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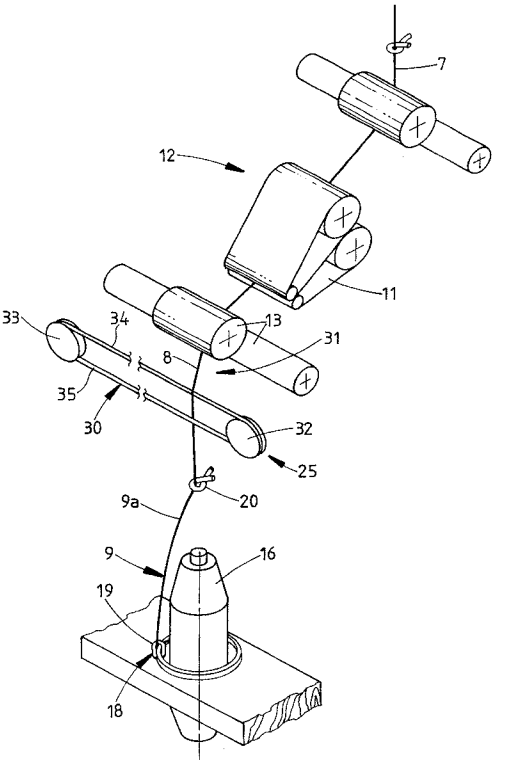
(30) 1996/02/29 (PN 8384) AU

(54) **REDUCTION DU TAUX DE CASSES DANS LA FILATURE OU LE RETORDAGE DE FILS**

(54) **REDUCING END BREAKS IN THE SPINNING OR TWISTING OF YARN**



(57) Procédé et appareil permettant de retordre un ensemble à fibre en défilement (7) afin de former un fil retors (9). On tire le fil simple à partir de moyens de pinçage (14) et on le fait tourner afin d'y introduire une torsion. On fait défiler le fil retors au contact d'au moins un brin (34 ou 35) d'une bande sans fin en défilement (30) en aval du point de pinçage, afin que la surface ou les surfaces de la bande fasse tourner le fil pour y introduire une fausse torsion en direction du point de pinçage. La (les) surface(s) présente(nt) une courbure convexe dans le sens de l'avance du fil, et le fil vient au contact de la (des) surface(s) selon une ligne courbée de contact total suffisant pour réduire matériellement la transmission de tension dans le fil au-delà de la (des) surface(s) et en direction du point de pinçage.

(57) A method and apparatus for twisting a travelling fibre assembly (7) to form a twisted yarn (9), in which the strand is drawn from nip means (14) and rotated to insert twist into the yarn. Downstream of the nip, the twisted yarn is drawn past and in engagement with at least one run (34 or 35) of travelling continuous belt means (30) so that a surface or surfaces of the belt means rotates the yarn and inserts a false twist into the yarn towards the nip. The surface(s) is convexedly curved in the direction of travel of the yarn, and the yarn engages the surface(s) over a total curved line contact which is sufficient to materially reduce the transmission of tension in the yarn past the surface(s) towards the nip.

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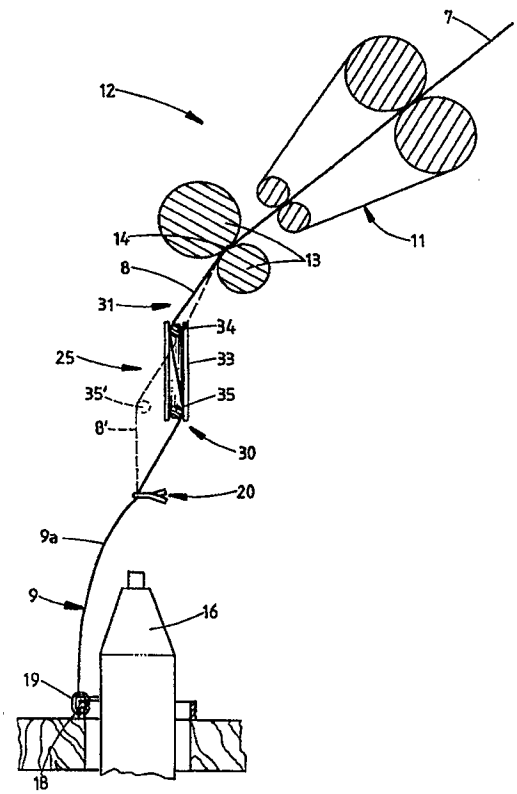
(54) Title: REDUCING END BREAKS IN THE SPINNING OR TWISTING OF YARN

(57) Abstract

A method and apparatus for twisting a travelling fibre assembly (7) to form a twisted yarn (9), in which the strand is drawn from nip means (14) and rotated to insert twist into the yarn. Downstream of the nip, the twisted yarn is drawn past and in engagement with at least one run (34 or 35) of travelling continuous belt means (30) so that a surface or surfaces of the belt means rotates the yarn and inserts a false twist into the yarn towards the nip. The surface(s) is convexedly curved in the direction of travel of the yarn, and the yarn engages the surface(s) over a total curved line contact which is sufficient to materially reduce the transmission of tension in the yarn past the surface(s) towards the nip.



