ABSTRACT: A winding machine for automatically transferring a continuously advancing strand of yarn between upper and lower winding heads. In order to transfer winding of the yarn from the lower head to the upper head, a guide wheel is moved into engagement with the advancing strand and routes it into position for attachment to the upper head. Then a transfer arm is actuated and moves the rerouted yarn so that it is attached to the upper winding head for winding thereon, whereupon the yarn is cut and the tail of the cut yarn winds onto the lower head which may then be stopped and doffed. The strand of yarn is advanced downwardly from above the heads and in order to transfer the strand from the upper head to the lower head, a vertically moving arm first actuates a fanning interceptor which holds a run of the strand against traversing movement whereupon a guide wheel on the vertical arm engages this run of the strand and lowers it into position adjacent the lower head for engagement by a guide wheel which reroutes the advancing strand for subsequent engagement by a transfer arm and cutter, as previously described, whereupon the upper head may be stopped and doffed.
STRAND TRANSFER EQUIPMENT FOR WINDING MACHINE

This invention relates to winding apparatus and, more particularly, to continuous takeup apparatus for automatically transferring winding of a continuously advancing strand between winding heads.

The term "yarn" is employed herein in a general sense to apply to all kinds of strand materials, either textile or otherwise, and the term "package" means the product of a winding machine whatever its form.

The subject winding machine provides fully automatic transfer and is an advance over a manually operated transfer mechanism disclosed in a copending Leesona Corporation patent application by John V. Keith for "Textile Machinery," Ser. No. 652,819, filed July 12, 1967, now U.S. Pat. No. 3,550,871. The copending application discloses numerous expedients applicable to the subject machine such as starting and stopping of the winding head spindles concurrently with transfer of the yarn between the winding heads, spindle speed control, constant yarn tension control, initial startup of the winding machine in addition to various safety features and other features. The copending application also discusses the advantages of a wasteless transfer of yarn between heads of a winding machine and also the effects of improvement in rigidity of the winding heads and the machine generally, and advantages of providing substantially constant yarn tension during transfer, as well as other advantages, all of which are incorporated into the automatic transfer equipment of this application, but which are omitted from the present disclosure since they are redundant over the disclosure of the copending application to which reference may be had for a description of these features.

The invention, in brief, is directed to a winding machine which provides fully automated transfer of a continuously advancing strand of yarn between winding heads.

Accordingly, it is a primary object of this invention to provide new and improved winding apparatus for continuously winding an advancing strand of yarn.

Another object is to provide new and improved winding apparatus for automatically transferring a continuously advancing strand of yarn between winding heads.

Still another object is to provide new and improved winding apparatus having a pair of winding heads at fixed locations and for providing uninterrupted winding as a continuously advancing strand of yarn is automatically transferred from an active one of the heads to a reserve one of the heads which then becomes the active head. A related object is provision of means for automatically initiating transfer of the yarn between the heads at a desired point in the winding.

These and other objects and advantages of the invention will be apparent from the following description and the accompanying drawings in which:

FIG. 1 is a fragmentary perspective view of a preferred embodiment of a winding machine having a pair of winding heads and automatically operable mechanism for transferring winding from one head to the other, with parts broken away and removed for clearer illustration;

FIG. 2 is a fragmentary perspective view of the machine during an intermediate stage in the transfer of the yarn from a lower one of the heads to an upper one of the heads;

FIG. 3 is a fragmentary perspective view of the right end of the upper head at the moment of transfer of the yarn to the upper head;

FIG. 4 is a plan view of a carrier portion of the transfer mechanism shown in FIGS. 1-3, during an initial stage of its operation;

FIG. 5 is an enlarged, fragmentary longitudinal sectional view of an arm of the carrier shown in FIG. 4, but in an intermediate position;

FIG. 6 is a sectional view similar to FIG. 5, but with the arm in final position;

FIG. 7 (Sheet 3) is an enlarged, developed view of a cam portion of the carrier;

FIG. 8 is a fragmentary, perspective view of a lower portion of the machine and illustrates a vertical arm shown in FIG. 1 but in an extended position preparatory to transferring the advancing strand of yarn from the upper head to the lower head;

FIG. 9 is an enlarged, fragmentary, foreshortened view with certain parts broken away generally along the section line 9-9 in FIG. 8;

FIG. 10 is an enlarged elevational view of a fanning interrupter mechanism as shown in FIG. 8;

FIG. 11 is a sectional view taken generally along the line 11-11 in FIG. 10;

FIG. 12 is a diagram of an electrical portion of a control system for operating the portion of the machine embodying the invention; and

FIG. 13 is a diagram of a pneumatic portion of the control system.

