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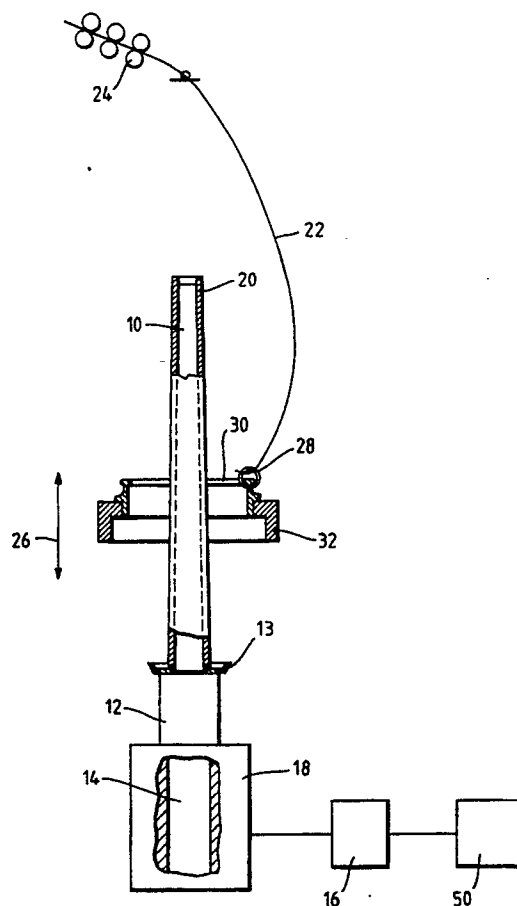
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54 **Ring spinning doubling and twisted frames with switched reluctance drive spindle motor.**

57 A textile machine of the ring spinning type, the ring doubling type or the ring twisting type including a switched reluctance drive motor to drive a spindle onto which a package former for winding yarn is placed. Delivery rollers are provided for feeding yarn to a ring and traveller assembly. At least one control unit is provided for controlling the speed of the motor, and the delivery rollers, and the axial movement of the ring.

An annular member is also provided for transferring the feed of yarn from the package former to the annular member once it has been determined that the package former is full and requires replacement. Completely automatic piecing, and automatic doffing of a loaded package former, can be provided.



RING SPINNING DOUBLING AND TWISTING FRAMES WITH SWITCHED RELUCTANCE DRIVE SPINDLE MOTOR

The present invention relates to the drive for a spindle of a textile machine of the ring spinning doubling and twisting frame type, to be referred to generally herein as ring frames.

AC motors have been explored to drive individually the spindle of the ring frame. Although this arrangement is capable of producing the necessary torque for winding yarn onto a package former placed on the spindle, the motor is not easily controllable especially at the beginning and at the end of the spinning operation. Furthermore, the AC motor does not generate any significant torque when stationary.

The present invention aims to provide a system to improve the yarn winding, piecing and doffing operations.

The apparatus according to the present invention is characterised by the features of claim 1.

A switched reluctance drive motor, of the type disclosed in GB-A-1, 597,486, can be controlled to operate in the required manner during the piecing and winding of the yarn, and provide a much more efficient automatic doffing operation than hitherto.

The present invention also provides a method of operating a ring frame (as herein defined) characterised by the features of claim 5.

A third aspect of the present invention provides a method of doffing a ring frame (as herein defined) characterised by the features of claim 7.

A fourth aspect of the present invention provides a method of piecing a spindle position of a ring frame (as herein defined) characterised by the features of claim 9.

The following description is given merely by way of non-limitative example with reference to the accompanying drawing in which the sole Figure is a schematic diagram of one spindle position of a ring frame.

With reference to the drawing, a spindle 10 is in this embodiment fixedly attached to an annular member 12 carrying a yarn cutter 13, and to the motor shaft 14 of a switched reluctance drive motor 18, for example of the type disclosed in GB-A-1,596,486. Control to the switched reluctance drive motor 18 is provided by means of a control system which incorporates two controllers 16 and 50 to be described later.

A yarn strand, in this case yarn 22 issuing from a pair of delivery rollers 24 in a ballooning condition, is delivered to a package former 20 mounted on the spindle, through a traveller 28 freely able to rotate on a ring 30 which is itself fitted in a horizontal ring rail 32. Vertical movement of the ring rail 32 carrying the rings 30, as shown by the

double headed arrows 26, is controlled in the conventional manner. The controller 16 is a local controller to the individual spindle position illustrated and is capable of determining the speed and acceleration of the switched reluctance drive motor 18 and of controlling the torque applied both while the motor is stationary and while it is rotating.

On the other hand the controller 50 is a global controller covering several spindle positions, for example all of the spindle positions down one side of a double sided machine, or even an entire multi-position machine, and operates by instructing the local controller of each individual spindle position to ensure synchronization of the various spindle positions under its control and to ensure that the spindle positions of the entire machine execute a desired simultaneous operation such as controlled acceleration upon start-up or controlled deceleration upon shut-down, for example prior to a doff.