REDUCING END BREAKS IN THE SPINNING OR TWISTING OF YARN

Field of the Invention

This invention relates generally to the spinning or twisting of yarn and in a particular though not exclusive application addresses the problem of end breaks in ring spinning.

Background Art

It is known that the incidence of end breaks in ring spinning, which primarily occur in the spinning zone between the front drafting rollers and the yarn guide, depends on the tension and twist level in the yarn. Transmission of tension generated by the spindle and balloon is partially reduced by the guide but it has been observed that the twist level tends to diminish in the direction from the guide to the nip of the front drafting rollers. The twist level in this zone also tends to fluctuate locally. Other relevant factors are the cross-section of the yarn and the number of fibres in a cross-section, both of which also vary along the yarn. An end break occurs when the combination of twist level, cross-section and fibre density falls below a critical level relative to the tension present in the yarn.

Past proposals for reducing the incidence of end breaks have therefore focused on increasing twist levels above the yarn guide or on reducing the transmission of tension towards the front drafting rollers, with the broad object of improving the twist-tension balance in the spinning zone. One approach, for which there have been a number of proposals, was a rotating yarn guide for inserting false twist into the yarn in the spinning zone between the guide and the front drafting rollers, thus increasing the twist level in the zone. In one of these proposals, disclosed in W. Kampen, *Melliand Textilber.*, (English Ed) June 1979, 60, 433, the yarn guide comprises a friction tube driven by a magnetic coupling with the spindle. In another, disclosed in TA Subramanian et al "End breaks in ring spinning", published 1974 by Ahmedabad Textile Industry's Research Association

(ATIRA), the tube is rotated by the yarn itself. In other cases, a separate mechanical drive is provided.

US Patent 4384448 to Wilkie proposes a pneumatic false twister between the guide and the front drafting rollers. Various further forms of mechanical false twisters at this location are found in related disclosures by H.M. Brown, i.e. US patents 2590374 and 2718111, a report entitled "Clemson Dean proposes New Technique", at *Textile Bulletin*, 1949, and a paper entitled "Reduce Ends Down" in *Textile Industries*, May 1954, page 96. These false twisters are primarily discs in various orientations and configurations, but US patent 2590374 includes an embodiment (Figures 7 and 8) which utilises a transversely acting belt run close to and just above the guide.

While these rotating yarn guides are effective in increasing twist levels, and in some cases in also beneficially reducing tension transmission, they are difficult to thread up and, being discrete devices for each spindle, involve a significant capital cost.

Another approach, with the object of reducing spinning tension, has been to provide modifications at the spindle top, known as spindle crowns. This approach is reviewed in Schenkel et al, *Textile-Praxis (International)*, page 150 (1963), and generally involves partial or complete collapse of the balloon by a yarn wrap device. Spindle crowns have not achieved significant commercial use, perhaps again because of issues of cost and complexity.

A somewhat different approach has been to utilise pneumatic compression to increase yarn strength during yarn formation by spinning without a spinning triangle or with a compressed triangle so the fibres are more closely bound together. Such systems are described, e.g., in Betz, D "Innovations in the Ring Spinning Sector", *Melliand International* (1995), 1:30-34

Summary of the Invention

It is an object of the invention, at least in its application to ring spinning, to reduce the relative incidence of end breaks in a manner which is both effective and economically attractive.

The invention stems from an appreciation that the aforementioned transversely acting belt disclosed in Figures 7 and 8 of US patent 2590374 has potential utility as a false-twister in the present context but that a further modification would be advantageous. Specifically, the angular contact depicted in the patent between the yarn and the belt surface is very small, reflecting the small angular deviation of the yarn path by the belt. The present invention proposes, in one aspect, that reduction of end breaks is enhanced by not merely inserting false twist into the spinning zone but additionally materially reducing the propagation of tension into the spinning zone, and that this can be achieved by taking advantage of Capstan Theory and Amontons' law, predicting that the higher the angular contact, the less tension is propagated.

The arrangement shown in Figures 7 and 9 of US patent 2590374 has another disadvantage. The belt must be positioned very close to the yarn guide to avoid excessive sideways disturbance of the yarn path by the transversely moving belt surface. In its second aspect, the invention avoids this restriction, and balances sideways drag, by arranging for the yarn to engage both runs of a continuous belt means.

The invention therefore provides, in a first aspect, a method of twisting a travelling fibre assembly to form a twisted yarn, in which the strand is drawn from nip means and rotated to insert twist into the yarn, wherein, downstream of the nip, the twisted yarn is drawn past and in engagement with at least one run of travelling continuous belt means so that a surface or surfaces of the belt means rotates the yarn and inserts a false twist into the yarn towards the nip, wherein said surface(s) is convexedly curved in the direction of travel of the yarn, and the yarn engages said surface(s) over a total curved line contact which is sufficient to materially reduce the transmission of tension in the yarn past the surface(s) towards the nip.