GENERAL DESCRIPTION

Referring to FIG. 1 of the drawings, a winding machine includes a frame 10 having three fixed shelves supports 12, 14 and 16 and thereafterabove a mounting panel 18. Control cabinets 19 are at the bottom of the frame 18. The lower support 12 mounts a lower winding head 20 and the intermediate support 14 mounts an upper winding head 22. These heads may be of any suitable type such as Leesona No. 959 Winders, manufactured by Leesona Corporation, Warwick, Rhode Island. Each of these winding heads 20 and 22 includes a body portion 24 having a mechanism (not shown) for traversing an advancing strand of yarn Y and to and fro onto a core C of a takeup package P mounted on a chuck 26 rotated by an associated spindle 28 as the package is urged against a roller nail (not shown) to provide a nip for the advancing strand.

As the strand advances and is taken up by one of the winding heads 20 or 22, it passes across various fixtures on the panel 18 including a treatment roll 30 and then a pair of godets rolls 32 after which it passes around a guide wheel 34 of a spring-urged idler 36 and then about a compensator guide wheel 38 on a compensator arm 40 pivotally mounted on the panel 18 and connected with suitable well-known mechanism (not shown) for regulating the speed of the active winding head (on which the strand is being wound) to maintain a substantially constant linear speed and tension of the advancing strand Y.

Throughout this description reference numerals "primed" refer to similar parts on the lower head.

TRANSFER TO THE UPPER HEAD

As shown in FIG. 1, the advancing strand Y is being wound on the lower winding head 20 and after passing about the compensator wheel 38 it passes about a fixed guide wheel 42 on the body 24 of the upper winding head 22 and then to the traversing mechanism (not shown) and package P on the lower winding head.

When the lower head 20 is about full, the spindle 28 of the upper head 22 is started in operation (see Ser. No. 652,819) and transfer of the advancing strand of yarn Y to the upper head is initiated. First, a carrier mechanism 44 of the upper head is actuated to intercept the strand Y as it advances to the lower head 20, and then a transfer mechanism 46 and a cutter 48 of the upper head are actuated to engage the strand with a hub 50 of the upper chuck 26 and to cut the strand, respectively.

CARRIER MECHANISM

The carrier mechanism 44 (FIGS. 1-6) has an arm 52 with a bracket 54 fixed to one end. The bracket 54 is secured to a mounting part 56 by a pin 58 for pivotal movement of the arm 52 about a horizontal axis. The mounting part 56 is secured to the upper support 16 by a pin 60 (FIG. 4) for pivotal movement about a vertical axis. This arm 52 includes a cylinder 62 secured to the bracket 54 with a hollow piston rod 64 (FIGS. 5 and 6) in the form of a tube having an irregular cross-sectional area at its lead end and a smooth cross-sectional area at its rear end.
configuration, such as hexagonal, slidably received through a complementary aperture in a front head 66 of the cylinder 62 to hold the rod 64 against pivotal movement relative to the cylinder. A front piston 68 is secured to the rear end of the hollow rod 64. Another piston rod 70 is telescoped within the hollow rod 64 and through the front piston 68 and carried by a rear piston 72 behind the front piston. Ports 74 in the rear piston 72 permit passage of air to the rear face of the front piston 68. Relative low air pressure, such as 30 p.s.i., introduced into the rear end of the cylinder 62, telescopes the pistons 68 and 72 and their rods 64 and 70, respectively, forward into the piston rod 68 engages a spiral compression spring 76 encircling the hollow rod 64 and seated against the cylinder head 66 and the front face of the front piston 68.

