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(54) **Controlled-tension yarn-feeding apparatus for textile machines, with yarn recovering function**

Garnzuführungsvorrichtungen mit geregelter Spannung für Textilmaschinen, mit Garnrückgewinnungsfunktion

Appareil d'alimentation en fil à tension contrôlée pour machines textiles, avec une fonction de récupération de fils

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**EP-A2- 1 258 550**
**BE-A3- 1 016 285**

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## Description

**[0001]** The present invention relates to a controlled-tension yam-feeding apparatus for textile machines, with yam-recovering function

**[0002]** In the textile field, yam feeders are known which are provided with a stationary drum on which a motorized swivel arm winds a plurality of yarn loops forming a weft stock. The yarn unwinding from the drum upon request from a downstream textile machine is subject to the action of a stabilizing brake which maintains the delivered yarn under a slight tension. The stabilizing brake typically comprises a frustoconical hollow member which is biased with its inner surface against the delivery edge of the drum, by manually adjustable elastic means.

**[0003]** As disclosed in EP 2 031 106, a controlled brake may be arranged downstream of the feeder in order to maintain the feeding tension substantially constant, e.g., a lamina-based brake of the type described in EP 0 622 485. The controlled brake is subject to a feedback loop which receives a measured tension signal from a tension sensor, then compares it with a reference tension representing the desired tension, and finally modulates the braking action in such a way as to minimize the difference between the reference tension and the measured tension.

**[0004]** Certain particular processes, such as sewing the heels of socks, require that the yarn fed to the machine is periodically recovered and then returned. This operation is usually carried out by a dedicated yarn-recovering device arranged upstream of the machine.

**[0005]** A yarn-recovering device of this type is described in EP 1 741 817 and generally comprises a motorized reel having an oblique passage for the yarn defined therein. The passage extends between an axial inlet port formed on an end surface of the reel, and an outlet port formed on the cylindrical lateral surface of the reel. When yarn must be recovered, the machine sends a signal which activates the reel to the yarn-recovering device, thereby causing the yarn to be wound on the reel.

**[0006]** A drawback of a line constituted as above is that it is rather expensive, mainly because a textile machine is usually served by dozens yarns and, therefore, the cost of each device added downstream of the feeder (brake, yarn-recovering device, etc.) must be multiplied by the number of yarns.

**[0007]** In addition, introducing a controlled brake as well as a yarn-recovering device considerably increases the longitudinal dimension of the feeding line, also because the various components must be sufficiently spaced from each other, in order to prevent the yarn running from a device to the next one from undergoing deviations which are too pronounced and could cause excessive friction.

**[0008]** Therefore, it is a main object of the present invention to provide a controlled-tension yarn-feeding apparatus with yarn-recovering function, which is both less expensive and reduced in size with respect to prior art apparatuses, such as the above mentioned ones.

**[0009]** The above object and other advantages, which will better appear from the following description, are achieved by an apparatus having the features recited in claim 1, while the dependent claims state other advantageous, though secondary features of the invention.

**[0010]** 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 diagrammatically shows the apparatus according to the invention;

Fig. 2 is a broken-away view in side elevation of a component of the apparatus according to the invention;

Fig. 3 is a plan view of the component of Fig. 2 from the viewpoint defined by axis III-III;

Fig. 4 is a view similar to Fig. 3, which shows the component in a different operative configuration;

Fig. 5 is a diagram showing the tension of the yarn processed by the apparatus according to the invention, as a functon of variable operative parameters of the apparatus;

Fig. 6 is a view similar to Fig. 1 which shows an alternative embodiment of the apparatus according to the invention.

**[0011]** With initial reference to Fig. 1, a yarn-feeding apparatus 10 comprises a weft feeder 11 provided with a stationary drum 12. A flywheel 14, which driven to rotate by a motor 15, draws yarn F from a spool 16 and winds it on drum 12, thereby forming a stock of yarn loops. The yarn, which is unwound from drum 12 upon request from a general downstream machine 17, is subject to the action of a stabilizing brake which maintains the delivered yarn under tension. The stabilizing brake typically comprises a frustoconical hollow member 18 which is biased with its inner surface against the delivery edge of drum 12 by manually adjustable elastic means 19.

**[0012]** The amount of yarn stocked on drum 12 is controlled by a triad of sensors. A first sensor S1, preferably a Hall sensor, detects the passage of magnets M integral with the flywheel, in order to measure the amount of yarn wound on the drum as well as the winding speed. A second sensor S2, preferably a mechanical sensor, provides a binary information about the presence of a minimum amount of yarn stocked on an intermediate portion of drum 12. A third sensor, S3, preferably an optical sensor, provides an UWP pulse per each loop unwound from the drum.

**[0013]** Downstream of weft feeder 10, a yarn-recovering device 20 of the type described in EP 1 741 817 is

arranged, which is shown in detail in Figs. 2 to 4.