In its first aspect, the invention also provides an apparatus for twisting a travelling fibre assembly to form a twisted yarn, including:

delivery means including an exit nip;

twisting means rotatable to draw the fibre assembly from the nip while inserting twist into the fibre assembly to form a twisted yarn; and

belt means which in use is a travelling continuous belt means, disposed to define a pair of runs at least one of which is engaged by the twisted yarn as it is drawn past so that a surface or surface(s) of belt means rotates the yarn and inserts false twist into the yarn towards the nip;

wherein said surface(s) is convexedly curved in the direction of yarn travel and the belt means is arranged so that, in operation of the apparatus, the yarn engages said surface(s) over a total curved line contact which is sufficient to materially reduce the transmission of tension in the yarn past the surface(s) towards the nip.

In a second aspect of the invention, there is also provided a method of twisting a travelling fibre assembly to form a twisted yarn, in which the strand is drawn from nip means and rotated to insert twist into yarn, wherein, downstream of the nip, the twisted yarn is drawn past and in engagement with two oppositely moving runs of travelling continuous belt means so that a surface or surfaces of the belt means rotates the yarn and inserts a false twist into the yarn towards the nip, the sideways drag of the respective runs on the yarn being substantially counterbalanced.

The invention also provides, in its second aspect, an apparatus for twisting a travelling fibre assembly to form a twisted yarn, including:

delivery means including an exit nip;

twisting means rotatable to draw the fibre assembly from the nip while inserting twist into the fibre assembly to form the twisted yarn; and

belt means which in use is a travelling continuous belt means, disposed to define a pair of runs both of which are engaged by the twisted yarn as it is drawn past so that a surface or surfaces of the belt means rotates the yarn and inserts false twist into the

yarn towards the nip, the sideways drag of respective runs on the yarn in operation being substantially counter-balanced.

The twisted yarn is preferably drawn past and engages two runs of the belt means travelling in opposite directions, passing behind one of said runs and in front of the other run.

The apparatus is preferably spinning apparatus in which the delivery means includes drafting means and the twisting means is a spindle which takes up the yarn and is rotatable to insert twist into the yarn.

Preferably, the continuous belt means is arranged so that the or each engaged run travels transversely with respect to the direction in which the yarn is being drawn by the spindle, for example at substantially 90° to that direction.

The fibre assembly is preferably a staple fibre assembly, and is advantageously a wool roving/strand in particular.

Typically, the spinning apparatus would include a yarn guide such as a pigtail between the spindle and the nip, and a ring and traveller system to take up the yarn on the spindle.

The continuous belt means is preferably disposed between the yarn guide and the nip.

Preferably, in a spinning frame with multiple spindles, a single travelling belt is disposed to engage a plurality of yarns.

Means is preferably provided to allow adjustment of the characteristics of travel of the belt means and/or its orientation and contact with the yarn(s).

Brief Description of the Drawings

The invention will now be further described to cover by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic perspective view of a single spindle segment of a ring spinning frame modified to provide an embodiment of apparatus according to the invention and shown in operation;

Figure 2 is a corresponding diagrammatic cross-sectional view; and

Figure 3 is a reference diagram for applying Amontons' law.

Preferred Embodiments

The illustrated spinning segment includes a delivery or drafting section 12 of conventional configuration including a double apron 11 and front drafting rollers 13 defining an exit nip 14. Take up spindle 16 has a ring 19 and traveller 18. A pigtail yarn guide 20 is located as usual between the nip and the spindle. In operation, a roving 7 is drafted by drafting section 12 and the rotating spindle draws the drafted strand 8 from nip 14 and winds it up as yarn 9 onto spindle 16, while inserting twist into the yarn by virtue of its rotation. This twist travels back to nip 14 at a diminishing and locally fluctuating level. There is of course tension in the yarn, increased by the centrifugally generated yarn balloon 9 between ring 19 and pigtail yarn guide 20.

Disposed between nip 14 and yarn guide 20 is false twist belt unit 25. This unit includes a continuous belt 30 of a generally circular cross section and a suitable elastomeric material exhibiting appropriate surface friction. Belt 30 is mounted about respective drive and idler pulleys 32, 33 defining an orientation plane which obliquely intersects the direct yarn travel path from the nip 14 of front drafting rollers 15 to yarn guide 20 so that the upper run 34 of belt 30 is disposed forward of the direct line of yarn travel and the lower run 35 is rearward of this line. With this arrangement, and by virtue of its circular cross-section, the belt surface is convexedly curved in the direction and plane of yarn travel.

The modified spinning section is threaded up so that the yarn is drawn around the front of upper belt run 34 and behind lower belt run 35, thus effecting two curved lines of contact with the belt. If the spindle and belt are now set in motion (by mechanical drives

not detailed), the surfaces of the respective belt runs engaged by the travelling yarn travel transversely, indeed at 90° to, the yarn and thereby rotate the yarn to insert false twist into the yarn towards nip 14. The twist inserted by the two belt runs is cumulative above the upper run 34. This increases the twist level in the yarn in the spinning zone 31 above belt 30 without having any substantial effect on the average twist level of the yarn wound onto the spindle. Furthermore, the line contact of each belt run with the yarn is effective to reduce transmission of tension into the spinning zone. The increased twist level and the reduced tension both contribute to a substantial reduction in the relative incidence of end breaks in the spinning zone 31 above the belt.

