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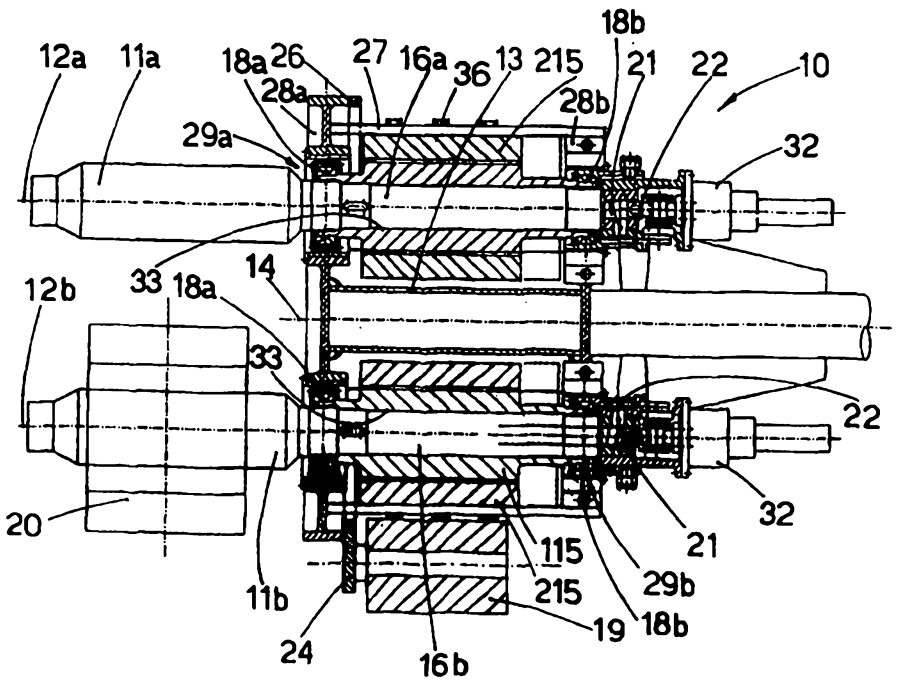
(54) Title: CAROUSEL WINDING REEL

(57) Abstract

Carousel winding reel (10) for thin or very thin strip/sheet, up to 0.5 mm, hot rolled and leaving in a continuous strip from a rolling train at speeds of 20 metres per second and more, the reel (10) comprising a pair of mandrels (11a, 11b) arranged with their respective axes parallel to each other (12a, 12b) and associated with a structure (13) able to rotate around a longitudinal axis (14) substantially between the axes (12a, 12b), the rotatable structure (13) including a front body side (28a) and a rear body side (28b), the mandrels (11a, 11b) including alternatively a position of winding and a stand-by position, the mandrels (11a, 11b) and the rotatable structure (13) cooperating with respective drive means and with a beam structure (17) attached to the floor, wherein the drive means of the mandrels (11a, 11b) consist of respective motors (15a, 15b) each of which is arranged coaxially with the respective mandrel (11a, 11b) and is positioned between the said body sides (28), the motors (15) including a stator (215) and a rotor (115), the body sides (28) including the seatings (29) of the main bearings (18) of the rotor (115), the stator (215) being connected to at least one body side (28) by anti-torsion means (27).



"CAROUSEL WINDING REEL"

FIELD OF THE INVENTION

This invention concerns a carousel winding reel for hot-rolled strip/sheet as set forth in the main claim.

The winding reel according to the invention is applied at the outlet of a finishing train in a continuous hot rolling line for thin or very thin strip/sheet, up to 0.5 mm, with speeds at outlet which may reach 20 metres per second and more.

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

BACKGROUND OF THE INVENTION

In the field of rolling flat products there is an increasingly marked tendency on the part of constructors to seek solutions for the high efficiency production of thin and ultra-thin rolled stock leaving the finishing train at ever greater speeds.

