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(54) **A YARN DELIVERY DEVICE AND A METHOD FOR DELIVERING YARN TO A TEXTILE MACHINE**

(57) A yarn delivery device for delivering yarn to a textile machine comprises at least two positive feeders (1) and a common control unit (2), wherein each positive feeder (1) comprises a yarn delivery wheel (21), a brushless d. c. motor for driving the wheel (21) and an individual control unit (23) with at least one microcontroller.

Each motor (22) comprises a sensor device (24) with Hall sensors for monitoring the position of the motor (22) in order to control coils of the motor (22), wherein the individual control unit (23) is designed to compare the monitored position of the motor (22) with a given position of the motor (22) corresponding to a movement of the textile machine and to adjust the currents for the coils of the motor (22) according to a difference between both.

For each feeder, the sensor device (24) comprises three analog Hall sensors, wherein the sensors are arranged with a displacement of 120° to each other, wherein the analog Hall sensors generate signals as sinusoidal waves (W1, W2, W3). The individual electronic control unit (23) is designed to determine the monitored position of the motor (22) by analyzing the three signals of sinusoidal waves (W1, W2, W3) with the help of their inverse trigonometric functions and, if so, by selecting the two of three signals without discontinuity for this determination.

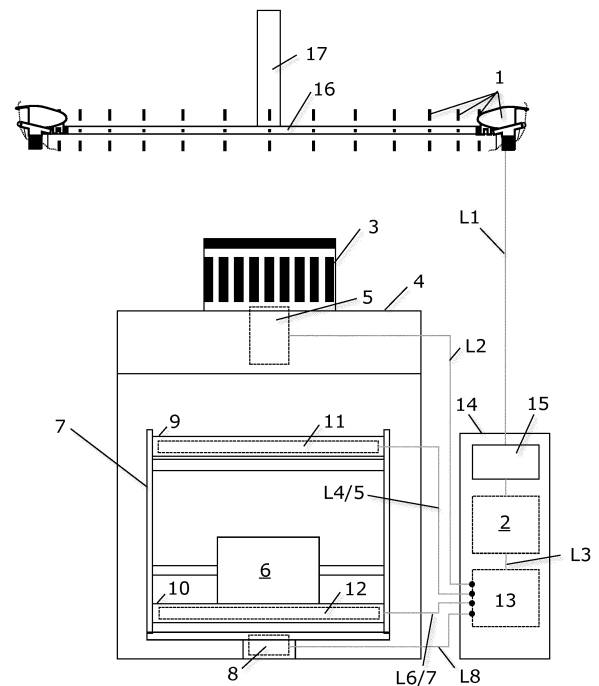


Fig. 1

Description

[0001] The invention concerns a yarn delivery device and a method for delivering yarn to a textile machine with at least two positive feeders and a common control unit according to the preamble of the independent claims. A subject of the invention is to synchronize the yarn delivering of the positive feeders with the speed of the textile machine using positive feeders with electric motors.

[0002] The US 2005/0146294 A1 describes an electronic device for delivering yarn to textile machines, able to regulate the delivery of yarn by varying the rotating speed of at least one motor, so as to maintain the speed as synchronized as possible, according to an adjustable scale factor, with respect to the rotation speed of the textile machine.

[0003] The device is associated with each yarn-winding wheel for delivering each single thread to the textile machine. It includes the motor and an electronic control board of the motor equipped with at least one microcontroller, which is able to control the rotating speed of the motor and the currents in the phases of the motor and which is able to maintain the rotating speed synchronous with the rotating speed of the cylinder of the textile machine. The motor is an d.c. brushless motor, which includes sensor devices for detecting the position of the rotor outside said motor. The electronic control board of the motor controls a driver, which switches the phases of the motor and the current to be delivered to the phases.

[0004] The electronic board is able to detect the input frequency coming from a first encoding device, which is engaged with the cylinder of the textile machine, in order to compare the input frequency with the output frequency deriving from a second encoding device fitted onto the shaft of the motor.

[0005] The second encoding device fitted onto the shaft of the motor does not allow to determine a very precise position of the motor.

[0006] A yarn delivery device for knitting machines is known from the US 2007/0272784 A1 which has a yarn delivery wheel, an electric motor for the yarn delivery wheel and an angle encoder for detecting the rotated position of the yarn delivery wheel.

[0007] In one embodiment among others, the angle encoder comprises a rotatable permanent magnet M and four Hall sensors arranged in the field of the permanent magnet M. It is denoted, that angle encoders of this type are installed in some brushless electric motors in order to control electronic switches used for triggering the motor coil. It is stated that this angle encoder can be used as the position sensor for the connected control loop but this is not specified.

[0008] The control loop comprises a regulating circuit, an actual value input to which the angle encoder is connected and a desired value input to which a preselection unit is connected.

[0009] In operation, several yarn delivery devices are controlled by a central control device. The central control

device sends control pulses to the preselection unit of each device, e. g. the central control device issues individual pulses wherein each single pulse of the rotation of the electric motor by one step corresponds to the angular resolution of angle encoder.

[0010] The angle encoder has an angular resolution which is at least so large that the ratio s/d between the angular resolution s and the diameter d of the yarn delivery wheel is greater than 3 mm^{-1} .

[0011] In case of a knitting machine with a several positive feeders, numerous yarn-winding wheel, i. e. numerous motors, must be synchronized. The position of the motor must be determined more precisely.

[0012] The subject of the invention is to improve the synchronization of the yarn delivering with the speed of the textile machine, especially to improve the resolution of the position determination of the motor position of the positive yarn delivering feeder for the synchronization.

