25, wherein the empty tube supporting mandrel is axially displaced to such extent that the end of the tube opposite the catching zone is positioned adjacent a zone on the friction drive drum having a larger diameter than the contacting area of the drum engaged by the tube during normal winding engagement.

27. The method as defined in claim 4, including the step of assisting the reverse movement of said support in the direction away from the friction drive drum by reversing the force acting on the support.

28. The method as defined in claim 5, wherein the reverse force acting on the support is maintained until the empty tube reaches or nearly reaches a labile dead-center position.

29. The method as defined in claim 6, including the step of again reversing the force acting on the support to urge the same towards the friction drive drum and applying during such time to the member positive rotation until or nearly until the member assumes the arresting position.

30. A method of automatically changing two tubes, each of which have been placed upon a respective mandrel arranged on a movable arm member and rotatable such that said tubes alternatingly contact a friction drive drum for taking up an endless thread delivered at high speed in a winding device, comprising the steps of rolling the full package wound upon one of the tubes during such time as the desired package size is reached along the friction drive drum in the sense of an extension of the thread path on said friction drive drum and until the other tube which is empty contacts the friction drive drum, accelerating such empty tube due to its contact with the friction drive drum, lifting the full package off the friction drive drum while the thread is still being wound thereon due to the rotational energy of the full package, lifting the thread out of a thread traversing guide, holding the thread passing onto the friction drive drum and from there to the full package which has been lifted out of contact with the friction drive drum in such position that the thread contacts a rotating thread catching zone of the mandrel supporting the empty tube, thereafter automatically catching and severing the connecting thread between the full package and the friction drive drum by means of the rotating catching zone, placing a number of reserve wraps onto the empty tube by releasing the thread passing onto the friction drive roll from said position in the catching zone, and enabling the thread to be rethreaded in the thread traversing guide by releasing the thread from the holding position.

31. The method as defined in claim 30, including the steps of controllably restraining the rotation of the arm member while continuing the rotation until the empty tube engages the friction drive drum for acceleration, and stopping the restraining action when the engagement with the friction drive drum takes place.

32. The method as defined in claim 31, wherein the rotation of the arm member against the controlled restraining force acting on the arm member is caused by urging the arm member towards the friction drive drum.

33. The method as defined in claim 31, wherein the restraining of the rotation of the arm member and the urging thereof towards the friction drive drum are selected to substantially maintain the contact pressure between the full tube and the friction drive drum during the rotation of the arm member.

34. The method as defined in claim 30, including substantially maintaining the contact pressure while the full tube rolls along the drive drum and during simultaneous engagement of both the full and the empty tubes with the friction drive drum.

35. A yarn wind-up and doffing apparatus for continuously winding yarn which permits transfer of a yarn from a completed package to an empty tube without interrupting the winding operation comprising, in combination, a pair of mandrels for rotatably supporting the tubes on which the yarn is wound, a friction drive drum for rotating the empty tube, the tube being filled and the completed package simultaneously and individually upon effecting contact with said drum, a support movable towards and away from said drive drum, a member rotatably mounted on said support for supporting said pair of mandrels, said support being arranged for movement substantially transverse to the axis of rotation of said member, means for rotating said member from a normal winding position of one mandrel through approximately a 180° increment to the normal winding position of the other mandrel while passing the mandrels through an intermediate simultaneous contact position of both mandrels with said drive drum, means for generating and transmitting a force acting on said member for causing the driving contact pressure between said tube and package and the drive drum while rotating at least partially through said 180° increment, said generating means also assisting the rotation of said member, means for arresting said member in normal winding position of one mandrel, said mandrels being axially movably mounted on said member in order to bring a thread catching zone within a thread traversing range, and means for determining the axial position of the mandrels as a function of the momentary position of said member.

36. The apparatus as defined in claim 35, wherein said support includes a platform member carrying said member, means for guiding said platform member in a direction approximately perpendicular to the axis of rotation of said friction drive drum, and a dampening mechanism for said platform member.

37. The apparatus as defined in claim 35, further including control means actuated by said member provided for said means for generating and transmitting said force acting on said member.

38. The apparatus as defined in claim 35, wherein said arresting means incorporates mechanism movable into a locking position for said member when the latter has assumed its normal operating position during the winding operation and movable into a retractable position during spool change.

39. The apparatus as defined in claim 37, wherein said rotating means includes mechanism for rotating said member, said control means serving to actuate said rotating mechanism for said member at a predetermined position of said member during spool change.

40. The apparatus as defined in claim 35, further including a braking mechanism acting upon said member during rotation thereof, said braking mechanism only exerting a temporary braking action upon said member which is dependent upon the movement of said member.

41. The apparatus as defined in claim 35, wherein said means determining the axial position of said mandrels comprises stationary cam means operably engaged by said mandrels, in order to produce an axial outward movement of such mandrels.

42. The apparatus as defined in claim 41, wherein said support includes a platform member, said cam means being adjustably mounted at said platform member.

43. The apparatus as defined in claim 35, further including a thread guide arrangement for traversing the thread and a deflecting mechanism controllable as a function of the position of said member for interrupting the traversing motion of the thread.

44. The apparatus as defined in claim 43, further including means for holding the thread in a predetermined position cooperating with said deflecting mechanism.

45. The apparatus as defined in claim 35, wherein each mandrel is provided with means defining a thread catching zone, the diameter of which is smaller than the external diameter of the associated tube placed upon such associated mandrel.

46. The apparatus as defined in claim 45, wherein each thread catching zone is of substantially cylindrical configuration and possesses a diameter which is smaller than the external diameter of the associated tube and which diameter decreases in a direction towards said tube.

