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(54) **Title:** ROLL LINE MODULE FOR CONTINUOUS CASTING

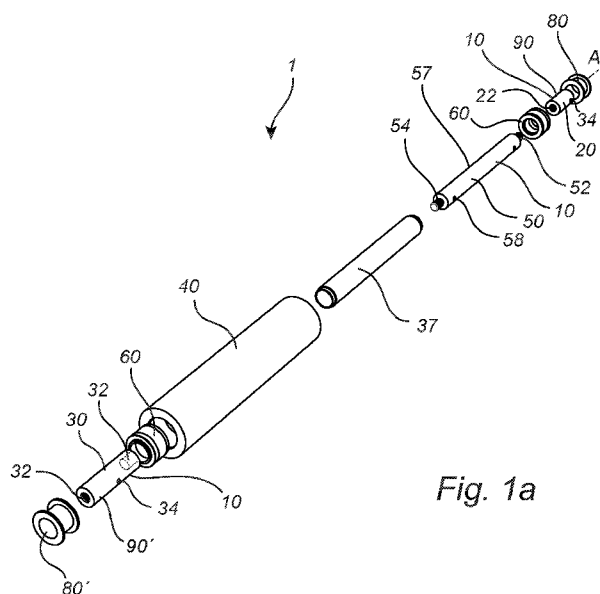


Fig. 1a

(57) **Abstract:** The present invention relates to a roll line module (1) for supporting and transporting hot material in a continuous caster, having an extension in an axial direction (A) and comprising a roll line shaft unit (10) and a roll mantle (40) enclosing the roll line shaft unit (10) along a circumferential direction (C), the roll mantle (40) having an outer surface (42) for supporting and transporting hot material: wherein the roll line shaft unit (10) comprises a first replaceable shaft end portion (20), a second replaceable shaft end portion (30), and an intermediate shaft portion (50) arranged therebetween, as seen in the axial direction (A); thereby the intermediate shaft portion (50), the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30) are maintained in axial alignment during rotation of the roll line module (1) the intermediate shaft portion (50) having a first end region (52) and a second end region (54); the first replaceable shaft end portion (20) having a first connecting portion (22) configured for being releasably connected to the first end region (52); and the second replaceable shaft end portion (30) having a second connecting portion (32) configured for being releasably connected to the second end region (54), allowing any of the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30) to be interchanged without interchanging the intermediate

shaft portion (50).

ROLL LINE MODULE FOR CONTINUOUS CASTING

Field of the Invention

The present invention relates to a roll line module for supporting and transporting hot material in a continuous caster. Moreover, the present invention
5 relates to a roll line shaft unit for a roll line module.

Background of the Invention

Continuous casting of steel, also called strand casting, is the process whereby slabs of metal are continuously cast from molten steel. More specifically, the molten
10 metal is poured from a ladle down into a tundish from which it is conveyed to a water-cooled mould. The molten steel is thereafter solidified into the semi-finished slab for subsequent rolling in the finishing mills. The slab is continuously fed between two tracks formed by a plurality of roll line modules that so as to further shape and cool the slab to the final thickness of the cast material. In this manner, the
15 slab is immediately supported by closely spaced rollers, i.e. roll line modules. To increase the rate of solidification, the roll line modules may be water-cooled or the slab may be sprayed with large amounts of water as it passes through a spray-chamber.

In a curved apron casting machine, the slab, or steel strand, exits the mould
20 vertically (or on a near vertical curved path) and as it travels between the tracks of roll line module, they gradually curve the slab, or steel strand, towards the horizontal.

Continuous casting of steel is a demanding process involving high temperatures and large temperature variations. Furthermore, water cooling of the slab, or steel strand, results in a very corrosive environment. Accordingly, the roll line
25 modules are required to withstand heavy conditions that are gradually destructing the roll line modules and its components. As an example, the material of the roll line modules may degrade due to corrosion or extremely high temperature. Eventually, the roll line modules must be replaced or undergo maintenance requiring a lengthy and costly interruption of the continuous casting process. In some continuous casting
30 machines, the two tracks formed by the roll line modules may include several block,

wherein each block includes a plurality of roll line modules. In this case, maintenance is carried out by replacing the complete block of roll line modules, including one or several damaged roll line modules, with a remanufactured block of roll line modules. The block including the damaged roll line modules will thereafter undergo
5 appropriate remanufacturing by remanufacturing of the damaged roll line modules so as to form a new and remanufactured block. In this manner, a part of the remanufacturing process can be carried out while the continuous casting machine is running. If the new and remanufactured block is not immediately installed, it will be lined-up for being installed when needed. The process of replacing a block of roll line
10 modules with a remanufactured block of roll line modules may be completed within 1 hour.

As the width of the roll line typically is several meters, the roll line often includes several roll line modules. Conventionally, a roll line module includes an inner shaft and a roll mantle having an outer surface for supporting and transporting
15 the slab, steel strand. Alternatively, the roll line module may include an inner shaft and several roll mantles arranged spaced apart along and about the inner shaft. In EP 1 537 927, for example, a configuration of a roll line is disclosed including a plurality of roll line segments. The roll line segments are supported by an inner non-rotating shaft. The roll line may further include various bearings and sealing cassettes in order
20 to improve the function of the roll line segments.

Over time, the components of the continuous casting machine have continuously been further developed and for the roll line, or roll line module, it has often been an aim to ensure, or minimize the risk, that the internal components, e.g. the shaft and the bearings, are not subjected to the hot temperature of the slab.
25 However, this is not an easy design even with various sealing arrangement. As such, the service life can only be momentarily extended.

It would be beneficial if it could be ensured that the replacement of the roll line, or roll line module, can be made in a simple and effective manner. In particular, it is desirable that the costs for remanufacturing of the roll line, or roll line module,
30 are minimised.

Summary of the Invention

It is an object of the present invention to provide roll line module having improved functionalities in relation to prior art solutions.

- 5 The invention is defined by the independent claim. Embodiments are set forth in the dependent claims, the description and the drawings.

According to a first aspect of the present invention there is provided a roll line module for supporting and transporting hot material in a continuous caster. The roll line module has an extension in an axial direction A and comprises a roll line shaft unit and a roll mantle enclosing the roll line shaft unit along a circumferential direction C. The roll mantle has an outer surface for supporting and transporting hot material. Moreover, the roll line shaft unit comprises a first replaceable shaft end portion, a second replaceable shaft end portion, and an intermediate shaft portion arranged therebetween, as seen in the axial direction A. Thereby, maintaining the intermediate shaft portion, the first replaceable shaft end portion and the second replaceable shaft end portion in axial alignment during rotation of the roll line module. The intermediate shaft portion has a first end region and a second end region. In addition, the first replaceable shaft end portion has a first connecting portion which is configured for being releasably connected to the first end region, the second replaceable shaft end portion has a second connecting portion which is configured for being releasably connected to the second end region, allowing any of the first replaceable shaft end portion and the second replaceable shaft end portion to be interchanged without interchanging the intermediate shaft portion.

25 The roll line module is typically used for supporting and transporting hot material such as hot steel in a continuous caster. By connecting an appropriate number of roll line modules, a roll line having a desired length can be provided.

