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

(11) **EP 3 849 720 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
15.06.2022 Bulletin 2022/24

(21) Application number: **19805393.6**

(22) Date of filing: **29.10.2019**

(51) International Patent Classification (IPC):
B21B 35/14 *(2006.01)* ***B21B 31/20*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B21B 35/14; B21B 31/20; B21B 35/147

(86) International application number:
PCT/IB2019/059249

(87) International publication number:
WO 2020/089783 (07.05.2020 Gazette 2020/19)

(54) **LUBRICANT RECOVERY AND PROTECTION SYSTEM FOR SPINDLE COUPLINGS**

SCHMIERMITTELRÜCKGEWINNUNGS- UND SCHUTZSYSTEM FÜR SPINDELKUPPLUNGEN

SYSTÈME DE RÉCUPÉRATION DE LUBRIFIANT ET DE PROTECTION POUR RACCORDS À BROCHE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **30.10.2018 IT 201800009918**

(43) Date of publication of application:
21.07.2021 Bulletin 2021/29

(73) Proprietor: **Danieli & C. Officine Meccaniche SpA**
33042 Buttrio (UD) (IT)

(72) Inventors:
- **CODARIN, Morris**
  33050 Carlino (UD) (IT)
- **DONADON, Andrea**
  33100 Udine (UD) (IT)
- **MATTANZA, Carlo**
  25100 Brescia (BS) (IT)
- **TIUSSI, Gianni**
  34076 Romans d'Isonzo (GO) (IT)

(74) Representative: **Münchow, Vera Ute Barbara**
C/o Adexe Srl
Corso Porta Nuova, 131
37122 Verona (VR) (IT)

(56) References cited:
DE-A1- 1 902 894
DE-A1- 19 711 609
US-B1- 6 276 427
US-B2- 7 131 801
US-B2- 7 383 712

EP 3 849 720 B1

Description

TECHNICAL FIELD

[0001] The invention relates to a lubricant recovery system to be used for spindle couplings, in particular for couplings which connect a spindle to the respective working roll and which are part of a reversible rolling unit, as well as a protection system of said couplings from the external environment. In particular, the invention finds application in roller stands where the mutual distance between the working rolls may have to vary. A lubricant recovery and protection system and and a protective casing according to the preamble of claim 12 is for example known from DE 197 11 609 A1. Another lubricant recovery and protection system according to the preamble of claim 1, but with two separate oil collecting receptacles, is known from US 7,383,712 B2.

BACKGROUND ART

[0002] The rolling mill is a set of hot or cold rolling and/or forming units (or stands) for malleable materials, in particular for metals. Each unit is composed of a set of rollers that progressively press a semi-finished product, giving it the desired shape and dimensions. The rollers can be of various shapes and sizes: smooth and cylindrical for the production of flat rolled products, shaped for the production of bars, angles and long products in general. The product rolling process involves applying permanent plastic deformations by the action of appropriate forces applied by the rolling cylinders to the product, which are reflected in the structure of the material.

[0003] The rolling of the semi-finished steel products is generally carried out at high temperatures so as to reduce the stresses on the equipment: for example, the steel comes from the continuous casting machine or exits the heating furnace around 1100 °C, but cools around 900 °C by convection before the rolling begins; during rolling, the crushing work heats the material, compensating for its rapid cooling. For particular types of steel, subsequent cold rolling follows.

[0004] The roller stands which make up the rolling mill consist essentially of two or more cylinders generally with parallel axes, which are moved so as to be counter-rotating, between which the piece to be worked is passed. In general, in the so-called four-high stands, consisting of four rolls, there are two working rolls which are used to roll the product, and two backup rolls generally of a larger diameter than the working ones, which serve to confer rigidity and prevent the latter from flexing during rolling, since this would cause a non-constant thickness in the rolled product. In order for the cylinders to grasp the product and process it, it is necessary that certain proportions exist between the diameter of the cylinders, the distance (or gap) between them and the dimensions of the product. The cylinders are supported by frames called shoulders, which define the roller stand; the set of several stands destined to subsequent rolling is called rolling mill train.

[0005] From the functional point of view, the rolling mills can be reversible or unidirectional (so-called tandem trains). In reversible rolling mills, the material is rolled alternately in one direction and then in the other, sliding back and forth between the working rolls until the desired degree of reduction is obtained. In this case, the distance between the working rolls is progressively reduced with each pass. The product passes completely through the working rolls of the first stand set to a gap G1, while it is still partially gripped it begins to pass in the second stand set to a gap G2 smaller than G1, thus decreasing its thickness. The leading end of the product coming out of the second stand is then wrapped in a reel. When also the trailing end of the product has passed first through the first stand, then through the second, then it is wrapped around the reel, the process is reversed: the trailing end (which becomes the leading end) passes again through the second stand set to a gap G3 smaller than G2 and then to G4 smaller than G3, to be wound again on a second reel. The process is repeated for the number of times sufficient to obtain the desired thickness. The product then leaves the rolling mill train to continue towards the downstream machines. In units with a single roller stand, the product being processed passes completely downstream of the stand and is rolled by the working rolls spaced to define a first slot or a first gap G1 and re-rolled again going back upstream in the opposite direction from the same working rolls set to a second slot or a second gap G2 lower than said first gap G1 (G2 < G1). The product steps in the gap of the reversible stand can continue several times until reaching the desired thickness, providing to have the gap between working rolls decreasing at each step.