[0013] A yarn delivery device for delivering yarn to a textile machine according to the invention comprises at least two positive feeders and a common control unit. Each feeder comprises a yarn delivery wheel, a brushless d.c. motor for driving the wheel and an individual control unit with at least one microcontroller. The motor comprises a sensor device with Hall sensors to monitor the position of the motor in order to control coils of the motor. The common control unit is designed to provide the individual control units with information about the movement of the textile machine.

[0014] Each individual control unit is designed to control the position of its motor in correspondence to the movement of the textile machine. It is designed to compare the monitored position of the motor with a given position of the motor corresponding to the movement of the textile machine and to adjust the currents for the coils of the motor according to a difference between both. The given position of the motor is determined with respect to the movement of the textile machine, e. g. the rotating speed of a needle cylinder, and an adjustable scale or ratio factor.

[0015] The sensor device of each feeder is provided with three analog Hall sensors for monitoring the position of the motor are used. The sensors are arranged with a displacement of 120° to each other in view of a motor axis. The three analog Hall sensors are designed to generate signals as sinusoidal waves.

[0016] The individual control unit is designed to determine the monitored position of the motor by analyzing the three signals of sinusoidal waves with the help of their inverse trigonometric functions. It is designed to determine the monitored position of the motor by selecting the two of three signals without discontinuity for this determination, when a discontinuity of the inverse trigonometric function of one of the sinusoidal waves occur.

[0017] As the three analog Hall sensors are arranged with a displacement of 120° to each other, the discontinuities of the inverse trigonometric function of the sinusoidal waves are also displaced. Thereby, at each rota-

tion angle, if so, at most one of the three inverse trigonometric functions shows a discontinuity.

[0018] As a result, it is possible to determine values of the motor position at each angle i.e. at each point of the sinusoidal waves. The resolution of the determination is only limited by the provided number of bits for the values of the motor position.

[0019] Such a very precise determination of the motor position of each feeder enables a uniform knitted fabric using positive feeders with electric motors.

[0020] In one embodiment, the individual control unit is designed to determine a position of the textile machine from the movement information and to determine the given position of the motor related to the determined position of the textile machine.

[0021] Movement information of the textile machine, namely of a circular knitting machine, are e.g. a speed signal with a pulse sequence from an encoder arranged at a motor of the knitting cylinder or at the knitting cylinder itself. In one embodiment, the individual control unit is designed to analyze the speed signal, i. e. the pulse sequence, in order to determine the speed or frequency of the knitting cylinder and to determine the position of the knitting cylinder. The individual control unit is designed to assign to the position of the knitting cylinder a given position of the motor, e. g. subject to a desired knitting pattern.

[0022] In one embodiment, the individual control unit is designed to control the motor using a field oriented control FOC method. The field oriented control FOC used for the motor rotation needs a precise indication of the motor position. Such a precise indication of the motor position is provided with the sensor device with the three analog Hall sensors, as described above.

[0023] In one embodiment, the individual control is designed to regulate the position of the motor by adjusting the currents for the coils of the motor with a pulse width modulation PWM.

[0024] Thus, the individual unit is designed to determine the monitored position by analyzing the sinusoidal waves and to use a field oriented control FOC method for controlling the motor rotation by adjusting the currents for the coils of the motor.

[0025] A method for delivering yarn to a textile machine according to the invention is suitable to use the yarn delivery device with the features and advantages described above.

[0026] A method for delivering yarn to a textile machine by a yarn delivery device which comprises at least two positive feeders and a common control unit, wherein each positive feeder has a yarn delivery wheel, a brushless d.c. motor for driving the wheel and an individual control unit with at least one microcontroller, comprises monitoring the position of the motor by a sensor device with Hall sensors in order to control coils of the motor, providing the individual control units with information about a movement of the textile machine by the common control unit, and controlling, in correspondence to the

movement of the textile machine, the position of the motor by the individual control unit.

[0027] The monitored position of the motor is compared with a given position of the motor corresponding to the movement of the textile machine by the individual control unit and, according to a difference between both, the currents of the coils of the motor are adjusted by the individual control unit.

[0028] The method further comprises, for each positive feeder, providing signals of three analog Hall sensors of the sensor device which are arranged with a displacement of 120° to each other in view of the motor axis, as sinusoidal waves, and determining the monitored position of the motor by the individual control unit by analyzing the three signals of sinusoidal waves with the help of their inverse trigonometric functions and, if so, by selecting the two of three signals without discontinuity for this determination.

[0029] In one embodiment, the method comprises determining a position of the textile machine from the movement information and the given position of the motor related to the determined position of the textile machine by the individual control unit.

[0030] In one embodiment, the method comprises controlling the coils of the motor by the individual electronic control unit using a field oriented control FOC method.

[0031] In one embodiment, the method comprises regulating the position of the motor by the individual electronic control unit by adjusting the currents of the coils of the motor using a pulse width modulation PWM.

[0032] In one embodiment, the method comprises, for calibration, recording the shapes of the three sinusoidal waves at a given rotation speed by the individual control unit and, for synchronization, determining the position of the motor during partial rotation of the motor. The size of the partial rotation depends on the number of magnetic pole pairs of the motor, wherein the size is one rotation divided by the number of magnetic pole pairs.

[0033] In one embodiment, the method comprises, providing a stop signal for the textile machine by the individual control unit when a difference between the monitored and the given position of the motor is greater than 1 mm.