Now, a suitable cylinder 78 (FIG. 4) (either double acting or spring returned) is suitably pivotally mounted on the upper support 16 as by a pin 80 (FIG. 4) and has the outer end of its piston rod 82 pivoted to the mounting part 56, and is actuated by compressed air to swing the carrier arm 52 counter-clockwise. A follower wheel 84 (FIGS. 1, 4 and 7) on the bracket 54 rides on a cam surface 86 of a curved cam plate 88 fixed, as by bolts 89 to a stationary part 90 (FIG. 4) on the upper support 16 as seen in FIGS. 1, 4 and 7, to move the carrier arm 52 up and down in a desired path. A carrier guide wheel 92 is pivotally mounted on a bracket 94 (FIGS. 4 and 6) mounted on the outer end of the piston rods 64 and 70 engages and routes the advancing strand Y, first moving upwardly (phantom position FIG. 2) to deposit the strand Y in a guide wheel 96 (FIGS. 1 and 2) on a mounting bracket fixed to the body 24 of the upper head 22 and then downwardly under a threading bail 98 and upwardly to clear the chuck 26 as the strand Y continues to advance from the carrier guide wheel 92 to the package P on the lower (active) head 20.

After the carrier guide wheel 92 has passed under the threading bail 98 the linkage assembly 94 and piston rods 64 and 70 operate to twist the axis of the carrier the carrier guide wheel 92 in order to retain the strand Y on the guide wheel as the carrier arm 52 is moved downwardly into its final position as shown in FIG. 3, with the follower wheel 84 held against upward and downward or counter-clockwise movement by a semicircular portion 100 (FIG. 7) of the cam surface 86 which receives the follower wheel.

In order to twist the carrier guide wheel axis, the linkage assembly 94 is operated from the position shown in FIG. 4, to the position shown in FIG. 6. As shown in FIGS. 4 and 6, the linkage assembly 94 includes a bifurcated, axially offset bracket 102 fixed to the free end of the hollow piston rod 64 which is secured to the forward piston 68. Pivotively generally to the axis of the rods 64 and 70 and between the arms of the offset portion of the bifurcated bracket 102 by means of a pivot pin 104 is a guide wheel support 106 having an axis askew of the rod axes for receiving the guide wheel 92 at a location spaced from the pivot pin 104. The outer end of the inner piston rod 70 is pivoted between tabs 108 on the guide wheel support 106.

When the carrier arm 52 is first extended, responsive to the low air pressure injected into the rear end of the cylinder, the rods 64 and 70 are moved outwardly generally to the position shown by dotted lines in FIG. 2, until abutment rods 110 fixed to the rear piston 72 and freely telescoped through apertures in the forward piston 68 engage the front cylinder head 66 (FIG. 5) thus stopping forward movement of the inner piston rod 70 and its rear piston 72. After the carrier arm 52 has been swung outwardly clockwise and the guide wheel 92 has passed under the threading ball, the air pressure in the cylinder 62 is raised, for example to 60 p.s.i., causing the forward piston 68 to again move outwardly relative to the cylinder and the rear piston 72, to the position shown in FIG. 6. Forward movement of the hollow piston rod 64 and its forward piston 68 continue as the small air pressure passes through a guide piston 68 engaging the front piston 72 and against the rear face of the forward piston to move the forward piston against the force of the spiral compression spring 76, thus telescoping the hollow piston rod 64 outwardly relative to the inner piston rod 70 so that the guide wheel support 106 is pivoted about its pivot pin 104 to position the carrier guide wheel 92 as shown generally in FIGS. 3 and 6.

**TRANSFER ARM AND CUTTER**

With the carrier arm 52 in its final position as shown in FIG. 3, the advancing strand Y continues to be taken up by the lower winding head 20 until the transfer mechanism 46 of the upper head is actuated. When actuated, a transfer ball 112 on a transfer arm 113 engages the advancing strand Y between the threading bail 98 and the carrier arm guide wheel 38 and urges the strand against the hub 50 of the chuck 26 of the upper winding head 22. The advancing strand Y now actuates a typical yarn engaging finger 114 on the hub and this finger snags the strand. The cutter 48 of the upper winding head 22 cuts the strand Y so that the tailing end from the lower head 20 may wind onto the lower package P.

