YARN WINDING PROCESS AND A MACHINE ADAPTED FOR CARRYING OUT SAME

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ABSTRACT
In winding a yarn onto a bobbin, the free end is first drawn and held by a suction device adjacent the rotating bobbin. A jet of air moves the yarn in close proximity to the bobbin for engagement by a catcher. A cutter severs the yarn adjacent the catcher and the yarn is wound on the bobbin while the waste is carried away by the suction device. Upon filling the bobbin the yarn is cut and again engaged by the suction device. An empty bobbin is then substituted for the full bobbin and the cycle is repeated.

4 Claims, 16 Drawing Figures
YARN WINDING PROCESS AND A MACHINE ADAPTED FOR CARRYING OUT SAME

This invention relates to a process and machine for carrying out yarn winding operations, especially in a continuous manner when desired. When a yarn consisting of a multifilament, although not always limited thereto, is manufactured by the conventional wet-, dry-, or melt-spinning process, from a spinning solution, the spun yarn must be subjected to several after-treatments, for instance, in the case of wet-spinning process, the spun yarn must be scored, dried and then wound on a bobbin. In the case of the dry-spinning process, the extruded yarn must pass through a spinning cylinder, so as to be brought into contact with heated air for removal of the contained solvent, and then the yarn must be wound on a bobbin. On the other hand, in the case of the melt-spinning process, the extruded yarn must be brought into contact with cooled air streams in a spinning cylinder, and then, the cooled and formed yarn must be wound equally on a bobbin. Naturally, these yarns may be subjected to drafting or stretching processing step. They must be occasionally twisted and subjected to other several further conventional after-treating processings. Regardless of the spinning process used, the spun yarn must be generally wound on a bobbin. This bobbin winding operation is, as commonly known, carried generally into effect in a continuous way so that the replacement of the wound-up bobbin by a new one; the cutting operation for removal of the waste yarn end from the yarn mass on the bobbin or the yarn package; and the carrying-away from position of the waste yarn end and the like procedures are highly troublesome and time-consuming which results in a greatly reduced manufacturing efficiency. In addition, a new yarn end must be attached in each case to a new bobbin and the yarn cutting operation must be accompanied necessarily by this yarn-attaching operation, which will further reduce the manufacturing efficiency to a substantial degree.

Various prior proposals have been made for reducing such additional labor cost in carrying-out the bobbin exchange operations by providing a full-automatic or semi-automatic yarn winding machine. However, such prior machines represent normally a highly complicated design and arrangement of the main working parts thereof, thereby inviting a large additional investment cost and/or, under occasions, a rather reduced manufacturing efficiency are/is accompanied by the employment of these apparently improved automatic yarn winding appliances.

The present invention avoids many of the aforementioned conventional drawbacks, so as to provide a unique and highly improved automatic yarn winding process and machine, capable of obviating the aforementioned various conventional drawbacks, and for further improving the currently available yarn winding techniques, especially by providing a newly proposed unique principle of yarn threading and bobbin exchange.

A specific object of the present invention is to provide a highly improved process and machine for carrying out yarn winding on a bobbin by utilizing a specific combination of the injection effect with the sucking effect of the high speed air jet streams, for discharge of the waste yarn from a wound-up bobbin and for applying onto an empty bobbin the yarn end formed upon cutting off the latter, to be carried out in a highly efficient way.

A specific second object of the invention is to provide a process and machine adapted for carrying out the bobbin exchange operation in an automatic and in an efficient and reliable way. These and further objects, features and advantages of the invention will appear more apparent when reading the following detailed description of the invention by reference to the accompanying drawings illustrative of substantially a preferred embodiment and several modifications adapted for carrying out the process according to the invention.

In the drawings:

FIG. 1 is a schematic and highly simplified perspective view of the main yarn winding parts employed in the first embodiment.

FIG. 2 is an enlarged perspective view of the first or yarn injection nozzle unit appearing in FIG. 1.

FIG. 3 is a longitudinal section of the yarn injection nozzle shown in FIGS. 1–2.

FIG. 4 is substantially a sectional view of one end of a bobbin placed at its service position, together with several nozzle units and a yarn cutter unit positioned in proximity the bobbin end for cooperation therewith and shown in their outside appearance.

FIG. 5–9 are several schematic elevational views of main working parts of an automatic bobbin exchanger adapted for cooperation with the yarn winder proper shown in FIG. 1, and representing several successive steps of a bobbin exchange operation cycle.

FIG. 10 is an enlarged sectional elevation of a bobbin-mounting cradle unit capable of performing a cradle movement for exchange of a fully wound-up bobbin by a new one, wherein several related control elements are shown additionally and schematically.

FIG. 11 is a timing chart representing the relative timing of several control valves to be set in an automatic bobbin exchange cycle.