[0034] In one embodiment, the method comprises, automatically decreasing the rotation of the motor of the feeder by its individual control unit by a given degree, when a yarn tension dropping is recognized. Thus, the yarn tension is increased as quick as possible. In one example, the rotation speed of the motor is decreased by a given modification of the adjustable scale or ratio factor with respect to the speed of the needle cylinder. The yarn tension dropping is recognized e.g. by an output sensor of the feeder. Yarn tension dropping is e. g. recognized when the speed of textile machine is reduced or when the textile machine comes to a stop.

[0035] The invention is further explained using one embodiment of the yarn delivery device arranged at a circular knitting machine, which is schematically shown in the

figures. It shows:

Figure 1 a schematic view of the yarn delivery device arranged at a circular knitting machine;

Figure 2 a schematic view of a positive feeder of the yarn delivery device;

Figure 3 the sinusoidal waves W1, W2 and W3 as a function of the rotation angle θ ;

Figure 4 a flow diagram of a calibration procedure; and

Figure 5 a flow diagram of a synchronisation procedure.

[0036] Figure 1 schematically shows a yarn delivery device for delivering a yarn Y to a textile machine with several positive feeders 1 and a common control unit 2. The yarn Y which is delivered by one positive feeder 1 is only shown in figure 2.

[0037] In this embodiment, the yarn delivery device is arranged at the textile machine, namely at a circular knitting machine. The circular knitting machine comprises a knitting cylinder 3, a housing 4, and within the housing 4, an electrical motor 5 of the knitting cylinder 3 and a take-off device for taking-off the knitted fabric 6. The take-off device has a frame 7 with an electric motor 8 and two sets of rollers 9, 10 with their electric motors 11, 12. The circular knitting machine comprises a machine control unit 13 which is arranged in a second housing 14. The housing is provided with a display 15.

[0038] The positive feeders 1 of the yarn delivering device are fixed to a machine ring 16 which is supported by a hanging device 17. Only two of the positive feeders 1 are schematically shown, the other positive feeders are indicated in figure 1 by short lines.

[0039] The common control unit 2 of the yarn delivering device is placed into the second housing 14. The common control unit 2 is connected to each positive feeder 1 by a communication line L1. The machine control unit 13 is connected to the motor 5 by a second communication line L2, to the common control unit 2 by a third communication line L3, to the two motors 11 of the rollers 9 by communication lines L4, L5 and to the two motors 12 of the rollers 10 by communication lines L6, L7.

[0040] One positive feeder 1 is schematically shown in figure 2. Each positive feeder 1 comprises a feeder housing 20, yarn delivery wheel 21, a brushless d.c. motor 22 for driving the wheel 21 and an individual control unit 23. The motor 22 and the individual control unit 23 are arranged inside the feeder housing 20 shown by dashed lines. A shaft A of the motor 22 on which the driving wheel 21 is fixed is also shown by dashed lines.

[0041] The positive feeder 1 is provided with a fastening device 24 to fasten the feeder 1 to the machine ring 16. It is also provided with an eyelet 25 for the yarn Y, a braking device 26, an input sensor 26 and an output sensor 27.

[0042] The motor 22 has a sensor device 24 with three analog hall sensors to monitor the position of the motor

22 in order to control coils of the motor. The sensors are arranged with a displacement of 120° to each other in view of a axis of the motor shaft A, i.e. the motor axis.

[0043] The three analog hall sensors of the sensor device 24 are designed to generate signals as sinusoidal waves W1, W2 and W3. Figure 3 shows the sinusoidal waves W1, W2 and W3 as a function of the rotation angle θ . One sinus curve of e. g. the sinusoidal waves W1 corresponds to a period p of one pole pair of the motor 22.

[0044] The motor 22 has at least five magnetic pole pairs. In this embodiment, the motor 22 has seven pole pairs of rotor permanent magnets and stator coils.

[0045] The individual control unit 23 is designed as an electronic control unit with at least one microcontroller.

The individual control unit 23 is designed to precisely determine the monitored position of the motor 22 by analyzing the three signals of sinusoidal waves W1, W2, W3 with the help of their inverse trigonometric functions. It is designed to select the two of three signals without discontinuity for this determination.

[0046] The individual control unit 23 is designed to determine values of the motor position at each angle θ , i. e. at each point of the sinusoidal waves W1, W2 and W3.

[0047] The resolution of the monitored motor position is only limited by the provided number of bits for the values of the motor position. In this embodiment, the values of the motor position for each pole pair is monitored by a 16-bit variable. The resolution of the motor position is $5,5^\circ \cdot 10^{-3}$ per pole pair p. In this case of seven pole pairs, the resolution is $7,85^\circ \cdot 10^{-4}$.

[0048] The individual control unit 23 is designed to control the motor 22 using a field oriented control FOC method and to regulate the position of the motor by adjusting the currents for the three coils of the motor 22 with a pulse width modulation PWM.

[0049] The individual control unit 23 is designed to determine a position of the textile machine from the movement information and to determine the given position of the motor 22 related to the determined position of the textile machine. Movement information of the textile machine, namely of a circular knitting machine, is e.g. a speed signal with a pulse sequence from encoder (not shown in figure 1) arranged at the motor 5 of the knitting cylinder 3.

[0050] In one alternative, the encoder is connected to the individual control unit via the communication line L2, the machine control unit 13 and the communication line L3. In another alternative, the encoder is connected to the individual control unit 23 via a separate a communication line (not shown in figure 1).

[0051] The individual control unit 23 is designed to analyze the speed signal, i. e. the pulse sequence, in order to determine the speed or frequency of the knitting cylinder and with that the position of the knitting cylinder. The individual control unit 23 is designed to assign to the position of the knitting cylinder a given position of the motor, subject to a desired knitting pattern.

