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(54) **METHOD FOR FEEDING A PLURALITY OF YARNS TO A TEXTILE MACHINE BY WAY OF RESPECTIVE POSITIVE YARN FEEDERS**

(57) A method for feeding a plurality of yarns to a textile machine by respective yarn feeders (12), each one of which is provided with a motorized reel (14) on which a yarn (F) is wound repeatedly. A control unit (CU) modulates the speed of the reel (14) by way of a first control loop (CL1) on the basis of a reference position signal (PS_ref) generated by a second control loop (CL2) which

uses a position signal of the textile machine (MP) in order to maintain a given transmission ratio between the reel (14) and the textile machine (18). The transmission ratio is automatically corrected by a third control loop (CL3) on the basis of a measured tension signal (T_meas) generated by a tension sensor (28) which is associated with the yarn (F).

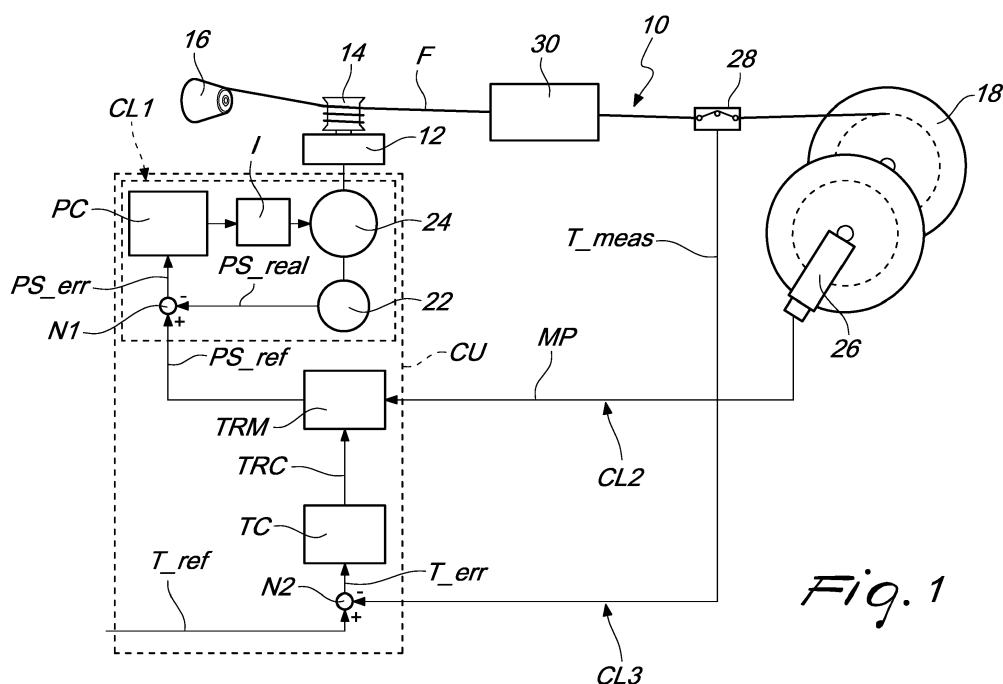


Fig. 1

Description

[0001] The present invention relates to a method for feeding a plurality of yarns to a textile machine by way of respective positive yarn feeders.

[0002] As is known, in a generic weaving process, multiple yarns can be fed to a textile machine by way of respective yarn feeders of the "positive" type.

[0003] This type of feeder is provided with a motorized reel, on which the yarn is repeatedly wound (e.g., 3 or 4 windings). When the reel is rotated, the yarn is unwound from a spool and is fed to a textile machine downstream, e.g., a knitting machine or a warping machine.

[0004] The yarn tension in output from the feeder is monitored continuously by a tension sensor which is connected to a control unit. This control unit modulates the speed of the reel on the basis of the signal received from the tension sensor, so as to maintain the tension of the yarn fed to the textile machine substantially constant at a desired level, to the advantage of the quality of the garment.

[0005] As is known, it would be preferable to measure the yarn tension in the immediate vicinity of the textile machine, downstream of any transmission pulleys and yarn guide rings which could alter the real value of the tension with which the yarn enters the textile machine.