FIG. 12 is a schematic explanatory representation of several control cams adapted for control of the various control valves schematically shown on the foregoing timing chart and appearing more specifically in several of the foregoing figures.

FIG. 13 is a similar view to FIG. 12, yet showing a modification thereof.

FIG. 14 is a further similar modification using a timer unit.

FIG. 15 is a similar view to FIG. 2, shown in a highly enlarged and partially sectional way, of a slightly modified and eccentric arrangement of the injection pipe element relative to the sleeve element constituting the said first nozzle unit.

FIG. 16 is an enlarged and partially sectional view of a second or yarn reception nozzle unit shown substantially in FIG. 1, yet representing a slight modification thereof by addition of an axial slit.

In the following, referring to FIGS. 1–4, a preferred embodiment of the apparatus adapted for carrying out the present invention method will be described in detail.

For convenience, the description will be directed to the use of acetate yarn. But, this specific use is only by way of example and the inventive principles can be applied equally in use of other kind yarn, thread or the like continuous elongated and linear product.

In FIG. 1, numeral 1 represents a continuous elongated acetate yarn supplied from a certain conven-
tional supply source, for instance, a spinning cylinder, said supply source being shown only schematically and partially at 2 and said yarn being fed substantially vertically from upper to below in FIG. 1. In the case of acetate yarn, the spinning solution is prepared, filtered and extruded through a spinneret into said spinning cylinder for bringing the extruded yarn into contact with heated air to 80°C, as an example, so as to remove the contained solvent acetone to provide the formed yarn. This yarn 1 may be a multifilament consisting of 18 or so filaments of each 4 denier, as a preferred example. This yarn 1 is threaded on a rotating oiling roller 3 for being oiled by contact therewith, as conventionally. After thus oiled, the yarn 1 is threaded around a godet 4 and then passes through a stationary yarn guide 5 which, in the present preferred embodiment, constitutes the starting point of the yarn traverse movement to be described.

In close proximity of the yarn guide 5 and nearly at the same point of the latter, there is provided an injection nozzle unit 6, a representative structure of this nozzle unit being shown in a more specific way. As seen, the nozzle unit 6 comprises a combination of a compressed air supply and injecting pipe element 7 with a slitted sleeve element 8 tightly and telescopically coupled with each other. The pipe element 7 is connected to a suitable air supply source, preferably air reservoir, not shown, through a control valve means, again not shown. The thus supplied compressed air is discharged at a high speed and pressure, preferably several atmospheric pressures, from the downstream open end 7a of the pipe element 7 into the interior of the slitted bore of the sleeve element 8. In this way, a relatively strong air jet stream is discharged from the downstream end 8b into the open atmosphere, yet in a specifically selected direction, as will be more specifically described hereinafter.

Sleeve element 8 is substantially axially of the nozzle and substantially in the direction of the yarn travel, slitted at 8a. With generation of the aforesaid jet stream, a negative suction pressure will be generated substantially along its overall length. In this way, the traveling yarn 1 in proximity of the nozzle unit substantially in parallel therewith will be subjected to a lateral suction force and sucked into the interior bore space of the sleeve element, yet downstream of the air supply pipe element 7. The mode of coupling of pipe element 7 with sleeve element 8 is not limited to the concentric one as shown. An eccentric coupling mode may rather efficient in the yarn sucking effect. This laterally offset and eccentric arrangement of pipe element 7 may preferably be performed in such a way that the pipe element is positioned as far as possible remote from the axial slit 8a.

The jetting direction of nozzle unit 6 is slightly inclined from the true vertical and directed towards a second suction nozzle 9 having a distance, for instance 1 m from the first nozzle unit 6 which may be called "yarn projector nozzle" for the purpose of discrimination therefrom of the second nozzle 9 which may preferably be called "yarn reception nozzle." Although not shown, the downstream end of this second nozzle 9 is connected to a waste box. The nozzle 9 is shown in FIG. 1 only schematically. A more specific structure thereof is shown in FIG. 16.

The yarn 1 is subjected to a traverse movement by engagement with a conventional traverse unit, generally shown at 11, comprising a traverse member 11a which is driven to perform a lateral reciprocating movement as known per se. Although in the drawing, this traverse unit 11 is shown in the form of rather classic style, but, in practice, it may be, when necessary, replaced by a rather modern style, such as of split drum type or any other known type.

Upon being traversed, the yarn 1 is wound on a rotating bobbin 10. The structure of this bobbin 10 and its support frame 15 is shown more specifically in FIG. 4. This yarn winder may be, when necessary, replaced by a more modernized surface drive type or spindle drive type unit, although not shown.

As shown in FIG. 1, the second suction nozzle 9 is mounted at a position selected in close proximity to one end of the bobbin 10 which is provided with a yarn end catcher, preferably consisting of a laterally (or axially of the bobbin) extending strip as shown stuck on the related bobbin end. This yarn end catcher may be a recess cut-in substantially in the axial direction of the bobbin and in the related end peripheral part thereof. The bobbin 10 is rotatably mounted on the holder 15 through a pair of end bearings of which only one is shown in FIG. 4. The yarn end catcher 12 may be provided on the outer bearing race 18 when necessary.