[0052] The individual control unit 23 is designed to

compare the monitored position of the motor with the given position of the motor 22 corresponding to the movement of the textile machine and to adjust currents for the coils of the motor according to a difference between both.

[0053] Thus, the individual unit 23 is designed to precisely determine the monitored position by analyzing the sinusoidal waves W1, W2, W3 and to control the motor rotation by using a field oriented control FOC method and by adjusting the currents for the coils of the motor 22 with the pulse width method PWM.

[0054] In operation the yarn is delivered to the textile machine by the a. m. yarn delivery device with at least two positive feeders 1 and a common control unit 2, wherein each positive feeder 1 comprises a yarn delivery wheel 21, a brushless d.c. motor 22 for driving the wheel 21 and an individual control unit 23 with at least one microcontroller, by

- for each feeder 1, monitoring the position of the motor 22 by the sensor device 24 with three Hall sensors of the motor 22 in order to control coils of the motor 22, wherein the signals of the three analog Hall sensors which are arranged with a displacement of 120° to each other are provided as sinusoidal waves W1, W2, W3,
- determining the monitored position of the motor 22 by the individual control unit 23 by analyzing the three signals of sinusoidal waves W1, W2, W3 with the help of their inverse trigonometric functions and, if so, by selecting the two of three signals without discontinuity for this determination,
- providing the individual control units 23 with information about a movement of the textile machine by the common control unit 2,
- controlling the position of the motor 22 by the individual control unit 23, by comparing the monitored position of the motor 22 by the sensor device 24 with a given position of the motor 22 corresponding to the movement of the textile machine and, according to a difference between both, by adjusting the currents of the coils of the motor 22 by the individual control unit 23.

[0055] In order to determine the monitored position of the motor 22, the analysis of each of the three signals of sinusoidal waves W1, W2, W3 results in three monitored rotation angles Θ_i phase-shifted of 120°. Therefore, the inverse trigonometric functions of the monitored sinusoidal waves W1, W2, W3 are calculated and stored in a data reducing form, from which the rotation angles Θ_i are reconstructed. Discontinuities could arise using the reduced data. If a discontinuity arises, the data of the two of three signals without discontinuity are selected for this determination.

[0056] A position of the textile machine from the move-

ment information and the given position of the motor 22 related to the determined position of the textile machine are determined by the individual control unit 23.

[0057] The coils of the motor 22 are controlled by the individual electronic control unit 23 using a field oriented control FOC method.

[0058] The position of the motor 22 is regulated by the individual electronic control unit 23 by adjusting the currents of the coils of the motor 22 using a pulse width modulation PWM.

[0059] Figure 4 shows a block diagram of a calibration procedure which is executed by the each individual control unit 23 for its motor 22.

[0060] The calibration procedure is executed once after a first start which is initialized as Start1 command.

[0061] In a first step, it is checked, if calibration data CD of the motor 22 are recorded. If yes, a synchronization procedure is initialized by a Start2 command.

[0062] If no, in a second step, the rotation of the motor 22 is controlled in order to rotate with a rotation speed of e. g. 200 rotations per minute, i. e. 200 rpm.

[0063] In a third step, the sinusoidal waves W1, W2, W3 are analyzed. It is checked, if a certain start value, e. g. an minimum value $W2_{\min}$ of the sinusoidal wave W2, is reached. If no, the analysis is proceeded.

[0064] If yes, in a fourth step, the calibration data CD of one full rotation of the motor 22, i. e. the values of the sinusoidal waves W1, W2 and W3 of all periods p of the pole pairs, are recorded once.

[0065] In a sixth step, the calibration data CD are stored in a non-volatile memory of the individual control unit 23.

[0066] After storing the calibration data CD the calibration procedure is ended by an End command.

[0067] Thus, for calibration, the shapes of the three sinusoidal waves W1, W2, W3 of one full rotation of the motor 22 are recorded at a given rotation speed as values of the sinusoidal waves W1, W2, and W3 depending on the rotation angle θ , named calibration data CD, by the individual control unit 23.

[0068] The calibration data CD are used to overcome deviation of the measured sinusoidal waves W1, W2, W3 from normal conditions, e. g. due to mechanical tolerances during motor assembling process, inequalities in rotor magnets and deviation of the arrangement of the three Hall sensors from their 120° displacement.

[0069] Figure 5 shows a block diagram of the synchronization procedure which is executed by the each individual control unit 23 for its motor 22.

[0070] The synchronization procedure is initialized as Start2 command at each activation of the yarn delivering with the Start1 command, if calibration data CD of the motor 22 are recorded.

[0071] In a first step, the values of the sinusoidal waves W1, W2 and W3 are reset.

[0072] In a second step, values $W_i(p)$ of the sinusoidal waves W1, W2 and W3 are recorded and checked if one full period p corresponding to one pole pair is recorded. If no, the recording is continued.

[0073] If yes, in a third step, the recorded values $W_i(p)$ are analyzed and compared with the calibration data CD in order to determine the period P of the calibration data CD(P) to which the recorded values $W_i(p)$ match best.

[0074] In a fourth step, the position of the motor 22 is determined with the help of the calibration data CD(P). The recorded values $W_i(P)$ are assigned to the position of the motor 22, i. e. its angle Θ for the following operation.

[0075] After the position of the motor 22 is determined, the synchronization procedure is ended by an End command.

[0076] Thus, for synchronization, the position of the motor 22 is determined with the help of the calibration data CD during a partial rotation of the motor 22, i. e. one full period p corresponding to one pole pair.

[0077] The third step of figure 5 is further described in **Figure 6**.