**[0014]** yarn-recovering device 20 comprises a reel 22 keyed to a driving shaft 24 of a motor 26, preferably a stepping motor or, alternatively, a brushless motor provided with an absolute sensor which allows its real position to be determined, by means of techniques which are conventional in the field. Reel 22 is arranged with its axis A sloping at a first angle $\alpha$ with respect to the direction of the incoming yarn, which direction is indicated by arrow D, so that its end surface 22a facing away from motor 26 obliquely faces the incoming yarn. Reel 22 has a cylindrical seat 28 extending coaxially from an axial opening 29 formed on end surface 22a of reel 22. A passage 30 is defined within reel 22, which extends between an inlet port 30a opening to cylindrical axial seat 28, and an outlet port 30b opening to the lateral winding surface 22b of the reel. Passage 30 is rectilinear and is sloping at a second angle $\beta$ substantially equal to first angle $\alpha$ with respect to axis A of the reel. The edge of axial seat 28 and outlet port 30b have respective internally beveled, ceramic wearproof rings 32, 33 applied thereto. An inlet yarn-guide eyelet 34 and an outlet yarn-guide eyelet 36 are arranged upstream and downstream of reel 22 respectively, at the same level of ceramic ring 32.

**[0015]** yarn F passes through upstream yarn-guide eyelet 34, axial seat 28, passage 30, and downstream yarn-guide eyelet 36.

**[0016]** Unlike what described in EP 1 741 817, with the apparatus according to the invention yarn-recovering device 20 is not activated by a request from machine 17, based on the need of recovering/returning yarn. Instead, the angular position of reel 22 about its axis A is continuously adjusted on the basis of braking signals BI received from a control unit CU, in order to apply a braking action by friction to the yarn, which braking action is caused by the yarn creeping against the contact surfaces of reel 22 and yarn-guide eyelets 34, 36, and increases in intensity with increasing angle of rotation $\gamma$ of the reel with respect to an angular position of minimum braking; the latter, in the example of Fig. 3, is defined as the position in which passage 30 is aligned to inlet/outlet yarn-guide eyelets 34, 36, so that the reel does not interfere with the path of the yarn.

**[0017]** In particular, control unit CU is programmed to modulate the braking action in order to maintain the yarn tension substantially constant. To this purpose, a tension sensor 38 arranged downstream of yarn-recovering device 20 measures the tension of yarn F unwinding from the drum and sends a corresponding measured tension signal T_meas to control unit CU. The latter comprises a tension control block TC which is programmed to compare measured tension T_meas with a reference tension T_ref, and to adjust the above braking signal BI - from which the rotation angle of the reel is dependent - in order to minimize the difference between them.

**[0018]** In case of a sudden drop in tension, e.g., due to a release of yarn from downstream machine 17 in particular processes, or to a yarn breakage, yarn-recovering device 20 will automatically perform its yarn-recovering function, because reel 22 will keep on rotating and winding the yarn upon itself, until the yarn tension will reach the reference value T_ref again. Therefore, also while recovering, the tension will automatically tend to the constant reference value T_ref.

**[0019]** In case the tension does not reach the predetermined value within a number of revolutions set by the user on the basis of the type of process, which circumstance would be indicative of a yarn breakage, control unit CU is advantageously programmed to stop the reel, to generate an alarm, to position the reel at the angular position of minimum braking, which preferably corresponds to $\gamma = 0$, and to reset the counter. In order to perform the above operations, yarn-recovering device 20 is connected to send a position signal $P(\gamma)$, which is indicative of the instantaneous angular position $\gamma$ of the device, to control unit CU.

**[0020]** Therefore, with the apparatus of the invention, yarn-recovering device 20 also operates as a brake, with consequent reduction in terms of costs and dimensions.

**[0021]** Preferably, stabilizing brake 18 is adjusted in such a way as to apply a very slight braking action to the unwinding yarn, such that the tension of the yarn unwinding from the drum is lower than the minimum operative tension expected. In such a way, the controlled brake will effectively adjust the braking action over the entire range of possible operative tensions.

**[0022]** The diagram of Fig. 5 illustrates the tension T of the yarn as a function of the rotation angle $\gamma$ of reel 22, as measured during some tests at different speeds and with different tensions of the incoming yarn, the latter being varied by adjusting stabilizing brake 18. Rotation angle 0° represents the above-described position of minimum braking shown in Fig. 3.

**[0023]** The table below shows the test conditions per each of the curves illustrated in the diagram of Fig. 5.

| *curve* | *Speed. (m/min)* | *T inlet (g)* |
|---|---|---|
| L1 | 100 | 1 |
| L2 | 200 | 1 |
| L3 | 100 | 2 |
| L4 | 200 | 2 |
| L5 | 100 | 4 |

**[0024]** As shown in the diagram, with each curve the tension exponentially rises until the angle of rotation is about 250°, then the slope progressively decreases.

**[0025]** Preferably, in order to prevent excessive peaks of tension when textile machine 17 starts drawing yarn from feeder 11 (e.g., after a recovery step, or at the end of a period during which the feeder was disabled), control unit CU is programmed to activate a safety function when the feeder is disabled. According to this safety function, reel 22 is maintained at an angular position such that it

applies a braking action to the yarn that is slightly weaker with respect to the position corresponding to the reference signal. Accordingly, when the feeder is disabled, the yarn will be always maintained slightly under tension and, when the feeder will be enabled again, it will be immediately fed to textile machine 17 without undergoing tension peaks, thereby reducing the risk of yarn breakage.

**[0026]** Advantageously, similarly to what described in EP 2 031 106 in relation to a conventional controlled brake, tension control block TC is normally disabled, and control unit CU comprises a speed evaluator block SE, which processes the signals UWP from third sensor S3 in order to compute the real yarn comsumption speed on the basis of the time interval between said UWP pulses, and generates an enabling signal LE which enables the normal operation of tension control block TC only when said speed is > 0. On the contrary, when the calculated speed is equal to zero, the above-described safety function is enabled.