At a slightly higher level than and above the second suction nozzle 9, there is provided a third nozzle 13 of the air injection type adapted for shifting the waste yarn laterally relative to the running route shown at A in FIG. 1. The air delivery quantities to the first, second and third nozzles 6, 9 and 13 may be on-off controlled by respective valves V-2, V-1 and V-3 shown in a highly simplified way in FIG. 1.

Numerical 14 represents generally and schematically a yarn cutter unit which is supported by a piston rod 113 of a pneumatic piston-cylinder shown generally and schematically at 114 in FIG. 1. In the arrangement shown in FIG. 4, the yarn cutter 14 is shown somewhat in a modified form comprising a pair of movable cutter blades 14a and 14b, while the cutter shown in FIG. 1 the blades 14a and 14b fixed together.

The piston cylinder unit 114 is connected through pipings 115 and 116, only schematically shown, to a certain pressure air supply source, not shown, said piping 115 being provided with an on-off control valve V-7-1.

Bobbin 10 is rotatably mounted through bearings 18 on a holder 15 which is fixedly mounted on a shaft 16 urged normally resiliently by a spring 17. This spring 16 is tensioned between the holder 15 having a pair of inwardly swingable arms 15a and 15b, each carrying an anti-friction bearing unit on top thereof. When necessary, the spring 17 may be replaced by a suspended weight mass, although not shown. By the provision of said spring 17 or the suspended weight, the bobbin holder 15 is held in its operative position shown in FIG. 1. For this purpose, the bobbin 10 is kept in pressure contact in this shown position with a conventional bobbin driver roll 118 appearing in FIGS. 5–9.

Bobbin 10 is, when fully wound up with the yarn, automatically exchanged by a new one by use of the automatic bobbin exchanger as shown in FIGS. 5–12 in which FIG. 11 shows a timing diagram thereof.

Control valve V-1 when actuated to open acts so that compressed air is supplied from a proper supply source, not shown, through a piping 119 to second suction nozzle 9.
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The valve V-1 operates for about 17 seconds, as shown at the top line denoted with “SUC-
TION GUN” of the timing diagram shown in FIG. 4, extending from “0” to “17”, the numeral “0” being the in-
tiation time of the automatic bobbin exchanger, the time corresponding to the full wound condition of bob-
bin 10.

Control valve V-2, when actuated, allows a supply of compressed air from a certain supply source, not shown, through piping 120 to the first injection nozzle 6. This valve operates for about 16 seconds from “1” to “17” as shown in the second line of the timing dia-
gram of FIG. 11. It will be seen from the foregoing that this valve starts to actuate upon lapse of 1 second
after the first fully wound condition of bobbin 10. The termination of this valve operation is in coinci-
dence with that of the valve V-1. The nozzle 6 is fre-
quently called “SLIT NOZZLE” as shown.

Valve V-3, frequently called “YARN SHIFT NOZ.
ZLE VALVE” as represented in the third line of the timing dia-
gram, operates for about 2 seconds from “14.5” to “16.5” on the diagram. This control valve V-3, when actuated, allows a supply of compressed air from a certain supply source, not shown, through pip-
ing 121 to third or yarn shift nozzle 13.

Valve V-4, shown in FIG. 10 controls the supply of pressure air from a certain supply source, not shown, through a piping 122, only schematically shown, to the working space 22 of a cradle cylinder 19 having a pair of opposingly arranged spring-loaded pneumatic pis-
tons 20 and 21. These pistons 20 and 21 are provided with respective piston rod rigidly connected therewith, said piston rods being pivotally connected at 15c and 15d, respectively, with the cradle arms 15a and 15b. It
will be seen that this cradle piston-cylinder unit 19; 20;
20a; 21; 21a and 22 has been omitted from FIG. 1 only for avoidance of complexity. In addition, in FIG. 10, the an-
tifriction bearing units already shown at 18 in FIG. 4,
are shown in their somewhat modified form at 33 and
34, respectively. In FIG. 10, the bobbin 10 is shown only schematically by its outer configuration, so as to illustrate the specific structure of the modified bearing units 33 and 34.

When the control valve V-4 is opened, compressed air is supplied through piping 122 to the working space
22 and the pistons 20 and 21 are moved oppositely and outwardly and thus the cradle arms 15a and 15b
carrying the fully wound-up bobbin 10 are swivelled to outwardly expand. Then, the bobbin 10 drops down-
wardly by gravity action. The control valve V-4 oper-
ates for about 6 seconds from “4” to “10” on the dia-
gram of FIG. 11.