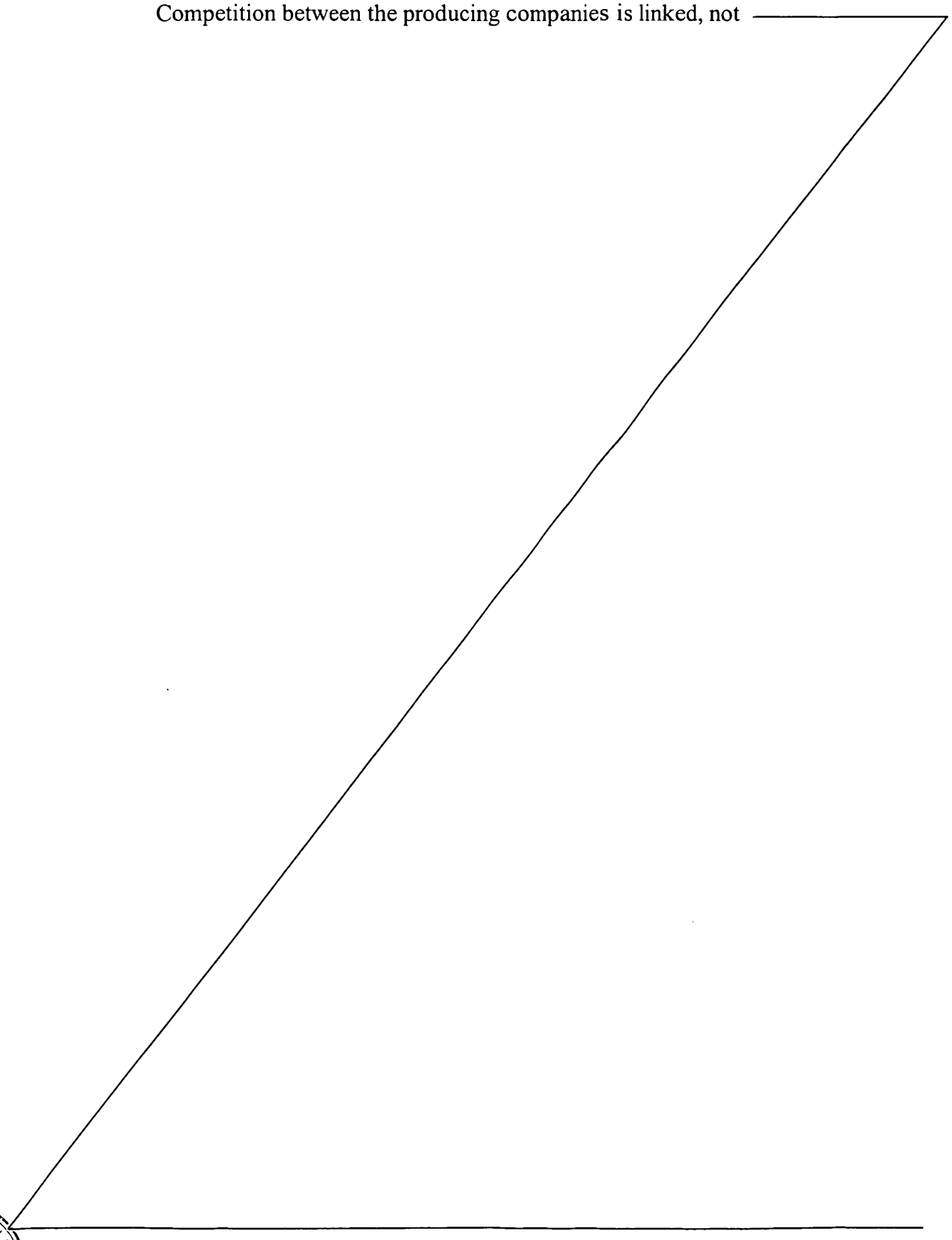
The thinner the strip is, the greater must be the speed at which it leaves the finishing train; this is because it is necessary to maintain the rolling temperature and the winding temperature within well-defined fields, for both technological and metallurgical reasons.

It is well-known that there is an increasing demand on the part of users for finished strip and sheet with a thickness of less than 1 mm, to as little as 0.5÷0.6 mm, since these values offer two possibilities:

- cold rolling can be eliminated and the hot rolled product may be used directly, or after pickling. This solution uses thicknesses of more than 0.6 mm.

- the rolling passes in cold rolling mills and also any intermediate heat treatments may be reduced. In this case thicknesses of less than 0.6 and as little as 0.1 mm are used.

Competition between the producing companies is linked, not



only to the quality of the final product, but also to the speed with which the strip/sheet can be extracted from the finishing train and wound onto the respective collection means. The greater the speed, the higher the production.

In the light of the fact that there are more and more endless rolling systems, even in hot rolling mills, it has become evident that one of the main obstacles against obtaining, in a highly efficient and continuous manner, speeds of above 10 metres per second to as much as 20 metres per second and more, is that of coiling the strip/sheet as it leaves the finishing train.

For this purpose, the state of the art has developed a winding reel of the rotary type, which is placed at the outlet of the finishing train, and is called a carousel reel.

The winding reel includes at least two mandrels which exchange their working position alternately and continuously, that is to say the position in which they wind the strip as it leaves the finishing train and the position in which they wait for the subsequent strip.

With this solution the winding conditions are always the same, regardless of which mandrel the strip is wound onto.

This does not happen in conventional downcoilers where slight differences in functioning (which are difficult to compensate, because they have origins which cannot be controlled), as well as differences in the path followed by the strip, can cause different winding conditions which have an effect on the geometric quality of the coil and on the metallurgical quality of the strip.

In the winding cycle of the carousel winding reel, after the strip has started winding onto the first mandrel in the working position and a desired number of spirals have been wound, the reel rotates and, while the first mandrel

continues and concludes the winding, the second mandrel places itself in the working position while it waits for the next strip.

At this point a shears element intervenes; it is placed between the finishing train and the entrance to the winding reel, and shears to size the strip with respect to the continuous rolled stock and thus obtains coils of finished weight.

Carousel winding reel such as are known to the state of the art therefore include at least a pair of winding mandrels associated with a supporting structure which is governed by a drive mechanism suitable to make it rotate through an arc of at least 180°, in order to perform the variations in the position of the said mandrels according to the step of the winding cycle.

In the state of the art the drive mechanisms for the mandrels include complex kinematisms with off-axis motors fixed to the floor which supply motion by means of kinematic chains including respective transmission gears, or which use transmission systems with a universal joint or similar.

Although these proposals of the state of the art are satisfactory for particular and limited applications, they have not shown themselves to be efficient enough in hot rolling mills where the radiance of the strip can cause thermal deformations of the structure and where it is necessary to begin winding at the same operating speed, something which never happens in cold rolling mills.