**[0027]** Alternatively, as shown in Fig. 6, in order to compute the yarn winding speed, speed evaluator block SE processes the signals UWP' from first sensor S1, on the basis of the time interval between such pulses UWP' generated by the sensor, and is programmed to generate an enabling signal LE which enables tension control block TC only when said speed is > 0. On the contrary, when the computed speed is equal to zero, the safety function is enabled. With this second embodiment, the signal generated by first sensor S1, which detects the rotation of yarn-winding flywheel 14, is considered as indicative of the real comsumption of yarn, because it is assumed that, when feeder 10 is operative, the amount of yarn drawn from spool 16 corresponds to the amount of yarn delivered.

**[0028]** 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. In particular, the described embodiments show the yarn-recovering device positioned in such a way that it can assume a non-interfering position, as illustrated in Figs. 2 and 3. However, for some applications in which the direction of the yarn delivered by the feeder is perpendicular to the direction of the yarn drawn by the downstream machine, the yarn-recovering device may also be positioned with its end surface 22a facing the incoming yarn at right angles. Moreover, the reel, at its position of minimum braking, which in the described examples corresponds to a non-interfering position as shown in Fig. 3, could also be rotated in such a way as to apply a slight braking action to the yarn. Also, although in the above-described examples inlet port 30a of passage 30 is very close to the axis of rotation of reel 22, so that the incoming yarn does not swing and, therefore, is not subject to tension fluctuations during the rotation of the reel, however, for some applications, slight fluctuations could be tolerated and therefore inlet port 30a could also be positioned farther than illustrated from axis A. In addition, passage 30 connecting the inlet port to the outlet port could have various shapes and sizes. For example, if the reel is made hollow, the passage could be the empty area within the reel. Moreover, passage 30 could directly lead to the front surface of the reel, without needing any cylindrical axial seat 28. Also, instead of providing a pair of dedicated yarn-guide eyelets 34, 36 upstream and downstream of yarn-recovering device 20, their function could be carried out by the last yarn-guide eyelet of the feeder positioned at sensor S3, and by the first yarn-guide eyelet of tension sensor 38. Of course, the control logic according to which measured tension signals T_meas are processed to generate braking signals BI, could also differ from what described, the latter being only intended as a preferred example.

## Claims

1. A yarn-feeding apparatus for textile machines, comprising:

   - a weft feeder (11) provided with a stationary drum (12) having a yarn (F) wound thereon which is withdrawable by a textile machine (17),
   - a stabilizing brake (18) which is arranged to maintain the yarn unwinding from the drum (12) under tension while it is withdrawn by said textile machine (17),
   - controlled braking means (20) arranged downstream of said stabilizing brake (18) for applying a modulated braking action to the yarn,
   - a control unit (CU) programmed to generate braking signals (BI) as a function of measured tension signals (T_meas) received from a tension sensor (38), **characterized in that** said controlled braking means comprise a motorized reel (22) having an inlet port (30a) communicating with an opening (29) defined on an end surface (22a) of the reel, and an outlet port (30b) defined on the lateral winding surface (22b) of the reel, a passage (28) traversed by the yarn (F) extending between said ports, said reel (22) being driven to adjust its angular position about its axis (A) on the basis of said braking signals (BI), whereby a braking action by friction is applied to the yarn, which is determined by the friction of the yarn against the contact surfaces of the reel (22), and which increases in intensity with increasing angle of rotation ($\gamma$) of the reel (22) with respect to an angular position of minimum braking.

2. The apparatus of claim 1, **characterized in that** said control unit (CU) is programmed to stop said reel (22) at the completition of a maximum number of revolutions set by a user.

3. The apparatus of claim 2, **characterized in that** the control unit (CU) is also programmed to generate an alarm signal at the completition of said maximum number of revolutions.

4. The apparatus of any of claims 1 to 3, **characterized in that** said reel (22) is arranged with its axis of rotation (A) slanting at a first angle ($\alpha$) with respect to the direction (D) of the incoming yarn (F), and the axis defined between said inlet port (30a) and said outlet port (30b) is slanting with respect to the axis (A) of the reel at a second angle ($\beta$) which is substantially equal to said first angle ($\alpha$).

5. The apparatus of any of claims 1 to 4, **characterized in that** said reel (22), at said minimum braking angular position, is rotated at a position non-interfering with the path of the yarn (F).

6. The apparatus of any of claims 1 to 5, **characterized in that** it comprises a pair of yarn-guiding eyelets (34, 36) respectively arranged upstream and downstream of said reel (22) to guide the yarn while braking.

7. The apparatus of any of claims 1 to 6, **characterized in that** said inlet port (30a) is open to a cylindrical seat (28) extending coaxially from said axial opening (29).

8. The apparatus of claim 7, **characterized in that** a first wearproof ring (32) is applied to the edge of said cylindrical seat (28).

9. The apparatus of any of claims 1 to 8, **characterized in that** a second wearproof ring (33) is applied to said outlet port (30b).

10. The apparatus of any of claims 1 to 9, **characterized in that** said control unit (CU) comprises a tension control block (TC) which is programmed to compare said measured tension (T_meas) with a reference tension (T_ref) and to adjust said braking signal (BI) such as to minimize the difference between them.