With reference to FIG. 1, the transfer arm 113 is fixed to an end of a horizontal shaft 116 journaled in a tube 118 fixed to the body 24 of the winding head 22. A lever 120 is fixed to the end of this shaft 116 opposite the transfer arm 113 and is connected by a straight link 122 pivoted to a bifurcated link 124 which is in turn pivoted to a bifurcated mounting bracket 126 fixedly secured to the intermediate support 14. The bifurcated link 124 has a depending tab 128 (FIG. 1) which is engaged by the end of a piston rod 130 of an actuating cylinder 132 (double acting or spring return). Upon applying compressed air to the cylinder 132, the rod 130 pivots the bifurcated link 124 and through the straight link 122 and lever 120 pivots the shaft 116 and the transfer arm 113 clockwise, as seen in FIGS. 1–3, to engage the advancing strand Y as shown in FIG. 3. As the transfer ball 112 engages the advancing strand, the cutter 48 cuts the strand and the trailing end of the strand from the lower head may wind thereon.

As shown in FIGS. 1–3 of the drawings, the cutter 48 comprises a cutting arm 134 is horizontally pivoted to a mount 136 fixed to the tube 118 and has lost motion connection 138 with the transfer arm 113 so that as the transfer arm is swung to transferring position a blade 140 on the cutting arm enters an annular slot in the hub 50 and cuts the strand.

After the strand Y has been attached to the upper head 22, it extends from the compensator wheel 38 to the hub 50 and across the path of the traverse (not shown) so that as the traverse continues to operate it engages the advancing strand and causes the portion of the advancing strand between the compensator guide wheel and the traverse to traverse to and fro along an upper package on the chuck 26. The carrier arm rods 64 and 70 are now telescoped into the cylinder 62 so that the carrier guide wheel 92 can clear the advancing strand of yarn Y as it is swung back to the retracted position shown by solid lines in FIG. 1.

**TRANSFER TO THE LOWER HEAD**

During normal winding operation on the upper head 22, the advancing strand Y follows a path from the compensator guide wheel 38 to the traverse (not shown) of the upper head, generally as indicated by the phantom line in FIG. 1. For transfer to the lower head 20 the strand must be rerouted into the operating path of a lower carrier arm guide wheel 92 mounted on the intermediate support 14 and associated with the lower winding head 20. To this end, a vertical arm 150 and a fanning interruptor 152 are provided.

**VERTICAL ARM AND FANNING INTERRUPTOR**

With reference to FIGS. 1, 8 and 9, the vertical arm 150 is shown in its inoperative or full retracted position in FIG. 1 and in its fully extended position in FIGS. 8 and 9. The vertical arm 150 includes a port 74 in the cylinder 154 (FIGS. 8 and 9) connected by means of lower lugs 156 and 158 to a fixed bifurcated bracket 160. The piston 162 of this cylinder 154 has a hollow piston rod 164 carrying a guide wheel assembly 166 at
its upper end. This piston rod 164 further serves as an inner cylinder, also 164, having a piston 168 and a piston rod 170 carrying a straight-acting rack 172 and extending through the rod or cylinder 164 toward the guide wheel assembly 166. The guide wheel assembly 166 includes a castor assembly 174 fixed to the upper end of the cylinder 164 and receiving a smooth upper concave surface of an arcuate guide wheel rack 176 urged against casters 178 of the assembly 174 by a pinion 180 drivenly mated with the arcuate rack 176. This pinion 180 is fixed to a shaft 182 (FIG. 9) journaled in through the cylinder 164 and carrying a second fixed pinion 184 within the cylinder. These pinions 180 and 184 are rotated by means of the straight-acting rack 172 drivenly mated with the inner pinion 184.

A sheath 186 is telescoped about the outer cylinder 154 and has a pair of identical cam slots 188 receiving opposing intermediate lugs 190 and 192 which extend through a bifurcated mounting bracket 194 attached to the body 24 of the lower head into the bottom of the vertical arm 150 in position. One of these lugs 192 serves as an air inlet through which relatively low-pressure air, for example 30 p.s.i., is constantly applied through a passage 197 (FIG. 9) within the inner cylinder 164 and against a top face of the outer cylinder piston 162 (which is integral with the inner cylinder) to urge the inner cylinder downwardly, and against the lower face of the inner piston 168 to rod 170 upwardly. However, when the retracted or inoperative position (FIG. 1), the inner piston 168 is held down (retracted within its inner cylinder 164) by a higher air pressure, for example 60 p.s.i., applied to the upper face of this piston 168 through an upper lug 198 and an associated passage 200 to the upper face of the inner piston 168. The upper lug 198 and a companion upper lug 202 (FIG. 9) lock the sheath 186 and inner cylinder 164 for movement together. During the initial phase of the transfer operation it is 30 p.s.i. air pressure is constantly applied to the lower portion of the inner cylinder 164, and the 60 p.s.i. air pressure is initially supplied to the upper portion of this cylinder 164 so that its piston 168 and piston rod 170 cease fully telescoped within the inner cylinder 164.