[0078] The recorded values $W_i(p)$ are analyzed e. g. by determining characteristic terms, such as peak-to-peak terms ΔA_p . The characteristic term are compared with corresponding terms, such as peak-to-peak terms $\Delta A_0, \Delta A_1, \dots$, of the calibration data CD of the periods P0, P1, ... of the pole pairs in order to determine the period P with the calibration data CD(P) to which the recorded values $W_i(p)$, especially their peak-to-peak terms ΔA_p , match best. In this case, the period P with the calibration data CD(P) with the lowest differences of the peak-to-peak terms $\Delta A_{\min}$ of the recorded values $W_i(p)$ and of the calibration data CD is determined.

[0079] A stop signal for the textile machine is provided by the individual control unit 23 when a difference between monitored and given position of the motor 22 at any position is greater than a threshold value of the difference, e. g. than 1 mm.

[0080] When a yarn tension dropping is recognized by the output sensor 28, the rotation of the motor 22 is automatically decreased in a given degree by its individual control unit 23.

List of reference signs

[0081]

- 1 positive feeder
- 2 common control unit
- 3 knitting cylinder
- 4 housing
- 5 electric motor
- 6 knitted fabric
- 7 frame
- 8 electric motor
- 9 roller
- 10 roller
- 11 electric motor
- 12 electric motor
- 13 machine control unit
- 14 second housing
- 15 display

- 16 machine ring
- 17 hanging device
- 20 feeder housing
- 5 21 yarn delivering wheel
- 22 motor
- 23 individual electronic control unit
- 24 fastening device
- 25 eyelet
- 10 26 braking device
- 27 input sensor
- 28 output sensor
- L1 communication line
- 15 L2 communication line
- L3 communication line
- L4/5 communication lines
- L6/7 communication lines
- Y yarn
- 20 A motor shaft

Claims

- 25 1. A yarn delivery device for delivering yarn to a textile machine
with at least two positive feeders (1) and a common control unit (2),
wherein each positive feeder (1) comprises a yarn delivery wheel (21), a brushless d.c. motor (22) for driving the wheel (21) and an individual control unit (23) with at least one microcontroller,
wherein the motor (22) comprises a sensor device (24) with Hall sensors for monitoring the position of the motor (22) in order to control coils of the motor (22), ,
wherein the common control unit (2) is designed to provide the individual control units (23) with information about the movement of the textile machine, and
wherein the individual control unit (23) is designed to control the position of its motor (22) in correspondence to the movement of the textile machine,
wherein the individual control unit (23) is designed to compare the monitored position of the motor (22) with a given position of the motor (22) corresponding to the movement of the textile machine and to adjust the currents for the coils of the motor (22) according to a difference between both,
characterized in that
50 for each feeder, the sensor device (24) comprises three analog Hall sensors, which are arranged with a displacement of 120° to each other in view of an axis of a motor shaft (A), wherein the analog sensors are designed to generate signals as sinusoidal waves (W1, W2, W3), and
55 wherein the individual electronic control unit (23) is designed to determine the monitored position of the motor (22) by analyzing the three signals of sinusoi-

dal waves (W1, W2, W3) with the help of their inverse trigonometric functions and, if so, by selecting the two of three signals without discontinuity for this determination.

2. A yarn delivery device according to claim 1, **characterized in that** the individual control unit (23) is designed to determine a position of the textile machine from the movement information and to determine the given position of the motor (22) related to the determined position of the textile machine.
3. A yarn delivery device according to claim 1 or 2, **characterized in that** the individual electronic control unit (23) is designed to control the coils of the motor (22) using a field oriented control FOC method.
4. A yarn delivery device according to one of the claims 1 to 3, **characterized in that** the individual electronic control unit (23) is designed to regulate the position of the motor (22) by adjusting the currents of the coils of the motor (22) using a pulse width modulation PWM.
5. A method for delivering yarn to a textile machine by a yarn delivery device which comprises at least two positive feeders (1) and a common control unit (2), wherein each positive feeder (1) comprises a yarn delivery wheel (21), a brushless d.c. motor (22) for driving the wheel (21) and an individual control unit (23) with at least one microcontroller, wherein the position of the motor (22) is monitored by a sensor device (24) with Hall sensors in order to control coils of the motor (22), wherein the individual control units (23) are provided with information about a movement of the textile machine by the common control unit (2), wherein, in correspondence to the movement of the textile machine, the position of the motor (22) is controlled by the individual control unit (23), wherein the position of the motor (22) which is monitored by the sensor device (24) is compared with a given position of the motor (22) corresponding to the movement of the textile machine by the individual control unit (23) and, according to a difference between both, the currents of the coils of the motor (22) are adjusted by the individual control unit (23), **characterized in that** for each positive feeder (1), the sensor device (24) comprises three analog Hall sensors which are arranged with a displacement of 120° to each other in view of an axis of a motor shaft (A), wherein the signals of the three analog Hall sensors are provided as sinusoidal waves (W1, W2, W3), and wherein the monitored position of the motor (22) is determined by the individual control unit (23) by analyzing the three signals of sinusoidal waves (W1,

W2, W3) with the help of their inverse trigonometric functions and, if so, by selecting the two of three signals without discontinuity for this determination.