Moreover, these solutions do not obtain high productivity winding cycles with the extremely high outlet speeds of the strip/sheet from the finishing train, speeds of up to 20 metres per second and more, which present-day technology can achieve and with the ever more reduced thickness of the strip, as required by the market.

The limitations of the proposals known to the state of the art concern the resistance to stresses of a mechanical, heat and electric nature, given the violent slopes of acceleration/deceleration to which the mandrels are subjected during the steps preparatory to winding and at the end of winding.

To be more exact, the mandrel is subject to high torsional stress because of the axial distance with respect to the motor.

Other disadvantages concern the complexity of assembly-disassembly, the difficulty of maintenance operations, premature wear of the more delicate components of the kinematic chain and other problems.

JP-A-61.124478 teaches that every shaft of each mandrel is associated with an electric motor, the stator being made solid with the rotatable structure.

By extracting the mandrel shaft, which operates on bearings on the rotatable structure, it is possible to remove the electric motor once the stator has been disconnected from the rotatable structure.

This teaching is interesting, but there are considerable problems connected with the day-to-day maintenance of the mandrel, which causes frequent maintenance work, and with the non-routine maintenance of the motor.

Moreover, there are problems to arrange the rotor and the stator coaxial, and to arrange the mandrel shaft and the rotor coaxial.

EP-A-0.812.634, precisely to reduce the problems typical of JP-A-61.124478, teaches that the rotatable structure should have seatings onto which electric motors complete with casings are applied.

The casing bears the main bearings of the rotor and the assembly structure allows to extract the mandrel, extract

the rotor alone and also with the mandrel and to dis-assemble the casing to remove the stator too.

This solution is also interesting, but has disadvantages such as the increased weight caused by the casings of the motor, the alignment of the main bearings of the rotor, the reduced rigidity of the structure, since the drawing force of the sheet or strip is supported by the individual casing, the connection between the casing and the rotatable structure when there are continuous vibrations and stresses, the centrifugal force which is discharged on the casing and on the clamping means.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a carousel winding reel for thin or very thin strip/sheet, up to 0.5 mm, hot rolled and leaving as a continuous strip from a rolling train at speeds of 20 metres per second and more, the reel comprising a pair of mandrels arranged with their respective axes parallel to each other and associated with a structure able to rotate around a longitudinal axis substantially between the axes of said mandrels, the rotatable structure including a front body side and a rear body side, the mandrels including alternately a position of winding and a position of stand-by, the mandrels and the rotatable structure cooperating with respective drive means and with a beam structure attached to the floor, wherein the drive means of the mandrels consist of respective motors each of which is arranged coaxially with the respective mandrel and is positioned between the said body sides, the motors including a stator and a rotor, the stator of each motor being connected with at least one of said body sides by anti-torsion means, wherein each of said body sides comprises a central base element and two removable cap elements associated thereto and in that the seatings for the main bearings of the rotor of each motor are realised partly in said central base element and partly in said two removable cap elements.

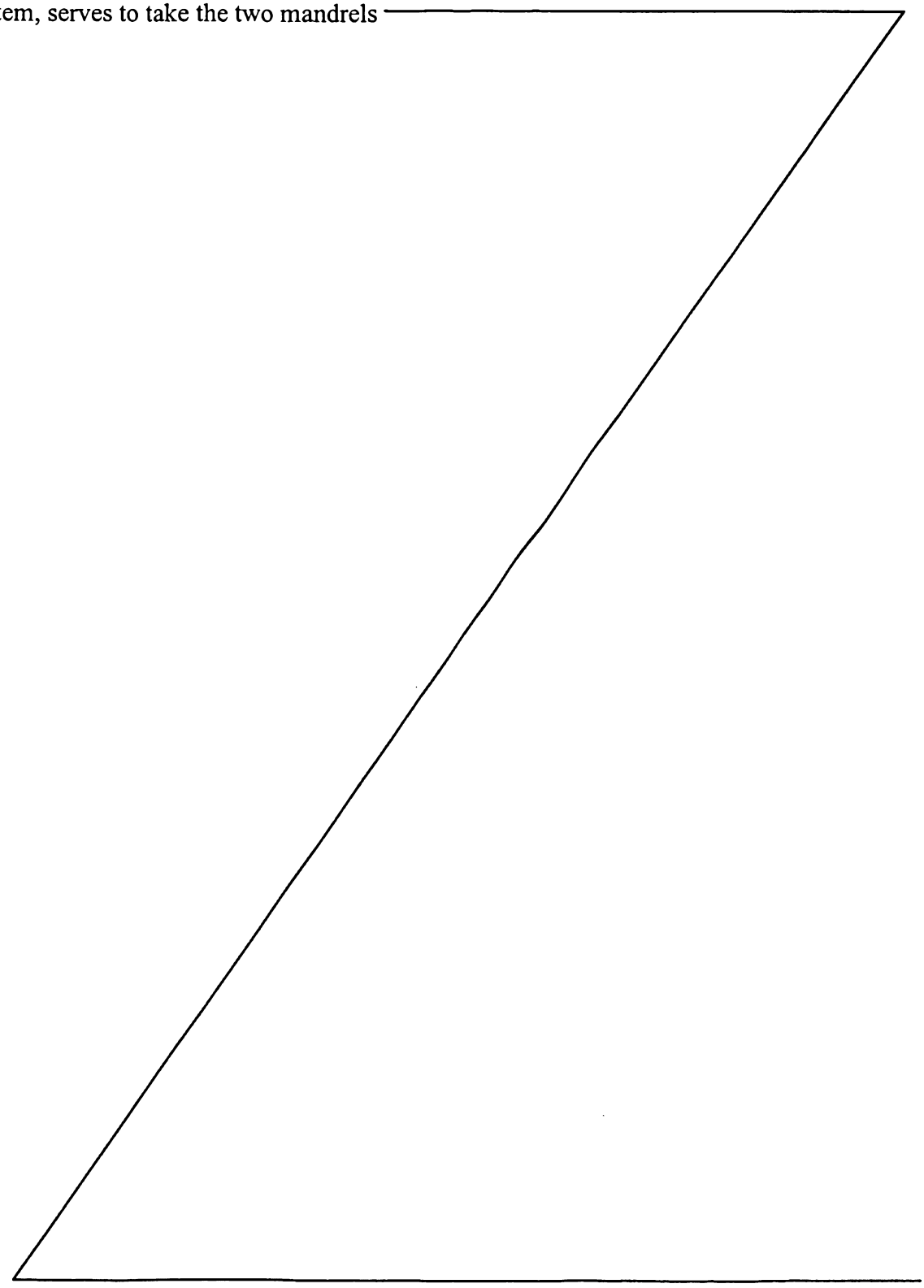
Unless the context clearly requires otherwise, throughout the description and the claims, the words 'comprise', 'comprising', and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