By the principle of the present invention, it becomes possible to provide a roll line module having a replaceable shaft portion. More specifically, by the provision that the first replaceable shaft end portion has a first connecting portion which is configured for being releasably connected to the first end region, and the second replaceable shaft end portion has a second connecting portion which is configured for being releasably connected to the second end region, it is not required to replace the

complete roll line shaft unit when a part of the shaft unit is worn-out or damaged due to a break out, i.e. an accident caused by the failure of the walls of the hearth of the steel slab, resulting in liquid steel flowing uncontrolled out of the steel slab. Instead, by the principle of the present invention, it becomes possible to only replace the
5 damaged portion of the roll line shaft unit. Hence, the present invention is superior over prior art rollers, or roll line modules, which require a complete replacement of the roll line shaft unit.

The present invention is particularly useful for roll line modules including various bearings and/or sealing elements. In this type of roll line modules, the first
10 replaceable shaft end portion may be arranged adjacent the sealing area (including the sealing element). The sealing area is often the initial region that is damaged by the hot steel since it is located external from the surface of the roll mantle. Analogously, the second replaceable shaft end portion may be arranged adjacent the sealing area (including the sealing element). As such, according to various example embodiments,
15 the first replaceable shaft end portion may be arranged external from the roll mantle as seen in the axial direction of the roll line module. Similarly, the second replaceable shaft end portion may be arranged external from the roll mantle as seen in the axial direction of the roll line module. It is to be noted that since the first replaceable shaft end portion and the second replaceable shaft end portion are arranged on opposite
20 sides of the intermediate shaft portion, as seen in the axial direction of the roll line module, the intermediate shaft portion may be completely enclosed by the roll mantle along an axial length of the intermediate shaft portion.

Because the first replaceable shaft end portion and the second replaceable shaft end portion are arranged outside the intermediate shaft portion, only the
25 replaceable shaft portions of the roll line shaft unit may be subjected to the hot steel material. In this manner, the first replaceable shaft end portion and the second replaceable shaft end portion are arranged at a location where the risk of flowing hot steel material is highest. The hot steel material is detrimental to the structure of the roll line shaft unit due to its extreme high temperature.

30 Accordingly, the intermediate shaft portion, which is typically arranged between the bearings of the roll line module, as seen in the axial direction, can be reused after remanufacturing of the roll line module. Since the location of the

bearings sometimes corresponds with the location of the sealing elements, the intermediate shaft portion is typically arranged between sealing elements, as seen in the axial direction.

In other words, by the provision that any of the first replaceable shaft end
5 portion and the second replaceable shaft end portion can be interchanged without interchanging the intermediate shaft portion, means that the intermediate shaft portion can be reused in the remanufactured roll line module.

In this manner, it becomes possible to replace a damaged or worn-out part of the roll line shaft unit while maintaining the non-damaged (i.e. in working order)
10 parts of roll-line shaft unit.

In one example embodiment, the first replaceable shaft end portion is an outer end portion of the roll line shaft unit.

Another advantage of the present invention is that the costs for remanufacturing can be kept to a minimum. In this context, it is to be noted that two
15 factors of significant impact on the remanufacturing cost are the costs for maintenance work (repair of worn out or damaged components) and the costs for the new components. By only having to replace a part of the roll line shaft, i.e. the first replaceable shaft end portion and/or the second replaceable shaft end portion, it becomes possible to radically reduce the material costs at remanufacturing compared
20 to the situation when the entire roll line shaft unit is to be replaced. Accordingly, the costs for remanufacturing can be kept to a minimum by only replacing the first replaceable shaft end portion and/or the second replaceable shaft end portion, and not the intermediate shaft portion.

During remanufacturing, the roll mantle and possible bearings are initially
25 removed from the roll line module. Thereafter, either the first replaceable shaft end portion or the second replaceable shaft end portion is replaced by a new replaceable shaft end portion. Alternatively, both the first replaceable shaft end portion and the second replaceable shaft end portion are replaced by two new replaceable shaft end portion, respectively. It should be readily understood that also the roll mantle can be
30 replaced at remanufacturing. Alternatively, it can be maintained unchanged at remanufacturing.

Further, it is to be noted that the first replaceable shaft end portion and the second replaceable shaft end portion may not necessarily be entirely replaced during remanufacturing. Instead, the surface(s) of any one of the first replaceable shaft end portion and the second replaceable shaft end portion may be remanufactured if
5 desired. For instance, the replaceable shaft end portion can be remanufactured by turning down its outer circumferential surface and thereafter applying a so-called speedy sleeve about the surface.

The roll line shaft unit is typically operatively connected to the roll mantle via a bearing. More specifically, the roll line shaft unit is typically rotatable connected to
10 the roll mantle via the bearing, as is further explained below. Advantageously, although not strictly required, the first replaceable shaft end portion of the roll line shaft is rotatable connected to the roll mantle via a bearing. In addition, or alternatively, the second replaceable shaft end portion of the roll line shaft is rotatable connected to the roll mantle via a bearing.

15 According to one example embodiment, the outer ring of the bearing is rotating relative to the inner ring of the bearing. Hence, the roll line shaft unit is non-rotating while the roll mantle(s) is rotating during use of the roll line module in a continuous caster.

According to another example embodiment, the inner ring of the bearing is
20 rotating relative to the outer ring of the bearing. Hence, the roll line shaft unit is rotatable about its centre axis. In this configuration, the roll mantle is rotating via the rotating roll line shaft unit during use of the roll line module in a continuous caster. In other words, the roll mantle and the roll line shaft unit rotate together.

According to an example embodiment, the roll line shaft and the roll mantle
25 are separate components and arranged spaced apart via a bearing. According to an example embodiment, the roll line shaft and the roll mantle are separate components and spaced apart via a distance sleeve. One function of the distance sleeve is to impart a desired axial pre-tension to the arrangement so as to ensure that the inner ring of the bearing is not accidentally displaced in the axial direction, which may result in that the
30 bearing becomes damaged or jammed. Hence, the distance sleeve may be arranged to abut the inner ring of the bearing. However, it is to be noted that the distance sleeve may not necessarily be in direct contact with the roll mantle. Instead, there is typically

a minor gap between the distance sleeve and the roll mantle. In this context of the present invention, the distance sleeve is configured for facilitating a dismounting of the roll line module. Dismounting of the roll line module is realised by applying a pressure on the distance sleeve allowing the bearings to be removed.

- 5 The diameter of the roll line module may be between 100 - 300 mm. The roll mantle is typically made of steel and sufficiently dimensioned to withstand the hot steel material.

 According to an example embodiment, the first replaceable shaft end portion, the second replaceable shaft end portion, and the intermediate shaft portion may form
10 a solid and continuous roll line shaft unit during use of the roll line module. The roll line shaft unit should be designed to withstand a load in the axial direction of the roll line module (roll line shaft unit).

 It is to be noted that the term "releasably connected" means that the first replaceable shaft end portion and the second replaceable shaft end portion are
15 operatively connected to the intermediate shaft portion during rotation of the roll line module so as to ensure that the first replaceable shaft end portion and the second replaceable shaft end portion are maintained in axial alignment during use (i.e. rotation of the roll line module), whilst allowing the first replaceable shaft end portion and the second replaceable shaft end portion to be released from the intermediate
20 shaft portion when the roll line module is to be remanufactured, i.e. when the roll line module is not in use. Accordingly, it should be readily understood that the first replaceable shaft end portion, the second replaceable shaft end portion and the intermediate shaft portion form a continuous roll line shaft unit during use (rotation of the roll line module) due to the arrangement of the shaft portions and by being
25 releasably connected to each other. In this manner, the shaft portions are arranged in an axially fixed manner when assembled.