- 5 6. A method for delivering yarn according to claim 5, **characterized in that** a position of the textile machine from the movement information and the given position of the motor (22) related to the determined position of the textile machine are determined by the individual control unit (23).
- 10 7. A method for delivering yarn according to claim 5 or 6, **characterized in that** the coils of the motor (22) are controlled by the individual electronic control unit (23) using a field oriented control FOC method.
- 15 8. A method for delivering yarn according to one of the claims 5 to 7, **characterized in that** the position of the motor (22) is regulated by the individual electronic control unit (23) by adjusting the currents of the coils of the motor (22) using a pulse width modulation PWM.
- 20 9. A method for delivering yarn according to one of the claims 5 to 8, **characterized in that** for calibration, the shapes of the three sinusoidal waves are recorded at a given rotation speed during one full rotation of the motor (22) as calibration data (CD) by the individual control unit (23) and, for synchronization, the position of the motor (22) is determined during a partial rotation of the motor (22) with the help of the calibration data (CD).
- 25 10. A method for delivering yarn according to one of the claims 5 to 9, **characterized in that** the rotation of the motor (22) of the feeder (1) is automatically decreased by a given degree by its individual control unit (23) when a yarn tension dropping is recognized.
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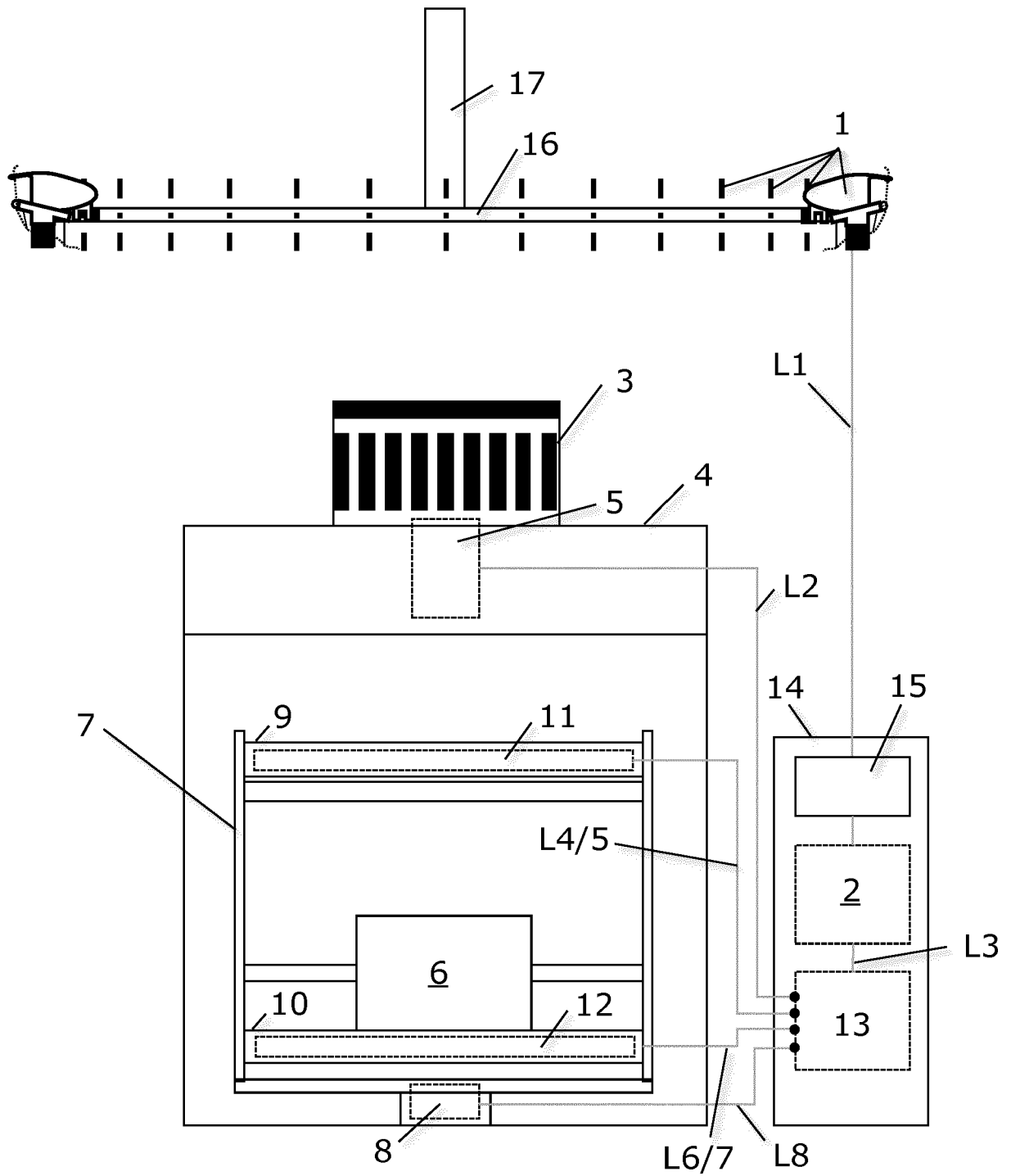


