(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 977 839 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
08.10.2008 Bulletin 2008/41

(51) Int Cl.:
B21C 47/06 *(2006.01)* ***B65H 18/26*** *(2006.01)*

(21) Application number: **07251504.2**

(22) Date of filing: **05.04.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

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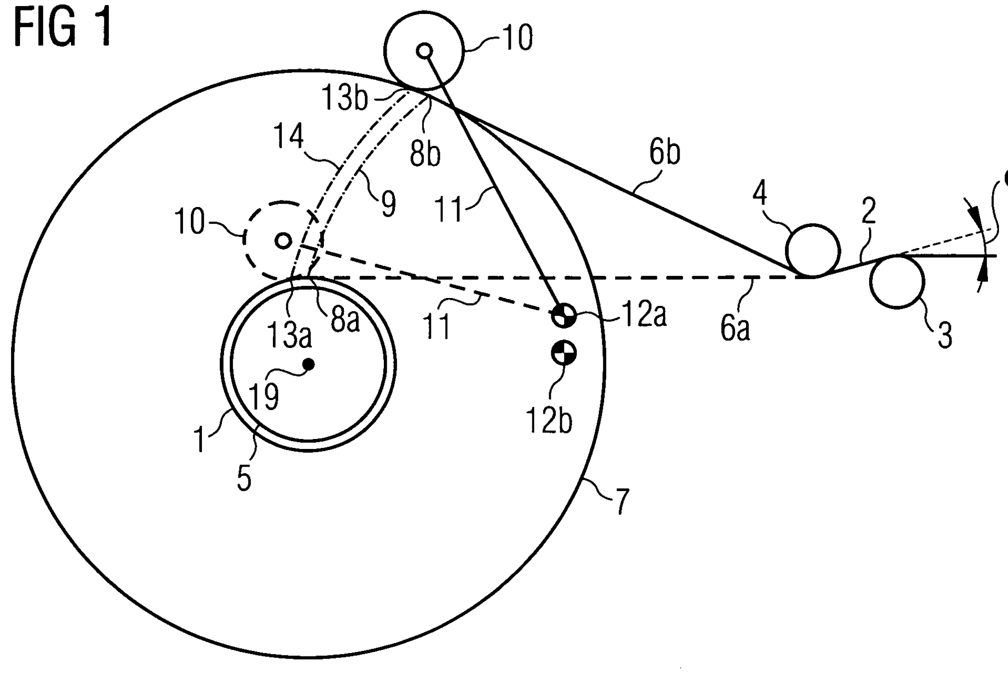
(54) Dual pivot ironing roll

(57) Apparatus for coiling a strip-shaped material with at least one ironing roll (10) which is carried by at least one pivoted lever (11) of constant length that is pivotable about the swivel axis of an adjustable pivot point, and with a deflection roller device for monitoring the strip-shaped material's shape which comprises a shape meter roll (3) and a tucking roll (4), the tucking roll (4) being at least vertically adjustable and fixable in at least two tucking roll positions. The adjustable pivot point is fixable in at least two pivot point positions, which are positioned in such a way that for each tucking roll position there exists a pivot point position in which, throughout coiling, the distance between the ironing roll's contact point with the coil and the strip-shaped material's tangent point onto the coil (7) is maintained at the optimum working distance within a tolerance of ±5 mm.

FIG 1



EP 1 977 839 A1

Description

[0001] The present invention relates to a method and an apparatus for coiling strip-shaped material, preferably a metal foil.

Background of the invention

[0002] When coiling strip-shaped material, for example metal foil after a rolling process, on a coiling apparatus with a horizontal coiler unit for receiving the coiling-spool, air tends to be trapped between the overlapping wraps of the coil, causing problems like coil weave, telescoping, low density coils, breaks and transverse waves. To avoid such problems, which can lead to the coil becoming completely unusable, it is usual to employ an ironing roll which presses the strip-shapedmaterial on the coil. The ironing roll is positioned downstream of the strip-shaped material's tangent point of entry onto the coil. During the coil's build-up, due to the increase of the coil's diameter, the tangent point changes its position, the different positions passed through forming a tangent point path. In order to ensure optimal effect of the ironing roll, the distance between the tangent point and the contact point of the ironing roll with the coil has to be maintained within a certain range throughout coiling. Thereby optimal speed, yield and productivity, manifested for example by the number of coils rolled in a certain time, of the coiling apparatus can be achieved. Furthermore, optimized ironing permits improved performance of downstream processing, since coils with a poor build up and low density are more susceptible to damage and therefore require more careful handling, and reduction of processing speeds on downstream equipment, for example a Doubling machine, may be necessary to avoid problems when processing the strip and prevent interlap slippage or scratches.