The reduction in tension is believed to be a reflection of Amontons' law and Capstan Theory, stating that slippage of a cable around a capstan or post will occur where the ratio of the tensions T_1/T_2 exceeds the exponential of $\mu\theta$, where μ is the coefficient of friction between the cable and capstan surface and θ is the subtended angle at the axis of the arc of contact. An alternative expression of Capstan Theory suggests that around a capstan (or free standing post) a relative small force can balance a much greater force at a very high angle of wrap.

Relating Amontons' law to the arrangement of the false twist belt modification, and with reference to Figure 3, the yarn tension is dependent on the angle of wrap as follows:

$$T_2/T_1 = e^{\mu\theta 1} \;\&\; T_3/T_2 = e^{\mu\theta 2}$$

Combining

$$T_3/T_1 = e^{\mu(\theta 1 + \theta 2)}$$

So as the angle of wrap ($\theta 1 + \theta 2$) increases, the value of T_3/T_1 also increases (i.e. the difference between T_1 and T_3 is greater). Therefore, the larger the angle of wrap, the greater is the tension reduction into the spinning zone. This prediction is borne out by observation.

The curved contact is sufficient to materially reduce the transmission of tension past the unit 25. By material reduction is meant at least 30%. In experiments to produce a 25 tex wool yarn with a draft of 14.5 at a spindle speed of 10,000 rpm, the yarn tension in a control test, without unit 25, was 20cN. With the unit 25 in position and adjusted to achieve angular deviations in the yarn path (and therefore angular wraps) of 2 x 33°, 56° + 47°, and 77° + 62° at the two belt runs, the measured yarn tension was respectively about 9cN, 10cN and 3cN. As evident from the formulae above, the tension reduction is also dependent on μ and therefore on yarn and belt materials.

It will be noted that twist belt unit 25 is sufficiently set back not to significantly interfere with doffing.

Although it is feasible, in accordance with the principles of the first aspect the invention, for a useful level of inserted twist and reduced tension to be achieved from contact with only one belt run, and although such contact would be simpler for threading up purposes than the illustrated arrangement, engagement with both runs is useful on three counts. The tension reduction at the two contacts is additive, and there is also an increase in the inserted false twist. The respective runs, because they are moving in opposite directions, substantially counterbalance sideways drag in the yarn and therefore any tendency to lateral movement of the travelling yarn. In a single contact configuration, some restraint on lateral yarn travel might be necessary, although this may also be required with a dual run contact during threading up. It will also be realised that more than two engagements using more than two belt runs could have advantages in certain cases.

A particular economic attraction of the illustrated arrangement is that a single continuous belt can be employed for multiple yarns on a spinning frame, in sharp contrast to most prior arrangements for inserting false twist or reducing tension, where individual devices were required for each spindle. Guide pulleys or other stabiliser devices may of course be required at intervals along long belt runs.

It will be appreciated that false twist belt unit 25 might incorporate a number of optional or advantageous features. For example, provision may be made to vary the speed of travel of belt 30 or to render its operation intermittent, eg on-off or forward-reverse, to obtain particular spinning effects. Intermittent operation of belt 30, eg by use of a stepper motor, to effect intermittent twist transfer would be useful in adding strand twist in two-fold yarns such as Sirospun (trade mark) yarn. In general, of course, the invention is applicable to any higher fold spinning, twisting or folding operation.

The angle of the plane of belt 30 to the direct line of travel between the front drafting rollers and the yarn guide may be adjustable to control the angle of contact of the belt with the yarn and therefore to control the transmission of tension in the yarn. Adjustment of tension can be used, for example, to compensate for tension changes during the cycle of building a yarn package from the spindle. The balance between tension reduction and twist level increase can also be controlled by varying the cross-sectional diameter or surface friction of belt 30. The spacing between the belt runs can be made adjustable, eg by means of adjustable idlers.

In particular embodiments, the false twist belt may be employed to effect yarn surface treatment, eg through the addition of wax, moisture, lubricant or tint.

Reversing the direction of the belt can be effective, if desired for particular purposes, to decrease both twist and tension in the upstream yarn.

Another option is to place the lower belt run vertically above the pigtail so as to maximise twist transmission upstream from the pigtail, provided it could be moved aside to allow doffing. This line of travel 8' for the yarn is depicted in broken lines in Figure 2.

A further effective modification is to orient the yarn path so as to be tangential to, or at least nearer to tangential to, the nip at the front drafting rollers, thereby allowing twist to propagate further up the yarn and reducing the incidence of breakage adjacent the nip. The modification of the path is facilitated by the unit 25 : it can be seen in Figure 1

that the yarn is lifted nearer to the tangential position. A position still nearer to tangential can be achieved by further adjusting the location and configuration of unit 25.

