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(54) **Yarn feeder provided with a weft-winding drum and with a feedback-controlled, weft-braking device**

Garnzuführvorrichtung mit Schussfaden-Wickeltrommel und feedbackgesteuerter Schussfaden-Bremsvorrichtung

Dispositif d'alimentation en fil pourvu d'un tambour à canetage et avec dispositif double face commandé par rétroaction

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Description

[0001] The present invention relates to a yarn feeder provided with a weft-winding drum and with a feedback-controlled, weft-braking device.

[0002] As known, a generic yarn feeder may comprise a drum having a yarn wound thereon, which is adapted to be unwound upon request of a generic textile machine, such as a knitting machine or a loom. Before entering the textile machine, the yarn unwinding from the drum passes through a weft-braking device which controls the yarn tension.

[0003] In EP 0 707 102, the weft-braking device comprises a frustoconical, hollow member which is elastically biased against the delivery end of the drum by a spider assembly of springs, which have their inner ends anchored to the small end of the frustoconical member and their outer ends anchored to an annular support which is axially movable upon control of a screw mechanism driven by a motor. The yarn unwinding from the feeder is pressed between the drum and the frustoconical, hollow member, thereby receiving a braking action by friction. The motor which drives the screw mechanism is controlled by a feedback loop which modulates the braking action applied by the weft-braking device to the yarn on the basis of a signal received from a tension sensor arranged downstream of the weft-braking device, in order to maintain the tension of the yarn unwinding from the drum substantially constant on a predetermined level.

[0004] A drawback of known feedback-controlled, weft-braking devices, such as the the one disclosed in EP 0 707 102, is that they can only generate relatively weak braking forces, e.g., about 20 cN in knitting processes. However, as well known to the person skilled in the art, higher yarn-feeding tensions (up to 100-200 cN) are required for certain applications, such as for the insertion of "lay-in yarn" in circular knitting machines. Nowadays, so called "positive" yarn feeders are used for such applications, in which the yarn is wound on a drum which rotates at a speed synchronized with the downstream machine; however, it is well known in the art that such systems are not suitable for some applications, e.g., jacquard processes.

[0005] US 5,487,415 discloses a weft feeder for gripper or projectile looms. The weft feeder is provided with two braking devices arranged in series, the downstream one of which is a double-leaf brake. The latter is provided with a separating element controlled by an actuator for separating the two brake leaves of the double-leaf brake and to form a duct to guide the weft yarn from the first eyelet to the second eyelet. None of the braking devices is adapted to modulate the braking force during the feeding process.

[0006] EP 1072707 A1 discloses a weft brake actuation device comprising an electromagnetic linear actuator having a shaft which is directly keyed to a comb-shaped braking device. The actuator is devoid of any rotating parts. The axial movement of the shaft allows the braking action to be modulated.

[0007] US 2,774,551 discloses a strand tensioning mechanism comprised of a movable comb member interacting with a fixed comb member. No means for automatically controlling the mechanism during the yarn-feeding process are disclosed.

[0008] DE 19544202 A1 discloses a comb tensioner provided with stationary thread guide elements and with displaceable thread guide elements which are controlled by a drive mechanism having a current-force-proportional characteristic curve. The current supplied to the mechanism is adjusted by a thread tension force adjusting device.

[0009] EP 2610380 A1 discloses another controlled, weft-braking device. The latter is provided with a braking member having a circular profile, which is biased against a delivery edge of the drum by a piezoelectric actuators which is deformable in response to a voltage applied thereto.

[0010] Therefore, it is a main object of the present invention to provide a yarn feeder having a drum and a weft-braking device controlled by feedback, which is capable of applying considerably stronger braking forces to the yarn with respect to known systems of the above-mentioned type.

[0011] The above object and other advantages, which will better appear from the following description, are achieved by a yarn feeder having the features recited in claim 1, while the dependent claims state other advantageous, though secondary features of the invention.

[0012] The invention will be now described in more detail with reference to a few preferred, non-exclusive embodiments, shown by way of non-limiting example in the attached drawings, wherein:

Fig. 1 is a view in axial cross-section, with respect to the axis of the drum, of a delivery end portion of the yarn feeder according to the invention;

Fig. 2 is a diagrammatical view in side elevation of a component of a weft-braking device incorporated in the yarn feeder of Fig. 1;

Fig. 3 is a perspective view showing a weft-braking device incorporated in the yarn feeder according to a first alternative embodiment of the invention;

Fig. 4 is a perspective view isolately showing a component of the weft-braking device of Fig. 3 to an enlarged scale;

Fig. 5 is a perspective view showing a detail of the weft-braking device of Fig. 3 from a different standpoint and to an enlarged scale;

Fig. 6 is a view in side elevation of the weft-braking device of Fig. 3 in a first operative configuration;

Fig. 7 is a view in side elevation of the weft-braking device of Fig. 3 in a second operative configuration;

Fig. 8 is a perspective view showing a weft-braking device incorporated in the yarn feeder according to a second alternative embodiment of the invention;

Fig. 9 is a perspective view separately showing a few interconnected components of the weft-braking device of Fig. 8;

Fig. 10 is a view in axial cross-section, with respect to the axis of the motor, of the weft-braking device of Fig. 8 in a first operative configuration;

Fig. 11 is a view in axial cross-section of the weft-braking device of Fig. 8 in a second operative configuration;

Fig. 12 is a diagrammatical view in axial cross section of a further component of the weft-braking device incorporated in the yarn feeder of Fig. 1;

Fig. 13 is a block diagram showing the operation of the yarn feeder according to a preferred embodiment of the invention;

Fig. 14 is a broken-away, perspective view showing a weft-braking device incorporated in the yarn feeder according to a third alternative embodiment of the invention, which is improved with respect to the embodiment of Figs. 1 and 2 in relation to the operation shown in Fig. 13;

Fig. 15 is a broken-away view in side elevation of the weft-braking device of Fig. 14.

[0013] With reference to the above Figures, a yarn feeder 10 comprises a drum 12 having a yarn Y wound thereon. Upon request from a generic textile machine, such as a circular knitting machine (not shown), the yarn is unwound from drum 12, then passes through a yarn-braking assembly supported on an arm 20 connected to drum 12, and finally is fed to the textile machine.

[0014] The braking assembly comprises a passive weft-braking device 22 of a conventional type, which is adapted to apply an uncontrolled, predetermined braking action to the yarn unwinding from drum 12 at its delivery end 12a, and a weft-braking device 24 controlled by feedback, which is adapted to apply a modulated braking action to the yarn incoming from passive weft-braking device 22, in order to stabilize the yarn tension on a desired level.

[0015] In a way known per se, passive weft-braking device 22 comprises a frustoconical, hollow member 26 which is elastically biased with its inner surface against delivery end 12a of drum 12. Frustoconical, hollow member 26 is supported coaxial to drum 12 by a spider assembly of springs, such as 27, which have their inner ends 27a anchored to a ring 28 fixed to the small end of frustoconical member 26, and their outer ends 27b anchored to an annular support 29 which is axially movable upon control of a screw mechanism 30 incorporated in arm 20. Screw mechanism 30 may be manually operated by a knob 34, in order to adjust the pressure exerted by frustoconical hollow member 26 against drum 12 and, consequently, the braking force applied to the unwinding yarn Y, which is pressed between drum 12 and frustoconical, hollow member 26.