11. The apparatus of claim 10, **characterized in that** said control unit (CU), when said feeder is not operative, is programmed to maintain said reel (22) at an angular position such that it applies a braking action to the yarn which is slightly weaker with respect to the braking action corresponding to said reference tension (T_ref).

**Patentansprüche**

1. Garnzuführungsvorrichtung für Textilmaschinen, mit:

- einem Schussgerät (11), das mit einer stationären Trommel (12) ausgerüstet ist, auf die ein von einer Textilmaschine (17) abziehbares Garn (F) gewickelt ist,
- einer Stabilisierungsbremse (18), die dazu angeordnet ist, das sich von der Trommel (12) abwickelnde Garn unter Spannung zu halten, während es von der Textilmaschine (17) abgezogen wird,
- einer gesteuerten Bremseinrichtung (20), die stromabwärts der Stabilisierungsbremse (18) zum Aufbringen einer modulierten Bremswirkung auf das Garn angeordnet ist,
- einer Steuereinheit (CU), die zum Erzeugen von Bremssignalen (B1) als Funktion gemessener, von einem Zugspännungssensor (38) empfangener Zugspannungssignale (T_meas) programmiert ist,

**dadurch gekennzeichnet, dass** die gesteuerte Bremseinrichtung eine motorisierte Spule (32) mit einer Einlassöffnung (30a), die mit einer auf einer Stirnfläche (22a) der Spule festgelegten Öffnung (29) in Verbindung steht, und eine Auslassöffnung (30b) aufweist, die auf der seitlichen Wickelfläche (22b) der Spule gebildet ist, wobei ein Dürchlass (28) von dem sich zwischen den Öffnungen erstreckenden Garn (F) durchlaufen wird, und wobei die Spule (22) zum Einstellen ihrer Winkelstellung um ihre Achse (A) auf der Grundlage der Bremssignale (BI) angetrieben ist, wodurch eine durch Reibung erzeugte Bremswirkung auf das Garn aufgebracht wird, die von der Reibung des Garns gegen die Kontaktflächen der Spule (22) bestimmt ist und die in ihrer Stärke mit zunehmendem Drehwinkel ($\gamma$) der Spule (22) bezüglich einer Winkelstellung minimalen Aremsens zunimmt.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Steuereinheit (CU) dazu programmiert ist, die Spule (22) bei Vollendung einer von einem Benutzer eingestellten Maximalzahl an Umdrehungen anzuhalten.

3. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** die Steuereinheit (CU) ferner dazu programmiert ist, bei Vollendung der Maximalzahl an Umdrehungen ein Alarmsignal zu erzeugen.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Spule (22) mit ihrer Drehachse (A) unter einem ersten Winkel ($\alpha$) bezüglich der Richtung (D) des einlaufenden Garns (F) geneigt angeordnet ist und die zwischen der Einlassöffnung (30a) und der Auslassöffnung (30b) festgelegte Achse bezüglich der Achse (A) der Spule unter einem zweiten Winkel ($\beta$) geneigt ist, der im Wesentlichen gleich dem ersten Winkel ($\alpha$) ist.

5. Vorrichtung nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Spule (22) in der Winkelstellung minimalen Bremsens in eine Stellung gedreht ist,
die die Laufbahn des Garns (F) nicht stört.

6. Vorrichtung nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** sie ein Paar Garnführungsösen (34, 36) aufweist, die stromaufwärts bzw. stromabwärts der Spule (22) angeordnet sind, um das Garn beim Abbremsen zu führen.

7. Vorrichtung nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Einlassöffnung (30a) zu einem zylindrischen Sitz (28) hin offen ist, der sich koaxial von der axialen Öffnung (29) aus erstreckt.

8. Vorrichtung nach Anspruch 7, **dadurch gekennzeichnet, dass** ein erster verschleißfester Ring (32) auf den Rand des zylindrischen Sitzes (28) aufgebracht ist.

9. Vorrichtung nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** ein zweiter verschleißfester Ring (33) auf die Auslassöffnung (30b) appliziert ist.

10. Vorrichtung nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** die Steuereinheit (CU) einen Zugspannungssteuerblock (TC) aufweist, der dazu programmiert ist, die gemessene Zugspannung (T_meas) mit einer Bezugsspannung (T_ref) zu vergleichen und das Bremssignal (BI) so einzustellen, dass die Differenz zwischen ihnen minimiert ist.

11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die Steuereinheit (CU) dann, wenn der Garnzuführer nicht arbeitet, dazu programmiert ist, die Spule (22) in einer Winkelstellung zu halten, derart, dass sie eine Bremswirkung auf das Garn ausübt, die geringfügig schwächer als die der Bezugsspannung (T_ref) entsprechende Bremswirkung ist.