[0006] The other way around, unidirectional rolling mills are arranged in series and each stand contributes in part to the reduction in a gap decrease from stand to stand.

[0007] In rolling mills, both of the reversible and of the tandem type, the working rolls are connected with special couplings to spindles which in turn are connected to mandrels which are actuated, directly or indirectly through reducers, by one or more motors to rotate the spindle-coupling-working roll system.

[0008] The couplings that connect the working rolls to the spindles deriving from the drive system must provide effective lubrication to preserve their life over time.

[0009] The lubricants, usually grease, are disposed of, since they tend to accumulate particles deriving from wear and be soiled by contact with the external environment, for example by dust, rolling flakes and water from the cooling of the roller stands. Furthermore, their lubricating power is not among the best but it is a good compromise between quality and price. The amount of grease used and lost during rolling can also amount to over 120 g/h for each coupling: it is easy to see that in a continuous lamination, this amounts to over 4 kg/day per stand, with

the disposal costs associated with this loss. At the state of the art, such couplings, as well as the lubricant associated with them are not protected from dust, humidity or external aggressors. A protection of these couplings is desirable, but is made difficult by the rotating movement of the spindle-coupling-working roll system; in addition to that, the distance between the working rolls and, therefore, between the couplings of the spindles, is variable.

[0010] Normally the reversible roller stands are characterized by a large distance between the maximum and minimum aperture positions of the working rolls or work rolls. In reversible rolling mills, the distance between centrelines between the rolls in contact with the material to be rolled is variable. The couplings that transfer the motion through the spindles from the motor to the working rolls and the spindles connected to them must make a very high excursion, substantially corresponding to that of the maximum-minimum gap that is obtained between the rolls.

[0011] The documents DE 197 11 609 A1, US 7 383 712 B2 and DE 19 02 894 A1 describe the application of boxes around coupling-spindle systems, but do not propose a practical and effective solution with high protection of the couplings in case of variations of the distance between two couplings arranged one above the other.

DISCLOSURE OF THE INVENTION

[0012] The invention aims to overcome the aforementioned drawbacks and to propose a system that allows the recovery and reuse of the lubricant used for the couplings between working rolls and spindles in rolling mills, in particular with the continuous application of a lubricant at the coupling between spindles and working rolls, so as to extend the life, reducing the wear of these components and in order to possibly protect the lubricant and the couplings from dust, cooling water and other external agents. Another object of the invention is to provide a system for recovering and protecting the lubricant which allows the rotary movement of the protected parts, and in particular for reversible rolling mills also allows a change in the distance between centrelines of the working rolls and therefore of the gap between the couplings.

[0013] The state of the art so far does not describe lubricant recovery and protection systems for the aforementioned couplings and the lubricant which satisfactorily solve the problems arising from the movement of the couplings and the components connected thereto.

[0014] The object is achieved by a lubricant recovery and protection system for spindle couplings for reversible roller stands comprising

(a) at least two couplings which are arranged one above the other each of them connecting a spindle and a working roll forming relative connecting units and which are defining a distance between them correlating with a respective slot between said working rolls,
wherein said slot and consequently said distance are variable and wherein at least one of said couplings with the respective spindle and the respective working roll is variable in height so that:

(i) the upper coupling with its respective spindle and respective working roll is variable in height; and/or
(ii) the lower coupling with its respective spindle and respective working roll is variable in height; and

(b) a casing in which said couplings are housed at least partially such that said spindles and said working rolls can rotate and wherein in two opposite walls of the casing apertures are provided for the passage of the respective parts of the connecting unit entering the casing,
wherein said casing comprises in the respective wall for each part of the connecting unit passing in the casing a wall element with said aperture for containing the passing part of said connecting unit wherein at least one wall element of the spindle side and the respective wall element of the working roll side is variable in height and thus moveable in the direction that defines the distance between the two wall elements arranged one above the other.

[0015] The proposed system encloses in the casing the parts affected by lubrication, and protects them together with the used lubricant from external agents and prevents the loss of the lubricant that remains inside the casing. Thanks to the protection and recovery of the lubricant according to the invention, even the use of more valuable lubricants, such as lubricating oils, which are more effective in the lubrication of the couplings, is no longer a problem from the economic point of view since the oil can be recovered inside the casing and protected from external agents and therefore be reused. The lubricant is therefore preferably a lubricating oil. Preferably, said casing ensures protection according to the international class as defined in the IEC 60529 standard of at least IP 24.

[0016] In the case of parallel working rolls, which is the most widespread case for the arrangement of working rolls, it is possible to define a distance between centerlines between the rolls which, by subtracting the radiuses of the rolls themselves, provides the aforementioned gap.