[0016] Controlled weft-braking device 24 according to the invention comprises a first series of four comb-arranged prongs 36 projecting horizzontally, at right angles to the running direction of the yarn, from a support 38 screwed to arm 20, and a second series of three comb-arranged prongs 40, which are inserted in an alternated configuration between prongs 36 of the first series and are attached to a slide 42 which is anchored to the operative rod 44 of a stepper linear actuator 46 having its axis lying at right angles to the plane defined by prongs 36 of the first series. Yarn Y unwinding from drum 12 is slidably inserted in a zig-zag arrangement between prongs 36 of the first series and prongs 40 of the second series and, while running, it is subject to a braking action by friction which varies as a function of the angular extent of the portions of prongs engaged by the yarn, according to an exponential relation defined by the formula:

$$F_{out} = F_{in} e^{\mu(N-1)\alpha},$$

where F_{out} is the tension of the outcoming yarn, F_{in} is the tension of the incoming yarn which may be manually adjusted by passive, weft-braking device 22, μ is the friction coefficient between the yarn and prongs 36, 40, N is the overall number of prongs, and α is the angular extent of the portions of prong engaged by the yarn (Fig. 2), which depends on the position of the second series of prongs 40 with respect to the first series of prongs 36 which, in turn, depends on the position x (Fig. 2) of operative rod 44 of stepper linear actuator 46.

[0017] A control unit CU (which is only diagrammatically shown in Fig. 1) is programmed for controling stepper linear actuator 46 by feedback, on the basis of a tension signal T received from a tension sensor 50 arranged downstream of controlled weft-braking device 24, in order to maintain the tension of the yarn unwinding from drum 12 substantially constant on a desired level. Tension sensor 50 is provided with a circuit interface 52 including a micro-processor μP, via which it communicates with control unit CU, both parts being received in a housing 54 mounted to the free end of arm 20.

[0018] Advantageously, control unit CU is normally programmed to enable the feedback control of the tension only when there is yarn unwinding from the drum (which circumstance is indicative of the fact that the

downstream textile machine is in motion) and to disable it when the yarn is at rest.

[0019] However, as mentioned above, the present invention is particularly suitable for applications in which the yarn-feding tension is relatively high, such as the insertion of "lay-in yarn" (a type of yarn used, e.g., for covering mattreses, which is not mashed by the needles but simply inserted into the fabric as a filler). In this case, as well known to the person skilled in the art, if the machine is stopped for a long time, e.g., for mainteinance, the yarn is liable to slowly unwind from the drum, to slacken and, due to the very nature of the yarn, to swell. A so-swollen yarn may easily get stuck with the needles of the knitting machine, resulting in jamming or even breaking of the needles at the next start of the knitting machine, with consequent damages in the machine and in the fabric. This risk increases as the yarn count is increased, as the yarn-feeding tension is reduced, as the gauge of the machine is increased, etc.

[0020] In order to solve this problem, control unit CU is advantageously provided with an ALWAYS_LOOP operating mode, which may be enabled upon request, in which the feedback control loop is always enabled, even when the yarn is not unwinding, i.e., when the downstream knitting machine at rest. As a result, with the knitting machine at rest and the yarn consequently liable to slacken, the control loop will strengthen the braking action exerted by controlled weft-braking device up to restore the predetermined yarn-feeding tension. A so-tensioned yarn, even if at rest, will be less liable to unwind from the drum and to slacken.

[0021] Fig. 13 is a block diagram showing the operation of control unit CU in relation to the above ALWAYS_LOOP operating mode.

[0022] At block 70, control unit CU checks wether the operating mode ALWAYS_LOOP is enabled. If so (ALWAYS_LOOP == 1), the tension is controlled by feedback at block 74, typically by a Proportional-Integral-Derivative control TENS_PID adapted to compensate for the difference between a reference tension TENS_REF and a measured tension TENS. If not, at block 72 control unit CU checks wether the yarn-unwinding speed UNW_SP is higher than a minimum speed MIN. If so, the tension is controlled by feedback at block 74. If not, the routine is stopped at block 76.

[0023] The programming of control unit CU to perform the feedback control of stepper linear actuator 46 falls within the knowledge of the person skilled in the art and, therefore, will not be discussed in detail herein.

[0024] As shown in Fig. 12, in a way known per se, stepper linear actuator 46 generally comprises a hollow cylindrical body 46a which houses a plurality of stator windings 46b facing a rotor 46c which is coaxially supported within body 46a. Rotor 46c is keyed to a nut 46d, which is rotatably supported on bearings 46e and engages a threaded rod (corresponding to operative rod 44 of Figs. 1 and 2) which is guided to slide axially with respect to body 46a by guiding means (not shown). In other words, stepper linear actuator 46 is comprised of a stepper rotary motor and of transmission means which change the rotary motion of rotor 46c into a traslatory motion of the threaded, operative rod.

[0025] As shown in the Figures, all prongs 36, 38 preferably have a cylindrical profile and are equal to each other in diameter. Moreover, all prongs 36, 38 are advantageously made of a ceramic material, whereby the friction coefficient is typically in the range 0,2 to 0,3, depending on the type of yarn.

[0026] Between passive weft-braking device 22 and controlled weft-braking device 24, yarn Y passes through a first yarn-guide eyelet 56 attached to arm 20. Moreover, yarn Y also passes through a second yarn-guide eyelet 58 and a third yarn-guide eyelet 60, which are respectively attached to housing 54 of tension sensor 50 upstream and downstream of its sensitive end 50a.

[0027] In operation, a minimum level for the yarn-feeding tension is firstly set, by manually adjusting passive weft-braking device 22. Controlled weft-braking device 24 amplifies the braking action applied by passive weft-braking device 22, in such a way as to substantially stabilize the yarn-feeding tension on a desired level, which, as the person skilled in the art will appreciate, may be much higher then the highest level of tension which may be achieved by known controlled weft-braking devices. In particular, it has been found that the exponential relation which links the tension F_{out} of the outcoming yarn Y to the angle α, allows the braking action applied by the yarn-braking assembly to be adjusted in the range 0 to 200 cN and over, as required for certain applications, such as those cited in the background part of this description.

[0028] Figs. 3-7 show a controlled weft-braking device according to a first alternative embodiment of the invention. Controlled weft-braking device 124 comprises a first series of six comb-arranged arched prongs, which are attached to a support plate 138. The first series of prongs is formed of two combs, each of which is provided with three prongs 136a, 136b projecting monolithically from abase 136a', 136b', via which they are attached side-by-side to a shoulder 138a of support plate 138. Support plate 138 supports a swinging bracket 142 which is hinged about a first axis A1 between two arms 138b, 138c. Swinging bracket 142 supports a second series of six comb-arranged prongs, which are arched in the opposite direction with respect to prongs 136a, 136b of the first series, and are inserted in an alternated configuration between them. The second series of prongs is also formed of two side-by-side combs 140a, 140b which are identical to combs 136a, 136b attached to support plate 138. Swinging bracket 142 may swing, upon control of a stepper motor 146 via torque multiplying-means which will be described in more detail below, in order to vary the position of prongs 140a, 140b of the second series with respect to prongs 136a, 136b of the first series, between the two end-stop positions respectively shown in Figs. 6 and 7.

[0029] Stepper motor 146 is fixed to support plate 138 with its axis A2 lying at right angles to hinging axis A1 of braket 142. With this embodiment, the torque multiplying means comprise a cam consisting of a cylindrical member 152 which is coaxially keyed to driving shaft 144 of motor 146. Cylindrical member 152 has a contoured groove 154 formed on its outer surface, which is slidably engaged by a pin 156 supported by a lever 158 projecting radially from braket 142 at a misaligned position with respect to axis A1.

[0030] With the embodiment shown herein, groove 154 has a helical profile with a constant pitch about the axis of cylindrical member 152. However, this profile may be changed in order to vary the opening/closing action of the weft-braking device. For instance, the pitch may be reduced along a longitudinal portion of cylindrical member 152, in order to enhance the accuracy in adjusting the braking force in the corresponding stroke portion of the weft-braking device.