 Hence, the term "releasably connected" typically means that a component is capable of interacting with another component in a functional manner allowing the two components to be connected in one configuration when assembled while being
30 released from each other in another configuration (disassembled configuration). For example, a screw can be releasably connected to a nut, or a bolt can be releasably connected to an internally threaded cylinder.

There are several different possibilities to provide a releasable connection between the first replaceable shaft end portion and the intermediate shaft portion and between the second replaceable shaft end portion and the intermediate shaft portion. As is further explained hereinafter, the first replaceable shaft end portion may be

5 releasably connected to the intermediate shaft portion via a screw and nut arrangement. Analogously, the second replaceable shaft end portion may be releasably connected to the intermediate shaft portion via another screw and nut arrangement. In another example, the first replaceable shaft end portion may be

10 releasably connected to the intermediate shaft portion via a plug and socket arrangement. Analogously, the second replaceable shaft end portion may be releasably connected to the intermediate shaft portion via another plug and socket arrangement. In a plug and socket arrangement, the first end region of the intermediate shaft portion may include the socket whilst the first connecting portion of the first replaceable shaft end portion may include one or several pins that fit into

15 pin receptacles of the socket (i.e. the first end region of the intermediate shaft portion). More specifically, the socket typically comprises a body part and a pin receiving member having a plurality of pin receptacles. The pin receptacles are configured for providing openings in a front face of the socket and each being adapted to receive a respective pin of a plug. Analogously, the second end region of

20 the intermediate shaft portion may include another socket whilst the second connecting portion of the second replaceable shaft end portion may include one or several pins that fit into pin receptacles of the socket (i.e. the second end region of the intermediate shaft portion).

The screw and nut arrangement can be obtained in several different ways in

25 order to further improve the axial alignment of the roll line shaft unit. As an example, the first end region may be provided with a first threaded portion for engaging with a threaded portion of the first connecting portion. In addition, or alternatively, the second end region may be provided with a second threaded portion for engaging with a threaded portion of the second connecting portion. In this manner, the components

30 of the roll line shaft unit constitute a locked configuration when connected to each other. In addition, by this configuration, the roll line shaft unit is better designed to withstand a load in the axial direction of the roll line module (roll line shaft unit).

In this context of the present invention, a threaded portion may either be a threaded outer surface or a threaded inner surface. A threaded portion having a threaded inner surface is adapted to engage with a threaded portion having a threaded outer surface so as to form a releasable connection. A threaded portion having a threaded outer surface is adapted to engage with a threaded portion having a threaded inner surface so as to form a releasable connection.

In all example embodiments as mentioned above, it should be readily understood that once the shaft portions are operatively connected to each other, they are substantially fixed in the axial direction and retained in an axial alignment during use until being released by the remanufacturing workforce.

The locking configuration can further be improved by providing the surface of the first threaded portion with a coating of a suitable material, e.g. Loctite. In addition, or alternatively, the locking configuration can further be improved by providing the surface of the second threaded portion with a coating of a suitable material, e.g. Loctite.

In order to ensure that no corrosion arise at the interface between the first threaded portion and the threaded portion of the first connecting portion and/or between the second threaded portion and the threaded portion of the second connecting portion, the surface of any one of the threaded portions may be applied with a gel that locks, seals and retains threaded joints. This type of gel is commercially available and known to the skilled in the art.

Optionally, although not strictly required, the roll line module may further comprise a bearing for supporting the roll mantle. In particular, the bearing is arranged in the roll line module such that it is capable of supporting a rotational movement of the roll mantle in relation to the roll line shaft unit.

As an example, the bearing may be arranged on the first replaceable shaft end portion. In this context, the bearing is arranged in-between the roll mantle and the first replaceable shaft end portion as seen in a radial direction of the roll line module (roll line shaft unit). As such, the bearing is capable of supporting a rotational movement of the roll mantle in relation to the first replaceable shaft end portion (i.e. the roll line shaft unit). In addition, or alternatively, the bearing may be arranged on the second replaceable shaft end portion. In this context, the bearing is arranged

in-between the roll mantle and the second replaceable shaft end portion as seen in a radial direction of the roll line module (roll line shaft unit). As such, the bearing is capable of supporting a rotational movement of the roll mantle in relation to the second replaceable shaft end portion (i.e. the roll line shaft unit).

5 Different types of bearings may be installed in the roll line module. For instance, the bearing may be provided in the form of a locating bearing, e.g. a spherical roller bearing. The locating bearing is typically configured for locking the axial movement of the roll line shaft unit.

Alternatively, the bearing may be provided in the form of a non-locating
10 bearing, e.g. a toroidal roller bearing. A toroidal roller bearing is particularly suitable for the roll line shaft unit since it combines the self-aligning capability of a spherical roller bearing with the axial displacement ability of a cylindrical roller bearing. To this end, the toroidal roller bearing is capable of taking care of an axial displacement of the roll line module. In one example embodiment, the roll line module may
15 comprise one non-locating bearing and one locating bearing.

Advantageously, the bearing may be provided in the form of a spherical roller bearing. However, it is to be noted that any type of rolling bearing may be used in the roll line module. Hence, the bearing may be provided in the form of a radial rolling element bearing, a spherical roller thrust bearing, a tapered roller bearing, a
20 cylindrical roller thrust bearing, a thrust ball bearing, an angular contact ball bearing, a toroidal roller bearing, a needle bearing, or a combination of two or more of these bearing types.

Each bearing may be arranged in a bearing housing. Hence the bearing housing is configured for housing the bearing.

25 In various example embodiments, the roll line module may further comprise a sealing element being arranged along a circumference of the first replaceable shaft end portion. In addition, or alternatively, the roll line module may further comprise a sealing element being arranged along a circumference of the second replaceable shaft end portion. Thereby, the sealing element is arranged in-between an inner surface of
30 the roll mantle and an outer surface of any of the first replaceable shaft end portion and the second replaceable shaft end portion. The advantage of the sealing element is that the bearing and/or the roll line shaft unit can be protected from water and dirt. In

addition, the sealing element ensures that lubricant, e.g. grease, is maintained in the bearing. In this manner, the risk of having lubricant leakages is reduced.

In one example embodiment, the bearing may be provided with an integrated sealing element and configured for retaining the lubricant in the bearing. In addition,
5 or alternatively, the roll line module may comprise an additional sealing element (also denoted as a sealing cassette) enclosing the bearing. In this manner, the additional sealing element is capable of protecting the bearing from water and dirt.

There are several different possibilities to provide a functional reliable sealing element to the roll line module. For instance, the sealing element may be provided in
10 the form of a static seal element. In addition, or alternatively, the sealing element may be provided in the form of a dynamic seal element. According to one example embodiment, the sealing element is provided in the form of a sealing cassette including one static seal element and one dynamic seal element. Hence, the sealing element may include a combination of a static seal element and a dynamic seal
15 element.