[0006] However, as is known, if only this signal is used to control the rotation speed of the feeder then instabilities could arise, for example, during the phase of starting up the textile machine. In this phase, in fact, the tension of the yarn, which jumps suddenly when adjacent to the textile machine, can take some time to become distributed over the whole yarn, also taking account of the fact that the length of yarn between the feeder and the textile machine can be several tens of meters.

[0007] As a consequence, the feeder might start too early, or start rotating too rapidly, faster than required, thus leading to the above mentioned instabilities.

[0008] In the attempt to overcome such problem, EP 1901984 B1 proposes using two tension sensors for each yarn, one of which is arranged at the exit of the feeder while the other is arranged at the entry of the textile machine. The control unit, based on an adapted algorithm, controls the feeder by taking account of the tension values measured by both sensors, so as to limit the risk of instabilities arising.

[0009] A drawback of the system described in EP 1901984 B1 is its high cost, in that it envisages using two tension sensors for each yarn.

[0010] Especially in applications wherein the consumption of yarn is practically constant or varies very slowly, e.g., in the feeding yarns to warping machines, it would be desirable to have a solution that is less costly but which is still capable of compensating the slow variations in tension deriving from factors such as:

- the progressively increasing diameter of the winding drum on the warping machine,

- variations in tension on the distaff upstream of the feeder,
- variations in friction of the yarn guide loops owing to wear or to heating,

and other similar factors.

[0011] Therefore, the aim of the present invention is to provide a method for feeding a plurality of yarns to a textile machine by way of respective positive yarn feeders, which makes it possible to control the tension with precision, keeping it constant even in the event of variations in the operating conditions deriving from factors like the ones cited above, but using a single tension sensor which is positioned proximate to the textile machine, so as to reduce costs.

[0012] This aim and other objects, which will become clearer from the description that follows, are achieved by the method having the characteristics cited in the appended claim 1, while the appended dependent claims define other characteristics of the invention which are advantageous, although secondary.

[0013] Now the invention will be described in greater detail, with reference to a preferred but not exclusive embodiment thereof, which is illustrated for the purposes of non-limiting example in Figure 1, which is a schematic diagram of a feeding apparatus that uses the method according to the invention.

[0014] With reference to Figure 1, a yarn feeding apparatus 10 comprises a yarn feeder 12 of the "positive" type.

[0015] The feeder 12 is provided with a motorized reel 14, on which the yarn F is repeatedly wound (e.g., 3 or 4 windings). When the reel 14 is rotated, the yarn F is unwound from a spool 16 and is fed to a textile machine downstream, e.g., a warping machine (not shown in full) which is provided with a yarn winding drum 18.

[0016] In a manner that is known per se, a control unit CU modulates the speed of the reel 14 by way of a first control loop CL1 on the basis of a reference position signal PS_ref.

[0017] In detail, in the first control loop CL1, an encoder 22, which is connected to the motor 24 of the feeder 12, generates a real position signal PS_real. The real position signal PS_real is compared with the reference position signal PS_ref in a first subtracter node N1. The position error PS_err deriving from the comparison is sent to a position controller PC which, by way of an inverter I, drives the motor 24 in feedback.

[0018] The feeder 12 is programmed to actuate the reel 14 with the warping machine 18 according to a given transmission ratio (known as "operation according to an electrical axis").

[0019] To this end, the reference position signal PS_ref is generated by a second control loop CL2 which uses a position signal of the textile machine MP to maintain the aforementioned transmission ratio between the reel 14 and the warping machine 18.

[0020] In the embodiment described herein, the posi-

tion signal of the textile machine MP is generated by a synchronization device, e.g., an encoder 26, which is keyed on the yarn winding drum 18.

[0021] The position signal of the textile machine MP is sent to a module TRM, which generates the reference position signal PS_ref.

[0022] In the embodiment described herein, the module TRM is integrated in the control unit CU.

[0023] According to the invention, the transmission ratio is automatically corrected by a third control loop CL3 on the basis of a measured tension signal T_meas generated by a tension sensor 28 which is associated with the yarn F, so as to compensate the slow variations in tension deriving from factors such as:

- the progressively increasing diameter of the winding drum on the warping machine,
- variations in tension on the distaff upstream of the feeder,
- variations in friction of the yarn guide loops owing to wear or to heating,

and other similar factors.