[0003] Shape variations across a metal strip after rolling are generally measured and controlled by air bearing shape meters which comprise a shape meter roll and a tucking roll, a downward force on the shape meter roll within a certain range being necessary for accurate measurement. Downward force varies with tension applied to the strip by the coiling apparatus, and consequently with the desired strip thickness. Hence, for a given shape meter roll the downward force may be outside the shape meter roll's operating limits for certain strip thicknesses.

In commonly used dual wrap angle shape roll applications, vertical movement of the tucking roll to a secondary operating position changes the arc of strip coverage of the shape meter roll, known as wrap angle, and thereby the downward force on the shape meter roll. Such, a change in downward force keeps it within the optimal operating limits of the shape meter roll where the measurement is more sensitive, and thereby enables a wider range of strip thicknesses to be measured accurately.

[0004] The change in the strip path between the tucking roll and the coil which is caused by a change of the tucking roll's position leads to a displacement of the strip's tangent point. Hence, in dual wrap angle devices the tangent point's path during coiling is not constant but varies for different tucking roll positions.

[0005] To ensure a more constant distance between the tangent point and the contact point for a coiling apparatus with a constant strip path, and thereby a constant tangent point's path, throughout coiling, US5957404 employs a pivoted lever of adjustable length which is especially guided to make the ironing roll follow a path that keeps it within optimal distance to the tangent point's path. Since the guidance of the ironing roll's path is only suited to one tangent point path, it cannot provide equal ironing performances for different wrap angles, thereby limiting the range of strip thicknesses effectively and securely processable and the coil diameters achievable.

GB2238527 discloses a strip reel apparatus with constant strip path in which the optimal distance between contact point and tangent point is dynamically controlled throughout coiling by adjusting the pivoted lever's length and/or the position of its pivot point. Such dynamical distance control requires complicated devices for surveillance and regulation of the coil's diameter, tangent point position, contact point position, pivot point position and length of pivoted lever, which render the apparatus complex to handle.

Stiffness of the ironing roll's levers is essential to dampen the development of vibrations of the pivoted lever during coiling. Such vibrations are detrimental because they reduce the effectiveness of the ironing process and can contribute to the premature failure of components of the roll, such as the bearings. For pivoted levers of adjustable length the levers' stiffness is generally inferior to levers of constant length. In addition, changing the length - and thereby the stiffness of a lever - also directly affects the force applied at the end of the lever and in order to deliver a constant force any change in length and stiffness needs to be compensated for.

Object of the invention

[0006] It is the object of the present invention to provide a simple apparatus and a simple method for coiling strip-shaped material which allow effective ironing for a wide range of strip thicknesses, coil diameters and wrap angles, and are easy to handle.

Detailed description of the invention

[0007] This object is solved by an apparatus for coiling a strip-shaped material, preferably a metal foil, to a coil, with a horizontal coiler unit for receiving a coiling-spool on which the strip-shaped material is wound during coiling, with at least one ironing roll for pressing the strip-shaped material on the coil, which ironing roll is carried by at least one pivoted lever of constant length that is pivotable about the swivel axis of an adjustable pivot point, and with a deflection roller device for monitoring the strip-shaped material's shape which comprises a shape meter roll and, situated downstream of the shape meter roll between the coiling-spool and the shape meter roll, a tucking roll.