According to one example embodiment, the roll line module may be a roll line module without a lubrication system, i.e. a re-lubrication free roll line module. One example of a roll line module of this type is shown in WO 2010/005354. As an example, the roll line module may be provided with a closed compartment for
20 receiving lubricant for lubricating any one of the bearings of the roll line module. In this manner, the closed compartment keeps the lubricant in connection with the bearing.

According to one example embodiment, the roll line module may further comprise a distance sleeve arranged along a circumference of the intermediate shaft portion, and in-between an inner surface of the roll mantle and an outer surface of the
25 intermediate shaft portion. As mentioned above, one function of the distance sleeve is to impart a desired axial pre-tension to the arrangement so as to ensure that the inner ring of the bearing is not accidentally displaced in the axial direction, which may result in that the bearing becomes damaged or jammed. Hence, the distance sleeve may be
30 arranged to abut the inner ring of the bearing. However, it is to be noted that the distance sleeve may not necessarily be in direct contact with the roll mantle. Instead, there is typically a minor gap between the distance sleeve and the roll mantle as seen

in the radial direction. In this context of the present invention, the distance sleeve is configured for facilitating a dismounting of the roll line module. Dismounting of the roll line module is realised by applying a pressure on the distance sleeve allowing the bearings to be removed.

5 The intermediate shaft portion may be provided with a through-hole extending in a radial direction R of the intermediate shaft portion. More specifically, the through-hole is configured for receiving a torque bar. In this manner, it becomes possible to dismount the components of the roll line shaft unit in a simple and effective manner without damaging the structure of the intermediate shaft portion.

10 In addition, or alternatively, the second replaceable shaft end portion may be provided with a recess configured for receiving a hook spanner. In addition, or alternatively, the first replaceable shaft end portion may be provided with a recess configured for receiving the hook spanner. In this manner, a dismounting of each replaceable shaft end portion, or all of them, is simplified and possible without
15 damaging the structure of the replaceable shaft end portion.

 According to one example embodiment, the intermediate shaft portion may be completely encapsulated by the roll mantle along a length of the intermediate shaft portion.

 Optionally, although not strictly required, a part of the first replaceable shaft
20 end portion may extend beyond the roll mantle, as seen in the axial direction A. In this manner, the arrangement of further components, e.g. bearings, sealing elements and/or supporting blocks, is facilitated.

 Analogously, a part of the second replaceable shaft end portion may extend beyond the roll mantle, as seen in the axial direction A. In this manner, the
25 arrangement of further components, e.g. bearings, sealing elements and/or supporting blocks, is facilitated.

 According to an example embodiment, the first replaceable shaft end portion may be an end region of the roll line module, as seen in the axial direction A. Similarly, the second replaceable shaft end portion may be an end region of the roll
30 line module, as seen in the axial direction A.

 The total length of the roll line module as seen in the axial direction A is dependent on the width of the continuous casting machine and the number of roll line

modules making up a complete roll line (sometimes denoted the roll line assembly). However, the length of one roll line module, as seen in the axial direction A, typically ranges between 1 – 3 m.

In an example embodiment, the roll line module may include one or several
5 additional intermediate shaft portions. For instance, the roll line module may include a second intermediate shaft portion. As such, the roll line module may comprise the intermediate shaft portion, which here is a first intermediate shaft portion, and the second intermediate shaft portion. In this example, the second replaceable shaft end portion may be provided with an additional connecting portion being arranged
10 opposite the second connecting portion, as seen in the axial direction A, and configured for being releasably connected to an end region of a second intermediate shaft portion. In this manner, the second replaceable shaft end portion is bridging between the first intermediate shaft portion and the second intermediate shaft portion. In this context of the present invention, the first intermediate shaft portion and the
15 second intermediate shaft portion may form a complete roll line or roll line assembly. The length of the roll line assembly, as seen in the axial direction A, is typically between 1-3 meters.

In another example embodiment, the roll line module may include a third intermediate shaft portion and/or a fourth intermediate shaft portion. Effects and
20 features of the second intermediate shaft portion, third intermediate shaft portion and fourth intermediate shaft portion are largely analogous to those described above in relation to the first aspect of the present invention. In this context of the present invention, the first intermediate shaft portion, the second intermediate shaft portion and the third intermediate shaft portion may form a complete roll line or roll line
25 assembly. The length of the roll line assembly, as seen in the axial direction A, is typically between 1-3 meters. It should be readily understood that the roll line assembly may include additional shaft portions and roll mantles in order to obtain an appropriate length of the roll line assembly as seen in the axial direction A.

According to a second aspect of the present invention there is provided a roll
30 line shaft unit for a roll line module having an extension in an axial direction A and comprising a first replaceable shaft end portion, a second replaceable shaft end portion, and an intermediate shaft portion arranged therebetween, as seen in the axial

direction A. Thereby, maintaining the intermediate shaft portion, the first replaceable shaft end portion and the second replaceable shaft end portion in axial alignment during rotation of the roll line module. The intermediate shaft portion has a first end region and a second end region. In addition, the first replaceable shaft end portion has
5 a first connecting portion which is configured for being releasably connected to the first end region, the second replaceable shaft end portion has a second connecting portion which is configured for being releasably connected to the second end region, allowing any of the first replaceable shaft end portion and the second replaceable shaft end portion to be interchanged without interchanging the intermediate shaft
10 portion.

Effects and features of this second aspect of the present invention are largely analogous to those described above in relation to the first aspect of the present invention.

Further features of, and advantages with, the present invention will become
15 apparent when studying the appended claims and the following description. The skilled person realize that different features of the present invention may be combined to create embodiments other than those described in the following, without departing from the scope of the present invention. For example, the above description of the different advantages of the present invention is only described in relation to one roll
20 line module and/or one roll line shaft unit, however, the various embodiments of the invention are of course also applicable when providing a plurality of roll line modules for supporting and transporting hot material in a continuous caster. Likewise, the various embodiments of the invention are applicable when providing a roll line module including a plurality of roll line shaft units and/or a plurality if intermediate
25 shaft portions.

Brief Description of the Drawings

The various aspects of the invention, including its particular features and advantages, will be readily understood from the following detailed description and the
30 accompanying drawings, in which:

Fig. 1a schematically illustrates an exploded view of an example embodiment of a roll line module according to the present invention, wherein the roll line module comprises an intermediate shaft portion;

Fig. 1b is a cross sectional view of the example embodiment of the roll line module in Fig. 1a, in which the roll line module is in an assembled configuration;

Fig. 2a is a cross sectional view of another example embodiment of a roll line module according to the present invention, as seen in a non-assembled configuration, wherein the roll line module comprises a first intermediate shaft portion and a second intermediate shaft portion;

Fig. 2b is a cross sectional view of the example embodiment of the roll line module in fig. 2a, wherein the roll line module is in an assembled configuration.

Detailed Description of Exemplary Embodiments of the Invention

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided for thoroughness and completeness. Like reference characters refer to like elements throughout the description.

Referring now to the figures and Fig. 1a in particular, there is depicted an example embodiment of a roll line module 1 according to the present invention. The roll line module is suitable for supporting and transporting hot material in a continuous caster. Continuous casting of steel, also called strand casting, is the process whereby slabs of metal are continuously cast from molten steel. Since the process of continuous casting is well known to the skilled person, the description to follow is concerned with a roll line module being arranged in the continuous casting process.