The bobbin holder or cradle 15 is supported rigidly on the pivotable shaft 16 through a support member
215 and a sleeve 216 shown in FIG. 1. In this arrange-
ment, this member 215 is shaped into a plate. In the ar-
angement shown in FIG. 10, the support member is
formed into a tubular member 215', so as to increase its rigidity. The sleeve 216 is rigidly and concentri-
cally connected as at 16a with the shaft 16.

Upon closure of the control valve V-4, the pistons 20 and 21 will recover their shown position by virtue of the urging action of respective return springs 220 and
221 provided within the cylinder 19.

Control valve V-5 appearing in FIGS. 5–9, is ar-
anged to perform on-off control action on a suction
cup 23 for shifting once an empty bobbin shown gener-
ally at 28, from its reservation position shown in FIG.
5, to an intermediate transfer position shown in FIG. 8.
The operating period of this control valve V-5 extends for about 5 seconds from “5” to “10” on the diagram
of FIG. 11. With the control valve V-5 operated, a pneumatic negative pressure is supplied from a certain vacuum source, not shown, through a piping 123 which passes axially in the material of a carrier arm 29 to suc-
tion cup 23 which is rigidly mounted on the free end of
said arm 29. When the valve V-5 is actuated, suction
cup 23 is activated for sucking one of empty bobbins 28 placed on a reservoir vessel 124.

Control valve V-6 is adapted for on-off control of
compressed air from a certain supply source, not shown, through a main piping 125 and respective flexi-
ble branch pipeings 24 and 25 to a pair of pneumatic brake units 126 and 127 of the piston-cylinder type,
carrying out brake pads 126a and 127a, respectively.

These units 126 and 127 are mounted on the cradle
arms 15a and 15b, and, when pneumatically actuated, act upon the wound-up bobbin 10 to stop the rotation thereof after disengagement of the bobbin from driven contact with the driver roll 118. The control valve V-6
operates for about 3 seconds from “2” to “5” on the diagram of FIG. 11.

In practice, the aforementioned control valve V-7 is divided into two valve elements V-7-1 and V-7-2
adapted for actuating the piston-cylinder unit 114 in
one and in another direction, respectively, so as to ad-
vance and return the cutter 14 to and from its operating position. In FIG. 1, the cutter 14 is positioned at its re-
ceded off-service position. Valve V-7-1 is actuated at
“2” and “15.5” on the timing chart, so as to advance the cutter 14 for cutting off the yarn 1. On the other
hand, valve V-7-2 is actuated in the opposite phase to the action of said valve V-7-1 for receding the cutter 14 from its operational to its off-service position shown in FIG. 1.

Valve V-8-1 controls pressure air supply from a cer-
tain source, not shown, through piping 128 to air cylin-
der unit 26 fixedly mounted in proximity to the cradle 15, said unit having a sliding piston 26a mounted therein and mechanically and pivotally connected through piston rod 26b with the cradle at 15e. Or altern-
atively, the piston rod 26b may be linked to cranck bar supported 215 or 215', although not shown. With the
control valve V-8-1 operated, the cylinder pressurized at the right-hand piston chamber of the unit 26 so that the cradle 15 is receded from its normal working position,
FIG. 5, to its bobbin transfer position, FIG. 7. This valve V-8-1 operates for about 11 seconds from “1” to
“12” on the timing chart.

As seen from the timing chart, control valve V-8-2 is
actuated in the opposite phase to the operational mode of said control valve V-8-1. With this valve V-8-2 act-
uated, pressure air is conveyed from its related supply source, not shown, through a piping 129 to the opposite or left-hand side piston chamber in the cylinder unit 26, so as to return pivoting from the bobbin transfer posi-
tion shown in FIG. 7 to its normal working position
shown in FIGS. 1, 5 and 10. This return movement of
the cradle 15 is more specifically shown in FIGS. 8 and 9.

Valve V-9-1 is provided in an air supply piping, not
shown, extending between a certain pressure air supply
source, not shown, and the lower piston chamber of a
pneumatic cylinder 30 (FIG. 5) having a slidable piston 30a mounted therein. This piston 30a is linked at 230 to the upper end of the carrier arm 29 for suction cup 23. The upper end of said arm 29 is pivotally mounted at a certain stationary point 29a so that when control valve V-9-1 is de-energized, pressure air is evacuated from the lower side of piston 30a, thereby the latter being moved downwards from the position shown in FIG. 5 to that shown in FIG. 8 in full lines. In this way, the carrier 29 is swiveled clockwise around pivot 29a and the suction cup 23 will convey an empty bobbin from its position 28a through 28b, being shown in phantom way in FIG. 8, to that shown at 28 therein in full line. This off-position of control valve V-9-1 extends for about 1.5 seconds from “8” to “9.5” on the timing chart.