[0017] Spindles, working rolls and couplings that connect both are known in the state of the art and are part of the general technical knowledge of the person skilled in the art, thus a more detailed description thereof can be omitted.

[0018] This system according to the invention is suitable for any type of couplings between spindles and working rolls, and this for rolling mills of the reversible type as well as of the continuous type, the latter having a constant mutual distance between the working rolls of each roller

stand. Advantageously, these are guide shoe spindles.

[0019] It is to be understood that the coupling can connect the spindle directly to the working roll as well as indirectly through components connected to the working roll (or even to the spindle). Such components can be, for example, necks located at the ends of the roll which, in turn, at least in the case of the end that connects to the spindle, are inserted in respective housings or flanges which are part of the coupling itself or are connected to it.

[0020] Parts of the unit that can pass through the walls of the casing are the spindles or parts of them, parts of the working roll or components that connect it to the coupling or parts of the coupling itself, particularly if they are parts that do not require lubrication or particular protection, such as flanges for the necks of the working rolls that are integrated into the couplings. The casing can therefore also contain parts of the spindles or the connected working rolls, such as for example the necks. The case of partial containment of the coupling can, for example, occur if the casing contains the part of the coupling that realizes the actual connection and therefore the contact between two connected pieces, which also needs lubrication, but does not contain all the parts of the coupling. Parts which serve as a housing for the working roller or a neck thereof may be located outside the casing.

[0021] The two opposite walls of the casing affected by the passage of spindles or components of the working rolls are advantageously provided for this purpose with respective apertures which allow a rotation of the spindles and rolls inside the corresponding aperture. Individual openings can be provided for each spindle or working roll or aperture, for example in the form of slots, which allow a plurality of spindles or a plurality of working rolls to pass.

[0022] The rolling mill with which the casing is associated is a reversible rolling mill, the gap between the rolls and consequently the distance between the couplings is variable and at least one of the couplings with respective spindle and respective working roll is variable in height. The height dimension is defined by the direction determined by the aforementioned distance. This height adjustability can be achieved because of the fact that the upper coupling with respective spindle and respective working roll is variable in height, or in that the lower coupling with respective spindle and respective working roll is variable in height or because of the fact that both the couplings with respective spindles and respective working rolls vary in height.

[0023] According to the invention, the casing comprises in the respective wall for each part of the connecting unit passing in the casing a wall element with said aperture for containing the passing part of said connecting unit wherein at least one wall element of the spindle side and the respective wall element of the working roll side is variable in height and thus moveable in the direction that defines the distance between the two wall elements arranged one above the other to follow the distance variation between spindles and working rolls.

[0024] In this regard, preferably, the respective wall has guides on its sides, inside which guide shoes or respective profiles created on the side edges of the wall elements slide.

[0025] In an advantageous variant of the invention, each aperture is made of antifriction material and/or includes at the edges of the aperture at least two sliding rolls projecting into the aperture to facilitate the rotation of the cylindrical element, spindle or working roll.

[0026] Preferably, in order to allow a hermetic sealing of the casing without having to leave free spaces in the wall which make it possible to move the wall elements, it is provided that

(I) between two wall elements arranged one above the other is arranged a first deformable element; and wherein

(II) between the upper part of the wall containing said wall elements and/or the lower part of the wall containing said wall elements and the consecutive moveable wall

element is arranged a further deformable element.

[0027] In other words, deformable elements are provided in positions where the distance between a moveable wall element and another wall element or between a wall element and the upper/lower part of the wall can vary. For example, if the protection contains two couplings and only one of the two couplings is variable in height, there will be a deformable element between the two wall elements arranged one above the other and between the upper or lower part of the wall near the moveable part element, while it is not necessary to arrange a deformable element between the fixed wall element and the respective upper or lower part of the wall. If both couplings are movable, deformable elements are provided between the wall elements and between the upper wall element and the upper part of the wall and between the lower wall element and the lower part of the wall.

[0028] Deformable elements of different kinds are conceivable: elements folded like a squeezebox or creasable elements as known from bellows, shutter elements, elastic (reversibly) expandable polymeric materials.

[0029] The preferred variant for the deformable element is an element folded like a squeezebox or in other words a zig-zag-folded or Leporello-fold element, like a polymeric sheet. An element folded in this manner allows a practically perfect reversible and repeated compression and expansion of the deformable element.

[0030] Preferably, the combination of movable wall elements and deformable elements allows for the casing applied to the reversible rolling mills an airtight seal with a protection degree of at least IP 24.

[0031] Preferably, inclinations made possible with spherical or wedge joints on the spindles support and simplify the adaptation of the distance between the couplings or of the slot between the working rolls and the inclination of the spindle to ensure their correct connec-

tion to the drive systems.

[0032] In a further advantageous variant of the protection system, the casing comprises a device for lubricating the couplings with a lubricant. These devices advantageously relate to the external lubrication of the couplings; moreover an internal lubrication can be managed by a flow of a lubricant coming from the inside of the spindles. The oil recovery system according to the invention thus also allows continuous lubrication of the couplings.