As is shown in Fig. 1b, the roll line module has an extension in an axial direction A. The roll line module comprises a roll line shaft unit 10 and a roll mantle 40. The roll mantle 40 encloses the roll line shaft unit 10 along a circumferential direction C. The roll mantle 40 has an outer surface 42 for supporting and transporting hot material. The roll mantle 40 here is made of a structural steel which

often is toughened (quenched and tempered) in order to better withstand the hot temperature from the slab. Another suitable material of the roll mantle is stainless steel. However, the roll mantle 40 can be made of any suitable material which is capable of being used in this specific environment. In addition, the roll mantle structure may also be made of several layers of different material. As an example, the outer surface 42 can be made of a corrosive resistant material while the inner structure of the roll mantle 40 is made of a different material. However, the entire roll mantle 40 is typically made from one integral component.

As may be gleaned from Fig. 1a and Fig. 1b, the intermediate shaft portion 50 here is completely encapsulated by the roll mantle 40 along a length of the intermediate shaft portion 50 as seen in the axial direction A.

Moreover, as illustrated in Fig. 1a and Fig. 1b, the roll line shaft unit 10 comprises a first replaceable shaft end portion 20, a second replaceable shaft end portion 30, and an intermediate shaft portion 50 arranged therebetween, as seen in the axial direction A.

The roll mantle 40 is rotatable about the roll line shaft unit 10. Hence, the roll mantle is rotatable about the axis A. Since the roll mantle 40 encloses the intermediate shaft portion 50 and a part of the first replaceable shaft end portion 20 and the second replaceable shaft end portion 30, it can be readily understood that the roll mantle 40 is rotatable about the intermediate shaft portion 50, the first replaceable shaft end portion 20 and the second replaceable shaft end portion 30.

Due to this arrangement, the intermediate shaft portion 50, the first replaceable shaft end portion 20 and the second replaceable shaft end portion 30 are maintained in axial alignment during rotation of the roll line module 1, i.e. when the roll line module is used to support and transport the hot steel. In this context of the present invention, it should be readily understood that by axial alignment means that the components of the roll line module 1 are assembled so as to form an assembled configuration, as is illustrated in Fig. 1b.

In addition, a part of the first replaceable shaft end portion 20 here extends beyond the roll mantle 40 as seen in the axial direction A. In other words, first replaceable shaft end portion 20 projects from the roll mantle 40 as seen in the axial

direction A. Analogously, a part of the second replaceable shaft end portion 30 here extends beyond the roll mantle 40 as seen in the axial direction A.

As shown in Fig. 1a and Fig. 1b, the intermediate shaft portion 50 has a first end region 52 and a second end region 54.

5 Moreover, the first replaceable shaft end portion 20 has a first connecting portion 22 configured for being releasably connected to the first end region 52. In this manner, the first replaceable shaft end portion 20 is capable of being disengaged from the intermediate shaft portion 50 in a simple manner. Thus, by being releasably connected to the first end region 52, the first replaceable shaft end portion 20 is
10 capable of being replaced (or interchanged) by a new first replaceable shaft end portion. In particular, the first replaceable shaft end portion 20 can be interchanged without interchanging the intermediate shaft portion.

Analogously, the second replaceable shaft end portion 30 has a second connecting portion 32 configured for being releasably connected to the second end
15 region 54. In this manner, the second replaceable shaft end portion 30 is capable of being disengaged from the intermediate shaft portion 50 in a simple manner. Thus, by being releasably connected to the second end region 54, the second replaceable shaft end portion 30 is capable of being replaced (or interchanged) by a new second replaceable shaft end portion. In particular, the second replaceable shaft end portion
20 30 can be interchanged without interchanging the intermediate shaft portion 50.

Accordingly, by the above configuration, it becomes possible to replace any of the first replaceable shaft end portion 20 and the second replaceable shaft end portion 30 without interchanging the intermediate shaft portion 50. However, it is not required that the first replaceable shaft end portion 20 and the second replaceable
25 shaft end portion 30 are simultaneously replaced, i.e. at the same occasion. Instead, dependent on the level of damage of the roll line module, the maintenance personnel may opt for only replacing either the first replaceable shaft end portion 20 or the second replaceable shaft end portion 30. Even if only one of the first replaceable shaft end portion 20 and the second replaceable shaft is to be replaced, the present
30 invention allows for a replacement of the shaft end portion without interchanging the intermediate shaft portion 50.

In the example embodiment as shown in Fig. 1a and 1b, the first end region 52 here is provided with a first threaded portion 53 for engaging with a threaded portion of the first connecting portion 22. Likewise, the second end region 54 here is provided with a second threaded portion 55 for engaging with a threaded portion of the second connecting portion 32.

The roll line module 1 here further comprises a bearing 60 for supporting the roll mantle 40. The bearing 60 is either a locating bearing or a non-locating bearing.

Typically, but not strictly necessarily, one bearing 60 is arranged on the first replaceable shaft end portion 20 and another bearing 60 arranged on the second replaceable shaft end portion 30. However, in another example embodiment (not shown), the bearing 60 may be arranged on the intermediate shaft portion 50. In yet another example embodiment (not shown), one bearing 60 may be arranged on the intermediate shaft portion 50, while a second bearing 60 is arranged on the first replaceable shaft end portion 20 and a third bearing 60 is arranged on the second replaceable shaft end portion 30. It should therefore be readily understood that the bearing 60 may be arranged on any of the shaft portions as long as bearing is capable of supporting the roll mantle 40.

By the above functional configuration, the bearing 60 is arranged in the roll line module 1 such that it is capable of supporting a rotational movement of the roll mantle 40 in relation to the roll line shaft unit 10. From the above, it is thus to be noted that the bearing 60 may be installed in several different arrangements. It is to be noted that the bearing is often accommodated in a bearing housing.

The roll line module may comprise supporting blocks 95, 95' arranged between the roll mantles as seen in an axial direction. In one example embodiment (not shown), the supporting blocks may encapsulate the bearings 60. As an example, the first bearing 60 can be encapsulated by a first supporting block. A second bearing 60' can be encapsulated by a second supporting block. The first supporting block may be arranged about the first replaceable shaft end portion 20. The second supporting block 95' may be arranged about the second replaceable shaft end portion 30.

The supporting blocks 95, 95' may have a base portion and a portion having a through-hole for receiving a shaft, for example the first replaceable shaft end portion 20. The base portion may be adapted for mounting on an external structure, for

example a structure that supports the roll line module 1. The other supporting blocks may be similarly configured with respective base portions and through-hole portions.

In the example embodiment illustrated in Fig. 1a and Fig. 1b, the roll line module 1 here further comprises a first sealing element 80 and a second sealing
5 element 80'. The first sealing element 80 is arranged along a circumference of the first replaceable shaft end portion 20. The second sealing arrangement 80' is arranged along a circumference of the second replaceable shaft end portion 30. In this manner the first sealing element 80 is arranged in-between an inner surface 82 of the roll mantle 40 and the outer surfaces 90 of the first replaceable shaft end portion 20.
10 Likewise, the second sealing arrangement 80' is arranged in-between the inner surface 82 of the roll mantle 40 and the outer surfaces 90' of the second replaceable shaft end portion 30.