[0031] Figs. 8-11 illustrate a controlled weft-braking device 224 according to a second alternative embodiment of the invention, which only differs from the previous embodiment in the torque-multiplying means. Accordingly, the description of the parts in common with the previous embodiment will not be repeated.

[0032] With this embodiment, the torque-multiplying means comprise a crank 252 keyed to driving shaft 244 of motor 246. Crank 252 has a cylindrical seat 251 having an axis A3 which is inclined at an angle θ with respect to axis A4 of motor 246 and which intersects it at a point P lying on hinging axis A5 of bracket 242. Bracket 242 is provided with a first pin 253, whose axis A6 is arranged at right angles to hinging axis A5 of bracket 242 and intersects it at point P. First pin 253 is pivotally engaged by a bush 255 provided with a second pin 257, which radially projects at right angles outwards and pivotally engages cylindrical seat 251. In practice, the above-described system of pins provides a cross joint having one branch obliquely hinged to the crank and the other branch hinged to the bracket. Accordingly, also in this case, the rotation of the motor causes bracket 242 and prongs 240a, 240b of the second series to swing between the two end-stop positions shown in Figs. 10 and 11 respectively, such oscillation being 2θ in amplitude.

[0033] Figs. 14 and 15 show a further embodiment of controlled weft-braking device 324, which is modified with respect to the first embodiment of Figs. 1 and 2 in view of the possible use of the above-described ALWAYS_LOOP operative mode.

[0034] With this embodiment, controlled weft-braking device 324 comprises a first series of four, comb-arranged stationary prongs 336, and a second series of three comb-arranged prongs 340 which are inserted in an alternated configuration between prongs 336 of the first series and are attached to a slide 342. Slide 342 is anchored to an operative rod 344 of a stepper linear actuator 346 having its axis arranged at right angles to the plane defined by prongs 336 of the first series. With this embodiment, slide 342 has a yarn-locking member 347 attached thereto in the shape of an ondulated plate having two recesses 347', 347" suitably shaped to partially engage, or embrace, the two inner prongs of the first series in the area engaged by the yarn, with the weft-braking device in its position of massimum braking. Accordingly, with the knitting machine at rest, once reached the position of massimum braking the yarn remains clamped, or locked, between yarn-locking member 347 and the two inner stationary prongs, thereby preventing the yarn from slackening (and consequent swelling) in the area between the weft feeder and the downstream machine, with even more certainty.

[0035] Of course, the same solution with yarn-locking member may be applied to other embodiments of the controlled weft-braking device such as those described herein, with mere changes which will be obvious to the person skilled in the art.

[0036] A few preferred embodiments of the invention have been described herein, but of course many changes may be made by a person skilled in the art within the scope of the claims. For example, although reference has always been made to stepper motors in this description, different types of motors in a linear/rotary configuration may be used, in particular, brushless motors. Moreover, in the first and last embodiments, the operative rod of the linear actuator may also be arranged obliquely, e.g., in the lateral direction, with respect to the running direction of the yarn, provided that the operative rod shifts in a direction capable of progressively varying the angular amplitude α of the portions of prongs engaged by the yarn. Furthermore, the number of stationary prongs and movable prongs may be increased or reduced depending on the requirements, in order to respectively increase or reduce the average braking action applied to the yarn. The material of the prongs may also be changed, e.g., hardened steel may be used, although ceramics should be construed as a preferred material due to its high resistance to wear. Of course, the above-mentioned formula, which links angle α to the tension of the yarn upstream and downstream of the brake, can be applied to the embodiment described herein by way of example, in which all the prongs have a cylindrical profile, are equal in diameter at least in the area engaged by the yarn, and are equally spaced from each other, so that angle α is the same for all the prongs. However, in view of the informations found herein, the person skilled in the art will easily find formulas which can be applied to other geometries, in which, e.g., the prongs have are different in diameter and/or are not equally spaced from each other. In addition, the transmission means and/or torque-multiplying means, via which the movable prongs are connected to the electric motor in the various embodiments, may be replaced by other conventional systems, e.g., gear-based systems or lever systems of different types which can be devised by a person skilled in the art.

Claims

1. A yarn feeder (10), comprising

- a drum (12) having a yarn (Y) wound thereon which is adapted to be unwound upon request from a downstream textile machine, and
- a passive weft-braking device (22), which is arranged to exert a predetermined, uncontrolled braking action upon the yarn (Y) unwinding from the drum (12), **characterized in that** it also comprises
- a controlled weft-braking device (24), which is arranged downstream of said passive weft-braking device (22) and is provided with

  - a first series of comb-like arranged prongs (36),
  - a second series of comb-like arranged prongs (40), which are inserted in an alternated configuration between the prongs (36) of the first series, said yarn (Y) being slidably inserted in a zig-zag arrangement between the two series of prongs (36, 40) for receiving a braking action by friction from them which changes in strength depending on the position of said second series of prongs (40) with respect to said first series of prongs (36), and
  - a stepper motor (46), which is operatively connected via transmission means to move said second series of prongs (40) with respect to said first series of prongs (36) in such a way as to adjust the strength of said braking action by friction,

- a tension sensor (50), which is arranged downstream of said controlled, weft-braking device (24) for measuring the tension of the yarn (Y) unwinding from the drum (12) and generating a corresponding tension signal (T), and
- a control unit (CU), which is connected to feedback control said motor (46) based on said tension signal (T), in such a way as to substantially stabilize the tension of the yarn (Y) on a desired level.

2. The yarn feeder of claim 1, **characterized in that** said second series of prongs (40) is attached to a rod (44) which is guided to slide axially upon control of said motor (46a, 46b, 46c) via rotation-to-translation convertion means (44, 46d).

3. The yarn feeder of claim 1, **characterized in that** said second series of prongs (140, 240) is attached to a bracket (142, 242) swinging about an hinging axis (A1, A5), upon control of said motor (146, 246,) via torque multiplying means.

4. The yarn feeder of claim 3, **characterized in that** said torque multiplying means comprise a cam (152, 154) which is attached to the driving shaft (144) of said motor (146) and is operatively engaged by an engaging member (156) which is attached to said bracket (142) at a misaligned position with respect to its hinging axis (A1, A5).

5. The yarn feeder of claim 4, **characterized in that** said cam consists of a cylindrical member (152) which is coaxially keyed to the driving shaft (144) of the motor (146) and has a contoured groove (154) on its outer surface, and said engaging member consists of a pin (156) which slidably engages said contoured groove (154).

6. The yarn feeder of claim 5, **characterized in that** said groove (154) has a substantially helical contour about the axis of the cylindrical member (152).

7. The yarn feeder of claim 3, **characterized in that** said torque multiplying means comprise a cross joint having one branch hinged to a crank (252) keyed to the driving shaft (244) of the motor (246) about an oblique axis (A3) intersecting the axis (A4) of the motor (246), and the other branch hinged to said support (242) about an axis (A6) lying at right angles to the hinging axis (A5) of the support (242).

8. The yarn feeder of any of claims 3 to 7, **characterized in that** the prongs of said first series and the prongs of said second series have opposed arched profiles.

9. The yarn feeder of any of claims 1 to 8, wherein all the prongs (36, 40) are equally spaced from each other and, at least in the area contacting the yarn, have cylindrical profiles with the same diameter, **characterized in that** said control unit (CU) is programmed to control said motor (46) based on the formula:

$$F_{out} = F_{in} e^{\mu(N-1)\alpha},$$

where F_{out} is the tension of the outcoming yarn, F_{in} is the tension of the incoming yarn, μ is the friction coefficient between the yarn and said prongs (36, 40), N is the overall number of prongs, and α is the angular extent of the portion of prongs engaged by the yarn.