According to a second aspect of the present invention there is provided a carousel winding reel for thin or very thin strip/sheet, up to 0.5 mm, hot rolled and leaving as a continuous strip from a rolling train at speeds of 20 metres per second and more, the reel comprising a pair of mandrels arranged with their respective axes parallel to each other and associated with a structure able to rotate around a longitudinal axis substantially between the axes of said mandrels, the rotatable structure including a front body side and a rear body side, the mandrels including alternately a position of winding and a position of stand-by, the mandrels and the rotatable structure cooperating with respective drive means and with a beam structure attached to the floor, wherein the drive means of the mandrels consist of respective motors each of which is arranged coaxially with the respective mandrel and is positioned between the said body sides, the motors including a stator and a rotor, the stator being connected with at least one body side by anti-torsion means, wherein the body sides include the seatings for the main bearings of the rotor, and the rotors include an axial cavity associated with the respective shaft of the mandrel, which association being torsionally stable and axially movable.

Advantageously, at least in a preferred form the present invention provides a winding reel, specifically designed for the hot coiling of thin strip/sheet at high speed, that is to say at speeds higher than 10 metres per second to more than 20 metres per second, suitable to ensure high performance, greater torque transmitted, reliability, high productivity, efficiency, little maintenance, and high resistance to mechanical and heat stresses.

The winding reel according to the invention has a pair of mandrels rotating on their own longitudinal axis and associated with a structure able to rotate around an axis substantially between the axes of the mandrels.

The rotation of the structure during the winding cycle, as in a conventional system, serves to take the two mandrels



alternately from the working position to the stand-by position and vice versa, so as to obtain coils of finished weight from strip leaving the finishing train continuously and at high speed.

The mandrels have respective motors mounted on the axis of the longitudinal axis of the mandrel.

The motors are the type with an axial cavity into which the shaft of the relative mandrel is inserted, torsionally connected; they are arranged immediately next to the rotatable structure which supports the mandrels and positions them circumferentially.

The motors extend symmetrically on one side and the other of the axis of rotation of the rotatable structure, which cooperates with drive means which position the said structure and make it rotate.

According to the invention, the rotors are supported by bearings which are housed in seatings made in the two body sides of the rotary structure; the body sides are positioned in front and behind the rotor, and in contact therewith.

In this way it is possible to have a rigid, stable structure.

The stator is torsionally connected to one body side, for example the front body side, or to a bar element which connects the two body sides.

The seating for the bearings is made so as to cooperate with a cap-type element which is stably connected with attachment means to the underlying base; the cap-type element and the underlying base together form one body side.

This solution maintains a high structural rigidity of the system and at the same time it makes it possible to dismantle both the mandrel and the rotor plus the stator together.

According to a variant, the stator is divided lengthwise

into two parts, so that by opening the stator, that is, by dismantling one of its parts, it is possible to remove the rotor without dismantling the whole stator.

The axial position of the motors connected to the respective shafts of the mandrel, and also the proximity to the position of maximum load, minimises the forces and mechanical stresses for the transmission of motion, even when there are extremely steep slopes of acceleration/ deceleration.

In fact, the connection of the motor and mandrel is extremely compact and torsionally rigid.

This solution simplifies and lightens the structure, and makes it extremely easy and quick to maintain or replace any components or even the mandrel itself.

According to one embodiment of the invention, the means to circumferentially position the rotatable structure consist of motor means arranged on the axis of the axis of rotation of the structure.

According to a variant, the circumferential positioning means consist of motor means with an axis orthogonal to the axis of rotation and connected to the rotatable structure by a kinematic chain with bevel gears. or with a worm screw.