It will be understood that the invention has broad application to both short and long staple ring spinning of singles yarns in worsted spinning, or more generally to woollen or semi-worsted spinning, to two-folding in general and to short and long staple Sirospun (trade mark) processes in particular, and to simple ring twisting operations.

In general, it will be appreciated that the capacity provided by the invention to reduce the relative incidence of end breaks allows higher spindle speeds for a given yarn break rate, or allows yarns to be spun at lower twist at a given yarn break rate. Alternatively, yarn break rates can be reduced for a given yarn count and twist level. The invention permits lower quality fibrous material to be spun at a given yarn count, spindle speed and twist level, and allows yarns with fewer fibres in the cross section to be successfully spun into an acceptable yarn product.

It has been found that the illustrated embodiment, and perhaps the invention generally, in causing a change in the twist and tension levels at the yarn formation zone (ie at the front drafting rollers), results in a yarn where the twist distribution along the yarn is more uniform. This is of benefit in reducing streakiness in yarns and fabrics, and in reducing cockling or stitch distortion in knitted fabrics made from folded yarns.

It has also been observed that, as expected from prior reports, with the smaller spinning zone, there is reduced fibre shedding and a less hairy yarn.

It will also be understood that the term "comprises" or its grammatical variants as used herein is equivalent to the term "includes" and is not to be taken as excluding the presence of other elements or features.

Claims:

1. A method of twisting a travelling fibre assembly to form a twisted yarn, in which the strand is drawn from nip means and rotated to insert twist into the yarn, wherein, downstream of the nip, the twisted yarn is drawn past and in engagement with at least one run of travelling continuous belt means so that a surface or surfaces of the belt means rotates the yarn and inserts a false twist into the yarn towards the nip, wherein said surface(s) is convexedly curved in the direction of travel of the yarn, and the yarn engages said surface(s) over a total curved line contact which is sufficient to materially reduce the transmission of tension in the yarn past the surface(s) towards the nip.

2. A method according to claim 1 wherein the twisted yarn is drawn past and engages two runs of the belt means travelling in opposite directions, passing behind one of said runs and in front of the other run.

3. A method according to claim 1 or 2 wherein the fibre assembly is a strand and the method includes spinning the strand to form a twisted yarn taken up onto the spindle which rotates to insert twist into the yarn.

4. A method according to claim 1, 2 or 3 wherein the continuous belt means is of substantially circular cross-section.

5. A method according to any preceding claim wherein the fibre assembly is a staple fibre assembly, preferably of wool.

6. Apparatus for twisting a travelling fibre assembly to form a twisted yarn, including:

delivery means including an exit nip;

twisting means rotatable to draw the fibre assembly from the nip while inserting twist into the fibre assembly to form a twisted yarn; and

belt means which in use is a travelling continuous belt means, disposed to define a pair of runs at least one of which is engaged by the twisted yarn as it is

drawn past so that a surface or surface(s) of belt means rotates the yarn and inserts false twist into the yarn towards the nip;

wherein said surface(s) is convexedly curved in the direction of yarn travel and the belt means is arranged so that, in operation of the apparatus, the yarn engages said surface(s) over a total curved line contact which is sufficient to materially reduce the transmission of tension in the yarn past the surface(s) towards the nip.

7. Apparatus according to claim 6, wherein the belt means is arranged so that two runs thereof travelling in opposite directions intersect the yarn path, the yarn passing behind one of said runs and in front of the other run.

8. Apparatus according to claim 6 or 7 wherein the apparatus is spinning apparatus in which the delivery means includes drafting means and the twisting means is a spindle which takes up the yarn and is rotatable to insert twist into the yarn.

9. Apparatus according to claim 8, further including a yarn guide between the spindle and the nip, and a ring and traveller system to take up the yarn on the spindle.

10. Apparatus according to claim 9 wherein said continuous belt means is disposed between the yarn guide and the nip.

11. Apparatus according to any one of claims 6 to 9 wherein the continuous belt means is of substantially circular cross-section.

12. Apparatus according to any one of claims 6 to 11 wherein the continuous belt means is arranged so that the or each engaged run travels transversely with respect to the direction in which the yarn is being drawn by the spindle, for example at substantially 90° to that direction.

13. Apparatus according to any one of claims 6 to 12 in a spinning frame with multiple spindles, wherein said belt means is a single travelling belt disposed to engage a plurality of yarns.

14. Apparatus according to any one of claims 6 to 13 further including means to allow adjustment of the characteristics of travel of the belt means and/or its orientation and contact with the yarn(s).

15. A method of twisting a travelling fibre assembly to form a twisted yarn, in which the strand is drawn from nip means and rotated to insert twist into yarn, wherein, downstream of the nip, the twisted yarn is drawn past and in engagement with two oppositely moving runs of travelling continuous belt means so that a surface or surfaces of the belt means rotates the yarn and inserts a false twist into the yarn towards the nip, the sideways drag of the respective runs on the yarn being substantially counterbalanced.