10. The yarn feeder of any of claims 1 to 9, **characterized in that** said passive weft-braking device (22) comprises a substantially frustoconical hollow member (26), which is biased with its inner surface against the delivery edge (12a) of the drum (12) by a support

(29), which is connected to said substantially frustoconical hollow member (26) via elastic means (27) and is axially movable, upon control of manual adjusting means (30, 34), for adjusting the pressure exerted by the substantially frustoconical hollow member (26) against the drum (12).

11. The yarn feeder of any of claims 1 to 10, **characterized in that** said control unit (CU) is normally programmed to enable said feedback control with the yarn unwinding from the drum and to disable it with the yarn at rest, and is further provided with an operating mode which may be enabled upon request, in which said feedback control is always enabled, even with the yarn at rest.

12. The yarn feeder of claim 11, **characterized in that** it comprises a yarn-locking member (347) which is attached to said second series of prongs (340) and is arranged in such a way as to engage at least one of the prongs of said first series (336) in the area engaged by the yarn, with the controlled, weft-braking device in a configuration of maximum braking, whereby the yarn is clamped between said yarn-locking member (347) and said at least one prong of said first series (336).

13. The yarn feeder of claim 12, **characterized in that** said yarn-locking member (347) has at least one recess (347', 347") which is suitably shaped to partially embrace said at least one prong of said first series (336) with the controlled, weft-braking device in said configuration of maximum braking.

Patentansprüche

1. Eine Garnzuführvorrichtung (10), die Folgendes umfasst:

- eine Trommel (12), auf die ein Garn (Y) aufgewickelt ist, das ausgebildet ist, um auf Anfrage von einer stromabwärts angeordneten Textilmaschine abgewickelt zu werden, und
- eine passive Schussfaden-Bremsvorrichtung (22), die angeordnet ist, um eine vordefinierte, nicht gesteuerte Bremswirkung auf das Garn (Y) auszuüben, das von der Trommel (12) abgewickelt wird,

dadurch gekennzeichnet, dass sie auch Folgendes umfasst:

- eine gesteuerte Schussfaden-Bremsvorrichtung (24), die stromabwärts von der passiven Schussfaden-Bremsvorrichtung (22) angeordnet und mit Folgendem ausgestattet ist:
  - einer ersten Reihe kammähnlich angeordneter Zinken (36),
  - einer zweiten Reihe kammähnlich angeordneter Zinken (40), die in alternierender Anordnung zwischen den Zinken (36) der ersten Reihe eingefügt sind, wobei das Garn (Y) gleitend in einer Zickzack-Anordnung zwischen den beiden Reihen von Zinken (36, 40) eingefügt ist, um durch Reibung von ihnen eine Bremswirkung zu empfangen, deren Stärke sich verändert, je nach Position der zweiten Reihe von Zinken (40) im Verhältnis zu der ersten Reihe von Zinken (36), und
  - einen Schrittmotor (46), der über Übertragungsmittel operativ angeschlossen ist, um die zweite Reihe von Zinken (40) im Verhältnis zu der ersten Reihe von Zinken (36) so zu bewegen, dass die Stärke der Bremswirkung durch Reibung angepasst wird,

- einen Spannungssensor (50), welcher stromabwärts von der gesteuerten Schussfaden-Bremsvorrichtung (24) angeordnet ist, um die Spannung des Garns (Y) zu messen, das von der Trommel (12) abgewickelt wird, und um ein entsprechendes Spannungssignal (T) zu erzeugen, und
- eine Steuereinheit (CU), die angeschlossen ist, um den Motor (46) anhand des Spannungssignals (T) durch Feedback zu steuern, um so die Spannung des Garns (Y) im Wesentlichen auf einem gewünschten Niveau zu stabilisieren.

2. Die Garnzuführvorrichtung gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die zweite Reihe von Zinken (40) an einem Stab (44) befestigt ist, welcher von Mitteln zur Umwandlung von Rotation in Translation (44, 46d) geführt wird, um bei der Steuerung des Motors (46a, 46b, 46c) axial zu gleiten.

3. Die Garnzuführvorrichtung gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die zweite Reihe von Zinken (140, 240) über Drehmomentmultiplikationsmittel an einem Träger (142, 242) befestigt ist, der bei Steuerung des Motors (146, 246) um eine Schwenkachse (A1, A5) schwingt.

4. Die Garnzuführvorrichtung gemäß Anspruch 3, **dadurch gekennzeichnet, dass** die Drehmomentmultiplikationsmittel einen Nocken (152, 154) umfassen, der an der Antriebswelle (144) des Motors (146) befestigt ist und in den ein Eingriffsglied (156) operativ eingreift, welches an dem Träger (142) in einer versetzten Position mit Bezug auf seine Schwenkachse (A1, A5) befestigt ist.

5. Die Garnzuführvorrichtung gemäß Anspruch 4, **da-**

durch gekennzeichnet, dass der Nocken aus einem zylindrischen Glied (152) besteht, welches koaxial auf der Antriebswelle (144) des Motors (146) verkeilt ist und eine konturierte Nut (154) an seiner Außenfläche hat, und das Eingriffsglied aus einem Stift (156) besteht, der verschiebbar in die konturierte Nut (154) eingreift.

6. Die Garnzuführvorrichtung gemäß Anspruch 5, **dadurch gekennzeichnet, dass** die Nut (154) eine im Wesentlichen schraubenförmige Kontur um die Achse des zylindrischen Gliedes (152) hat.

7. Die Garnzuführvorrichtung gemäß Anspruch 3, **dadurch gekennzeichnet, dass** die Drehmomentmultiplikationsmittel eine Kreuzverzapfung mit einem Zweig umfassen, der schwenkbar mit einer Kurbel (252) verbunden ist, welche an der Antriebswelle (244) des Motors (246) um eine Schrägachse (A3) verkeilt ist, die die Achse (A4) des Motors (246) schneidet, wobei der andere Zweig um eine Achse (A6), die in rechten Winkeln zur Schwenkachse (A5) des Trägers (242) liegt, schwenkbar mit dem Träger (242) verbunden ist.

8. Die Garnzuführvorrichtung gemäß einem beliebigen der Ansprüche 3 bis 7, **dadurch gekennzeichnet, dass** die Zinken der ersten Reihe und die Zinken der zweiten Reihe entgegengesetzte bogenförmige Profile haben.

9. Die Garnzuführvorrichtung gemäß einem beliebigen der Ansprüche 1 bis 8, wobei alle Zinken (36, 40) gleich voneinander beabstandet sind und zumindest in dem Bereich, der das Garn berührt, zylindrische Profile mit demselben Durchmesser haben, **dadurch gekennzeichnet, dass** die Steuereinheit (CU) programmiert ist, um den Motor (46) nach folgender Formel zu steuern;

$$F_{out} = F_{in} e^{\mu(N-1)\alpha},$$

worin F_{out} die Spannung des ausgehenden Garns ist, F_{in} die Spannung des eingehenden Garns ist, μ der Reibungskoeffizient zwischen dem Garn und den Zinken (36, 40) ist, N die Gesamtzahl der Zinken ist und α die Winkelausdehnung des Abschnitts der Zinken ist, der mit dem Garn in Eingriff steht.