The control line between the local controller 16 and the switched reluctance drive motor 18 includes a feedback from the motor to the local controller in order that the controller is aware of the status of the motor 18 and can verify that the instructed operation of the motor is being achieved in practice.

For example, the local controller 16 may be capable of instructing two or more separate torque values from the switched reluctance drive motor 18 such that a higher holding torque may be applied by the motor when stationary, when required during a manual or an automatic doff, and a lower holding torque may otherwise be provided such that the motor will remain stationary in the absence of external influences and is capable of controlled rotation subject to an external mechanical influence, for example unwinding of the yarn on its spindle by an operator during a manual doff.

The limitation of the time during which the high holding torque is applied by the motor 18 allows minimization of the amount of heat generated by the motor which may occur at that high holding torque.

For a manual doff the higher holding torque value will not be necessary. The control lines between the global controller 50 and the various local controllers 16 subordinate to it will include a feedback of the status of the individual drive motors, to allow the global controller to verify the status of the drive motors under its control.

The advantage of having both a local controller and a global controller is that it is possible to isolate the control function from the global controller, for example when piecing after an end break,

so as to allow localized control of one particular spindle position, whereas otherwise the operation of each of the spindle positions will be under the control of the global controller, and this will even apply to the operation of all of the other normally-functioning spindle positions during piecing of one particular spindle position following an end break.

In steady state operation of the apparatus, the spindle 10 is set to rotate at a preset speed by the global controller 50 and yarn strand 22 passes through the traveller 28 and onto the package former 20 also at a constant speed by means of the delivery rollers 24.

Once sufficient yarn has been wound onto the package former 20, the rings 30 carrying the travellers 28 are moved to their lowermost positions by descent of the ring rail 32. In this case, the feed of yarn will then transfer itself from the package former to the annular member 12 on the spindle and this operation is controlled to ensure that at least a few turns of the yarn are made onto the annular member to hold the yarn. In doing so, the yarn will pass between two consecutive radially extending blades of the yarn cutter 13.

The motor 18 is then controlled to stop completely and to hold its rest position by virtue of a holding torque set by the local controller 16 instructed by the global controller 50. Meanwhile the doffer unit (not shown) descends onto the loaded package former 20 and lifts it off the spindle 10 while causing the yarn between the package former 20 and the annular member 12 to be cut by one of the blades of the yarn cutter 13. Preferably the motor torque is controlled at a higher level (by means of the local controller 16) during this lifting action to provide the required yarn tension for yarn cutting. This lifting and the resulting tension on the yarn which imposes an unwinding action on the few turns carried by the annular member 12 would, in the absence of braking effort on the spindle, together turn the spindle. During this doffing operation the yarn remains threaded up through the traveller 28 and on the annular member 12 and is strained by the high holding torque in the motor 18.

The loaded package former 20 lifted from the spindle is then replaced by an empty one.

Use of a switched reluctance drive motor not only enables the control of the winding rate of the yarn during the deceleration of the spindle 10 but also ensures that there is an adequate holding torque to stop the spindle 20 and annular member 12 from rotating during doffing of the loaded package former 20 when the motor rotor is at rest.

On insertion of the next empty package former 20 onto the spindle, the ring rail 32 is lifted again so that the yarn is taken up automatically onto the package former 20 and the winding operation can commence again immediately. Very accurate con-

trol of the motor 18 makes it possible to achieve the appropriate rapid acceleration of the spindle to re-establish the balloon.

The build-up of yarn on the annular member 12 is removed by any suitable means, not shown.

It is also possible with the use of a switched reluctance drive motor to ensure that the correct number of turns of twist per unit length are imparted to the yarn both during the start and during the end of the winding operation as well as during winding. Such accurate control, which has not been possible with other types of motor, enables the spindle speed always to be appropriate to the speed of the delivery rollers 24 and the rotational velocity of the traveller.

The piecing operation may be effected either manually or automatically. In the case of a manual piecing operation the local controller 16 will be operated by the operator to apply a low holding torque during which time the operator can pay out a length of yarn for connecting back to the yarn strand at the delivery rollers 24 by manually pulling that yarn to rotate the partially loaded package former against the low holding torque of the drive motor 18, until sufficient yarn has been paid out to enable the operator to twist together the yarn strand at the delivery rollers 24 with the yarn 22 shown in the balloon in the drawing, at which point the operator can release the spindle to accelerate to normal operating speed. The yarn strand will be delivered continuously by the delivery rollers up to the instant of twisting together, and will preferably be sucked away to waste.