The sealing element 80, 80' is typically provided in the form of a sealing cassette including a static seal element and a dynamic seal element. In one example
15 embodiment, the sealing element 80, 80' is a static seal element. In another example embodiment, the sealing element 80, 80' is dynamic seal element.

Optionally, although not strictly required, the roll line module 1 here comprises a distance sleeve 37 arranged along a circumference of the intermediate shaft portion 50 and in-between an inner surface 82 of the roll mantle 40 and an outer
20 surface 57 of the intermediate shaft portion 50. The distance sleeve may be arranged to abut an inner ring (not shown) of the bearing 60 as seen in the axial direction. However, it is to be noted that although the distance sleeve is arranged in-between the inner surface 82 of the roll mantle 40 and the outer surface 57, it may not necessarily be in direct contact with the roll mantle as seen in the radial direction. Instead, there is
25 typically a minor gap between the distance sleeve 37 and the roll mantle 40. The distance sleeve 37 is configured for facilitating a dismounting of the roll line module 1. Dismounting of the roll line module 1 is realised by applying a pressure on the distance sleeve 37 allowing the bearings to be removed 60.

As may be gleaned from Fig. 1a and Fig. 1b, the intermediate shaft portion 50
30 may optionally be provided with a through-hole 58 extending in a radial direction R of the intermediate shaft portion 50. The through-hole 58 here is configured for

receiving a torque bar facilitating a removal of the first replaceable shaft end portion 20 or the second replaceable shaft end portion 30.

Although only optional, the second replaceable shaft end portion 30 here is provided with a recess 32 configured for receiving a hook spanner. Likewise, the first
5 replaceable shaft end portion 20 here is provided with a recess 32' configured for receiving the hook spanner. It should be readily understood that the roll line module may be provided with other means for facilitating a removal of the any one of the first replaceable shaft end portion 20 and the second replaceable shaft end portion 30.

Fig. 2a and Fig. 2b illustrate another example embodiment of a roll line
10 module according to the present invention. In this example embodiment, the roll line module includes at least two intermediate shaft portions. Fig. 2a shows the configuration in a non-assembled configuration, wherein the roll line module comprises a first intermediate shaft portion and a second intermediate shaft portion, while Fig. 2b shows a cross sectional view of the example embodiment of the roll line
15 module in fig. 2a, wherein the roll line module is in an assembled configuration.

In this example embodiment, the intermediate shaft portion 50 is a first intermediate shaft portion. In addition, the roll line module includes a second intermediate shaft portion 50'. As is illustrated in Fig. 2a, the second replaceable shaft end portion 30 here is provided with an additional connecting portion 36 which is
20 arranged opposite the second connecting portion 32, as seen in the axial direction A. The additional connecting portion 36 is configured for being releasably connected to an end region of a second intermediate shaft portion 50'. Thereby, the second replaceable shaft end portion 30 is bridging between the first intermediate shaft portion 50 and the second intermediate shaft portion 50'.

Moreover, Fig. 2b shows an additional intermediate shaft portion, a third intermediate shaft portion 50'', which is connected to the second intermediate shaft portion 50' via an additional replaceable shaft portion. The configuration of the additional replaceable shaft portion here is provided with the same features and effects as mentioned above with respect to the second replaceable shaft end portion
25 30.

The function of the roll line module is similar for all example embodiments. That is, during operation, the roll line module(s) rotates around its centre axis,

whereby a material, such as hot steel, which is supported by the roll mantle outer surfaces, is transported along a direction that is substantially perpendicular to the centre axis.

Thanks to the present invention, as described above with references to the
5 various figures, it becomes possible to provide a roll line module having a replaceable shaft portion. More specifically, by the provision that the first replaceable shaft end portion 20 has a first connecting portion 22 which is configured for being releasably connected to the first end region 52, and the second replaceable shaft end portion 30 has a second connecting portion 32 which is configured for being releasably
10 connected to the second end region 54, it is not required to replace the complete roll line shaft unit when a part of the shaft unit is worn-out and/or damaged due to a break out, i.e. an accident caused by the failure of the walls of the hearth of the steel slab, resulting in liquid steel flowing uncontrolled out of the steel slab. Instead, by the principle of the present invention, it becomes possible to only replace the damaged
15 portion of the roll line shaft unit after the break out. Likewise, at remanufacturing, it becomes possible to only replace the worn-out shaft component without replacing the complete roll line shaft. Hence, the present invention is superior over prior art rollers, or roll line modules, which require a complete replacement of the roll line shaft unit.

Additionally, variations to the disclosed embodiments can be understood and
20 effected by the skilled person in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these
25 measured cannot be used to advantage.

Reference numerals

- 30 1 roll line module
- 10 roll line shaft unit
- 20 first replaceable shaft end portion
- 22 first connecting portion

- 30 second replaceable shaft end portion
- 32 second connecting portion
- 34 recess
- 34' recess
- 5 36 additional connecting portion
- 37 distance sleeve
- 40 roll mantle
- 42 roll mantle outer surface
- 50 intermediate shaft portion
- 10 50' second intermediate shaft portion
- 52 intermediate shaft portion first end region
- 53 first threaded portion of intermediate shaft portion first end region
- 54 intermediate shaft portion second end region
- 55 second threaded portion of intermediate shaft portion second end region
- 15 57 outer surface of intermediate shaft portion
- 58 through-hole
- 60 bearings
- 80, 80' sealing element
- 82 inner surface of roll mantle
- 20 90, 90' outer surface of replaceable shaft end portions
- A axial direction
- C circumferential direction

CLAIMS

1. A roll line module (1) for supporting and transporting hot material in a continuous caster, having an extension in an axial direction (A) and comprising a roll
5 line shaft unit (10) and a roll mantle (40) enclosing the roll line shaft unit (10) along a circumferential direction (C), the roll mantle (40) having an outer surface (42) for supporting and transporting hot material; wherein the roll line shaft unit (10) comprises a first replaceable shaft end portion (20), a second replaceable shaft end portion (30), and an intermediate shaft portion (50) arranged therebetween, as seen in
10 the axial direction (A); thereby the intermediate shaft portion (50), the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30) are maintained in axial alignment during rotation of the roll line module (1), the intermediate shaft portion (50) having a first end region (52) and a second end region (54); the first replaceable shaft end portion (20) having a first connecting portion (22)
15 configured for being releasably connected to the first end region (52); and the second replaceable shaft end portion (30) having a second connecting portion (32) configured for being releasably connected to the second end region (54), allowing any of the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30) to be interchanged without interchanging the intermediate shaft portion (50).

20

2. The roll line module (1) according to claim 1, wherein the first end region (52) is provided with a first threaded portion (53) for engaging with a threaded portion of the first connecting portion (22), and the second end region (54) is provided with a second threaded portion (55) for engaging with a threaded portion of the second
25 connecting portion (32).

3. The roll line module (1) according to any one of the preceding claims, further comprising a bearing (60) for supporting the roll mantle (40).

30 4. The roll line module (1) according to claim 3, wherein the bearing (60) is arranged on any one of the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30).

5. The roll line module (1) according to claim 3 or claim 4, wherein the bearing (60) is a locating bearing or a non-locating bearing.

6. The roll line module (1) according to any one of the preceding claims, further comprising a sealing element (80, 80') arranged along a circumference of any of the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30), and in-between an inner surface of the roll mantle (40) and an outer surface (90, 90') of any of the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30).