10. Die Garnzuführvorrichtung gemäß einem beliebigen der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** die passive Schussfaden-Bremsvorrichtung (22) ein im Wesentlichen kegelstumpfförmiges hohles Glied (26) umfasst, das mit seiner inneren Oberfläche gegen die Abgabekante (12a) der Trommel (12) durch einen Träger (29) vorgespannt ist, welcher über elastische Mittel (27) mit dem im Wesentlichen kegelstumpfförmigen hohlen Glied (26) verbunden und bei Steuerung manueller Einstellmittel (30, 34) axial beweglich ist, um den Druck anzupassen, der vom im Wesentlichen kegelstumpfförmigen hohlen Glied (26) gegen die Trommel (12) ausgeübt wird.

11. Die Garnzuführvorrichtung gemäß einem beliebigen der Ansprüche 1 bis 10, **dadurch gekennzeichnet, dass** die Steuereinheit (CU) normalerweise programmiert ist, um die Feedbacksteuerung einzuschalten, wenn das Garn von der Trommel abgewickelt wird, und sie auszuschalten, wenn das Garn im Ruhezustand ist, und weiter mit einem Betriebsmodus ausgestattet ist, der bei Bedarf eingeschaltet werden kann und in dem die Feedbacksteuerung immer eingeschaltet ist, selbst wenn sich das Garn im Ruhezustand befindet.

12. Die Garnzuführvorrichtung gemäß Anspruch 11, **dadurch gekennzeichnet, dass** sie ein Garn-Blockierglied (347) umfasst, welches an der zweiten Reihe von Zinken (340) befestigt und so angeordnet ist, dass es mit mindestens einer der Zinken der ersten Reihe (336) in dem Bereich in Eingriff steht, der mit dem Garn in Eingriff steht, wenn sich die gesteuerte Schussfaden-Bremsvorrichtung in einer Konfiguration maximalen Bremsens befindet, wodurch das Garn zwischen dem Garn-Blockierglied (347) und der mindestens einen Zinke der ersten Reihe (336) eingeklemmt wird.

13. Die Garnzuführvorrichtung gemäß Anspruch 12, **dadurch gekennzeichnet, dass** das Garn-Blockierglied (347) mindestens eine Vertiefung (347', 347") hat, die passend geformt ist, um die mindestens eine Zinke der ersten Reihe (336) teilweise zu umgeben, wenn die gesteuerte Schussfaden-Bremsvorrichtung sich in der Konfiguration maximalen Bremsens befindet.

Revendications

1. Prédélivreur (10), comprenant

- un tambour (12) sur lequel est enroulé un fil (Y) qui est adapté pour être déroulé à la demande d'une machine textile en aval, et
- un dispositif de freinage de trame passif (22), qui est agencé pour exercer une action de freinage non commandée prédéterminée sur le fil (Y) se déroulant du tambour (12),

caractérisé en ce qu'il comprend également

- un dispositif de freinage de trame commandé

(24), qui est agencé en aval dudit dispositif de freinage de trame passif (22) et est pourvu
- d'une première série de dents agencées en peigne (36),
- d'une seconde série de dents agencées en peigne (40), qui sont insérées en une configuration alternée entre les dents (36) de la première série, ledit fil (Y) étant inséré en coulissement en un agencement en zigzag entre les deux séries de dents (36, 40) pour recevoir d'elles une action de freinage par frottement qui change d'intensité selon la position de ladite seconde série de dents (40) par rapport à ladite première série de dents (36), et
- d'un moteur pas-à-pas (46), qui est raccordé opérationnellement via un moyen de transmission pour déplacer ladite seconde série de dents (40) par rapport à ladite première série de dents (36) de façon à régler l'intensité de ladite action de freinage par frottement,
- un capteur de tension (50), qui est agencé en aval dudit dispositif de freinage de trame commandé (24), pour mesurer la tension du fil (Y) se déroulant du tambour (12) et générer un signal de tension (T) correspondant, et
- une unité de commande (CU), qui est raccordée pour commander en rétroaction ledit moteur (46) d'après ledit signal de tension (T), de façon à sensiblement stabiliser la tension du fil (Y) sur un niveau souhaité.

2. Prédélivreur selon la revendication 1, **caractérisé en ce que** ladite seconde série de dents (40) est fixée à une tige (44) qui est guidée pour coulisser axialement lors d'une commande dudit moteur (46a, 46b, 46c) via un moyen de conversion rotation-translation (44, 46d).

3. Prédélivreur selon la revendication 1, **caractérisé en ce que** ladite seconde série de dents (140, 240) est fixée à une console (142, 242) oscillant autour d'un axe d'articulation (A1, A5), lors d'une commande dudit moteur (146, 246), via un moyen de multiplication de couple.

4. Prédélivreur selon la revendication 3, **caractérisé en ce que** ledit moyen de multiplication de couple comprend une came (152, 154) qui est fixée à l'arbre d'entraînement (144) dudit moteur (146) et est enclenchée opérationnellement par un organe d'enclenchement (156) qui est fixé à ladite console (142) à une position désalignée par rapport à son axe d'articulation (A1, A5).

5. Prédélivreur selon la revendication 4, **caractérisé en ce que** ladite came est constituée d'un organe cylindrique (152) qui est claveté coaxialement à l'arbre d'entraînement (144) du moteur (146) et a une gorge profilée (154) sur sa surface externe, et ledit organe d'enclenchement est constitué d'une broche (156) qui enclenche en coulissement ladite gorge profilée (154).

6. Prédélivreur selon la revendication 5, **caractérisé en ce que** ladite gorge (154) a un contour sensiblement hélicoïdal autour de l'axe de l'organe cylindrique (152).

7. Prédélivreur selon la revendication 3, **caractérisé en ce que** ledit moyen de multiplication de couple comprend un joint vertical ayant une branche articulée sur un vilebrequin (252) claveté à l'arbre d'entraînement (244) du moteur (246) autour d'un axe oblique (A3) coupant l'axe (A4) du moteur (246), et l'autre branche articulée sur ledit support (242) autour d'un axe (A6) se trouvant à angles droits par rapport à l'axe d'articulation (A5) du support (242).

8. Prédélivreur selon l'une quelconque des revendications 3 à 7, **caractérisé en ce que** les dents de ladite première série et les dents de ladite seconde série ont des profils arqués opposés.

9. Prédélivreur selon l'une quelconque des revendications 1 à 8, dans lequel toutes les dents (36, 40) sont espacées équitablement les unes des autres et, au moins dans la zone venant en contact avec le fil, ont des profils cylindriques avec le même diamètre, **caractérisé en ce que** ladite unité de commande (CU) est programmée pour commander ledit moteur (46) d'après la formule :

$$F_{out} = F_{in} e^{\mu(N-1)\alpha},$$

où F_{out} est la tension du fil sortant, F_{in} est la tension du fil entrant, μ est le coefficient de frottement entre le fil et lesdites dents (36, 40), N est le nombre global de dents, et α est l'étendue angulaire de la portion de dents enclenchées par le fil.

10. Prédélivreur selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** ledit dispositif de freinage de trame passif (22) comprend un organe creux sensiblement tronconique (26), qui est sollicité avec sa surface interne contre le bord d'apport (12a) du tambour (12) par un support (29), qui est raccordé audit organe creux sensiblement tronconique (26) via un moyen élastique (27) et est mobile axialement, lors d'une commande d'un moyen de réglage manuel (30, 34), pour régler la pression exercée par l'organe creux sensiblement tronconique (26) contre le tambour (12).

11. Prédélivreur selon l'une quelconque des revendica-

tions 1 à 10, **caractérisé en ce que** ladite unité de commande (CU) est normalement programmée pour activer ladite commande de rétroaction avec le fil se déroulant du tambour et pour le désactiver avec le fil au repos, et est en outre pourvue d'un mode de fonctionnement qui peut être activé à la demande, dans lequel ladite commande de rétroaction est toujours activée, même avec le fil au repos.