**Revendications**

1. Appareil d'alimentation en fil pour des machines textiles, comprenant :

   - un délivreur de trame (11) doté d'un tambour stationnaire (12) autour duquel est enroulé un fil (F) qui peut être étiré par une machine textile (17).
   - un frein stabilisateur (18) qui est disposé de façon à maintenir le fil déroulé depuis le tambour (12) sous tension alors qu'il est étiré par ladite machine textile (17),
   - des dispositifs de freinage contrôlés (20) disposés en aval dudit frein stabilisateur (18) afin d'appliquer une action de freinage modulée sur le fil,
   - une unité de commande (CU) programmée pour générer des signaux de freinage (BI) en fonction des signaux de tension mesurés (T_meas) reçus de la part du capteur de tension (38)

   **caractérisé en ce que** lesdits dispositifs de freinage contrôlés comprennent un dévidoir motorisé (22) possédant un orifice d'entrée (30a) communicant avec une ouverture (29) définie sur la surface d'extrémité (22a) du dévidoir, et un orifice de sortie (30b) défini sur la surface d'enroulement latérale (22b) du dévidoir, un passage (28) traversé par le fil (F) s'étendant entre lesdits orifices, ledit dévidoir (22) étant actionné de façon à ajuster sa position angulaire autour de son axe (A) sur base desdits signaux de freinage (BI), au moyen desquels une action de freinage par friction est appliquée sur le fil, laquelle est déterminée par la friction du fil contre les surfaces de contact du dévidoir (22), et qui augmente en intensité alors que l'angle de rotation ($\gamma$) du dévidoir (22) par rapport à une position angulaire de freinage minimum augmente.

2. Appareil selon la revendication 1, **caractérisé en ce que** ladite unité de commande (CU) est programmée pour arrêter ledit dévidoir (22) une fois qu'un nombre maximum de révolutions a été effectué par un utilisateur.

3. Appareil selon la revendication 2, **caractérisé en ce que** ladite unité de commande (CU) est également programmée pour générer un signal d'alarme une fois qu'un nombre maximum de révolutions a été effectué.

4. Appareil selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** ledit dévidoir (22) est disposé avec son axe de rotation (A) incliné au niveau d'un premier angle ($\alpha$) par rapport à la direction (D) du fil entrant (F), et **en ce que** l'axe défini entre ledit orifice d'entrée (30a) et ledit orifice de sortie (30b) est incliné par rapport à l'axe (A) du dévidoir au niveau d'un second angle ($\beta$) qui est substantiellement égal audit premier angle ($\alpha$).

5. Appareil selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** ledit dévidoir (22), au niveau de ladite position angulaire de freinage minimum est pivoté au niveau d'une position n'interférant pas avec le chemin du fil (F).

6. Appareil selon l'une quelconque des revendications 1 à 5, **caractérisé en ce qu'**il comprend une paire d'oeillets guidant le fil (34, 36) disposés respectivement en amont et en aval dudit dévidoir (22) afin de guider le fil lors du freinage.

7. Appareil selon l'une quelconque des revendications 1 à 6, **caractérisé en ce que** ledit orifice d'entrée (30a) est ouvert sur un siège cylindrique (28) s'étendant de façon coaxiale à partir de ladite ouverture axiale (29).

8. Appareil selon la revendication 7, **caractérisé en ce qu'**un premier anneau résistant à l'usure (32) est appliqué sur le bord dudit siège cylindrique (28).

9. Appareil selon l'une quelconque des revendications 1 à 8, **caractérisé en ce qu'**un second anneau résistant à l'usure (33) est appliqué au niveau dudit orifice de sortie (30b).

10. Appareil selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** ladite unité de commande (CU) comprend un bloc de contrôle de la tension (TC) qui est programmé pour comparer ladite tension mesurée (T_meas) avec une tension de référence (T_ref) et pour ajuster ledit signal de freinage (BI) afin de minimiser la différence entre eux.

11. Appareil selon la revendication 10, **caractérisé en ce que** ladite unité de commande (CU), lorsque ledit délivreur n'est pas actionné, est programmé pour maintenir ledit dévidoir (22) au niveau d'une position angulaire de sorte qu'il applique une action de freinage sur le fil qui est légèrement plus faible par rapport à l'action de freinage correspondant à ladite tension de référence (T_ref).