According to a further variant, the circumferential positioning means consist of motor means with an axis lying on a plane parallel to but misaligned from the axis of rotation of the structure, and cooperating with intermediate means to transmit motion.

BRIEF DESCRIPTION OF THE DRAWINGS

The attached Figures are given as a non-restrictive example and show two preferential embodiments of the invention as follows:

Fig. 1 shows a side view of a first embodiment of the carousel winding reel according to the invention;

Fig. 2 shows in part cross section a variant of Fig. 1;

Fig. 3 is a front view from "A" of the variant shown in Fig. 1;

Fig. 4 shows a variant of the axial motor shown in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The carousel winding reel 10 for hot winding according to the invention is shown in two possible variants in Figs. 1 and 2.

The reel 10 has an axis of rotation and positioning 14 and two rotating mandrels, 11a and 11b, including respective longitudinal axes 12a and 12b and mounted cantilevered with respect to a rotatable structure 13.

The axis of rotation and positioning 14 is between the two axes 12a and 12b.

According to the invention, each mandrel 11a, 11b is axially associated with a respective drive motor, respectively 15a and 15b.

Each drive motor 15a, 15b consists of a rotor 115 and a stator 215.

The stator 215 is made torsionally attached to the rotatable structure 13 by anti-torsion means 27 which are connected to the stator 215 by attachment means 36.

The anti-torsion means 27 may be of the bridge type, connecting the body sides 28a and 28b of the rotatable structure 13, or they may be associated with one body side 28 or the other.

The seatings 29a and 29b for the main bearings 18a, 18b are on the body sides 28a and 28b.

The seatings 29 are obtained substantially orthogonally to the plane of conjunction 34 between the cap-type element 30 and the base 31, the cap-type element 30 being made temporarily solid with the base 31 by attachment means so as to form one body side 28 or the other.

The bearings 18a and 18b cooperate directly with the rotor 115, they position it and support it.

In order to remove the motor 15, first the stator 215 must be disconnected from the anti-torsion means 27 and then the cap-type elements 30 corresponding to the bearings of a rotor 115 must be dismantled.

The rotor 115 has an axial seating 33 suitable to receive the shaft 16 of the mandrel 11, clamping it torsionally but leaving it free to slide axially.

Rear hydraulic means 32 axially clamp the shaft 16 and give it the hydraulic and command functions it needs; the rear hydraulic means 32 include conventional means to axially clamp-unclamp the shaft 16 and to provide the necessary services and commands.

In the case shown in Figs. 1 and 3, the front body side 28a is located on rollers 37 and the rotatable structure 13 is supported at the rear by a support 38 which supports the shaft connected to the motor 19 which serves to circumferentially position the rotatable structure 13 and therefore the mandrels 11.

The position of the motors 15a, 15b on an axis with the respective mandrels 11a, 11b and directly gripping the mandrel shafts 16a, 16b in a position of close proximity ensures an extremely efficient transmission of motion, resistant to mechanical, heat and electric stresses, even violent ones, in a structure which is easy to maintain and to dis-assemble.

The motor 19 allows the rotatable structure 13 to rotate so as to take the mandrels 11a, 11b, according to the step of the winding cycle, from the winding position to the stand-by position and vice versa.

The inclusion of the motor 19 coaxial with the axis of rotation of the rotatable structure 13 and directly gripping

the rotation shaft without intermediate elements to transmit the motion, such as gears, joints, etc. ensures a high resistance to mechanical stresses and an efficient transmission of motion.

Fig. 2 shows an example of the rapid attachment/detachment elements 21 and the assembly bushings 22 for the rapid replacement of the mandrels 11a, 11b.

Fig. 1 shows the vertical supporting element 23 which supports the coil 20 once winding is completed and the relative trolley 25 to extract the coil 20 from the reel.

There may also be included a further supporting element cooperating with the outer end of the mandrel shaft and not shown here; it is used to support the weight of the coil 20 as it is being wound in the final position.

In the variant shown in Fig. 2, the motor 19 which makes the rotatable structure 13 rotate is placed on an axis parallel to but not coincident with the longitudinal axis of rotation 14 of the structure itself and transmits the motion thereto by means of a transmission gear 24 and a toothed wheel 26.

According to a further variant, the motor 19 has an axis orthogonal to the longitudinal axis 14 of the rotatable structure 13.

Fig. 4 shows a variant of the motor 15 in which the stator 215 is in two halves (215a and 215b); the two halves are reciprocally attached and positioned by a connecting case 35 also of two halves 35a and 35b.

In this case the anti-torsion means 27 may be positioned in any position whatsoever, for example 127, also in relation to the half-body of the connecting case 35.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Carousel winding reel for thin or very thin strip/sheet, up to 0.5 mm, hot rolled and leaving as a continuous strip from a rolling train at speeds of 20 metres per second and more, the reel comprising a pair of mandrels arranged with their respective axes parallel to each other and associated with a structure able to rotate around a longitudinal axis substantially between the axes of said mandrels, the rotatable structure including a front body side and a rear body side, the mandrels including alternately a position of winding and a position of stand-by, the mandrels and the rotatable structure cooperating with respective drive means and with a beam structure attached to the floor, wherein the drive means of the mandrels consist of respective motors each of which is arranged coaxially with the respective mandrel and is positioned between the said body sides, the motors including a stator and a rotor, the stator of each motor being connected with at least one of said body sides by anti-torsion means, wherein each of said body sides comprises a central base element and two removable cap elements associated thereto and in that the seatings for the main bearings of the rotor of each motor are realised partly in said central base element and partly in said two removable cap elements.