12. Prédélivreur selon la revendication 11, **caractérisé en ce qu'**il comprend un organe de blocage de fil (347) qui est fixé à ladite seconde série de dents (340) et est agencé de façon à enclencher au moins l'une des dents de ladite première série (336) dans la zone enclenchée par le fil, avec le dispositif de freinage de trame commandé dans une configuration de freinage maximal, moyennant quoi le fil est serré entre ledit organe de blocage de fil (347) et ladite au moins une dent de ladite première série (336),

13. Prédélivreur selon la revendication 12, **caractérisé en ce que** ledit organe de blocage de fil (347) a au moins un évidement (347', 347") qui est formé de façon appropriée pour épouser partiellement ladite au moins une dent de ladite première série (336) avec le dispositif de freinage de trame commandé dans ladite configuration de freinage maximal.

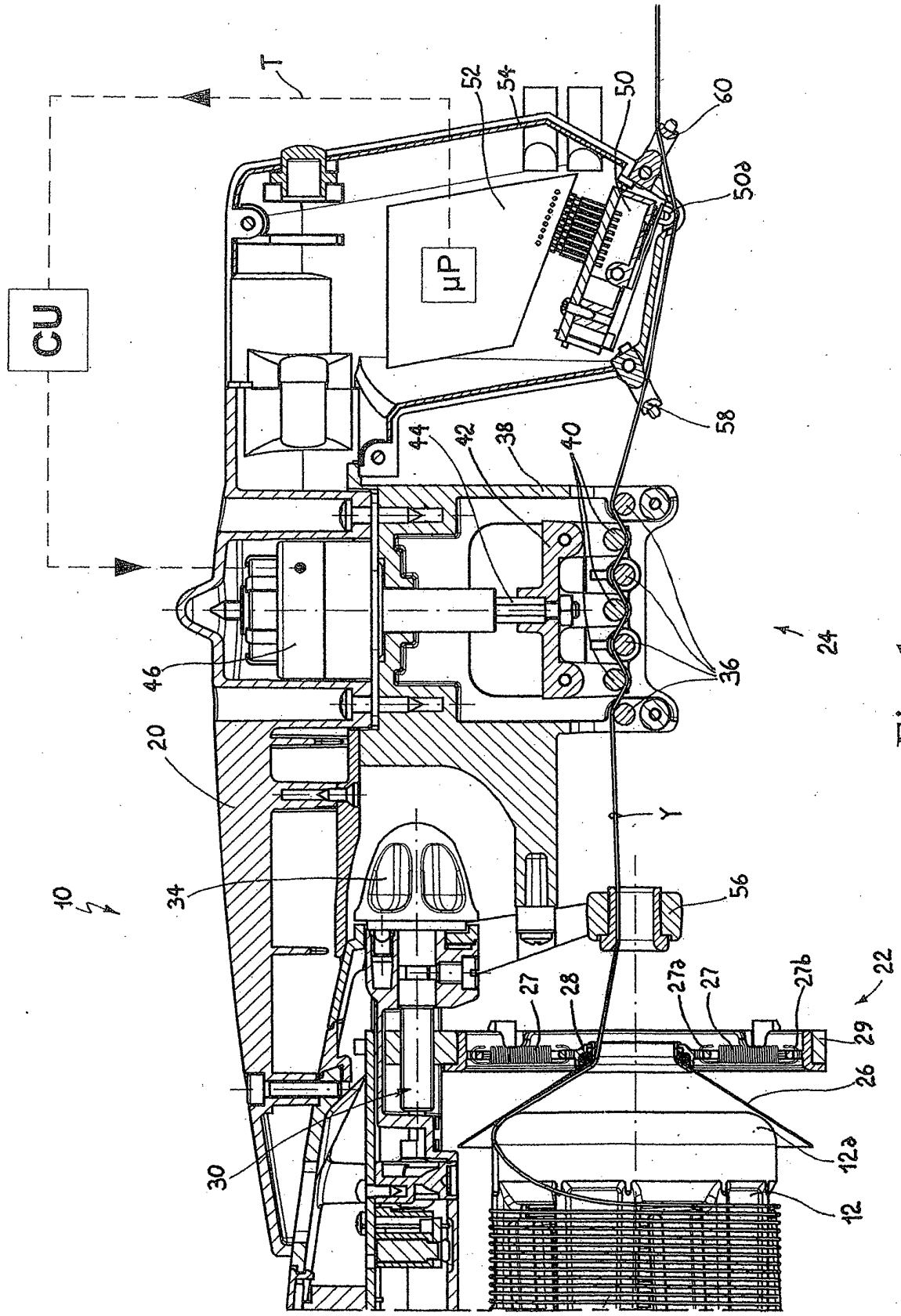
CU
T
μP
52
54
50
60
50a
58
44
42
38
40
36
46
20
24
1
Y
10
34
56
22
27
28
27a
27
27b
29
26
12a
12
30