47. The apparatus as defined in claim 45, wherein said thread catching zone together with the confronting face of the associated tube forms a series of circumferentially distributed slots which permit penetration of the thread into the slots.

48. The apparatus as defined in claim 47, wherein each slot merges with a recess extending at an inclination towards the outside away from the associated tube.

49. The apparatus as defined in claim 48, wherein each such recess defines tooth means having a sharp inside edge.

50. The apparatus as defined in claim 39, further including a free-wheeling device provided for said means for rotating said member in order to reset said rotating means into a starting position when rotational movement of said member is arrested.

51. The apparatus as defined in claim 35, further including a braking mechanism temporarily acting on said member depending upon the position of said member, said braking means being combined with a dampening means.

52. The apparatus as defined in claim 51, wherein said braking mechanism comprises a pivotal lever, a dampening cylinder with which one end of said pivotal lever is operatively connected, said pivotal lever being progressively pivoted as said member rotates.

53. The apparatus as defined in claim 35, further including switch means actuated by the mandrel supporting the full package during such time as the associated tube is loosened, and a mechanism actuated by said switch means for removing the full package and placing a new empty tube onto the associated mandrel.

54. The apparatus as defined in claim 35, further including control means programmed as a function of the

position of said member for initiating movement of said mandrels with respect to said friction drive drum.

55. The apparatus as defined in claim **54,** further including a thread guide arrangement for traversing the thread, means for unthreading the thread from said thread guide traversing arrangement, said member including a shaft, said control means embodying a number of cam discs seated upon said shaft and containing the control program for controlling the cyclic movements of the mandrels, and limit switch means actuated by said cam discs, said limit switch means controlling the movement of mechanism employed for controlling the force acting on said member and said means for unthreading the thread from said traversing guide arrangement.

56. The apparatus as defined in claim **35,** further including means for imparting movement to said member which incorporates high-speed responsive pneumatic piston-cylinder means.

57. The apparatus as defined in claim **35,** wherein said friction drive drum incorporates a thread contacting surface and a thread acceleration rim member, the diameter of said thread acceleration rim member exceeding the diameter of said thread contacting surface so as to accelerate an empty tube which is brought into contact with said rim member.

58. The apparatus as defined in claim **38,** further including control means provided for said arresting means.

59. The apparatus as defined in claim **35,** further including a braking mechanism provided for said member and exerting a braking action as a function of the momentary position of said member.

60. The apparatus as defined in claim **35,** further including a braking mechanism temporarily acting on said member depending upon the position of said member, said braking means being combined with a dampening means.

61. The apparatus as defined in claim **35,** wherein said rotating means for the member rotates the latter out of the normal winding position for such length of time until the empty tube arrives at the region of the friction drive drum, and after contact of both the package and the empty tube said member rotates further until the package is raised from the friction drive drum and has reached a package change position.

62. The apparatus as defined in claim **61,** wherein the rotating means comprises a cylinder and piston, a rack provided for said piston, and a gear in engagement with said rack and acting upon said member.

63. The apparatus as defined in claim **61,** wherein said rotating means for the purpose of rotating said member out of the normal winding position until the empty tube arrives at the region of the friction drive drum comprises a rotatable shaft for rotating said member, a disc provided at said shaft, two bolts carried by said disc, said two bolts being situated substantially opposite one another with respect to the axis of rotation of said rotatable shaft, a piston and cylinder arrangement, a transversely extending member operatively connected with the piston of said piston and cylinder arrangement, said transversely extending member having a guide track for guiding one of said bolts, a further piston and cylinder arrangement disposed essentially perpendicular to the first-mentioned piston and cylinder arrangement, the piston of said further piston and cylinder arrangement for the purpose of further rotating the member out of a position in which the package and the empty tube both bear against the friction drive drum into a package change position bearing against one of the bolts located within the operable zone of said piston of said further piston and cylinder arrangement, whereby the disc and therefore the member are rotated.

64. The apparatus as defined in claim **63,** further including a braking mechanism acting upon said member, said braking mechanism comprising a double-acting piston and cylinder arrangement, the piston of said double-acting piston and cylinder arrangement being operatively connected with said transversely extending member, and throttle valve means operatively connected with said double-acting piston and cylinder arrangement.

65. The apparatus as defined in claim **64,** further including control means for controlling said throttle valve means.

66. A yarn wind-up and doffing apparatus for continuously winding yarn which permits transfer of a yarn from a completed package to an empty tube without interrupting the winding operation, comprising, in combination:

a. a pair of mandrels rotatably supporting the tubes on which the yarn is wound;
b. a friction drive drum for rotating the empty tube to be filled and the completed package simultaneously and individually upon effecting contact with said friction drive drum;
c. a support movable towards and away from said friction drive drum;
d. a member rotatably mounted on said support for supporting said pair of mandrels;
e. said support being arranged for movement substantially transversely with respect to the axis of rotation of said member;
f. means for rotating said member at least temporarily during the rotation from a normal winding position of one mandrel to the normal winding position of the other mandrel while passing the mandrels through an intermediate simultaneous contact position of both the empty tube and the completed package with said drive drum;
g. means for generating and transmitting a force acting on said member for causing the driving contact pressure between said tube and package and the drive drum while rotating as well as for assisting said rotation of said member at least temporarily through said rotation of said member from a normal winding position of one mandrel to the normal winding position of the other mandrel;
h. said mandrels being axially movably mounted on said member;
i. means for arresting said member in normal winding position of one mandrel; and
j. means for determining the axial position of the mandrels as a function of the momentary position of said member.

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