[0033] Very advantageously, the casing is provided with an outlet for the lubricant collected in the casing. For a practical collection of the lubricant, the casing can be provided with a tray on its bottom, an inclination of the bottom or a recess in the bottom for lubricant discharge, so as to be able to recover it easily.

[0034] Another aspect of the invention relates to a roller stand or a rolling mill train which comprises one or more lubricant recovery and protection systems according to the invention.

[0035] A further aspect of the invention relates to a method for continuous lubrication and protection of spindle couplings which comprises the following steps:

(A) providing a lubricant recovery and protection system according to the invention equipped with a lubrication device and a respective outlet of the lubricant;
(B) lubrication of the couplings contained in the casing by said lubrication device;
(C) collecting of the lubricant in excess in the casing;
(D) recovery of the collected lubricant through said lubricant outlet;
(E) reuse of the drained lubricant in the lubrication device.

[0036] The invention also relates to a method for varying the slot between the working rolls in a roller stand and simultaneously protecting the couplings connecting the spindles to the working rolls. For this purpose, a lubricant recovery and protection system according to the invention is provided which allows the height adjustment of the spindles and of the working rolls. In particular in the case of the presence of deformable elements, during the reduction of the distance, the compression step of the deformable element between the respective spindles arranged one above the other and between the respective working rolls arranged one above the other expanding simultaneously the other deformable elements present in the same wall and, in the case of distance increase, the step of expanding the deformable element between the respective spindles arranged one above the other and between the respective working rolls arranged one above the other compressing simultaneously the other deformable elements present in the same wall are added. This method can be combined with the lubrication method described above, allowing lubrication even in the case of reversible rolling mills.

[0037] A last aspect of the invention relates to a protective casing which comprises at least two apertures arranged one above the other in each of two opposite walls of the casing forming a pair of opposite upper apertures and a pair of opposite lower apertures wherein each aperture is located in a wall element and wherein at least one pair of opposite wall elements is moveable in height inside the wall, preferably sliding with respective guide shoes or profiles inside of guides provided in the side edges of the respective side of the casing, and wherein the wall is formed in the parts affected by the movement of the wall elements of deformable material.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0038]

Fig. 1 shows a cross section of a group of reversible roller stands according to the state of the art.
Fig. 2 shows a side view of a roller stand with two working rolls according to the state of the art.
Fig. 3 illustrates, in a perspective view, an exemplary embodiment of a lubricant recovery and protection system according to the invention.
Fig. 4 shows an enlarged detail of Fig. 3 highlighting the casing of the protection.
Fig. 5 shows a sectional view of the casing for lubricant recovery and protection of couplings between spindles and working rolls of Figs. 3 and 4.
Fig. 6 shows a perspective view of a passage ring as a wall element for the spindles or the working rolls of the casing as shown in Figs. 3 to 5.

[0039] Fig. 1 shows a cross-section of a reversible rolling assembly comprising two roller stands **2**. Each stand **2** is equipped with two working rolls **6** (or work rolls) that define a slot **8** (or gap) between them to pass the material to be rolled. The backup rolls **4**, preferably of larger diameter, externally support the two working rolls **6** in contact with the material to be processed. Two upstream **10a** and downstream **10b** reels wrap and unwrap the product to be rolled allowing the evacuation of the same from the stands **2** between one rolling step and the following one, to allow adjustment of the slots **8** in such a way that the thick product can become thinner through the successive steps between the stands **2**. To maintain the temperature of the product being rolled, these two reels can be contained in heated ovens.

[0040] Fig. 2 shows a side view of a four-roll roller stand according to the state of the art. On the right, two working rolls **16** supported by a frame **19** and defining a gap **18** between them can be observed. Two backup rolls **17** of larger diameter externally support the two working rolls **16** in contact with the material to be processed. The two rolls **16** are connected through respective couplings **11** to spindles **14** which in turn are connected by means of respective couplings to pinions or shafts inside a reducer and/or splitter **13** powered by a motor **15**. During opera-

tion, the couplings **11** are lubricated and in the state of the art they are not protected from dust or other external agents.

[0041] Fig. 3 illustrates, in a perspective view, an exemplary embodiment of a lubricant recovery and protection system according to the invention. A casing **120** contains two couplings (not visible) that connect each a spindle **114a**, **114b** to the respective working roll or to the flange **116**a, **116b** which directly accommodates the neck of the working roll and protects them from external agents such as dust and prevents the loss of lubricating oil used to lubricate the couplings that is collected inside the casing **120**. Every flange **116a**, **116b** accommodates the neck of the working roll and is rotatably housed within a wall element **122a**, **122b** with a ring aperture. Respective rings are also found on the opposite side of the casing **120** to allow the passage of the spindle-coupling-roll systems which form a connecting unit. Between the housings **116a**, **116b** there is a slot or a gap **118** whose height is variable according to the needs. In the represented embodiment example, the casing **120** is equipped with two shutters i.e. two sheets folded in a zig-zag pattern, an upper one **124a** between the upper part of the casing **120** and the ring **122a** and an lower one **124b** located between the two rings **122a** and **122b**.