[0008] That apparatus is characterized in that the tucking roll is at least vertically adjustable and fixable in at least two tucking roll positions, and the adjustable pivot point is fixable in at least two pivot point positions, which are positioned in such a way that for each tucking roll position there exists a pivot point position in which, throughout coiling, the distance between the ironing roll's contact point with the coil and the strip-shaped material's tangent point onto the coil is maintained at the optimum working distance within a tolerance of ±5 mm.

[0009] With that apparatus optimum working distance between contact point and tangent point is achievable for all wrap angles, while effective ironing is simultaneously ensured by the pivoted lever's fixed length and stiffness. Optimum working distances are between 25 and 150 mm, preferably between 50 and 100 mm, including the boundary values of said ranges.

[0010] The strip-shaped material to be coiled may consist of any metal material, for example aluminum or steel or an alloy. Preferably the strip-shaped material is a foil.

[0011] The pivoted lever is pivoted by an actuation means engaging the pivoted lever. Any kind of actuation means may be used, for example hydraulic actuators or pneumatic actuators. Preferably the actuation means is a hydraulic actuator.

[0012] The axes of rotation of the shape meter roll and of the tucking roll are parallel to the axis of rotation of the coiling-spool.

[0013] Preferably, the at least two pivot point positions are located downstream of the tucking roll,

the swivel axis of the pivot point in its lowest position being located lower than the lowest point of the tucking roll in its lowest position,

and the swivel axis of the pivot point in its highest position being located lower than the lowest point of the tucking roll in its highest position,

and for all pivot point positions the swivel axis of the pivot point being located lower than the level of the highest point of the coiling-spool.

The terms upstream and downstream refer to the direction of movement of the strip-shaped material during coiling.

[0014] According to another preferred embodiment, the tucking roll positions and the swivel axes of the pivot point positions are located above the level of the coiling-spool's longitudinal axis.

[0015] In an especially advantageous arrangement the adjustable pivot point is mounted on a secondary pivoting arm. The secondary pivoting arm is movable about a fulcrum and can be fixed in at least two positions. The secondary pivoting arm is moved by a secondary actuation means engaging the secondary pivoting arm. For the secondary actuation means any kind of actuation means may be used, for example hydraulic actuators or pneumatic actuators. Preferably the secondary actuation means is a hydraulic actuator. The advantages of mounting the pivot point on a secondary pivoting arm are that thereby the position of the pivot point can be easily changed by swiveling the secondary pivoting arm about it's fulcrum, and that a secondary pivoting arm is a very simple and robust piece of equipment that requires only minimal maintenance.

[0016] Preferably the at least two positions of the secondary pivoting arm are defined by fixed stops. The secondary pivoting arm is fixed in a desired position by forcing it against the appropriately positioned fixed stop by means of the secondary actuation means.

In an advantageous embodiment the locations of these fixed stops are adjustable. Thereby different positions can be chosen for the secondary pivoting arm. Thus, it is possible to cope with different requirements of different applications, for example with different coiling-spool diameters.

[0017] The object of the invention is further solved by a method for coiling a strip-shaped material, preferably a metal foil, to a coil by means of a horizontal coiler unit for receiving a coiling-spool on which the strip-shaped material is wound during coiling, the strip material being pressed on the coil by an ironing roll during coiling, and the position of the ironing roll being adjusted during coiling by pivoting the at least one pivoted lever of constant length carrying the ironing roll about the swivel axis of its pivot point, and the strip material being led prior to coiling through a deflection roller device comprising a shape meter roll and, situated downstream of the shape meter roll between the coiling-spool and the shape meter roll, a tucking roll, characterized in that

- the position of the tucking roll of the deflection roller device is adjusted at least vertically before coiling starts and remains fixed throughout coiling, and
- the pivot point of the pivoted lever, which remains fixed throughout coiling, is adjusted before coiling starts, in dependency on the position of the tucking roll, in such a way that throughout coiling the distance between the path of the ironing roll's contact point with the coil and the path of the strip material's tangent point onto the coil is maintained at the optimum working distance within a tolerance of ±5 mm.

[0018] Pivoting the pivoted lever is effected by an actuation means engaging the pivoted lever.

[0019] The tucking roll's position is adjusted such that the downward force on the shape meter roll is within its operating limits throughout coiling.