At a position slightly before lapse of 10 seconds upon realization of fully wound-up condition of the bobbin 10, the control valve V-9-1 again actuated, the carrier arm 29 will be returned from its position shown in FIG. 8 wherein the empty bobbin 28 has been transferred from the arm 29 onto the cradle 15, to its position shown in FIG. 9.

Valve V-9-2 operates in the opposite phase to the foregoing valve V-9-1, as will be easily understood from the timing chart shown in FIG. 11. Although not shown, control valve V-9-2 is inserted in a piping, not shown, extending a pressure air supply source, not shown, and the upper piston chamber of the cylinder 30, for the control of air supply thereto. It will be seen, thus, that when control valve V-9-2 is actuated so as to deliver pressure air to the upper piston chamber in the cylinder 30. Therefore, the control valve V-9-2 acts in an operationally assisting mode to that of the foregoing valve V-9-1.

Valve V-10-1 is inserted in a piping 133 which extends from a certain pressure air supply source, not shown, to the right-hand side piston chamber of a pneumatic cylinder 32 having a piston 32a slidably mounted therein. The piston 32a has a piston rod 232 which is pivotably connected at its free end 232a with intermediate bobbin transfer arm 31. The root end 31a of this arm 31 is pivotably connected with a stationary cam member 231 having an inclined cam surface 231a. An elongated bobbin receiver 233 extending in the perpendicular direction to the plane of the drawing is fixedly attached to a bell crank 234 which is pivotally mounted at 234e on the upper end of the arm 31. A control bar 235 extending in parallel with the arm 31 is pivotally connected by its upper end with the bell crank 234 and slidably guided by a guide 236 which is rigidly attached to the arm 31. The lower end of the bar 235 is formed into a ball end and kept in slidable contact with cam surface 231a.

As seen from the timing chart of FIG. 11, control valve V-10-1 is opened concurrently with the establishment of the fully wound-up condition of the bobbin 10 and closed upon lapse of about 7 seconds counted therefrom.

With the valve V-10-1 kept in its closed position, the arm 31 occupies its position shown in FIGS. 5 and 6, while, when the valve is opened and pressure air is conveyed through the piping 133 to the right-hand side of cylinder 32. Thus, piston 32a slides leftwards and is brought into the position shown in FIG. 7.

Valve V-10-2 operates in the opposite operational phase to that of the foregoing valve V-10-1, as will be easily understood from the timing chart of FIG. 11. The Control valve V-10-2 is inserted in a piping 134 extending from a pressure air supply source, not shown, to the left-hand side piston chamber of the cylinder 32. With the valve V-10-2 opened, the arm 31 is pivotingly brought from the position shown in FIG. 7 through FIGS. 8 and 9 into the position shown in FIGS. 5-6.

The operation of the yarn winding apparatus so far shown and described is as follows.

The yarn 1 preferably a multifilament consisting, by way of example, of 18 monofilaments, each being 4 denier is continuously fed from a spinning unit, not specifically shown yet represented by the schematically and partly shown spinning cylinder 2, referred to hereinafore generally as “supply source” and passes through contact with rotatable oiling roller 3, positively driven goddet roller 4 to yarn guide 5, only partially shown. Bearing means for these rollers 3 and 4, drive means for the latter roller and mounting means for the yarn guide 5 have been omitted from the drawing on account of their very popularity. The similar conditions are also applicable to the remaining parts shown in FIG. 1.

At least when the initial end of yarn 1 arrives at a level below bobbin 10 which is empty at this stage, control valve V-1 is actuated to generate a suction effect at the inlet mouth of the second or yarn reception nozzle 9. The yarn cannot be, however, sucked thereinto at this operational stage.

After lapse of about 1 second from the valve opening at V-1, second control valve V-2 is opened, so as to actuate the first or yarn injection nozzle 6. Thus, a suction force is established laterally of and through slit opening 8a and the nearby passing yarn 1 is sucked into the nozzle and injected therefrom towards the yarn nozzle 9 and sucked into the latter which leads to a waste collecting box, not shown.

The yarn suction effect can be most clearly seen from FIG. 15 which shows, however, a slightly modified injection nozzle mechanism 6' on a substantially enlarged scale. In this figure, the air supply pipe 7' is introduced eccentrically into the interior of the sleeve 8'. The corresponding parts of this nozzle mechanism to those employed in that shown in FIGS. 1-3 are denoted with respective same reference numerals, but each being attached with a prime. A detail structure of the second or yarn sucker nozzle 9 is shown specifically in FIG. 16 on a substantially enlarged scale than before.

The substantially lateral sucking force established in the aforementioned way across the slit 8a can be easily understood by observing a plurality of small arrows a shown in FIG. 15. Thus, the similar lateral sucking force is also created in the case of the modified yarn injection nozzle 6'.

In this way, a yarn passage route is established in reality between the both nozzles 6 or 6' and 9. The bobbin 10, empty at this stage, is kept in rotation by engagement with the constantly rotating drive roll 118 as shown in FIG. 9 wherein, however, the empty bobbin is illustrated at 28 at the upper part of the figure.