Fig. 1

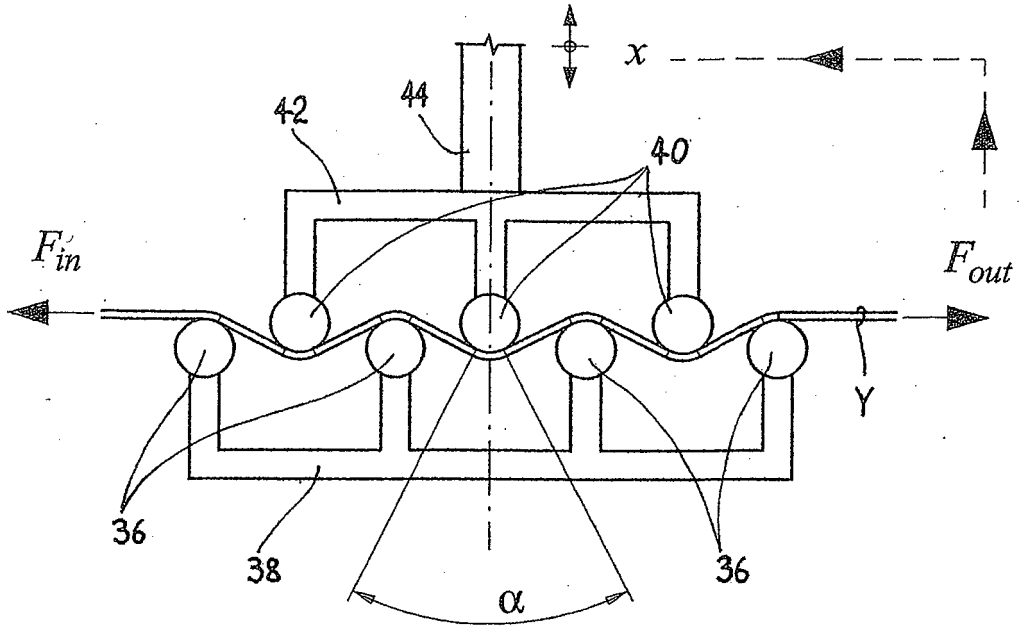

Fig. 2

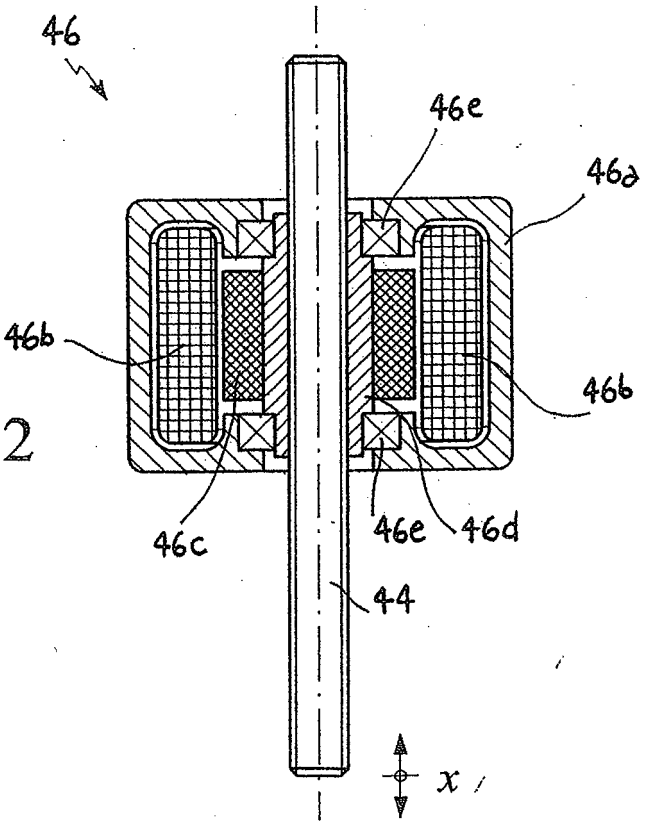

Fig. 12

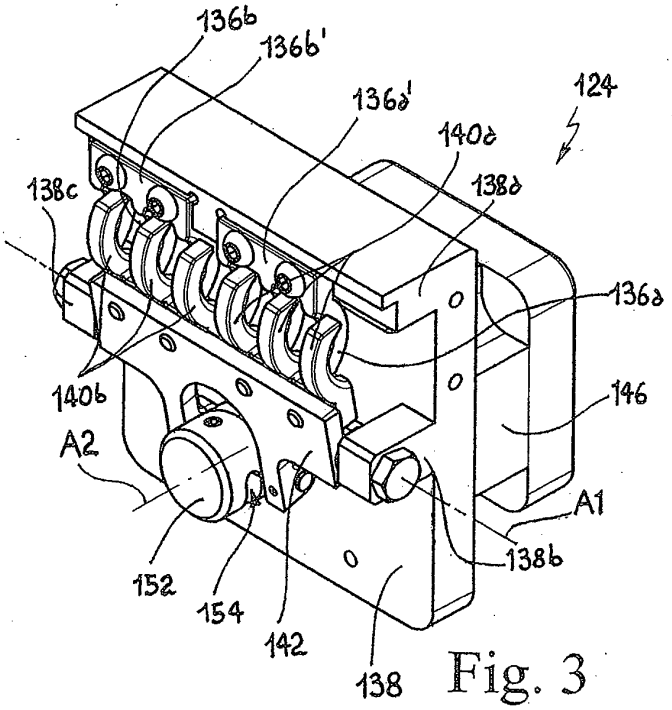

Fig. 3

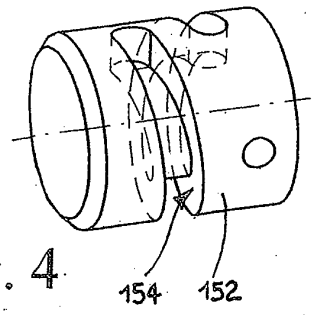

Fig. 4

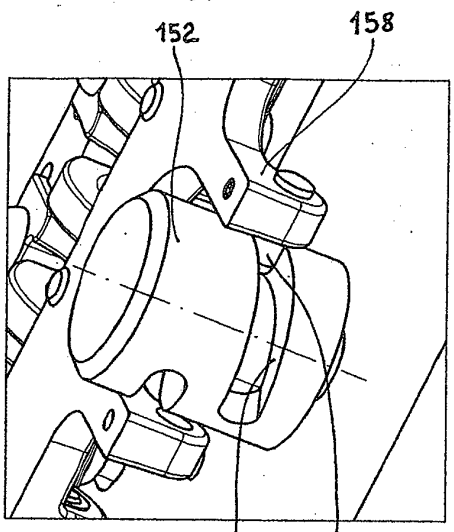

Fig. 5

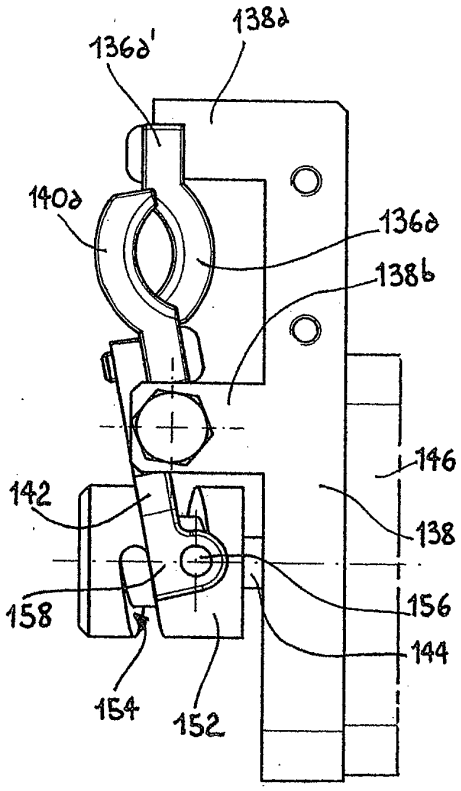

Fig. 6

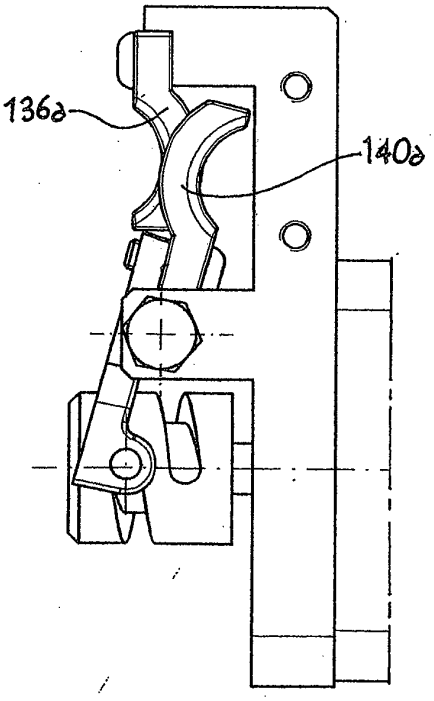

Fig. 7

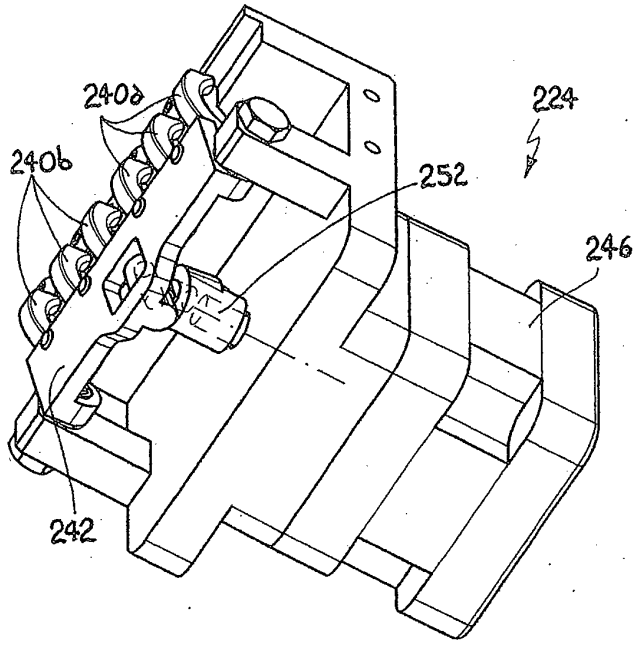