2. Winding reel as in Claim 1, wherein the rotors include an axial cavity associated with the respective shaft of the mandrel, the association being torsionally stable and axially movable.

3. Winding reel as in Claim 1 or 2, wherein the planes of conjunction of said cap elements with said central base element are substantially parallel therebetween and to said longitudinal axis.

4. Winding reel as in Claim 3, wherein the plane of conjunction divides the seatings of the main bearings into two substantially coinciding halves.

5. Winding reel as in any one of claims 1 to 4, wherein the drive means of the rotatable structure consist of motor means coaxial with the longitudinal axis of rotation of the rotatable structure.

6. Winding reel as in any one of claims 1 to 4 inclusive, wherein the drive means of the rotatable structure consist of motor means arranged with their axis parallel to and misaligned from the longitudinal axis of rotation of the rotatable structure.

7. Winding reel as in any one of claims 1 to 4, wherein the drive means of the rotatable structure consist of motor means arranged with their axis orthogonal to the longitudinal axis of rotation of the rotatable structure.

8. Carousel winding reel for thin or very thin strip/sheet, up to 0.5 mm, hot rolled and leaving as a continuous strip from a rolling train at speeds of 20 metres per second and more, the reel comprising a pair of mandrels arranged with their respective axes parallel to each other and associated with a structure able to rotate around a longitudinal axis substantially between the axes of said mandrels, the rotatable structure including a front body side and a rear body side, the mandrels including alternately a position of winding and a position of stand-by, the mandrels and the rotatable structure cooperating with respective drive means and with a beam structure attached to the floor, wherein the drive means of the mandrels consist of respective motors each of which is arranged coaxially with the respective mandrel and is positioned between the said body sides, the motors including a stator and a rotor, the stator being connected with at least one body side by anti-torsion means, wherein the body sides include the seatings for the main bearings of the rotor, and the rotors include an axial cavity associated with the respective shaft of the mandrel, which association being torsionally stable and axially movable.

9. Winding reel as in Claim 8, wherein correspondence with a seating of the main bearings there is the plane of conjunction of a cap element with the base, the combination of at least one cap element and the base constituting a body side.

10. Winding reel as in Claim 9, wherein the plane of conjunction divides the seatings of the main bearings into two substantially coinciding halves.

11. Winding reel as in Claim 8, wherein the drive means of the rotatable structure consist of motor means coaxial with the longitudinal axis of rotation of the rotatable structure.

12. Winding reel as in Claim 8, wherein the drive means of the rotatable structure consist of motor means arranged with their axis parallel to and misaligned from the longitudinal axis of rotation of the rotatable structure.

13. Winding reel as in Claim 8, wherein the drive means of the rotatable structure consist of motor means arranged with their axis orthogonal to the longitudinal axis of rotation of the rotatable structure.

14. A carousel winding sheet for thin or very thin strip/sheet substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

DATED this 21st day of December, 2000

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Attorney: JOHN D. FORSTER
Fellow Institute of Patent and Trade Mark Attorneys of Australia
of BALDWIN SHELSTON WATERS