When 60 p.s.i. air pressure is admitted through the lower lug 158 into the bottom of the outer cylinder 154, the sheath 186 and the inner cylinder 164 (which are fixed to each other by the upper lugs 198 and 202) are telescoped upwardly with the sheath cam slots 188 and cooperating intermediate lugs 190 and 192 causing this assembly to rotate generally clockwise from the position as seen in FIG. 1 to the position as seen in FIGS. 8 and 9. Next, 60 p.s.i. air pressure applied through the upper lug 198 to the upper end of the inner cylinder 164 is discontinued and the upper end of the inner cylinder vented through a shut-off valve (see "Control System") so that the inner cylinder piston 168 and the actuating rod 170 which carries the straight-acting rack 172 move upwardly thereby rotating the inner pinion 184 and causing the outer pinion 180 to rotate and drive the arcuate rack 176 thereby swinging a yarn guide wheel 204 at the end of the rack 176 to the position as shown in FIG. 8.

**FANNING INTERRUPTOR**

In order for the guide wheel 204 of the vertical arm 150 to engage the advancing strand Y as it is traversed onto the package of the upper head 22, traversing of a run of the strand is stopped by the fanning interruptor 152 (FIGS. 1, 8, 10 and 11) which engages the strand between the compensator arm guide wheel 28 and the traversing mechanism (not shown) of the upper head 22. Herein, this mechanism includes a generally horizontal shaft 206 mounted in journals 208 extending from the body 24 of the upper head 22. This shaft 206 carries a fanning interruptor member 210 and a counterweight finger 212 which normally maintains the member 210 in a retracted position (FIG. 1) and is positioned for engagement by the upper end of the vertical arm sheath 186 to pivot the shaft 206 clockwise and thereby to pivot an edge 212 of the fanning interrupter member 210 into the path of the traversing strand y. As may best be seen in FIG. 1, this edge 212 forms an apex at its center and is positioned to intercept the path of the traversing strand and cam the strand, along whichever portion of the edge 212 is engaged by the strand, to the apex of the edge and into a yarn guide 214 at the apex which holds the strand against fanning for the guide to the compensator guide wheel 38, while permitting fanning to the traversing mechanism of the upper head 22.

Next, the vertical arm is returned from the position shown in FIGS. 8 and 9 to its retracted position as shown in FIG. 1 and during such movement its guide wheel 204 engages the strand Y between the fanning interruptor guide 214 and the compensator arm guide wheel 38 and moves the advancing strand across a guide wheel 216 mounted on the fanning interruptor member 210 with the strand still retained in the fanning interruptor guide 214. As shown in FIG. 1, the run to the guide wheel 204 passes across the guide wheel 42 and engages in a ball 218 on the end of the arcuate rack 176 opposite the guide wheel 204 and then about the guide wheel 204 with the run from the guide wheel 204 passing across a ball 220 on the body of the upper head and then guide wheel 216 to the traverse of the upper head 22.

Return of the vertical arm guide wheel 204 to its retracted position (FIG. 1) is effected by admitting the 60 p.s.i. air pressure through the lug 158 to the upper end of the inner cylinder 164 thereby forcing its piston 168 downwardly to telescope the attached piston rod 170 and rack 172 downwardly causing the rack 172 to rotate the pinions 180 and 184 and retract the arcuate rack 176 and its guide wheel 204. Next, 60 p.s.i. air pressure is applied through the lug 158 to the bottom of the outer cylinder 154 is shut off and the cylinder is vented so that the 30 p.s.i. air pressure applied through the intermediate lug 192 forces the inner cylinder 164 downwardly thus causing the sheath 186 to rotate counterclockwise moving the vertical arm guide wheel 204 back to the position shown in FIG. 1.