[0020] Since the tucking roll's position and the pivot point, which both are adjusted before coiling starts, remain fixed throughout coiling, the method is easy to handle and needs no elaborate and complex surveillance devices. The use of a pivoted lever of constant length ensures a stiffness which permits successful and effective ironing by damping the development of vibrations of the pivoted lever during coiling. The constant length and stiffness of the lever allows the system to deliver a constant force throughout the range of the coil build-up. Since various tucking roll positions can be chosen, different wrap angles give access to the processing of a wide range of strip thicknesses.

[0021] Each change of the position of the tucking roll causes a dependent change of the position of the pivot point. Thereby, when the tangent point follows a new path due to the wrap angle change, the path of the ironing roll's contact point is also changed, since a change in the pivot point's position affects the path of the ironing roll's contact point during coil build-up. To ensure process efficiency and security, the choice of the pivot point's position is dependent on the tucking roll position.

The dependency is such that the pivot point position chosen has to determine a contact point path which ensures an optimal distance between the ironing roll's contact point and the strip-shaped material's tangent point throughout coiling. That distance has to be at the optimum working distance within a tolerance of ±5 mm.

[0022] In a preferred embodiment the pivot point of the at least one pivoted lever is adjusted in such a way that the lowest point of the tucking roll is situated higher than the swivel axis of the pivot point and lower than the level of the highest point of the coiling-spool.

[0023] Preferably, the tucking roll and the swivel axis of the pivot point of the at least one pivoted lever are adjusted in such a way that they are situated above the level of the coiling-spool's longitudinal axis.

Thus, an optimal set of wrap angles is accessible and optimal contact point paths can be provided for each tucking roll position.

[0024] In a preferred embodiment the adjustment of the pivot point of the at least one pivoted lever is effected by movement of a secondary pivoting arm.

[0025] Pivoting the secondary pivoting arm is effected by a secondary actuation means engaging the secondary pivoting arm.

[0026] In an especially advantageous embodiment the movement of the secondary pivoting arm is swiveling about a fulcrum between at least two fixed stops.

[0027] Preferably, the pivot point of the pivoted lever is fixed by forcing the secondary pivoting arm against a fixed stop.

[0028] The present invention is described exemplarily by reference to the accompanying schematic drawings, in which

Fig. 1 depicts an embodiment of the apparatus of the present invention in low wrap angle position in a lateral view,

Fig. 2 depicts an embodiment of the apparatus of the present invention in high wrap angle position in a lateral view, and

Fig. 3a and Fig. 3b depict how the pivoted lever's pivot point is positioned by lateral views of the secondary pivoting arm.

[0029] In Figure 1 the strip 1 is fed to the coiling apparatus from the right. In case of the strip-shaped material being metal foil, it may be delivered from a rolling process. On its way to the coiling-spool 1 the strip 2 is led through a dual wrap angle deflection roller device comprising a shape meter roll 3 and a tucking roll 4, the shape meter roll 3 being situated upstream of the tucking roll 4. First, the strip 2 is led over the shape meter roll 3, its arc of strip coverage on the shape meter roll 3 being low wrap angle α_1. The arc of strip coverage of the shape meter roll 3 a is the angle between the plane of the incoming strip 2 and the plane of the strip 2 after it has left the shape meter roll 3. The wrap angle is determined by the position of the tucking roll 4. In Figure 1, the tucking roll 4 is in its so called low wrap angle position. After leaving the tucking roll 4 the strip reaches the coiling-spool 1 which is fastened on a driven coiler unit 5, whose drive mechanism is not shown. The axes of rotation of the shape meter roll 3 and of the tucking roll 4 are parallel to the axis of rotation of the coiler unit 5 and to the axis of rotation of the coiling-spool 1 respectively.

Figure 1 shows the strip path in the moment when coiling starts 6a and the strip path in a moment during coiling 6b when the coil 7 is built up. When coiling starts, the strip enters the coiling-spool 1 in tangent point 8a, when strip path 6b is followed, the strip enters the coil 7 in tangent point 8b. Tangent point path 9 shows the tangent points passed through during coiling.