[0042] Fig. 4 shows an enlarged detail of figure 2 highlighting the casing **120** with bellows-shaped sides. In the state of the maximum distance between the two working rolls and therefore of the respective housings in the form of flanges **116a** and **116b**, the zig-zag folded sheet **124b** is expanded, while the other **124a** is compressed. In the state of the minimum distance between the two flanges **116a** and **116b**, the situation is reversed: the zig-zag folded sheet **124b** it is compressed and the other sheet **124a** is expanded. To increase the airtightness of the system, the wall elements **122a** is **122b** include gaskets **126** in the passage, i.e. in the rings for the flanges **116a** and **116b**. The wall elements **122a** and **122b** are housed in side guides **128** of the wall of the casing **120** containing the bellows-shaped system allowing the up and down movement of the wall elements in adjustment of the distance between centerlines between the essentially parallel working rolls. In this regard, each wall element preferably has (fig. 6) side guide shoes **132** which can be made to slide vertically along these guides so as to accommodate the mutual approach/departure movement between the working rolls while allowing the rotation of the corresponding spindle.

[0043] Fig. 5 shows a sectional view of the casing **120** for protection of the couplings **111a**, **111b** between the spindles **114a**, **114b** and the respective flange **116a**, **116b** for the working roll. In two opposite walls of the casing **120** it is possible to observe the presence of two pairs of opposite wall elements, and precisely **122a**, **122c** and **122b**, **122d** which each serve for passing through the casing **120** a spindle-coupling-roller unit in which the couplings **111a**, **111b** between spindle and roller, i.e. its corresponding housing are enclosed in the casing **120**. The opposite walls of the casing comprise, as already described with reference to fig. 4, two zig-zag folded sheets to allow the variation of the distance between the spindles or between the working rolls. At the bottom of the casing **120** an outlet **130** is provided to extract the lubricant collected on the bottom to then reuse it.

[0044] As can be seen in figures from 3 to 5, from the maximum aperture position to the minimum closing position there is a large space between the working rolls and their flanges **116a**, **116b** (which can reach about 10 to about 800 mm). The bellows-shaped casing is able to cover this extension. In fact, it allows the protection of the coupling to be lubricated from dirt and from the aggressive external environment, furthermore it allows the recovery of the lubricating oil, which being expensive and not getting dirty in the casing can be recirculated again for lubrication.

[0045] Fig. 6 shows a perspective view of a wall element with a ring for the passage of the spindles or of the working rolls, i.e. of their housings in the form of flanges in the casing as shown in figures 3 to 5. On the sides, it is possible to observe protrusions or profiles or guide shoes **132** that allow, inserted in the guides **128** (see Figs. 4 and 5) of the casing **120**, upward and downward sliding of the wall elements **122x** (x = a, b, c, d) in the respective wall of the casing **120**. Each ring includes sliding rolls **134** which protrude slightly from the surface of the aperture to facilitate the rotation of the spindle or the working roll (not shown) passing through the ring. In a preferential form, said sliding rolls **134** can be four.

[0046] In the embodiment example shown here that simplifies the machine, the lower working roll i.e. its flange **116b** with the corresponding spindle **114b** remains set at a fixed height, while only the upper counterpart **116a** with attached motion transfer devices is moved in approach/departure.

[0047] To achieve the hermetic separation between the internal environment of the bellows-shaped casing and the external environment, on the sides of the casing **120** there should be least two deformable shutter-shaped elements **124a**, **124b** and **124c**, **124d** for each wall, made of a plastic material suitable for folding on itself with zig-zag folds. The first part of this tent is connected between the upper edge of the casing **120** and the upper part of the upper wall element **122a**, **122c** while the lower part of the shutter **124b**, **124d** is connected between the lower edge of the upper wall element **122a**, **122c** and the upper edge of the lower wall element **122b**, **122d.** Said upper shutter **124a**, **124c** therefore extends to maximum tension when the lower and upper wall elements are spaced at the minimum gap between working rolls and vice versa the lower one **124b**, **124d** in this configuration is compressed to a minimum. When the gap between the wall elements **122a** and **122b** and between **122c** and **122d** (and therefore the working rolls) increases, the lower shutter **124b**, **124d** stretches and the upper one **124a**, **124c** contracts.

[0048] In this bellows-shaped casing, the lubricant is

sprayed directly on the connecting couplings between the working rolls and spindles (as well as injected inside them) with known systems, below the casing **120** a container or a funnel system can be arranged to allow the lubricating oil to flow out for subsequent recovery.

[0049] In the implementation step, further modifications or embodiment variants not included in the description may be applied to the lubricant recovery and protection system, to the roller stand or the rolling mill train, to the lubrication and/or distance adaptation methods between the working rolls and to the casing, object of the invention. If such modifications or such variants should fall within the scope of the following claims, they should all be considered protected by the present patent.