[0024] The tension sensor 28 is advantageously arranged directly upstream of the warping machine 18, downstream of any transmission elements such as pulleys and yarn guide rings, which are schematically indicated by the rectangle 30 in Figure 1, which can alter the real value of the tension with which the yarn enters the warping machine.

[0025] In the third control loop CL3, a reference tension signal T_ref, which is configurable by the user, is compared with the measured tension signal T_meas in a second subtracter node N2, and the tension error T_err deriving from the comparison is sent to a tension controller TC. The tension controller TC generates as a consequence a signal for correcting the transmission ratio TRC and sends it to the module TRM, which is programmed to generate the reference position signal PS_ref on the basis of the transmission ratio that was set which, as mentioned, is progressively corrected automatically.

[0026] As it is evident to the skilled person, the third control loop CL3 can operate at a relatively low sampling frequency, e.g., a few Hz, so as to be insensitive to sudden variations in tension deriving from accidental factors.

[0027] As the skilled person will be able to appreciate, the method according to the invention fully achieves the set aim and objects in that, although it uses a single tension sensor which is positioned proximate to the textile machine, makes it possible to control the tension with precision, keeping it constant even in the event of any variations in the operating conditions deriving from factors like the ones cited previously.

[0028] A preferred embodiment of the invention has been described, but obviously the person skilled in the art may make various modifications and variations within the scope of protection of the claims.

[0029] For example, in place of the encoder a different

synchronization device can be used, e.g., a proximity sensor.

[0030] Furthermore, although in the embodiment described herein the transmission ratio is set in the control unit, it may also be set directly on the feeder.

[0031] The disclosures in Italian Patent Application No. 102019000011448 from which this application claims priority are incorporated herein by reference.

[0032] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A method for feeding a plurality of yarns to a textile machine by way of respective yarn feeders (12), each one of said yarn feeders (12) being provided with a motorized reel (14) on which a yarn (F) that is adapted to be fed to said textile machine (18) is wound repeatedly, wherein a control unit (CU) modulates the speed of said reel (14) by way of a first control loop (CL1) on the basis of a reference position signal (PS_ref) generated by a second control loop (CL2) which uses a position signal of the textile machine (MP) in order to maintain a given transmission ratio (TRC) between said reel (14) and said textile machine (18), **characterized in that** said transmission ratio (TRC) is corrected automatically by a third control loop (CL3) on the basis of a measured tension signal (T_meas) generated by a tension sensor (28) which is associated with said yarn (F).
2. The method according to claim 1, **characterized in that** said position signal of the textile machine (MP) is generated by a synchronization device (26) which is associated with said textile machine.
3. The method according to claim 2, **characterized in that** said synchronization device comprises an encoder (26).
4. The method according to claim 2, **characterized in that** said synchronization device comprises a proximity sensor.
5. The method according to claim 1, **characterized in that** said third control loop (CL3) comprises a tension controller (TC) which is adapted to generate a signal for correcting the transmission ratio (TRC) on the basis of a comparison between a reference tension signal (T_ref) that can be set by the user and said measured tension signal (T_meas), and to send it to a module (TRM) which is adapted to generate said

reference position signal (PS_ref) on the basis of said position signal of the textile machine (MP) and said signal for correcting the transmission ratio (TRC).

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6. The method according to claim 1, **characterized in that** said tension sensor (28) is located immediately upstream of said textile machine (18).