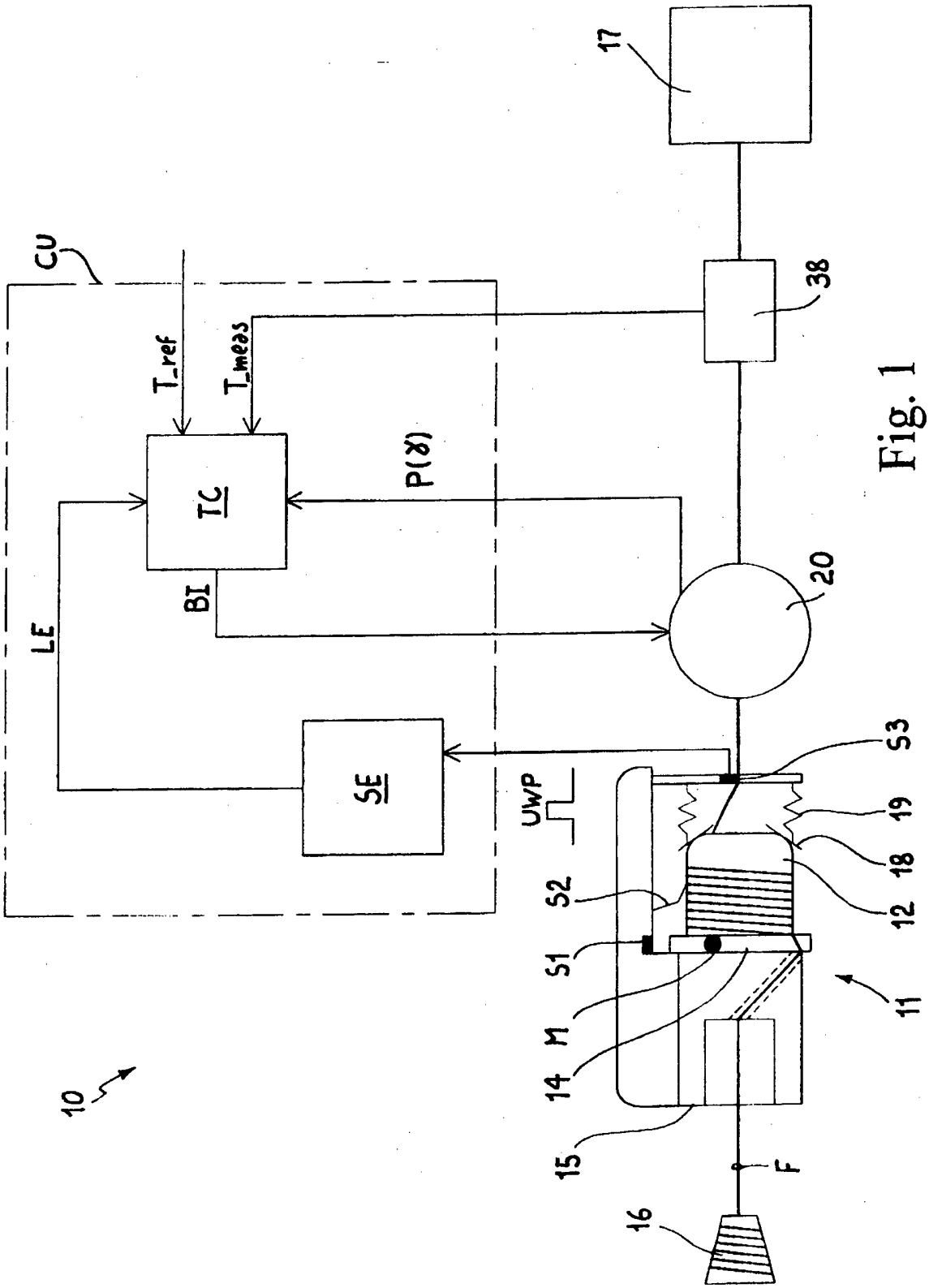

17
38
CU
T_ref
T_meas
TC
P(γ)
BI
LE
SE
20
S3
UWP
19
18
S2
12
S1
11
M
14
15
F
16
10