Claims

1. Lubricant recovery and protection system for spindle couplings (111a, 111b) for reversible roller stands comprising

(a) at least two couplings (111a, 111b) which are arranged one above the other each of them connecting a spindle (114a, 114b) and a working roll forming respective connecting units and which are defining a distance between them correlating with a respective slot (118) between said working rolls,
wherein said slot (118) and consequently said distance are variable and wherein at least one of said couplings (111a, 111b) with the respective spindle (114a, 114b) and the respective working roll is variable in height so that:

(i) the upper coupling (111a) with its respective spindle (114a) and respective working roll is variable in height; and/or
(ii) the lower coupling (111b) with its respective spindle (114b) and respective working roll is variable in height; **characterized in that** the lubricant recovery and protection systems further comprises

(b) a casing (120) in which said couplings (111a, 111b) are housed at least partially such that said spindles (114a, 114b) and said working rolls can rotate and wherein in two opposite walls of the casing (120) apertures are provided for the passage of the respective parts of the connecting unit entering the casing (120),
wherein said casing (120) comprises in the respective wall for each part of the connecting unit passing in the casing (120) a wall clement (122a, 122b, 122c, 122d) with said aperture for containing the passing part of said connecting unit wherein at least one wall element (122c, 122d) of the spindle (114a, 114b) side and the respective wall element of the working roll side is variable in height and thus moveable in the direction that defines the distance between the two wall elements (122a, 122b; 122c, 122d) arranged one above the other.

2. Lubricant recovery and protection system according to claim 1 wherein

(I) between two wall elements (122a and 122b, 122c and 122d) arranged one above the other is arranged a first deformable element (124b, 124d); and wherein
(II) between the upper part of the wall containing said wall elements (122a, 122b; 122c, 122d) and/or the lower part of the wall containing said wall elements (122a, 122b; 122c, 122d) and the consecutive moveable wall element (122a, 122c) is arranged a further deformable element (124a, 124c).

3. Lubricant recovery and protection system according to claim 2 **characterized in that** said deformable element (124a and 124b, 124c and 124d) is an element folded like a squeezebox.

4. Lubricant recovery and protection system according to anyone of the preceding claims **characterized in that** said apertures are realized in antifriction material and/or comprise in the edges of the aperture at least two sliding rolls (134) protruding into the aperture.

5. Lubricant recovery and protection system according to anyone of the preceding claims **characterized in that** said casing (120) comprises a device for the lubrication of said couplings (111a, 111b) with a lubricant.

6. Lubricant recovery and protection system according to claim 5 **characterized in that** said casing (120) is provided with an outlet (130) for said lubricant.

7. Lubricant recovery and protection system according to any one of the preceding claims, **characterized in that** the wall containing the wall elements (122a, 122b, 122c, 122d) provides guides (128) on its sides, inside which respective guide shoes or profiles (132) created on the side edges of the wall elements slide.

8. Lubricant recovery and protection system according to any one of the preceding claims **characterized in that** each aperture is made of antifriction material and/or includes at the edges of the aperture at least two sliding rolls (134) projecting into the aperture to facilitate the rotation of the cylindrical element, spindle or working roll.

9. Roller stand or rolling mill train comprising one or more lubricant recovery and protection systems according to anyone of the preceding claims.

10. Method for the continuous lubrication and protection of spindle couplings (111a, 111b) comprising the following steps:

(A) providing a lubricant recovery and protection system according to claim 6, 7 or 8;
(B) lubrication of the couplings (111a, 111b) contained in the casing (120) by said lubrication device;
(C) collecting of said lubricant in excess in said casing (120);
(D) recovery of said collected lubricant through said outlet (130);
(E) reuse of said drained lubricant in said lubrication device; and optionally in the case of a system according to claim 6 and anyone of the claims from 2 to 4 regulating of the distance between said couplings (111a, 111b) compressing/expanding the deformable element (124b, 124d) between two wall elements arranged one above the other (122a and 122b, 122c and 122d) for reducing/increasing the distance and accordingly expanding/compressing the other deformable elements (124a, 124d) present in the same wall.

11. Method for varying the slot (118) between the working rolls in a roller stand and simultaneously protecting the couplings (111a, 111b) connecting the spindles (114a, 114b) to the working rolls comprising the following steps:

(A) providing a lubricant recovery and protection system according to anyone of claims from 1 to 8; and
(B) varying the distance between said couplings (111a, 111b) and varying the height of the respective wall elements (122a, 122b, 122c, 122d);

wherein in the case of the presence of deformable elements (124a, 124b, 124c, 124d), during the reduction of the distance, the compression step of the deformable element (124b, 124d) between the respective spindles (114a, 114b) arranged one above the other and between the respective working rolls arranged one above the other expanding simultaneously the other deformable elements (124a, 124c) present in the same wall and, in the case of distance increase, the step of expanding the deformable element (124b, 124d) between the respective spindles (114a, 114b) arranged one above the other and between the respective working rolls arranged one above the other compressing simultaneously the other deformable elements (124a, 124c) present in the same walls are added.