Fig. 8

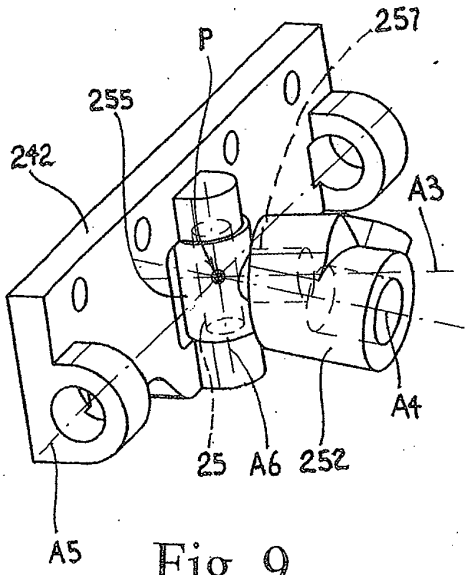

Fig. 9

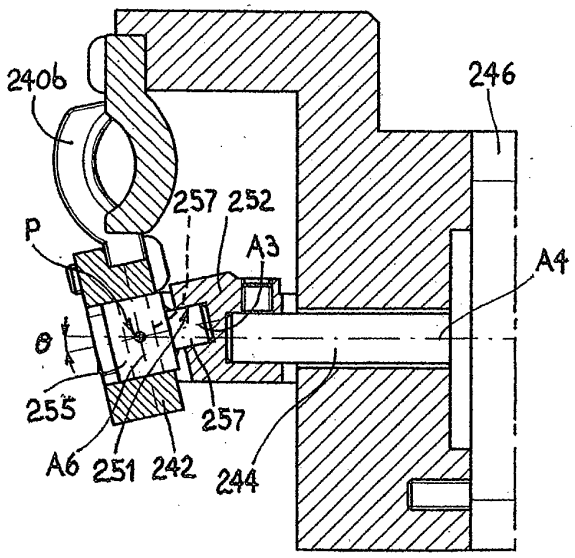

Fig. 10

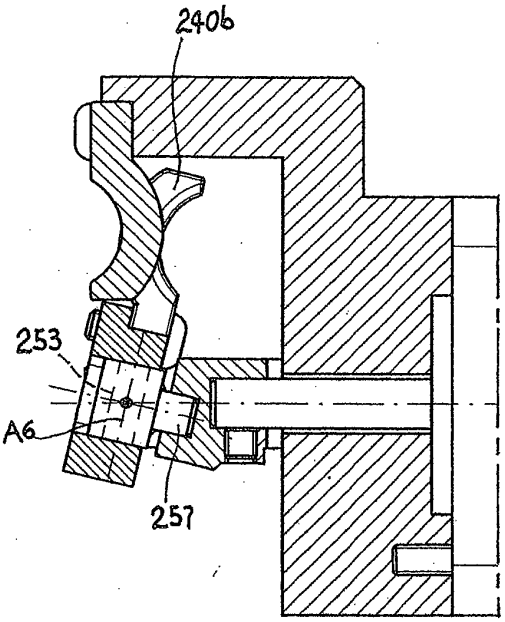

Fig. 11

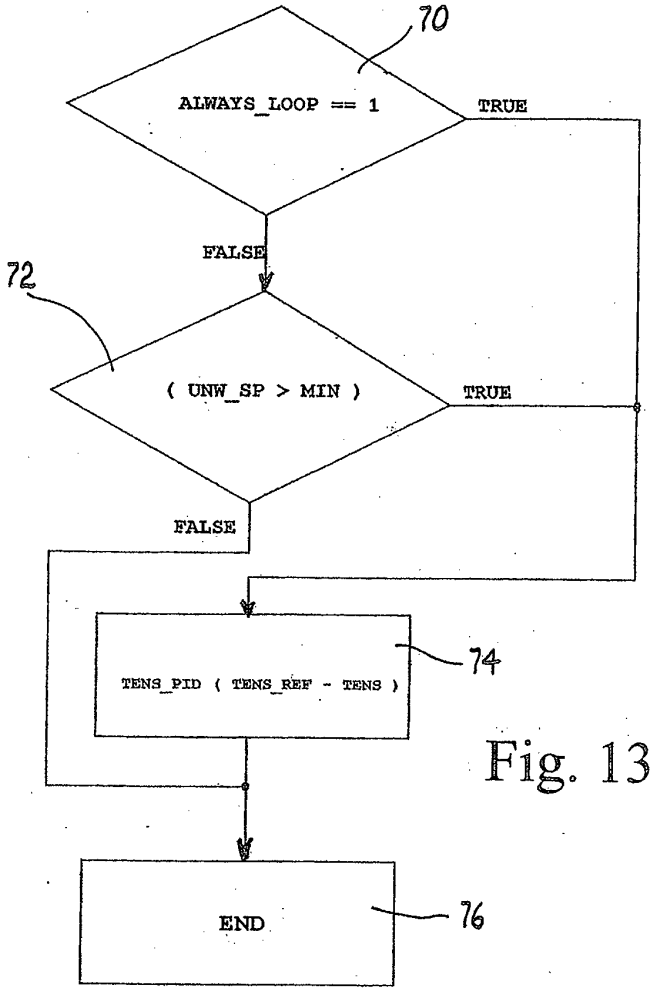

Fig. 13

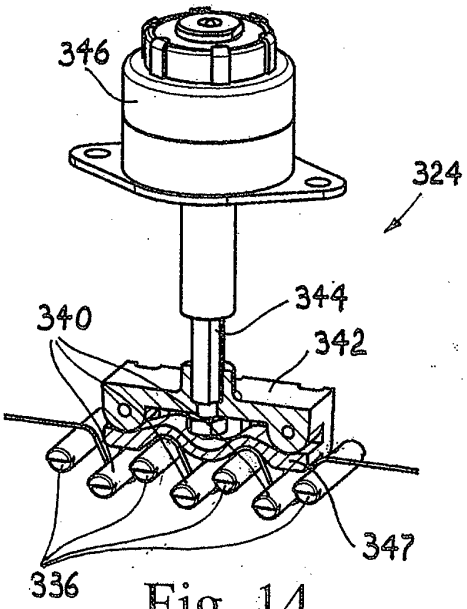

Fig. 14

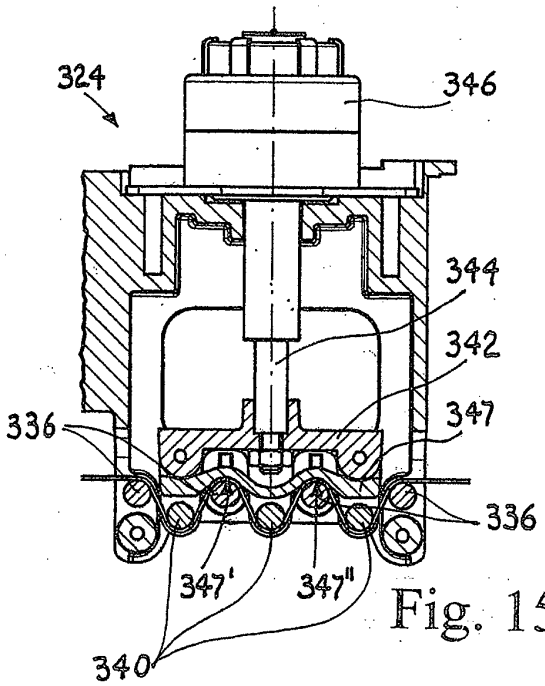

Fig. 15

REFERENCES CITED IN THE DESCRIPTION

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