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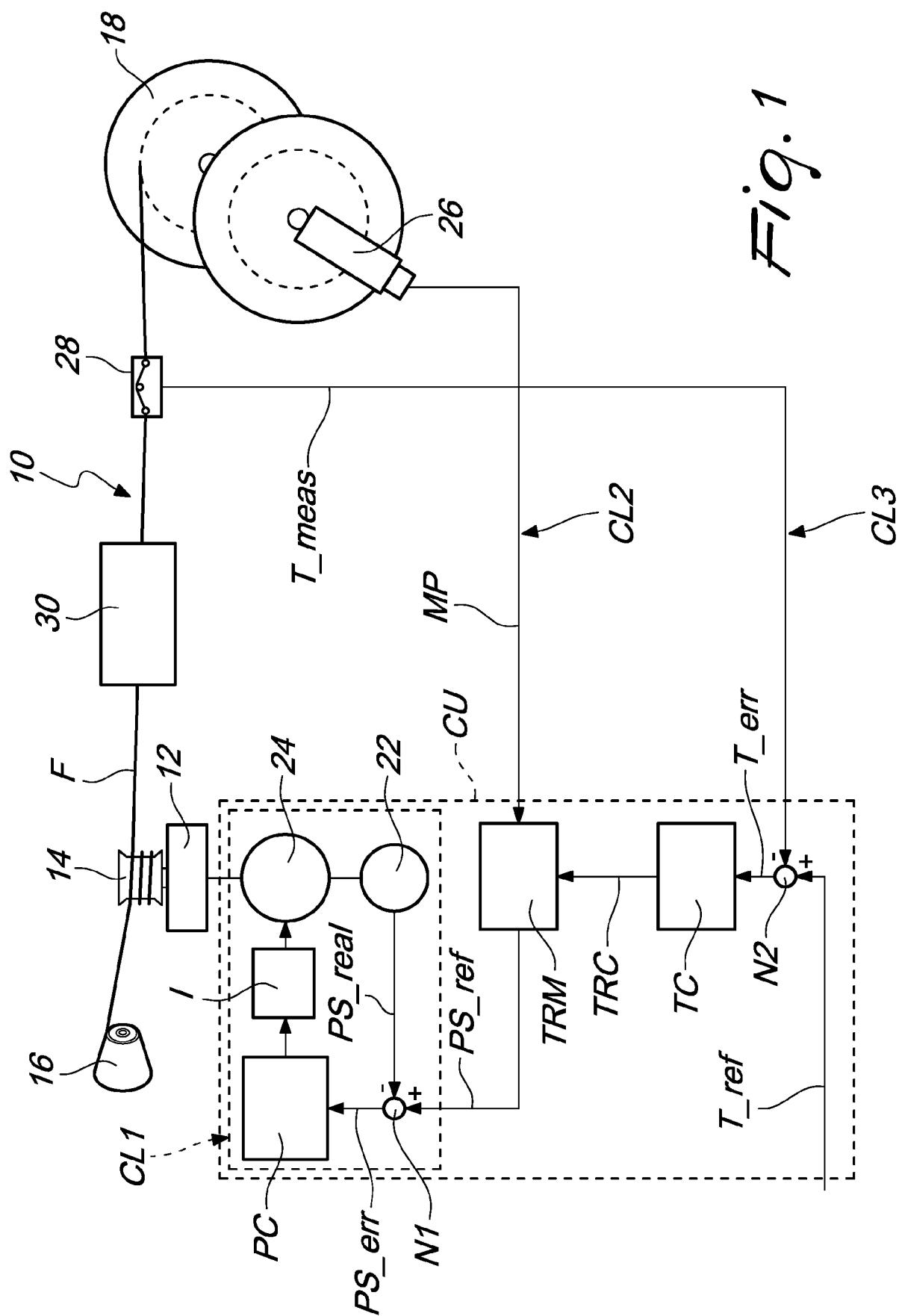
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EUROPEAN SEARCH REPORT

Application Number
EP 20 18 0924

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 754 742 A1 (LGL ELECTRONICS SPA [IT]) 16 July 2014 (2014-07-16) * abstract * * paragraph [0002] * * paragraph [0006] * * paragraph [0011] * * paragraph [0012] * * figure 1 *	1-6	INV. B65H51/30 B65H59/38 B65H51/20
A	US 6 328 081 B1 (GOTTI LUCA [IT] ET AL) 11 December 2001 (2001-12-11) * figure 1 *	1-6	
			TECHNICAL FIELDS SEARCHED (IPC)
			B65H
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 24 November 2020	Examiner Guisan, Thierry
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 18 0924

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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24-11-2020

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1901984 B1 [0008] [0009]
- IT 102019000011448 [0031]