Then, control valve V-3 is opened after lapse of about 14.5 seconds from the actuation of valve V-1, and the air jet streams are derived from the outlet end of the third nozzle 13, thereby the yarn now travelling along the laterally deviated route A or A' being shifted laterally of the mechanism shown in FIG. 1 (axially of the bobbin 10 when expressed in other words) into the operational zone constituted by a circle described by
the constantly rotating catcher 12, thereby the yarn being caught thereby. Almost concurrently, control valve V-7-1 is opened so as to advance the cutter 14 from its receded position shown in FIG. 1 to its advanced operating position corresponding to that shown in FIG. 4, thereby the waste part of the yarn 1 being cut out. The caught yarn 1 will then be wound upon the bobbin 10 until the latter is brought into fully wound-up condition, as schematically shown at 10 in FIG. 5. Upon performing the waste yarn cutting-off operation, control valves V-1; V-2; V-3 and V-7-1 will be closed almost concurrently, as may well be seen from the timing chart shown in FIG. 11.

When the bobbin 10 has been fully wound up as in the above described way, the relative position of the main working parts of the automatic bobbin exchanger shown substantially in FIGS. 5-10 will be that shown in FIG. 5. This bobbin 10, now wound up fully, will be transferred from its working position shown in FIGS. 1, 4, 5 and 10 onto a discharge conveyor 27 in a hop-and-step mode as hinted 10, 10' and 10'' in FIG. 5.

Upon attaining the fully wound-up state of the bobbin 10, control valve V-1 is actuated so as to operate the suction nozzle 9 as before, and the all other control valves are operated as illustrated on the timing chart shown in FIG. 11.

Thus, after lapse of about 1 second, the valve V-8-1 is operated which initiates the shifting of the cradle 15 thereby separating the fully wound bobbin 10 from the drive roll 118. As soon as this separation occurs, the rotational speed of the bobbin will decrease and the yarn leading to the bobbin will become slack. Substantially simultaneously the injection nozzle 6 will start to operate as before, and the yarn 1 will be shifted laterally into the position shown at A (FIG. 1) or at A' (FIG. 15).

Upon lapse of further 1 second, cutter 14 is brought into its advanced service position, so as to cut the yarn 1, thereby a further yarn winding being interrupted in spite of slight rotational over-running of the bobbin. By actuation of control valve V-6, the brake units 126 and 127, FIG. 10, will be brought into operation and the excess rotation of bobbin 10 is thereby positively prevented from continuing. At this stage, intermediate arm 31 is kept in its position shown in FIG. 1, so as to receive the fully wound-up bobbin 10 from the cradle 15. The waste yarn will be fed for a time being to the waste box, not shown, through the sucker nozzle 9 which is however shown in FIG. 16 in a slightly modified form having a slit 9a. In this modification, the arrow A'' shows the position of the initially sucked-in yarn. This position will be soon shifted to that shown at A'' by chain-dotted lines. Small arrows b represent an auxiliary sucking effect across the slit 9a.

Upon actuation of control valves V-8-1 and V-8-2, the cradle 15 is brought from the position in FIG. 5 to that shown in FIG. 6, thus the wound-up bobbin 10 being transferred from the cradle to the intermediate bobbin transfer arm 31, or more specifically onto bobbin receiver 233 pivotally mounted thereon.

For this purpose, cradle arms 15a and 15b are expanded outwardly by actuation of control valve V-4. Upon lapse of further one second from the actuation of valve V-4, suction cup 23 will be actuated to pick-up pneumatically an empty bobbin 28 by actuation of valve V-5.

In FIG. 7, the suction cup carrier 29 is performing a clockwise turning and upwardly shifting movement and the intermediate arm 31 is performing the discharge movement of the bobbin onto the discharge conveyor 27. During this operation, a relative swivel movement of bobbin receiver 233 relative to the arm 31 and controlled by the cooperation of bar 235 with stationary cam surface 231a is highly convenient to guarantee said bobbin discharge onto the discharge conveyor.

In FIG. 8, the empty bobbin 28 occupies the position shown therein at 28c which bobbin is positively held on the cradle 15 by contraction of the arms 15a and 15b from their outwardly expanded position to their normal or inwardly contracted position corresponding to the service position of the cradle. Although the empty bobbin can rotate about its own axis in a lighter and easy way by the provision of its supporting antifriction bearing units 18; 18 or 33; 34 as shown in FIG. 4 or 10, it should be noted that in the case of the present embodiment in contrast to the conventional comparative bobbin exchanged mechanism, there is no need for preparatory rotation of the empty bobbin at its ready-for-transfer position to its service position shown in FIG. 1 or 10 and in direct advance of its regular rotation for yarn winding. In the position shown in FIG. 8, the suction cup 23 is released from its bobbin sucking operation.