In summary, the advancing strand Y is now following the path indicated generally in FIG. 1 and, more particularly, follows a path (solid lines) downwardly from the compensator arm guide wheel 38 across the guide wheel 42 journaling on a bracket fixed to the body 24 of the upper winding head 22 and then, as indicated by dotted lines, through the arcuate rack ball 218, about the vertical arm guide wheel 204 and then upwardly across the ball 220 fixed on the upper winding head body, then about the fanning interruptor guide wheel 216 and then upwardly across the ball 220 to the retracted position of the fanning interruptor member 210 and to the traverse (not shown) of the upper winding head 22, to continue winding onto the upper package.

**LOWER CARRIER, TRANSFER AND CUTTER MECHANISMS**

The lower winding head carriker mechanism 44' is now actuated and moves as previously described with reference to the upper winding head 22 so that its guide wheel 92' engages the advancing strand Y between the guide wheel 42 fixed to the upper winding head and the vertical arm guide wheel 204 to move this run of the strand to a position which, relative to the hub 26' of the lower head 20, is comparable to that shown in FIG. 3 for the upper head 22. The lower head transfer mechanism 46' and cutter 48' are now actuated and the advancing strand is snagged by the finger 114' on the hub 50' of the lower winding head chuck 26' and is cut by the lower cutter 48'. The advancing strand is now picked up by the traverse mechanism of the lower winding head 20 and proceeds to traverse to and fro across the lower package P as it is wound thereon. The tailing end of the advancing strand to the upper head 22 is wound on to the upper package, the upper spindle 28 is stopped and the full package may now be doffed.
A control system for operating the wasteless transfer portion of the winding machine is shown in FIGS. 12 and 13. The actual control system is substantially like the one fully described in the aforementioned copending application but with obvious additions which may be as shown in FIGS. 12 and 13.

**ELECTRICAL SYSTEM**
A greatly simplified electrical diagram is shown in FIG. 12 to facilitate an understanding of the operation of the automatic wasteless transfer features of this invention.

As shown in FIG. 12, when transferring to either head, a suitable timer T provides a short signal such as an electrical pulse to a relay IR, energizing this relay to close its contact 1R1 during the time the relay is energized.

When transferring from the lower head 20 to the upper head 22, closing of the contact 1R1 energizes a terminal delay, time delay relay 2TDR to close its normally open contact 2TDR1, actuating a normally closed solenoid valve 1SV (FIG. 13) and energizing a normally closed initial delay, time delay solenoid valve 2TDSV (FIG. 13). When the 1R1 contact closes an initial delay, time delay relay 3TDR is energized (with its timer illustrated in FIG. 12) through its double throw contacts 3TDR1 and 3TDR2, and when the relay 1R is deenergized upon termination of the pulse and its contact 1R1 opens, the relay 3TDR remains energized through the contact 2TDR1. At the end of its initial delay, the relay 3TDR is actuated to reverse its double throw contacts. By this time the relay 1R has been deenergized so that the contacts 3TDR1 and 3TDR2 (now in their position opposite that illustrated in FIG. 12) are not carrying current and the time delay relay 3TDR is not energized. At the end of the terminal delay of the time delay relay 2TDR its contact 2TDR1 opens deenergizing the solenoid valves 1SV and 2TDSV causing these valves to close and thereupon to vent the pneumatic circuit (FIG. 13).

When transferring the strand from the upper head 22 to the lower head 20, a pulse from the timer T again energizes the relay 1R to close its contact 1R1 whereupon a circuit is completed through this contact and the double throw contacts 3TDR1 and 3TDR2 (which are in the position opposite that shown in FIG. 12) to energize the terminal delay, time delay relay 4TDR closing its normally open contact 4TDR1 to energize a solenoid valve 3SV (FIG. 13), a terminal delay, time delay solenoid valve 4TDSV (FIG. 13) and an initial delay, time delay solenoid valve 5TDSV (FIG. 13). At the end of the initial delay of time delay relay 3TDR its double throw contact 3TDR1 and 3TDR2 reverse their positions back to the positions as shown in FIG. 12 and at the end of the terminal delay of time delay relay 4TDR its contact 4TDR1 opens to close the solenoid valves 3SV, 4TDSV and 5TDSV which vent the pneumatic circuits.