An ironing roll 10 is carried by a pivoted lever 11 of constant length, which is pivotable about a pivot point in its high position 12a. The swivel axis of the pivot point in its high position 12a is situated lower than the lowest point of the tucking roll in its low wrap angle position, which is the highest tucking roll position achievable in the dual wrap angle device of Figure 1. The pivot point's high position 12a is the highest position achievable for the pivot point in the coiling apparatus of Figure 1. The actuation means for pivoting the pivoted lever is not shown. Figure 1 shows two positions of the pivoted lever 11 and the ironing roll 10 which correspond to the different strip paths 6a, 6b shown, in the moment when coiling starts and in a moment during coiling when the coil 7 is built up to a certain extent. When coiling starts, the ironing roll 10 contacts the strip in contact point 13a, when strip path 6b is followed, the ironing roll 10 contacts the coil in contact point 13b in a moment during coiling when the coil 7 is built up to a certain extent. Contact point path 14 shows the contact points passed through during coiling. Throughout build up of the coil 7 the distance between the tangent point and the contact point is kept between defined limits, thus ensuring optimal coiling conditions.

[0030] Figure 2 shows the apparatus of Figure 1 in which the position of the dual wrap angle deflection roller device's tucking roll 4 has been changed to high wrap angle position by vertical downward displacement of the tucking roll 4. The arc of strip coverage on the shape meter roll 3 is high wrap angle α_2. Hence, the strip path when coiling starts 6a and when the coil is built up 6b are different from Figure 1, and therefore the tangent point path 9 is different, too. The pivoted lever 11 is pivotable about the pivot point in its low position 12b. Therefore, the contact point when coiling starts 6a and when the coil is built up 6b as well as the contact point path 14 are different from Figure 1. Again, throughout build up of the coil 7 the distance between the tangent point and the contact point is kept between defined limits, thus ensuring optimal coiling conditions.

The swivel axis of the pivot point in its low position 12b is situated lower than the lowest point of the tucking roll in its high wrap angle position, which is the lowest tucking roll position achievable in the dual wrap angle device of Figure 2. The pivot point's low position 12b is the lowest position achievable for the pivot point in the coiling apparatus of Figure 2.

[0031] Figure 1 and Figure 2 depict the same coiling apparatus in two different wrap angle positions and pivot point positions. For comparison of the relative positions of the pivot point's high position 12a and the pivot point's low position 12b both are shown in Figure1 and Figure 2. As can be seen in both figures both pivot point positions 12a and 12b, and thereby their swivel axes, are located below the level of the highest point of the coiling-spool 1 and above the level of the coiling spool's longitudinal axis 19.

Figure 3a and Figure 3b show how the pivoted lever's 11 pivot point is positioned. A secondary pivoting arm 15 is movable about a fulcrum 16 by a hydraulic actuator 17. The pivot point of the pivoted lever 11 is mounted on the secondary pivoting arm 15. In Figure 3a the secondary pivoting arm 15 is fixed in an upper position by being forced against a fixed stop 18a. In Figure 3b the secondary pivoting arm 15 is fixed in a low position by being forced against a fixed stop 18b. In Figure 3a the pivot point is in its high position 12a and in Figure 3b it is in its low position 12b.

Claims

1. Apparatus for coiling a strip-shaped material, preferably a metal foil, to a coil (7), with a horizontal coiler unit (5) for receiving a coiling-spool (1) on which the strip-shaped material (2) is wound during coiling,
with at least one ironing roll (10) for pressing the strip-shaped material (2) on the coil (7), which ironing roll (10) is carried by at least one pivoted lever (11) of constant length that is pivotable about the swivel axis of an adjustable pivot point (12a, 12b),
and with a deflection roller device for monitoring the strip-shaped material's shape which comprises a shape meter roll (3) and, situated downstream of the shape meter roll (3) between the coiling-spool (1) and the shape meter roll (3), a tucking roll (4),
characterized in that
the tucking roll (4) is at least vertically adjustable and fixable in at least two tucking roll positions,
and the adjustable pivot point (12a,12b) is fixable in at least two pivot point positions, which are positioned in such a way that for each tucking roll position there exists a pivot point position in which, throughout coiling, the distance between the ironing roll's contact point with the coil and the strip-shaped material's tangent point onto the coil (7) is maintained at the optimum working distance within a tolerance of ±5 mm.