Fig. 1

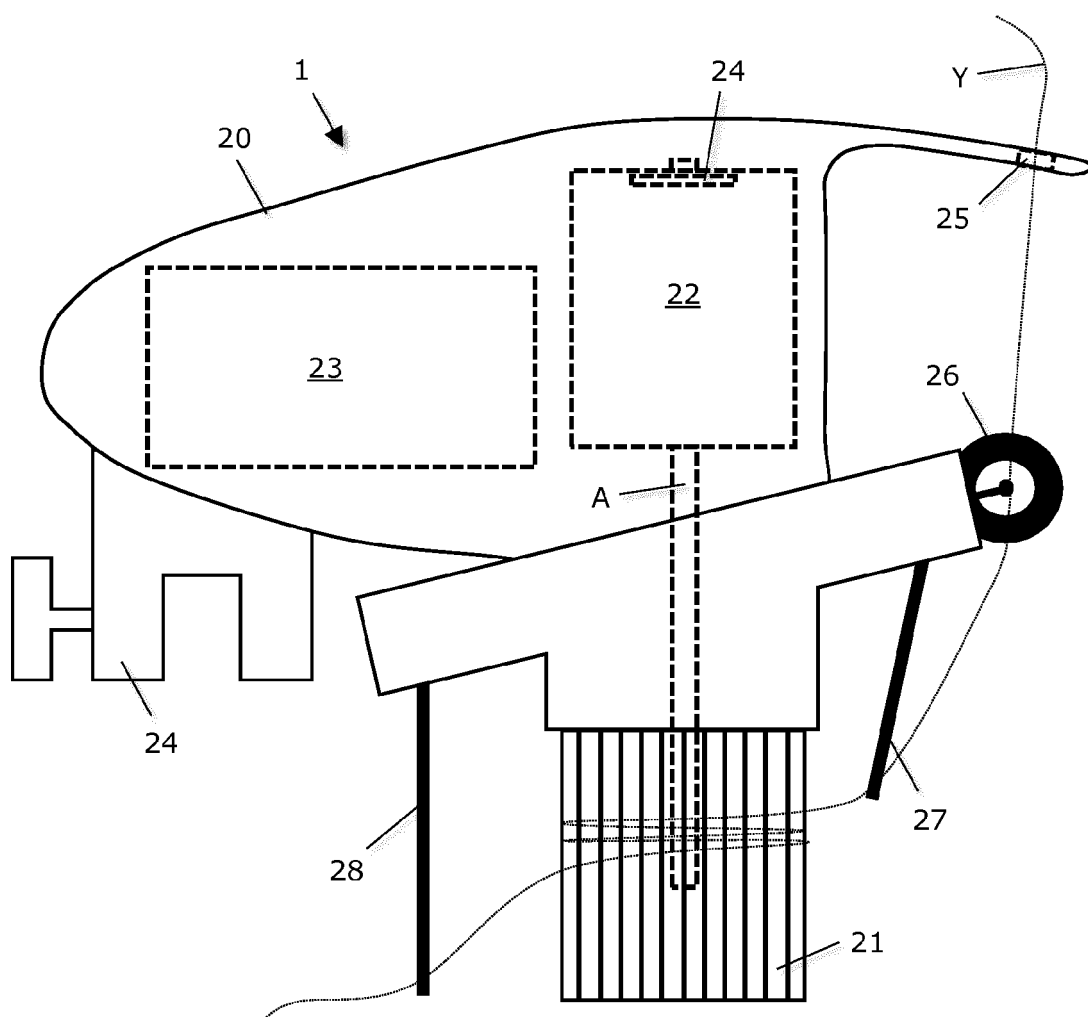


Fig. 2

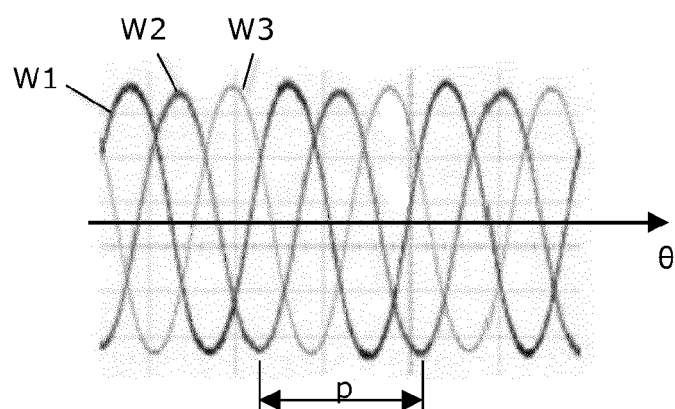


Fig. 3

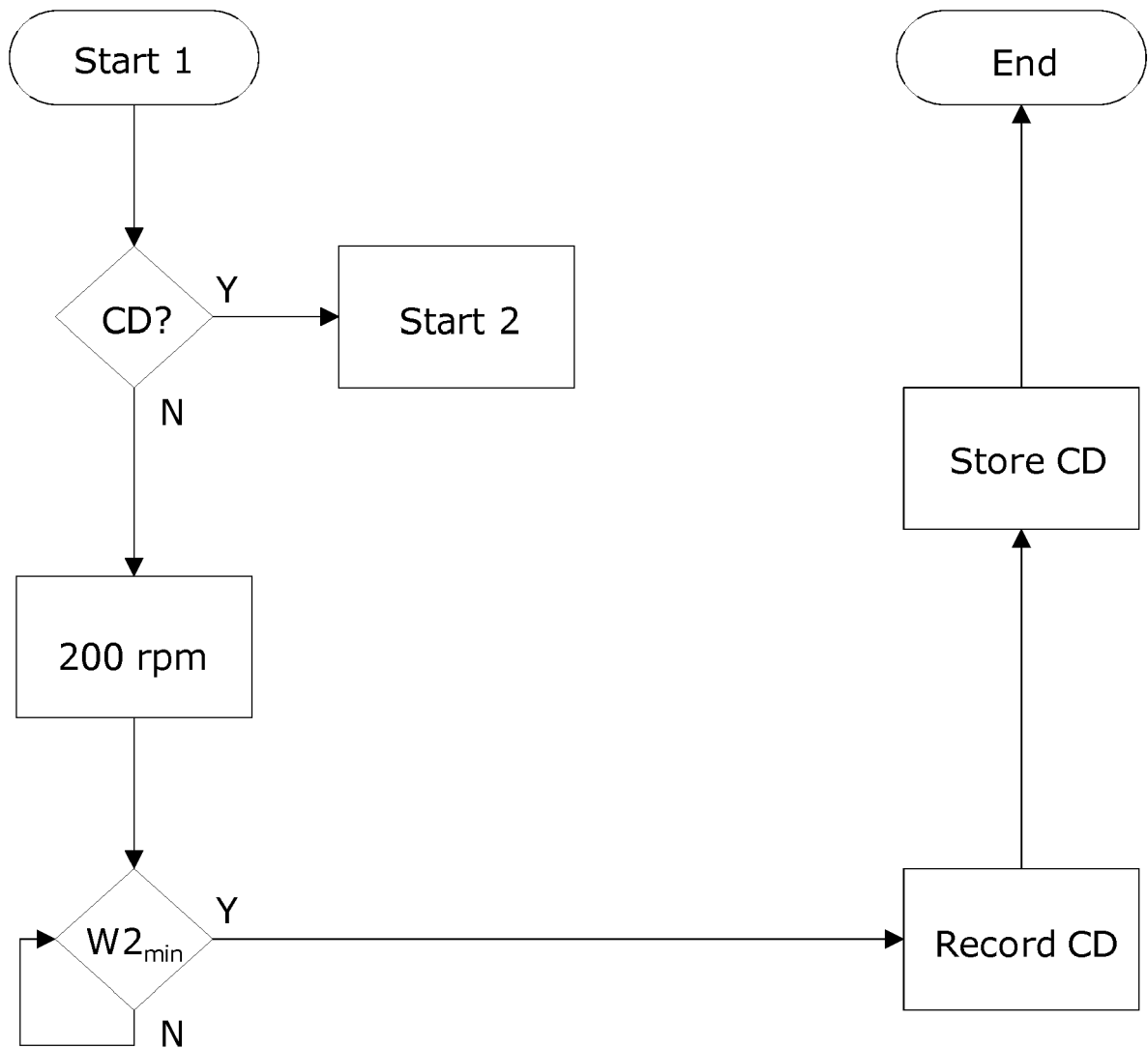


Fig. 4