10

7. The roll line module (1) according to claim 6, wherein the sealing element (80, 80') includes a combination of a static seal element and a dynamic seal element.

8. The roll line module (1) according to any one of the preceding claims, further comprising a distance sleeve (37) arranged along a circumference of the intermediate shaft portion (50), and in-between an inner surface (82) of the roll mantle (40) and an outer surface (57) of the intermediate shaft portion (50), the distance sleeve (37) being configured for facilitating a dismounting of the roll line module (1).

9. The roll line module (1) according to any one of the preceding claims, wherein the intermediate shaft portion (50) is provided with a through-hole (58) extending in a radial direction (R) of the intermediate shaft portion (50), and configured for receiving a torque bar.

10. The roll line module (1) according to any one of the preceding claims, wherein any of the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30) is provided with a recess (32) configured for receiving a hook spanner.

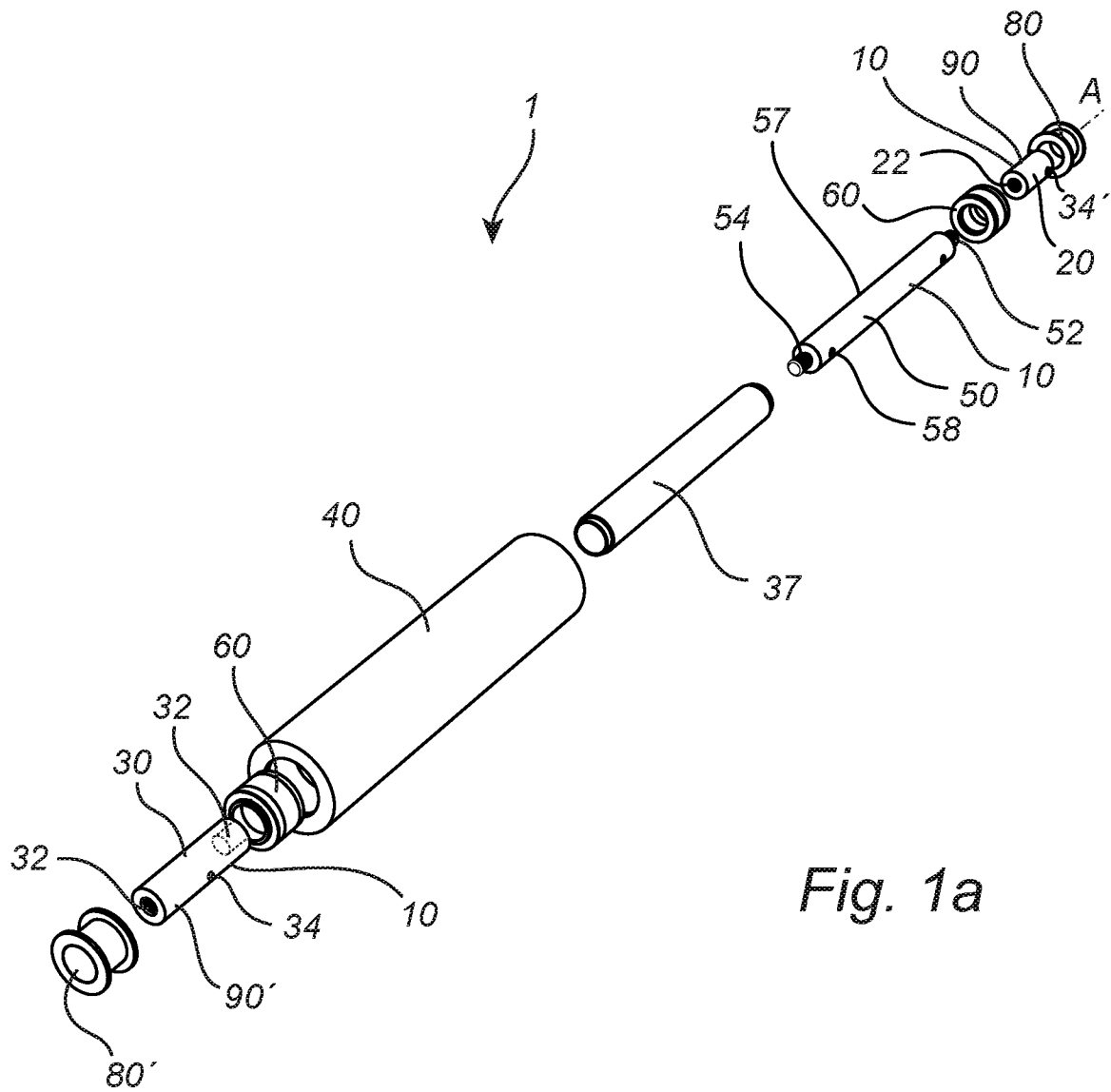
11. The roll line module (1) according to any one of the preceding claims, wherein the intermediate shaft portion (50) is completely encapsulated by the roll mantle (40) along a length (L) of the intermediate shaft portion (50).

12. The roll line module (1) according to any one of the preceding claims, wherein a part of the first replaceable shaft end portion (20) extends beyond the roll mantle (40) as seen in the axial direction (A).

5 13. The roll line module (1) according to any one of the preceding claims, wherein a part of the second replaceable shaft end portion (30) extends beyond the roll mantle (40) as seen in the axial direction (A).

10 14. The roll line module (1) according to any one of the preceding claims, wherein said intermediate shaft portion (50) is a first intermediate shaft portion, and the second replaceable shaft end portion (30) is provided with an additional connecting portion (36) being arranged opposite the second connecting portion (32), as seen in the axial direction (A), and configured for being releasably connected to an end region of a second intermediate shaft portion (50'), whereby the second
15 replaceable shaft end portion (30) is bridging between the first intermediate shaft portion (50) and the second intermediate shaft portion (50').

15. A roll line shaft unit (10) for a roll line module (1) having an extension in an axial direction (A) and comprising a first replaceable shaft end portion (20), a second
20 replaceable shaft end portion (30), and an intermediate shaft portion (50) arranged therebetween, as seen in the axial direction (A); thereby the intermediate shaft portion (50), the first replaceable shaft end portion (20) and the second replaceable shaft end portion (30) are maintained in axial alignment during rotation of the roll line module (1), the intermediate shaft portion (50) having a first end region (52) and a second end
25 region (54); the first replaceable shaft end portion (20) having a first connecting portion (22) configured for being releasably connected to the first end region (52); and the second replaceable shaft end portion (30) having a second connecting portion (32) configured for being releasably connected to the second end region (54), allowing any of the first replaceable shaft end portion (20) and the second replaceable
30 shaft end portion (30) to be interchanged without interchanging the intermediate shaft portion (50).