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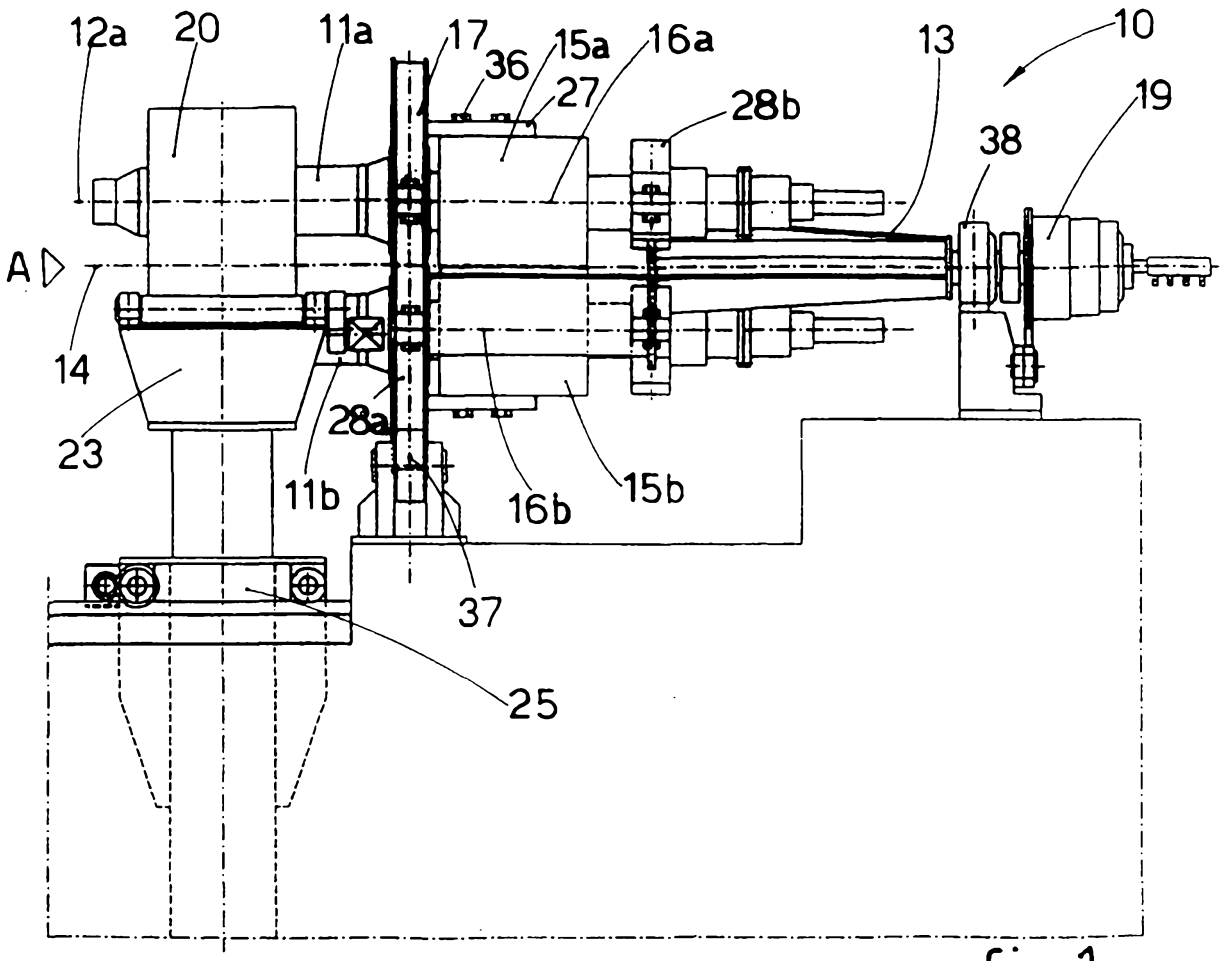
12a
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11a
17
36
15a
16a
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15b
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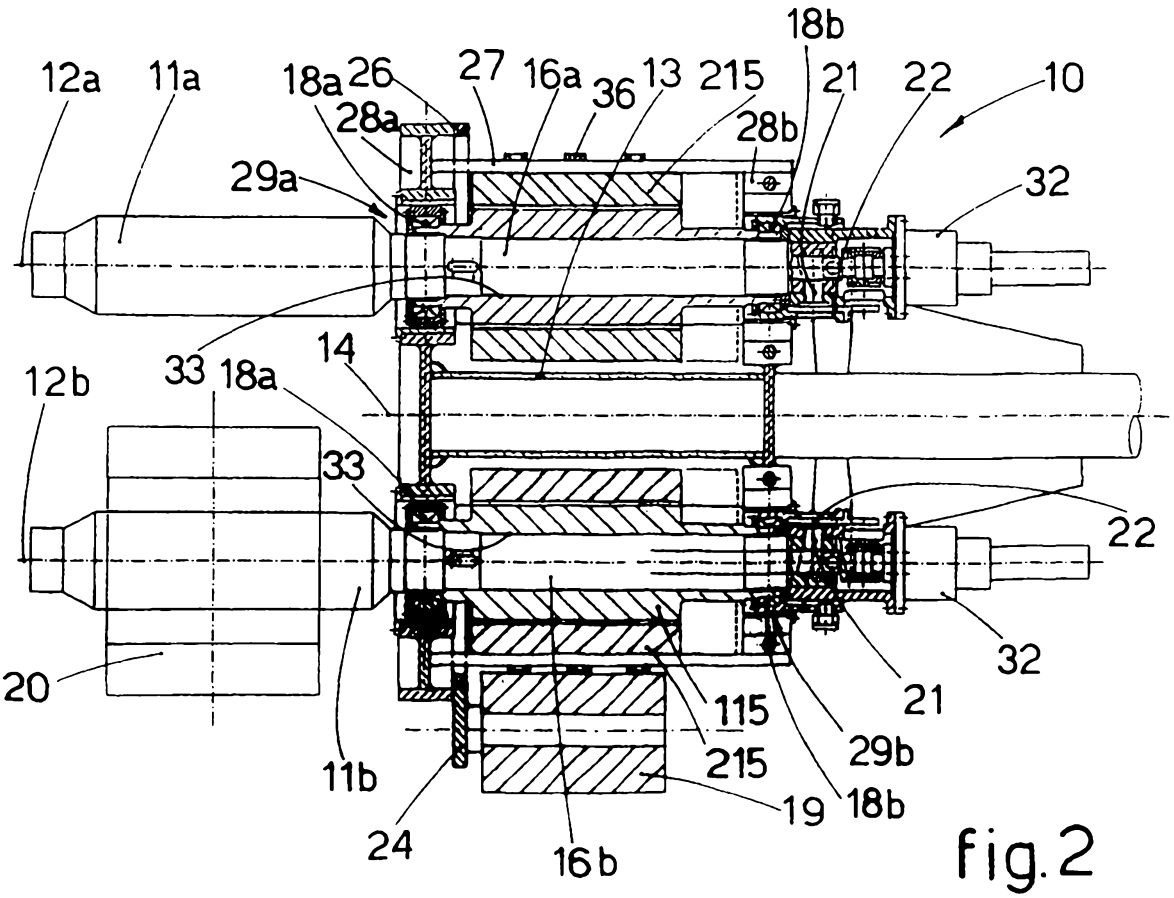
25