16. A method according to claim 15 wherein the twisted yarn is drawn behind one of said runs and in front of the other.

17. A method according to claim 15 or 16 wherein the fibre assembly is a strand and the method includes spinning the strand to form a twisted yarn taken up onto a spindle which rotates to insert twist into the yarn.

18. A method according to claim 15, 16 or 17 wherein the continuous belt means is of substantially circular cross-section.

19. Apparatus for twisting a travelling fibre assembly to form a twisted yarn, including:

delivery means including an exit nip;

twisting means rotatable to draw the fibre assembly from the nip while inserting twist into the fibre assembly to form the twisted yarn; and

belt means which in use is a travelling continuous belt means, disposed to define a pair of runs both of which are engaged by the twisted yarn as it is drawn

past so that a surface or surfaces of the belt means rotates the yarn and inserts false twist into the yarn towards the nip, the sideways drag of respective runs on the yarn in operation being substantially counter-balanced.

20. Apparatus according to claim 19, arranged so that, in operation, the twisted yarn is drawn behind one of said runs and in front of the other.

21. Apparatus according to claim 19 or 20 wherein the apparatus is spinning apparatus in which the delivery means includes drafting means and the twisting means is a spindle which takes up the yarn and is rotatable to insert twist into the yarn.

22. Apparatus according to claim 21, further including a yarn guide between the spindle and the nip, and a ring and traveller system to take up the yarn on the spindle.

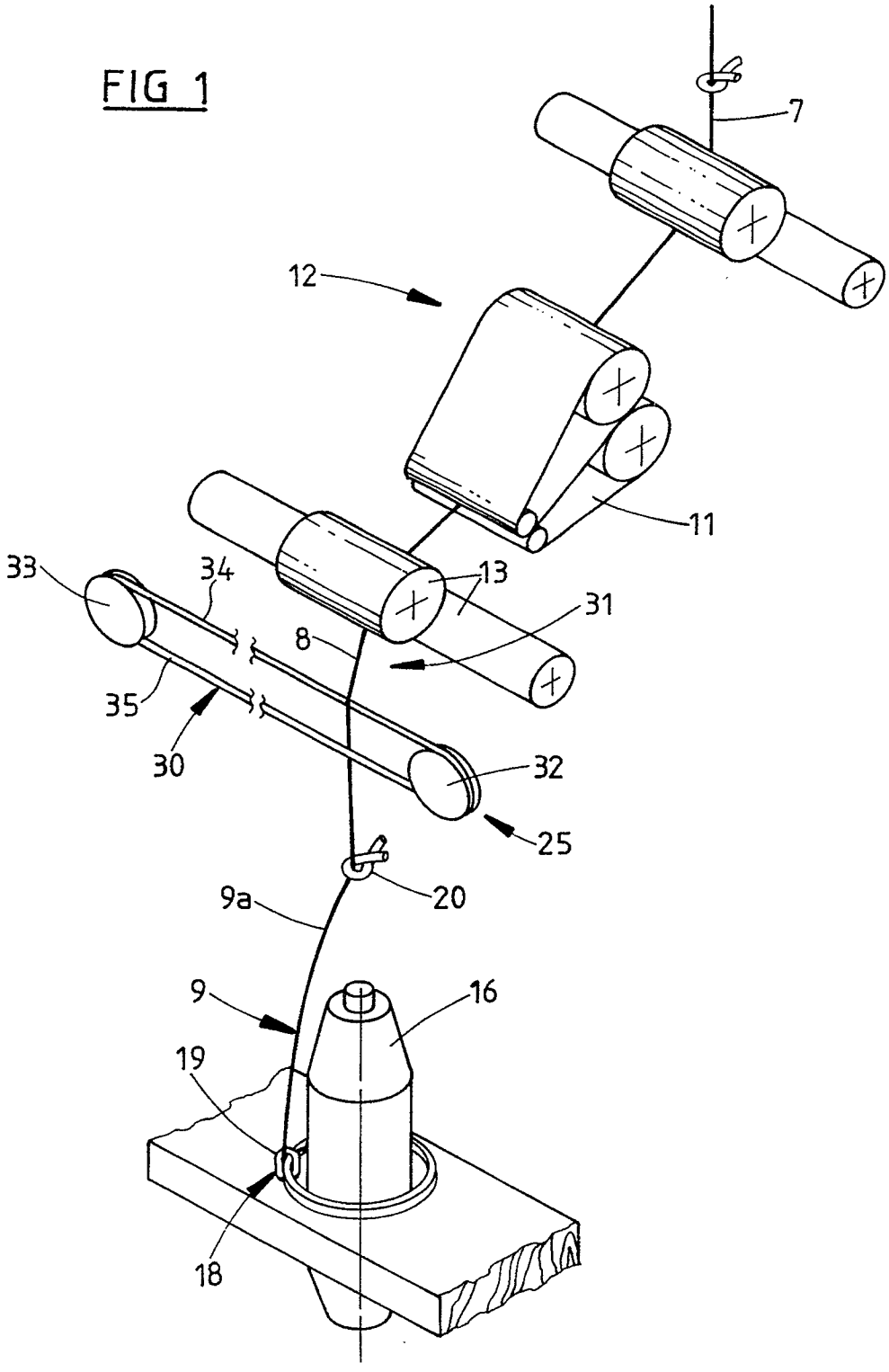
23. Apparatus according to claim 22 wherein said continuous belt means is disposed between the yarn guide and the nip.