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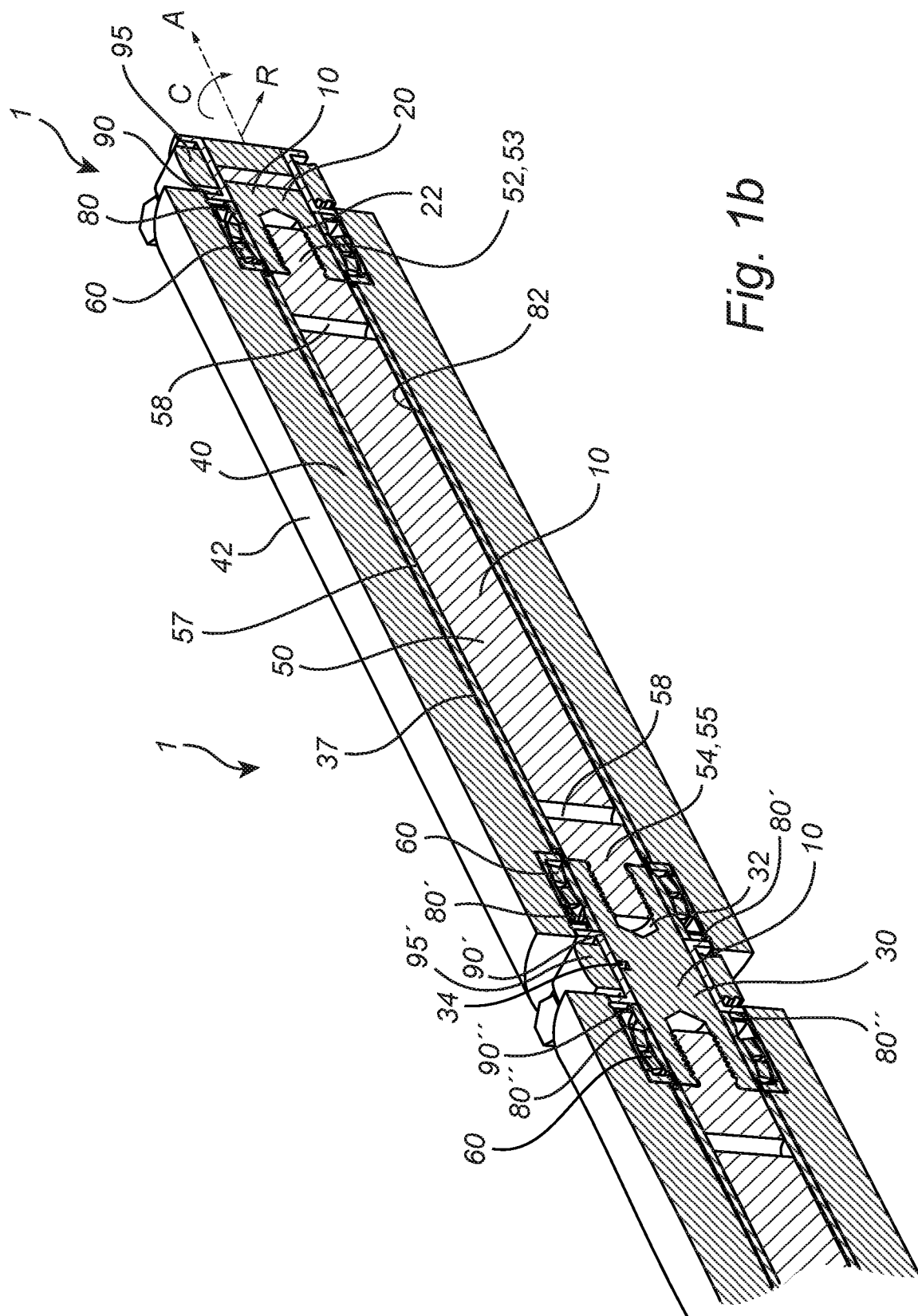


Fig. 1b

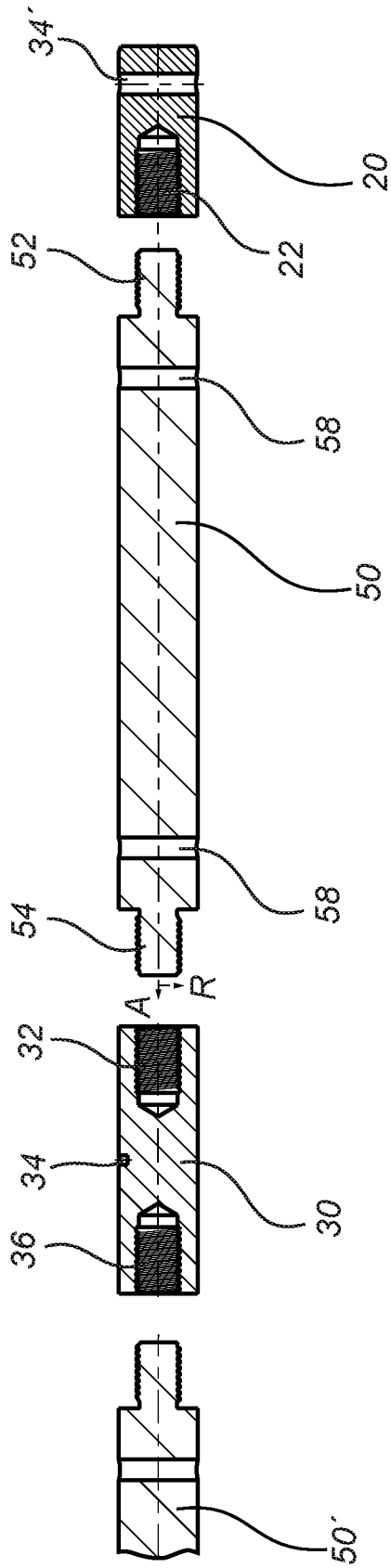


Fig. 2a

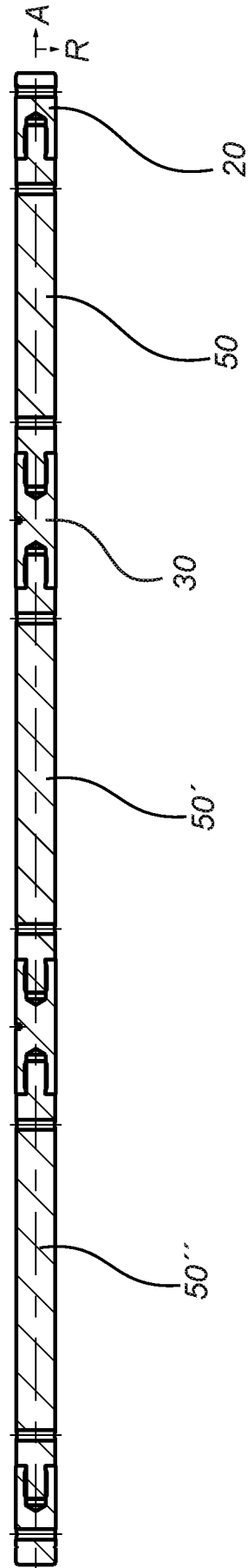


Fig. 2b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2014/050943

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B22D, B65G, F16C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005014029 A (JFE STEEL KK), 20 January 2005 (2005-01-20); whole document; abstract --	1-15
A	US 20100227749 A1 (URANISHI TAKEHARU), 9 September 2010 (2010-09-09); whole document; abstract --	1-15
A	US 20130146244 A1 (HOVESTAEDT ERICH ET AL), 13 June 2013 (2013-06-13); whole document; abstract -- -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T”

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X”

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y”

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&”

document member of the same patent family

Date of the actual completion of the international search

16-12-2014

Date of mailing of the international search report

16-12-2014

Name and mailing address of the ISA/SE

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Continuation of: second sheet

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B65G 39/18 (2006.01)

F16C 11/02 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2014/050943

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