In the case of an automatic piecing operation the reversal of the package former to pay out yarn for the automatic connection to the yarn strand at the delivery rollers 24 is effected by the local controller 16 reversing the motor to pay out yarn which can then be caught (for example by a suction nozzle) and fed back to the delivery rollers 24 for connection. At that point the spindle motor 18 is then controlled for rapid acceleration to re-establish the balloon of yarn shown at 22 and then to return to normal operating speed. The actual connection of the yarn back to the yarn strand at the delivery rollers 24 may be achieved while the motor 18 is momentarily held at a speed of rotation suitable for the connecting operation, and the motor 18 then accelerated up to normal operating speed to re-establish spinning with the minimum of substandard yarn where the accelerating spindle is unable to match the constant delivery rate of the delivery rollers.

Claims

1. A ring frame (as herein defined) including a

plurality of spindle positions each including:- a spindle (10) on which a package former (20) is placeable for winding a yarn thereonto; a respective drive motor (12) to drive said spindle; a respective ring spinning assembly comprising a ring (30) and traveller (28); delivery rollers (25) to supply a yarn strand (22) to said assembly; and control means (16) to control said motor to execute a varying speed during operation characterised in that said spindle drive motor is a switched reluctance drive motor.

2. A ring frame according to claim 1, characterised in that said control means is adapted to control the rate of rotation of the spindle motor relative to the delivery of the yarn strand to control the twist imparted to the yarn.

3. A ring frame according to claim 2, characterised in that feed back from the motor (12) is used to control the rate of rotation of the spindle (10) relative to the rate of supply of the strand (22) from the delivery rollers (25).

4. A ring frame according to claim 1, 2 or 3, characterised in that said control means comprises a local controller (16) specific to each spindle position and forming a feedback loop including the switched reluctance drive motor (12) of that spindle position, and a global controller (50) effective to ensure synchronized operation of several of the spindle positions.

5. A method of operating a ring frame (as herein defined) including a spindle (10) on which a package former (20) is placeable for winding a yarn thereonto; a drive motor (12) to drive the spindle; a ring spinning assembly comprising a ring (30) and traveller (28); delivery rollers (25) to supply a yarn strand (22) to said assembly; and control means (16, 50) to control said motor; said method being characterised by including the steps of controlling the rate of acceleration of the motor from rest relative to the rate of feed of the yarn strand (22) from said delivery rollers (25) to ensure that a predetermined number of turns per unit length of yarn is imparted into the yarn during acceleration of the motor; and controlling the rate of deceleration relative to the decelerating rate of feed of yarn strand (22) from said delivery rollers (25) until the spindle (10) stops; and by the fact that the drive motor is a switched reluctance drive motor.

6. A method according to claim 5, and characterised by including the steps of monitoring the rate of delivery of yarn strand (22) from said delivery rollers and the rotation of said traveller (28) on the ring (30) of the spindle position, for controlling the switched reluctance drive motor (12) to maintain a given number of turns of twist per unit length of yarn during the acceleration and the deceleration of the ring frame.

7. A method of doffing a ring frame (as herein

defined) comprising spindles equipped with individual drive motors, characterised in that the individual drive motors are switched reluctance drive motors (12) controlled to give a constant holding torque while stationary to prevent rotation thereof during removal of the loaded package former from the spindle and during severing of the yarn on the package former (20) from the yarn strand (22) being fed by the delivery rollers (25).

8. A method according to claim 6 and characterised by the step of controlling the switched reluctance drive motor (12) of the spindle position being doffed to apply a constant holding torque at a low level to hold the spindle (10) stationary until the loaded package former (20) is to be removed, and then controlling the individual switched reluctance drive motor (12) to apply a higher constant holding torque during removal of the loaded package former (20) from the spindle and severing of the yarn on the package former from the yarn strand (22) being fed from the delivery rollers.

9. A method of piecing a spindle position of a ring frame (as herein defined) driven by individual drive motors by stopping the drive motor to arrest the spindle, characterised in that the drive motor is a switched reluctance drive motor; and in that the motor is reversed under a controlled torque to pay out a length of yarn from the spindle (10), and then accelerated; and in that the length of yarn paid out becomes connected to the yarn strand at the delivery rollers to achieve piecing.

10. A method according to claim 9, characterised in that the acceleration of the drive motor is achieved by accelerating the drive motor to an intermediate speed at which the connection of the paid out length of yarn to the yarn strand at the delivery rollers is effected, followed by rapid acceleration of the drive motor to normal operating speed after yarn connection.

11. A method according to either of claims 9 and 10, characterised in that the step of reversing the drive motor to pay out a length of yarn comprises controlling the drive motor (12) to rotate in the reverse direction to pay out yarn which can then be taken back to the delivery rollers (25) for joining to the yarn strand (22) being delivered thereby.

12. A method according to claim 9 or 10, characterised in that reversal of the motor is effected by pulling off said length of yarn against the resistance of said controlled torque.

13. A method according to claim 12, characterised in that the switched reluctance drive motor (12) is controlled at a low holding torque until completion of manual reversal of the spindle for paying out yarn to be joined.