Fig. 1

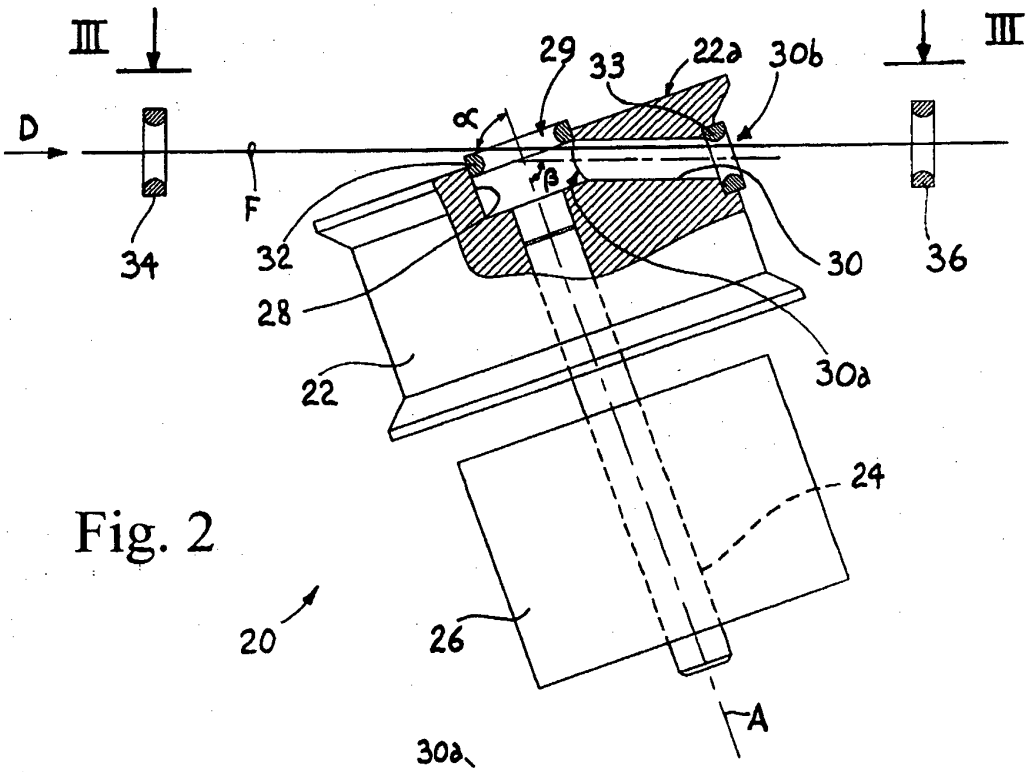



Fig. 2

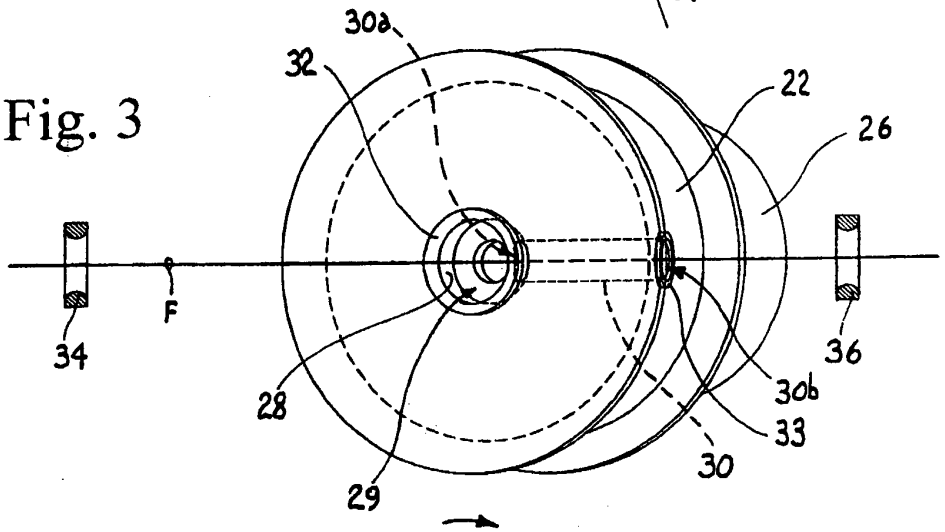



Fig. 3

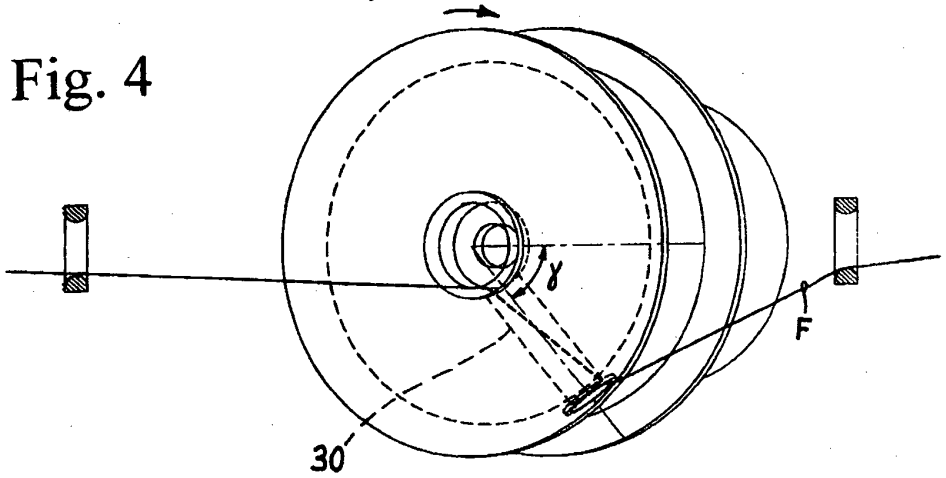



Fig. 4

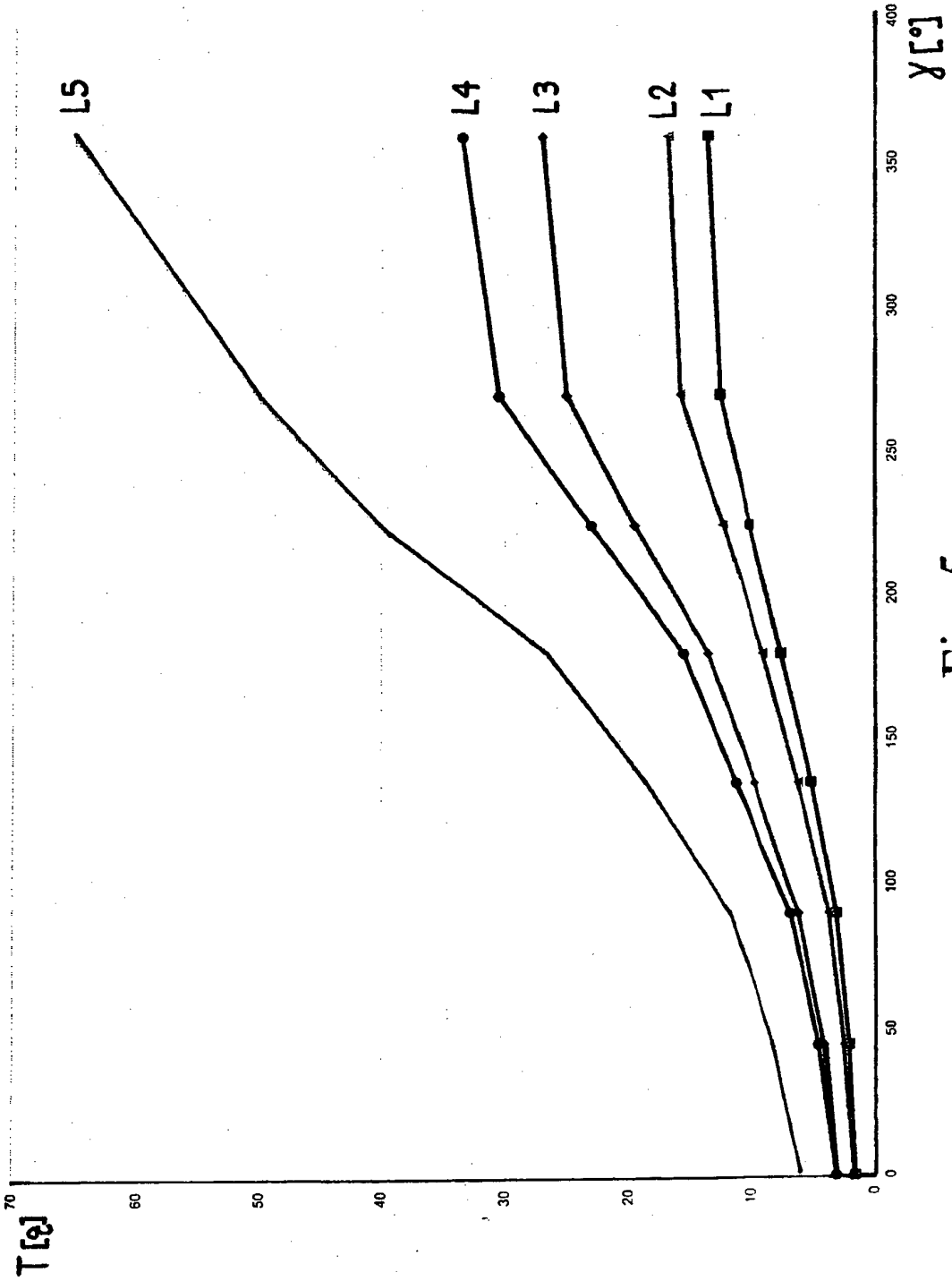

L5
L4
L3
L2
L1
T [g]
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