12. A protective casing (120) which comprises at least two apertures arranged one above the other in each of two opposite walls of the casing forming a pair of opposite upper apertures and a pair of opposite lower apertures **characterized in that** each aperture is located in a wall element (122a , 122b, 122c, 122d) and **in that** at least one pair of opposite wall elements (122a, 122c and 122b, 122d) is moveable in height inside the wall, and **in that** the wall is formed in the parts affected by the movement of the wall elements (122a, 122b, 122c, 122d) of deformable material (124a, 124b, 124c, 124d).

13. The protective casing (120) according to claim 12, **characterized in that** said at least one pair of opposite wall elements (122a, 122c and 122b, 122d) is moveable in height inside the wall sliding with respective guide shoes or profiles (132) inside of guides (128) provided in the side edges of the respective side of the casing (120).

Patentansprüche

1. Schmiermittelrückgewinnungs- und Schutzsystem für Spindelkupplungen (111a, 111b) für reversible Walzgerüste umfassend

(a) mindestens zwei Kupplungen (111a, 111b), die übereinander angeordnet sind, wobei jede von ihnen eine Spindel (114a, 114b) und eine Arbeitswalze verbindet, die jeweilige Verbindungseinheiten bilden, und die einen Abstand zwischen ihnen definieren, der mit einem jeweiligen Schlitz (118) zwischen den Arbeitswalzen korreliert,
wobei besagter Schlitz (118) und folglich besagter Abstand variabel sind und wobei mindestens eine der Kupplungen (111a, 111b) mit der jeweiligen Spindel (114a, 114b) und der jeweiligen Arbeitswalze in der Höhe variabel ist, so dass:

(i) die obere Kupplung (111a) mit ihrer jeweiligen Spindel (114a) und der jeweiligen Arbeitswalze in der Höhe variabel ist; und/oder
(ii) die untere Kupplung (111b) mit ihrer jeweiligen Spindel (114b) und der jeweiligen Arbeitswalze in der Höhe variabel ist; **dadurch gekennzeichnet, dass** das Schmiermittelrückgewinnungs- und Schutzsystem ferner umfasst

(b) ein Gehäuse (120), in dem besagte Kupplungen (111a, 111b) zumindest teilweise unter-

gebracht sind, so dass sich die Spindeln (114a, 114b) und die Arbeitswalzen drehen können, und wobei in zwei gegenüberliegenden Wänden des Gehäuses (120) Öffnungen für den Durchgang der jeweiligen Teile der Verbindungseinheit, die in das Gehäuse (120) eintreten, vorgesehen sind
wobei besagtes Gehäuse (120) in der jeweiligen Wand für jeden Teil der Verbindungseinheit, der in das Gehäuse (120) eintritt, ein Wandelement (122a, 122b, 122c, 122d) mit besagter Öffnung zum Aufnehmen des passierenden Teils besagter Verbindungseinheit umfasst, wobei mindestens ein Wandelement (122c, 122d) der Seite der Spindel (114a, 114b) und das jeweilige Wandelement der Seite der Arbeitswalze in der Höhe variabel und somit in der Richtung beweglich ist, die den Abstand zwischen den beiden übereinander angeordneten Wandelementen (122a, 122b; 122c, 122d) definiert.

2. Schmiermittelrückgewinnungs- und Schutzsystem nach Anspruch 1, wobei

(I) zwischen zwei übereinander angeordneten Wandelementen (122a und 122b, 122c und 122d) ein erstes verformbares Element (124b, 124d) angeordnet ist; und wobei
(II) zwischen dem oberen Teil der Wand, der besagte Wandelemente (122a, 122b; 122c, 122d) enthält, und/oder dem unteren Teil der Wand, der besagte Wandelemente (122a, 122b; 122c, 122d) enthält, und dem darauffolgenden beweglichen Wandelement (122a, 122c) ein weiteres verformbares Element (124a, 124c) angeordnet ist.

3. Schmiermittelrückgewinnungs- und Schutzsystem nach Anspruch 2, **dadurch gekennzeichnet, dass** das verformbare Element (124a und 124b, 124c und 124d) ein Element ist, das wie eine Quetschkommode gefaltet ist.

4. Schmiermittelrückgewinnungs- und Schutzsystem nach einem beliebigen der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** besagte Öffnungen aus reibungsarmem Material geschaffen sind und/oder an den Rändern der Öffnung mindestens zwei Gleitrollen (134) aufweisen, die in die Öffnung hineinragen.

5. Schmiermittelrückgewinnungs- und Schutzsystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Gehäuse (120) eine Vorrichtung zur Schmierung der Kupplungen (111a, 111b) mit einem Schmiermittel umfasst.

6. Schmiermittelrückgewinnungs- und Schutzsystem nach Anspruch 5, **dadurch gekennzeichnet, dass** das Gehäuse (120) mit einem Auslass (130) für besagtes Schmiermittel versehen ist.

7. Schmiermittelrückgewinnungs- und Schutzsystem nach einem beliebigen der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die die Wandelemente (122a, 122b, 122c, 122d) enthaltende Wand an ihren Seiten Führungen (128) aufweist, in denen an den Seitenkanten der Wandelemente ausgebildete jeweilige Führungsschuhe oder -profile (132) gleiten.