24. Apparatus according to any one of claims 19 to 23 wherein the continuous belt means is arranged so that the or each engaged run travels transversely with respect to the direction in which the yarn is being drawn by the spindle, for example at substantially 90° to that direction.

25. Apparatus according to any one of claims 19 to 24 in a spinning frame with multiple spindles, wherein said belt means is a single travelling belt disposed to engage a plurality of yarns.

26. Apparatus according to any one of claims 19 to 25 further including to allow adjustment of the characteristics of travel of the belt means and/or its orientation and contact with the yarn(s).

FIG 1



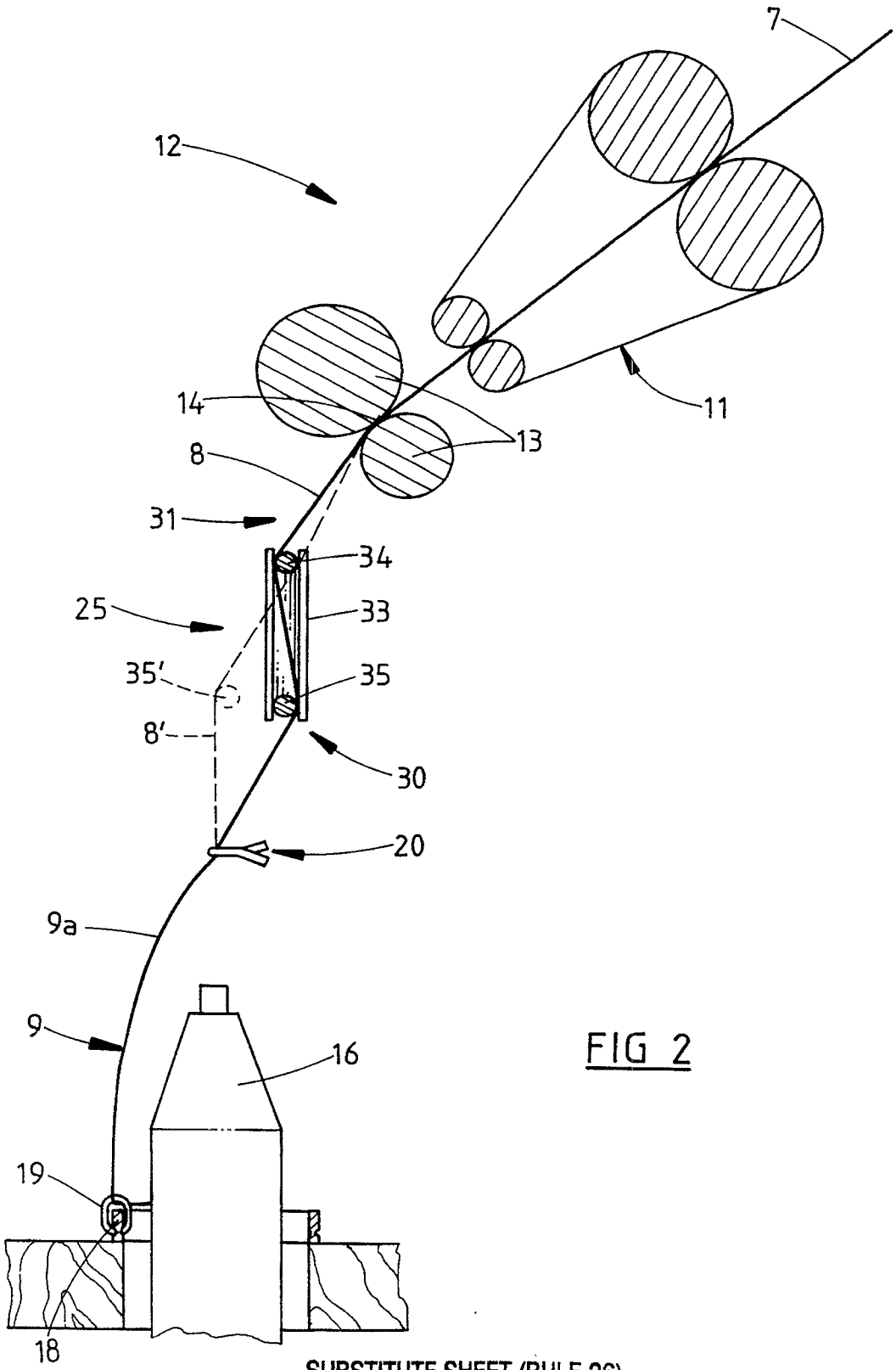


FIG 2

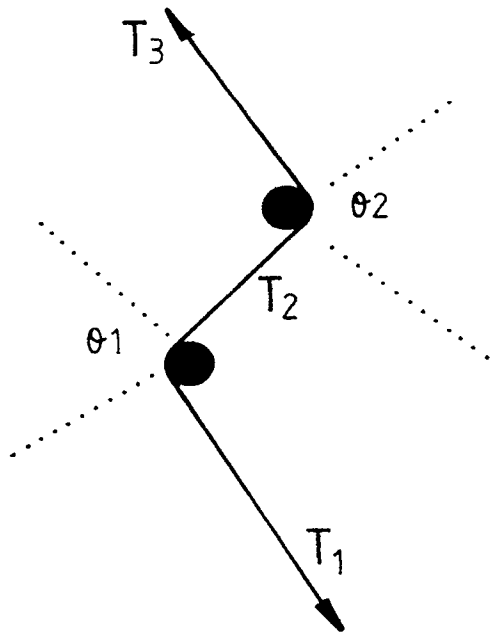
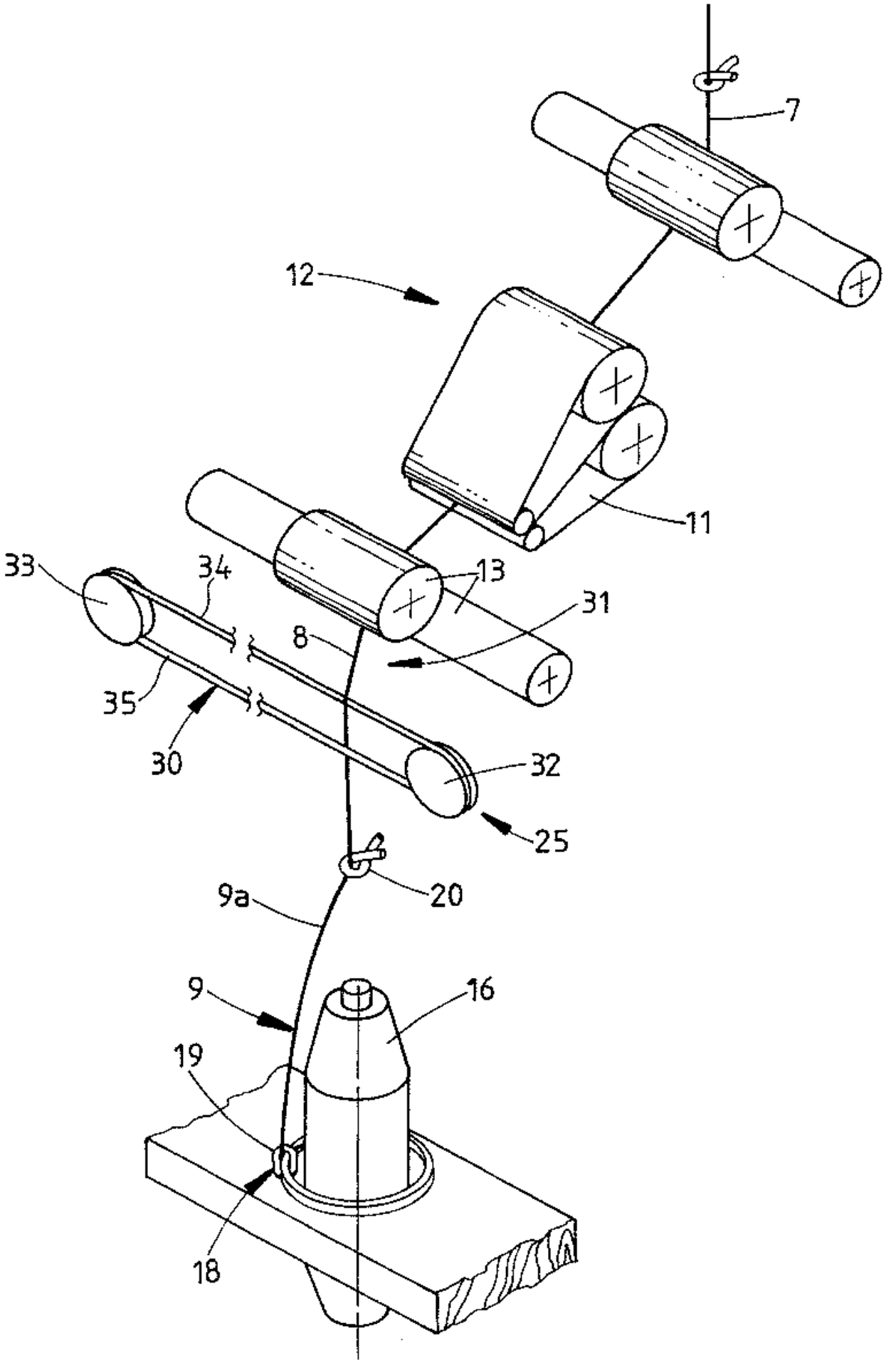


FIG 3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