fig.1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19
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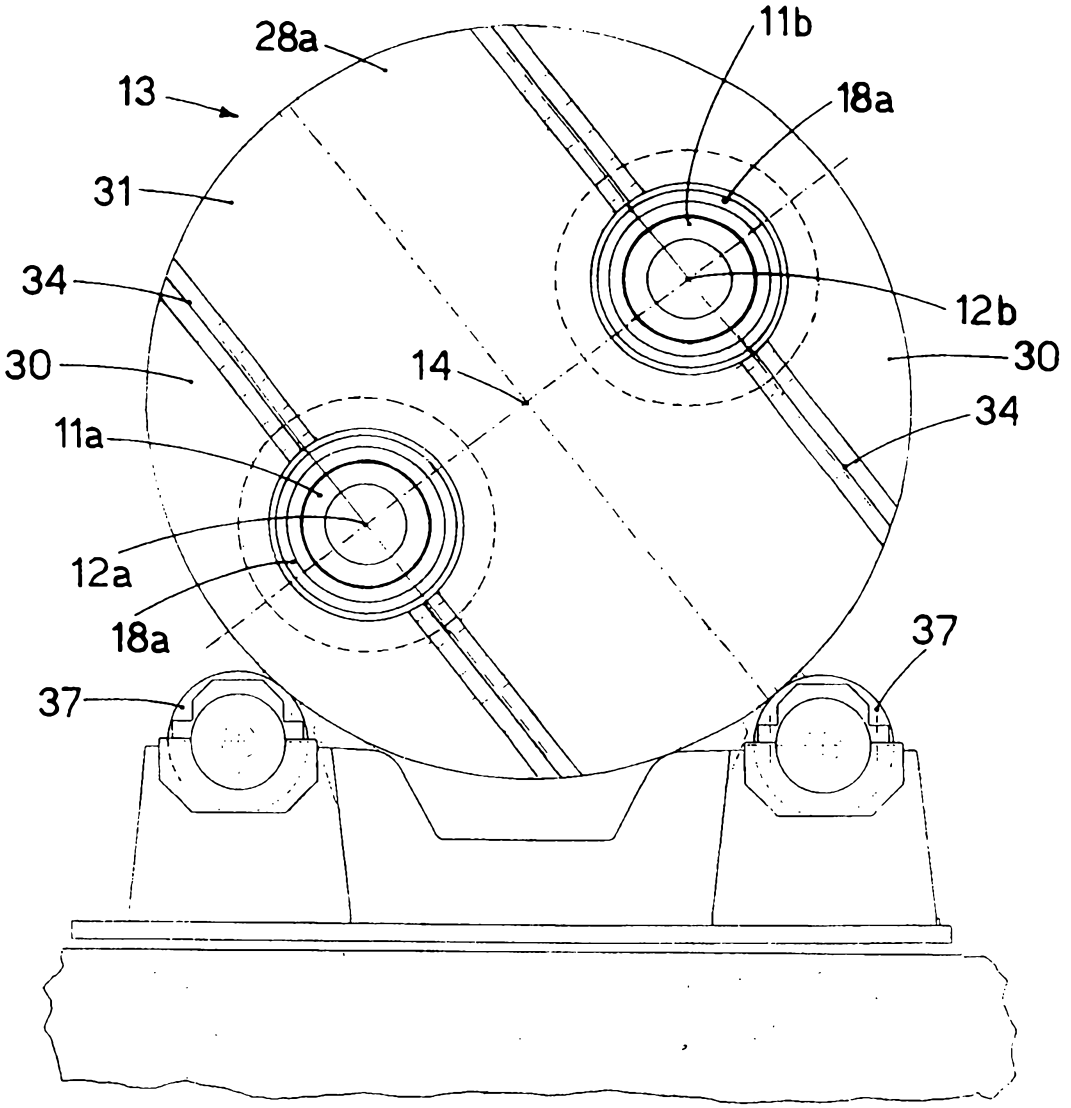
fig.2


28a
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12b
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14
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12a
18a
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fig.3

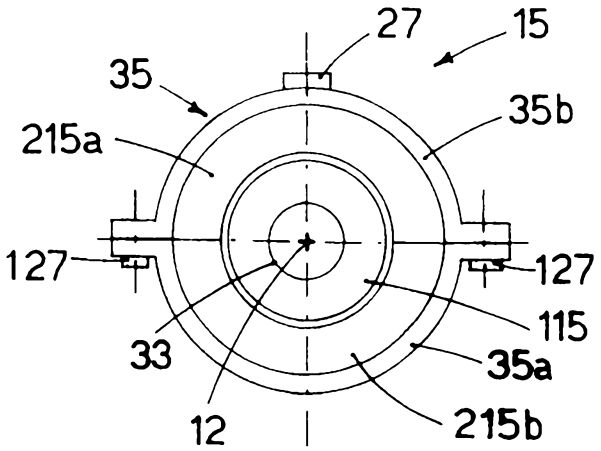
27
15
35
35b
215a
127
127
115
33
35a
12
215b

fig.4