2. Apparatus according to claim 1, **characterized in that**
the at least two pivot point positions are located downstream of the tucking roll (4),
the swivel axis of the pivot point (12a,12b) in its lowest position being located lower than the lowest point of the tucking roll (4) in its lowest position,
and the swivel axis of the pivot point (12a,12b) in its highest position being located lower than the lowest point of the tucking roll (4) in its highest position,
and for all pivot point positions the swivel axis of the pivot point (12a,12b) being located lower than the level of the highest point of the coiling-spool (1).

3. Apparatus according to claim 2, **characterized in that** the tucking roll positions and the swivel axes of the pivot point positions are located above the level of the coiling-spool's longitudinal axis (19).

4. Apparatus according to any one of claims 1 to 3, **characterized in that** the adjustable pivot point (12a,12b) is mounted on a secondary pivoting arm (15) which is movable about a fulcrum (16) and which is fixable in at least two positions.

5. Apparatus according to any one of claims 1 to 4, **characterized in that** the at least two fixed positions of the secondary pivoting arm (15) are defined by fixed stops (18a,18b).

6. Apparatus according to any one of claims 1 to 5, **characterized in that** the locations of the fixed stops (18a,18b) are adjustable.

7. Method for coiling a strip-shaped material, preferably a metal foil, to a coil by means of a horizontal coiler unit for receiving a coiling-spool on which the strip-shaped material is wound during coiling,
the strip material being pressed on the coil by an ironing roll during coiling,
and the position of the ironing roll being adjusted during coiling by pivoting the at least one pivoted lever of constant length carrying the ironing roll about the swivel axis of its pivot point,
and the strip material being led prior to coiling through a deflection roller device comprising a shape meter roll and, situated downstream of the shape meter roll between the coiling-spool and the shape

meter roll, a tucking roll,
characterized in that

- the position of the tucking roll of the deflection roller device is adjusted at least vertically before coiling starts and remains fixed throughout coiling, and
- the pivot point of the pivoted lever, which remains fixed throughout coiling, is adjusted before coiling starts, in dependency on the position of the tucking roll, in such a way that throughout coiling the distance between the path of the ironing roll's contact point with the coil and the path of the strip material's tangent point onto the coil is maintained at the optimum working distance within a tolerance of ±5 mm.

8. Method according to claim 7, **characterized in that** the pivot point of the at least one pivoted lever is adjusted in such a way that the lowest point of the tucking roll is situated higher than the swivel axis of the pivot point and lower than the level of the highest point of the coiling-spool.