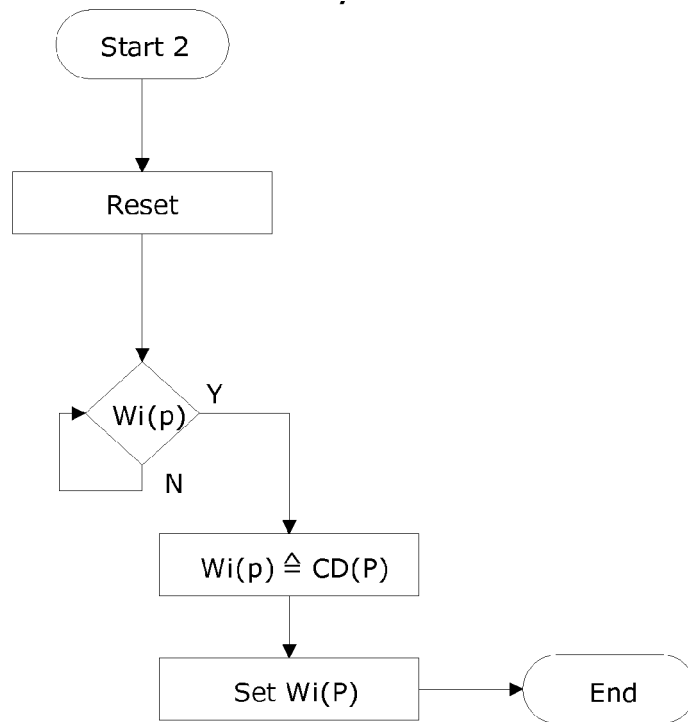


Fig. 5

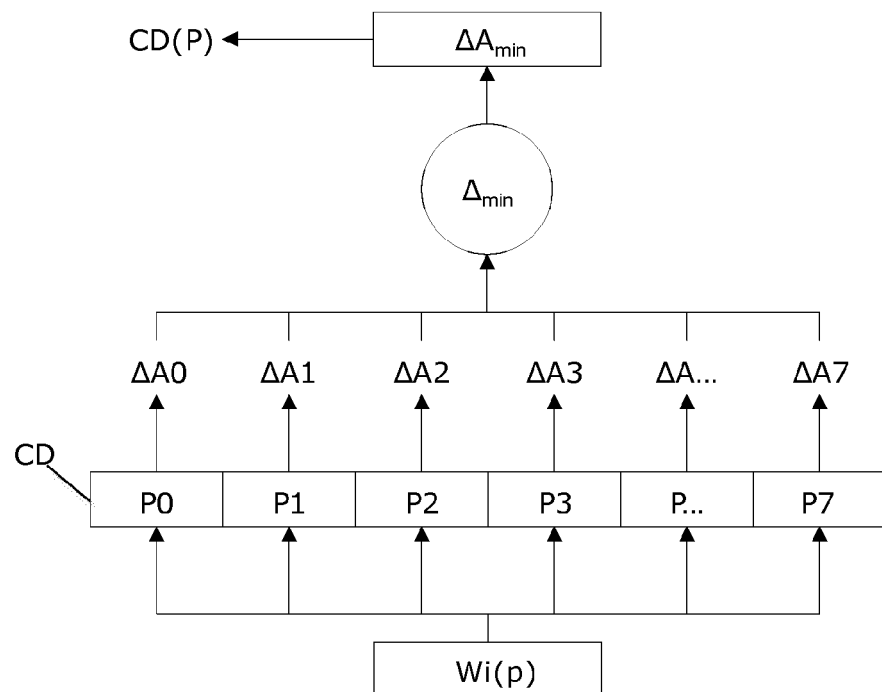


Fig. 6



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