From the position shown in FIG. 8 to that in FIG. 9, suction cup carrier 29 is swivelled counter-clockwise and downwards. Concurrently, the cradle 15 is moved from the position shown in FIG. 8 to that illustrated in FIG. 9 and thus into its regular service position, thereby the empty bobbin 28 being brought into a driven contact with drive roll 118. This bobbin will attain its regular yarn winding speed with a certain small time lag.

The yarn catch operation by the empty bobbin carrying naturally the yarn catcher thereon, although not shown, and the yarn cutting operation from the waste yarn part can be performed as before. It will be seen that upon lapse of about 15 seconds counted from the establishment of full yarn winding on a bobbin, the yarn catch by an empty bobbin and the yarn cut from the waste are brought into effect without interference with the automatic yarn exchange operation, in contrast to the conventional comparative technique wherein a preparatory rotation is necessary to perform during the ready-for-service period of an empty bobbin in direct advance of initiation of the regular yarn winding operation by the newly supplied or exchanged bobbin. This means naturally a substantial progress in the art.

FIG. 12 represents a control cam arrangement adapted for use in the foregoing embodiment.

A common shaft 35 is rotatably mounted, although the bearing means have been omitted from the drawing only for simplicity. The timing operation as illustrated on the chart of FIG. 11 can be realized by use of 10 cams.

Generally, each of these cams is arranged to operate once per complete revolution of the shaft 35, thus the cam being provided with a single cam rise, but, for instance, the cam for control of the yarn cutter operation must be brought into twice actuation during a complete revolution of the cam. Therefore, such cam must be provided naturally with two cam rises.
At the upper center of FIG. 12, there is shown a cam 36 fixedly mounted on the shaft 35, said cam 36 being arranged to control a limit switch 37 adapted to control a four-way electromagnetic valve 38. This valve 38 has an inlet piping 40 connected with a certain pressure air supply source, not shown, and air feed pippings 340 and 341 connected respective piston chambers formed in the interior space of the cylinder 39 and defined by a piston 39a slidably mounted therein as shown. Each of the aforementioned control valves V-1; V-2 - - - V-10 shown and described in the foregoing can be replaced each by such valve 38, so as to perform the required jobs. Necessary air discharge pippings for these piston chambers have been omitted, however, from the drawing only for simplicity.

At the left-side part of the embodiment shown in FIG. 12 an electromagnetic valve 43 of the direct-acting type is shown. By the rotation of cam 41 mounted fixedly on the shaft 35, limit switch 42 is off-controlled, so as to control in turn an electromagnetic valve 43 in a corresponding way. This valve 43 is adapted for control of pneumatic pressure supply through a piping 44 leading to a piston-cylinder unit similar to that shown at 39; 39a.

At the right-hand side of FIG. 12, there is shown a timer unit adapted for allowing positively a complete revolution of the shaft 35 when occasion desires it.

In this timer unit, numeral 45 represents only schematically a change-off timer so designed and arranged as in the case of a conventional clock timer; so as to set a predetermined time period, for instance, 3 hours and 20 minutes, extending from the initiation of yarn winding operation, to the establishment of the fully wound-up state of a bobbin as at 10. This timer 45, frequently called "change-off instruction timer," is set for a certain required time duration for attainment of the full yarn winding. When the period necessary for the full yarn winding has elapsed, the timer unit 46 including the timer proper 45 is actuated, so as to drive an electric motor for its certain revolutions. Motion is therefore transmitted from the motor 47 through a reduction pinion 48 to a drive gear 49 which is kept in mesh with the pinion and fixedly mounted on the shaft 35, so as to allow the latter for performing a complete revolution. Upon performing such a complete revolution of the shaft 35, cam 50 therein will be brought into its operating position for actuating a limit switch 51 which operates then through its connecting wire 251 to reset the timer unit 46. This time point corresponds to the initiation of yarn winding by a new empty bobbin as at 28 shown in the upper middle of FIG. 9. When it is desired to let the piston-cylinder unit as at 39 to operate in a rather softer mode, a conventional speed controller, not shown, may be added thereto.

In place of a number of limit switches shown in FIG. 12, a corresponding number of air limit switches can be employed, as shown, by way of example, in FIG. 13.

In the arrangement shown in FIG. 13, two examples of the usage of such air limit switches are representatively shown.

The shaft 35 carries a cam 52 arranged for unitary rotation thereof and for control of an air limit switch 53 having a piping 54 for receiving and discharging compressed air. Although only schematically shown, a valve means 55 of the cylinder, pintle or the like conventional type, or a ball cock, is arranged to be operated by the switch. The flow rate or on-off condition of a piping 56 in which said valve means 55 is provided and fluidically connected with a certain piston-cylinder unit as at 39; 39a. This unit can be controlled in its operation as before. This modified arrangement is highly convenient where antiexplosion characteristics are required.