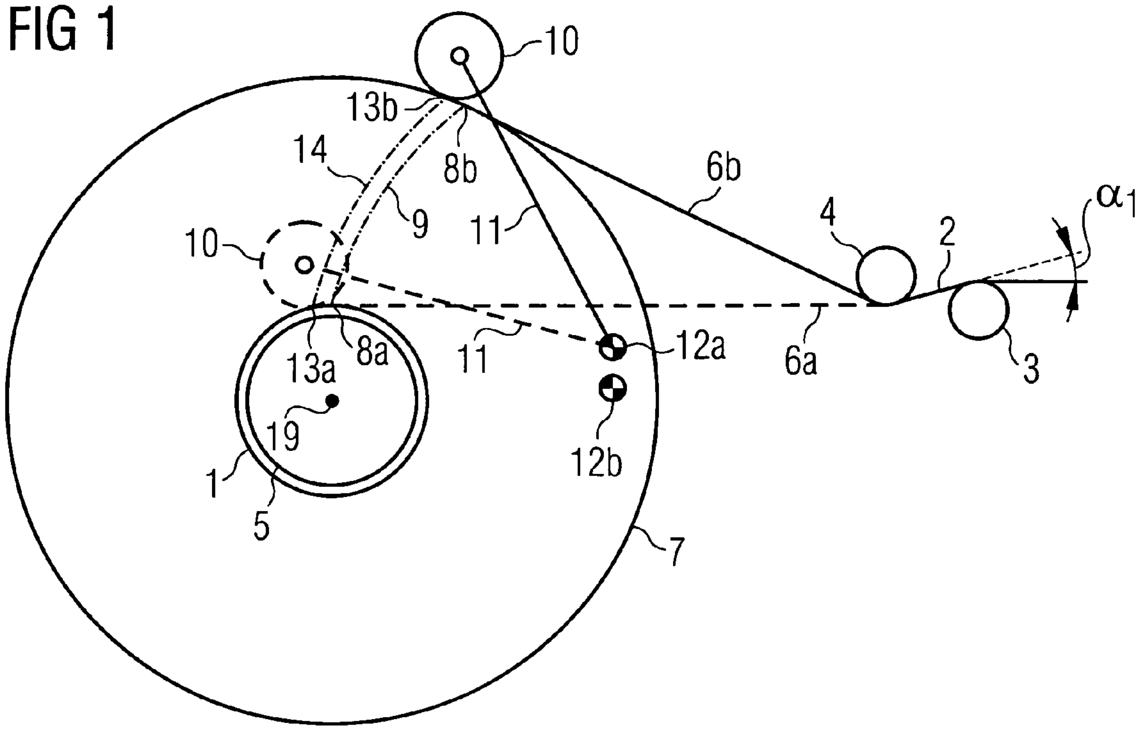
9. Method according to one of claims 7 and 8, **characterized in that** the tucking roll and the swivel axis of the pivot point of the at least one pivoted lever are adjusted in such a way that they are situated above the level of the coiling-spool's longitudinal axis.

10. Method according to any one of claims 7 to 9, **characterized in that** the adjustment of the pivot point of the at least one pivoted lever is effected by movement of a secondary pivoting arm.

11. Method according to claim 10, **characterized in that** the movement of the secondary pivoting arm is swiveling about a fulcrum between at least two fixed stops.

12. Method according to claim 11, **characterized in that** the pivot point of the pivoted lever is fixed by forcing the secondary pivoting arm against a fixed stop.

FIG 1


10
13b
14
8b
6b
9
11
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α1
10
12a
13a
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6a
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19
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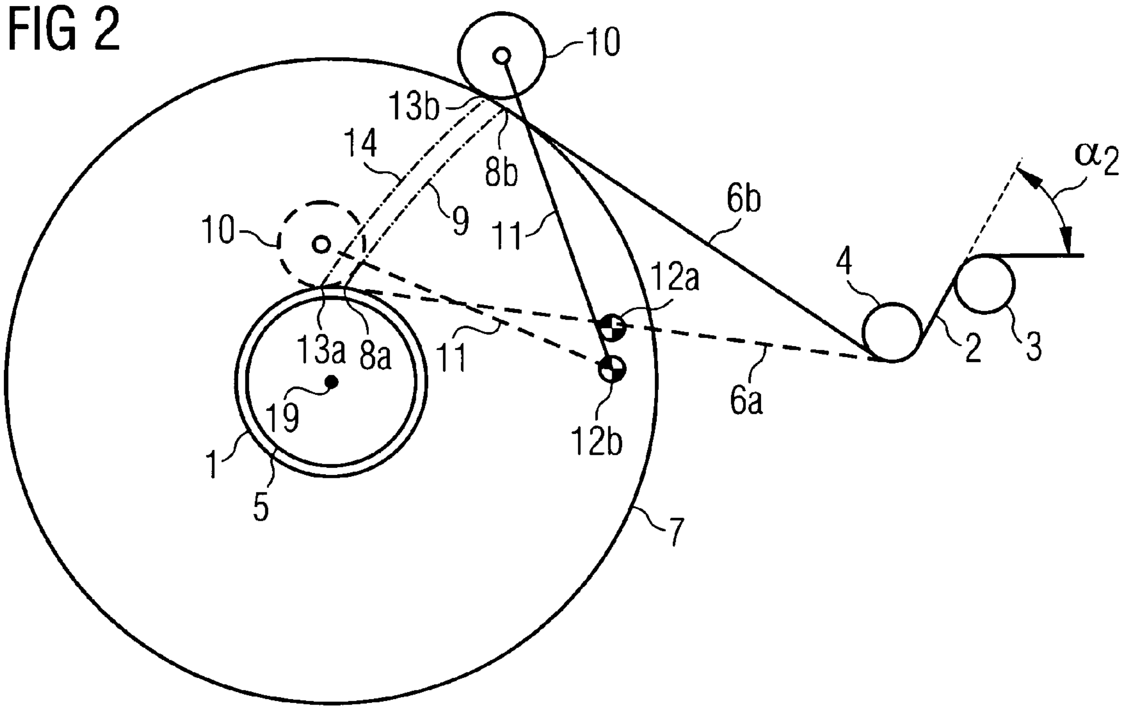
5
7