**NEUMATIC SYSTEM**
A pneumatic control system is shown schematically in FIG. 13. A 60 p.s.i. supply of air pressure has a branch to a reduction valve 230 which provides 30 p.s.i. pressure to various portions of the system. During normal winding constant pressure is applied through normally open air pilot valves 232 and 232' in circuit with the head ends of the carrier arm cylinders 62 and 62' respectively, to maintain their pistons retracted; and through unvalved conduit, to rear ends of the carrier swing cylinders 132 and 132' to maintain their piston rods 130 and 130', respectively, extended and the carrier arms in retracted position, and to the lug 192 of the vertical arm 150 to maintain the inner cylinder 164 retracted and to urge the inner cylinder piston 162 downwardly.

When the time comes to transfer winding of the strand of yarn Y from the lower active head 20 to the upper reserve head, the valve 1SV opens and the valve 2TDSV is energized. Upon opening valve 1SV, 60 p.s.i. air pressure is applied to the head end of the carrier arm swing cylinder 78 to cause the carrier arm 52 to swing counterclockwise, and as pilot air to open a normally closed air pilot valve 234 in the 30 p.s.i. circuit and communicating with a shuttle valve 236 communicating in turn with the rear end of the carrier arm cylinder 62 and also as pilot air to close the normally open air pilot valve 232 in the 30 p.s.i. circuit and communicating with the outer end of the carrier arm cylinder 62, this latter valve 232 then venting the cylinder 62 so that the 30 p.s.i. air applied through the shuttle valve causes the rods 64 and 70 to retract downwardly. As the carrier arm swings counterclockwise, its mounting bracket 56 engages and opens a normally closed valve 239 fixed on the stationary part 90 and 60 p.s.i. air pressure is provided through the shuttle valve 236 to the outer end of the carrier arm cylinder 62 to fully extend the rods 64 and 70. Thus, the carrier arm is caused to swing, extend and twist from its inoperative, retracted position as shown in FIG. 1 to its transferring position (FIG. 3). At the end of the initial delay of the terminal delay solenoid valve 2TDSV this valve opens and is connected through the solenoid valve 1SV in the 60 p.s.i. circuit to apply such pressure to the head end of the transfer arm actuating cylinder 132, to operate the transfer arm 113 for engaging the advancing strand and causing it to be attached to the upper winding head 22 and to be severed by the cutter 48 so that its tail end may wind onto the lower package 20. At the end of the terminal delay of the time delay relay 2TDR its contact 2TDR1 opens deenergizing the solenoid valves 1SV and 2TDSV to close these valves which thereupon vent their respective circuits.

To transfer winding from the upper winding head 22 to the lower winding head 20, the vertical arm 150 must first be operated. As previously discussed, this arm is connected in the 30 p.s.i. air pressure circuit through a line opening through the lug 192 into the outer cylinder to exert pressure on the upper face of the piston 162 of the outer cylinder and on the lower face of the piston 168 of the inner cylinder 164. The 60 p.s.i. air circuit is connected through a normally open mechanically actuated valve 240 and the lug 198 with the upper end of the inner cylinder 164 to exert pressure against the upper face of its piston 168 to retain the piston at the lower end of the inner cylinder and to hold it there against the 30 p.s.i. air pressure applied to the lower face of this piston, all as previously mentioned. Upon opening of the normally closed solenoid valve 3SV, 60 p.s.i. air pressure is applied to a normally open mechanically actuated valve 242 which is responsive to movement of the sheath of the vertical arm and to the valve 5TDSV communicating with the lower end of the cylinder 164, causing its piston 162 and therewith the lower cylinder 164 to elevate against the 30 p.s.i. air pressure applied to the upper end of this piston. Immediately upon elevation of the sheath 186, the mechanically actuated normally open valve 242 closes as a protrusion 244 on the sheath moves of the valve actuator to prevent actuation of the carrier swing cylinder 78. Closing of this valve is almost instantaneous so that any motion of the carrier swing cylinder 78 is inconsequential at this time.