At the right-hand side of FIG. 13, there is provided a cam 57 mounted on the shaft 35, so as to control of an air limit switch 58 which controls in turn the flow rate and on-off condition of an air piping 59. With the limit switch 58 actuated, master valve 60 is actuated so as to on-off control the air pippings 61 and 62 leading to a pneumatic cylinder unit 63 having an operating piston 63a slidably mounted therein as before. The piston-cylinder unit 63; 63a is arranged to actuate any one of the movable members 15; 29; 31; 114 or the like, although not specifically shown for simplicity.

In the modified arrangement shown in FIG. 14, a timer is employed in place of each combination of cam and limit switch shown and described in the foregoing. An instruction timer 64 is designed substantially in the similar way to that shown at 45 in FIG. 12, said timer 64 being operatively connected through conducting wire means shown at 264 to a conventional sequence controller only schematically shown in a block 65 which is adapted for delivery of timed instruction signals, for instance, in accordance with a timing schedule as shown and described with reference to the timing chart of FIG. 11. Control valves are shown only two representatives at 66 and 67. By actuation of these valves, a compressed air piping 68 and a pneumatic piston-cylinder unit 69; 69a can be controlled as before, and so on.

In place of the use of compressed air, certain piston-cylinder units can be operated hydraulically.

In the foregoing, the description has been directed to a spinning unit only which delivers a single multifilament yarn 1. It may be naturally conceivable to those skilled in the art that 100 or more similar yarn winders and bobbin exchange units can be employed of the same number of the spinning units for performing, when necessary, the desired yarn-threading, waste yarn discharge, yarn-cutting, yarn attachment to bobbin, bobbin discharge, bobbin introduction, bobbin transfer and the like aforementioned various necessary operational steps in unison to all the related spinning units, thereby further improving the yarn manufacturing and wind-up operation efficiency, where seen as a whole, to still further advantageous degree.

It should be noted at this stage that the traverse guide 11a of the unit 11 shown in FIG. 1 and the like is shown only schematically is an old-fashioned reciprocating rod type. Since this guide 11a must catch automatically the yarn 1 each time when it is brought into its regular passage course range defined between its positions shown by its full line and right-hand imaginary line. When employing the said kind of the reciprocating rod type, this kind of automatic yarn catch is rather difficult, although not impossible. Therefore, it should be understood that this reciprocating rod type traverse guide has been shown substantially for the purpose of clear graphical representation. In practice, however, the traverse unit 11 may preferably be of the grooved roller type one, although not shown, as well known to those skilled in the art.
As a preferred example, the distance between the nozzles 6 and 9 may be set, for instance, 1 meter or more.

The embodiments of the invention in which an exclusive property or privilege is claimed is as follows:

1. A process for automatically winding a yarn from a supply source onto a plurality of bobbins in succession comprising:

   subjecting the free end of said yarn to a first fluid force adjacent one end of said bobbin to shift said yarn to a position outside the regular traversing range of the yarn across the bobbin to provide the necessary clearance for a bobbin changing operation,

   applying a second fluid force to shift the free end of said yarn into engagement with the bobbin,

   rotating the bobbin by drive means to wind the yarn on the bobbin to a predetermined size,

   disengaging the wound bobbin from said drive means to provide a slack in said yarn,

   subjecting said slack yarn to said first fluid force to shift said slack yarn to said position outside the regular traversing range of said yarn across the bobbin,

   cutting the yarn adjacent the end of said bobbin so that the free end of said yarn will be properly disposed for a subsequent winding operation.

2. A process as set forth in claim 1 further comprising, cutting the waste from the free end of the yarn after shifting said yarn into engagement with the bobbin by said second fluid source.

3. A process as set forth in claim 2 further comprising removing said waste by creating a suction zone adjacent the end of said bobbin where said cutting occurs.

4. An apparatus for winding a continuously fed yarn comprising, a continuous yarn supply source for supplying a yarn having a free end, a yarn injection nozzle for placing the free end of the yarn in a predetermined axial position, a rotatable bobbin rotatably mounted at a space-apart distance from said yarn injection nozzle, a yarn traversing means mounted adjacent said bobbin between said bobbin and said yarn injection nozzle for traversing said yarn onto said bobbin, a fluid suction nozzle positioned adjacent one end of said bobbin for attracting the free end of a yarn being supplied from said supply source, a waste yarn collector fluidically connected to said fluid suction nozzle, a fluid injection nozzle mounted in proximity to said fluid suction nozzle adjacent said one end of said hollow nozzle for moving said yarn laterally for moving said yarn laterally into engagement with said bobbin, a cutter positioned between said fluid injection nozzle and said yarn traversing means, and control and timing means operatively connected to said yarn injection nozzle, said fluid suction nozzle, said fluid ejection nozzle, and said cutter to sequentially control each of said elements in a predetermined sequence.