FIG 2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14
8b
6b
α2
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12a
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13a
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11
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7

FIG 3A

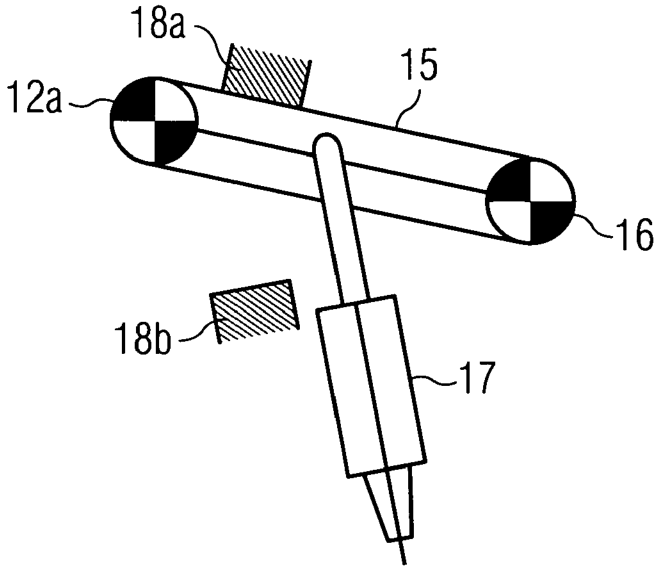
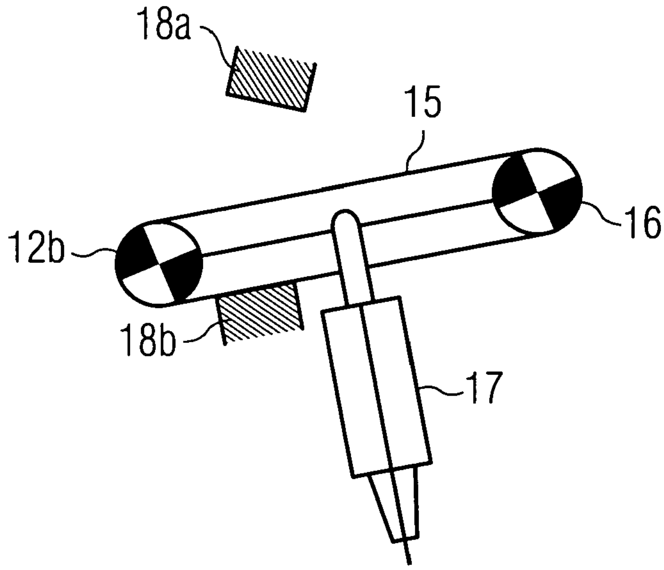


FIG 3B



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 25 1504

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 5 275 345 A (STAHL WERNER [DE] ET AL) 4 January 1994 (1994-01-04) * column 2, line 25 - line 42 * * column 4, line 7 - line 22; figure 1 *	1,4,7,10	INV. B21C47/06 B65H18/26
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D,A	US 5 957 404 A (FRAMPTON ANDREW [US] ET AL) 28 September 1999 (1999-09-28) * the whole document *	1,7	
A	JP 03 289510 A (SHOWA ALUMINUM CORP) 19 December 1991 (1991-12-19) * abstract; figures 1,2 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

B21C
B21B
B65H

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	9 May 2008	Ritter, Florian

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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09-05-2008

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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