When the sheath 186 has elevated its maximum amount, the protrusion 244 on the sheath engages and closes and vents the normally open valve 240 in the 60 p.s.i. circuit to the upper end of the cylinder 164, whereupon the 30 p.s.i. air pressure applied through the lug 192 to the lower end of the inner cylinder 164 causes its piston 168 and rod 170 to raise thus causing the rack 172 attached to the rod to rotate the pinions 180 and 184 and thereupon to move the arcuate rack 176 causing the vertical arm guide wheel 204 to move to the position shown in FIGS. 8 and 9, ready to engage the strand of yarn advancing to the upper winding head 22. Upon expiration of the terminal delay of the valve 5TDSV to the lug 158 and the lower end of the outer cylinder 154, this valve closes and vents the lower end of the cylinder so that the 30 p.s.i. air pressure applied to the upper end cylinder piston causes its piston 162 to move downwardly thus retraction the sheath 186 and the vertical arm guide wheel 204 which now engages the advancing strand of yarn and reroutes it downwardly.
Concurrently, the protrusion 244 moves away from the mechanical actuator of the normally open valve 240 thus opening this valve for passage of 60 p.s.i. air pressure to the lug 198 and the upper end of the inner cylinder 164 causing its piston 168 to move downwardly against the 30 p.s.i. air pressure applied to the lower face of this piston, moving the rack 172 and rotating the pinions 180 and 184 to move the arcuate rack 176 and the guilde wheel 204 attached thereto back to the position as shown in FIG. 1. In this position, the protrusion 244 on the sheath again actuates the mechanical actuator of the valve 242 to open this valve and provide 60 p.s.i. air pressure to the outer end of the lower head carrier arm swing cylinder 78', causing the carrier arm to swing and provide the action as previously described with reference to the upper head carrier arm. Other similar parts of this circuit are indicated by the same reference numerals as applied with reference to the description in the operation of the upper head but with the reference numerals primed.

Upon expiration of the terminal delay of the terminal delay solenoid valve 4TDSV this normally closed valve opens to actuate the transfer arm whereupon at the expiration of the terminal delay of the time delay relay 4TDR (FIG. 12) its contact 4TDR1 opens deenergizing the solenoid valves 3SV and 4TDSV which thereupon vent the circuit as previously described.

While this invention has been described with reference to a particular embodiment in a particular environment, various changes may be apparent to one skilled in the art and the invention is therefore not to be limited to such embodiment or environment except as set forth in the appended claims.

What is claimed is:

1. Winding apparatus comprising, winding units including at least one active unit and at least one reserve unit for successively winding a continuously advancing strand into packages, extendable carrier arm means having a free end with a strand retaining member thereon for engaging the advancing strand as it is winding on the active unit and moving it to a ready position adjacent the reserve unit, transfer arm means operable to move the strand from said ready position to winding engagement with said reserve unit, and actuating means for operating said carrier arm means.

2. Apparatus as set forth in claim 1 wherein said carrier arm means comprises a pair of arm members, one of said arm members having said retaining member attached thereto, and said actuating means comprises means mounting said arm members for movement generally longitudinally of each other.

3. Apparatus as set forth in claim 2 wherein said actuating means comprises a fluid operated actuating cylinder for moving said arm members.

4. Apparatus as set forth in claim 1 wherein said carrier arm means comprises a cylinder, means for injecting fluid into a rear end of said cylinder, a front piston in said cylinder having a hollow piston rod and a rear piston in said cylinder having a second piston rod telescoped in said hollow piston rod, a strand engaging member mounted on one of said rods for movement relative thereto, and means for moving said retaining member relative to the one rod.

5. Apparatus as set forth in claim 4 including means for stopping forward movement of said rear piston and its rod and means permitting movement of said front piston and its rod away from said rear piston after said rear piston has so stopped.

6. Apparatus as set forth in claim 1 including means providing strand paths to said winding units, a first of said paths extending to a first of said units and past a second of said units when the first unit is the active unit, and a second of said paths terminating short of the first unit when said second unit is the active unit, a pair of said carrier arm means, one for each of the last said units for transferring the strand to the associated unit, and further including spanning means for engaging the strand along said second path and moving the strand proximate said first unit for engagement by the transfer arm means associated with said first unit.

7. Apparatus as set forth in claim 6 wherein said spanning means comprises a plurality of fluid operated piston rods, and a strand retaining member mounted on one of said rods for movement therewith.

8. Apparatus as set forth in claim 1 wherein said carrier arm means comprises a cylinder and a rod movable relative to said cylinder, and a strand engaging member mounted on said rod for movement relative thereto.

9. Apparatus as set forth in claim 8 including means for controlling movement of said rod.