γ [°]

Fig. 5

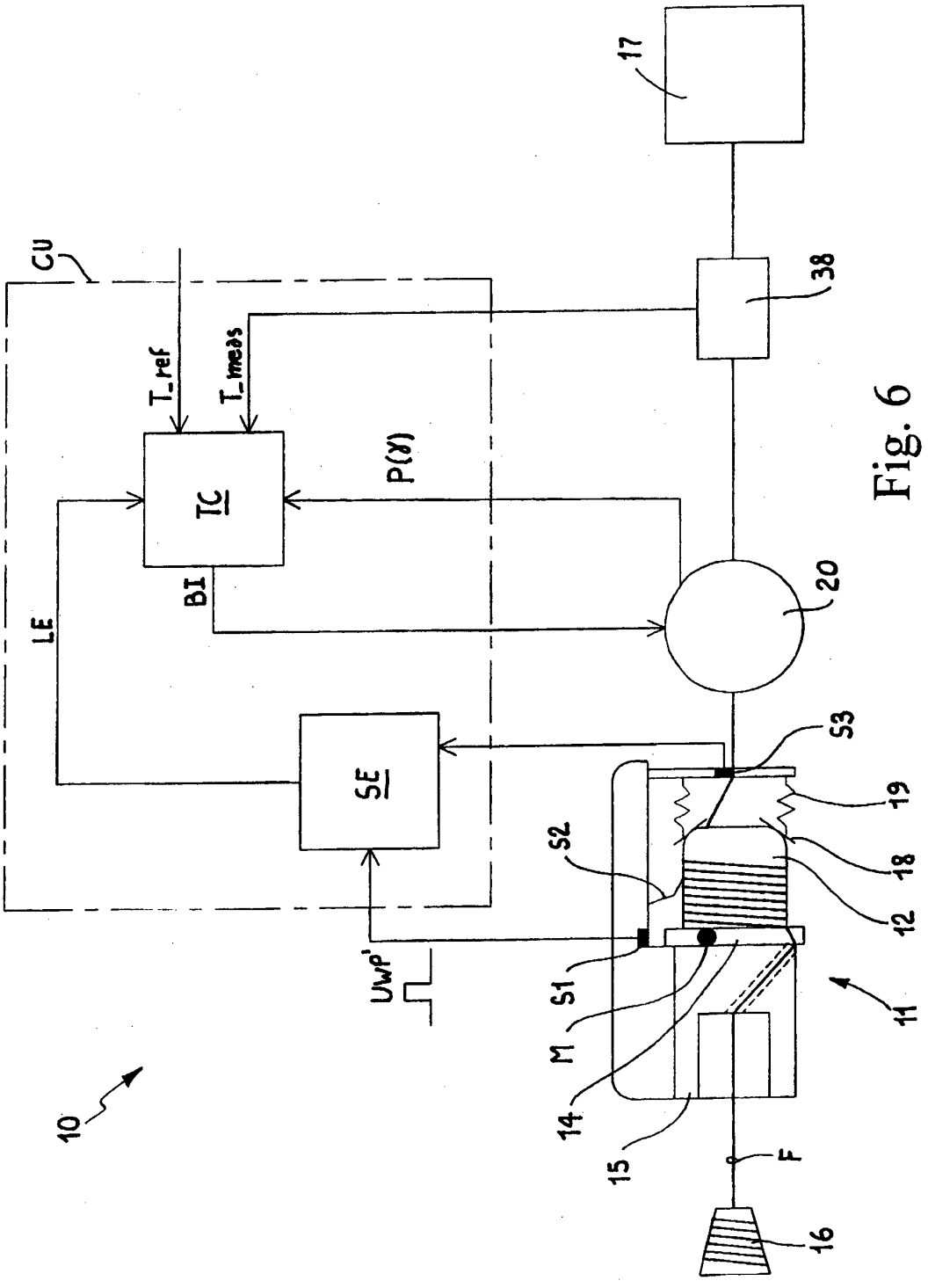

17
38
CU
T_ref
T_meas
P(y)
IC
BI
LE
20
SE
S3
19
S2
18
12
UwP'
S1
M
11
14
15
F
16
10

Fig. 6

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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