8. Schmiermittelrückgewinnungs- und Schutzsystem nach einem beliebigen der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** jede Öffnung aus reibungsarmem Material gemacht ist und/oder an den Rändern der Öffnung mindestens zwei Gleitrollen (134) umfasst, die in die Öffnung hineinragen, um die Drehung des zylindrischen Elements, der Spindel oder der Arbeitsrolle zu erleichtern.

9. Walzgerüst oder Walzstraße mit einem oder mehreren Schmiermittelrückgewinnungs- und Schutzsystemen nach einem beliebigen der vorhergehenden Ansprüche.

10. Methode zur kontinuierlichen Schmierung und zum Schutz von Spindelkupplungen (111a, 111b), umfassend die folgenden Schritte:

(A) Bereitstellen eines Schmiermittelrückgewinnungs- und Schutzsystems nach Anspruch 6, 7 oder 8;
(B) Schmierung der in dem Gehäuse (120) enthaltenen Kupplungen (111a, 111b) durch besagte Schmiervorrichtung;
(C) Sammeln des überschüssigen Schmiermittels in besagtem Gehäuse (120);
(D) Rückgewinnung besagten gesammelten Schmierstoffs durch besagten Auslass (130);
(E) Wiederverwendung des besagten abgelassenen Schmiermittels in besagter Schmiervorrichtung; und wahlweise im Fall eines Systems nach Anspruch 6 und einem beliebigen der Ansprüche 2 bis 4 Regulierung des Abstands zwischen besagten Kupplungen (111a, 111b), indem das verformbare Element (124b, 124d) zwischen zwei übereinander angeordneten Wandelementen (122a und 122b, 122c und 122d) zusammendrückt/ausdehnt wird, um den Abstand zu verringern/vergrößern und dementsprechend die anderen verformbaren Elemente (124a, 124d), die in derselben Wand vorhanden sind, auszudehnen/zusammenzudrücken.

11. Methode zum Verändern des Schlitzes (118) zwischen den Arbeitswalzen in einem Walzgerüst und

gleichzeitigem Schutz der Kupplungen (111a, 111b), die die Spindeln (114a, 114b) mit den Arbeitswalzen verbinden, umfassend die folgenden Schritte:

(A) Bereitstellen eines Schmiermittelrückgewinnungs- und Schutzsystems nach einem beliebigen der Ansprüche 1 bis 8; und
(B) Variieren des Abstands zwischen besagten Kupplungen (111a, 111b) und Variieren der Höhe der jeweiligen Wandelemente (122a, 122b, 122c, 122d);

wobei im Falle des Vorhandenseins von verformbaren Elementen (124a, 124b, 124c, 124d) während der Verringerung des Abstands der Schritt des Zusammendrückens des verformbaren Elements (124b, 124d) zwischen den jeweiligen übereinander angeordneten Spindeln (114a, 114b) und zwischen den jeweiligen übereinander angeordneten Arbeitswalzen, der gleichzeitig die anderen verformbaren Elemente (124a, 124a, 124c), die sich in derselben Wand befinden ausdehnt, und, im Falle einer Abstandsvergrößerung, der Schritt des Ausdehnens des verformbaren Elements (124b, 124d) zwischen den jeweiligen übereinander angeordneten Spindeln (114a, 114b) und zwischen den jeweiligen übereinander angeordneten Arbeitswalzen, der gleichzeitig die anderen verformbaren Elemente (124a, 124c), die sich in denselben Wänden befinden, zusammendrückt, hinzugefügt werden.

12. Schutzgehäuse (120), das mindestens zwei Öffnungen umfasst, die übereinander in jeder von zwei gegenüberliegenden Wänden des Gehäuses angeordnet sind und ein Paar gegenüberliegende obere Öffnungen und ein Paar gegenüberliegende untere Öffnungen bilden, **dadurch gekennzeichnet, dass** jede Öffnung in einem Wandelement (122a, 122b, 122c, 122d) angeordnet ist **und dass** mindestens ein Paar von gegenüberliegenden Wandelementen (122a, 122c und 122b, 122d) in der Höhe innerhalb der Wand beweglich ist, **und dass** die Wand in den Teilen, die von der Bewegung der Wandelemente (122a, 122b, 122c, 122d) betroffen sind, aus verformbarem Material (124a, 124b, 124c, 124d) gebildet ist.

13. Schutzgehäuse (120) nach Anspruch 12, **dadurch gekennzeichnet, dass** das mindestens eine Paar gegenüberliegender Wandelemente (122a, 122c und 122b, 122d) in der Höhe innerhalb der Wand beweglich ist, indem es mit jeweiligen Führungsschuhen oder -profilen (132) innerhalb von Führungen (128) gleitet, die in den Seitenkanten der jeweiligen Seite des Gehäuses (120) vorgesehen sind.

Revendications

1. Système de récupération de lubrifiant et de protection pour des accouplements de broche (111a, 111b) pour des cages de laminoir réversibles comprenant

(a) au moins deux accouplements (111a, 111b) qui sont disposés l'un au-dessus de l'autre, chacun d'eux reliant une broche (114a, 114b) et un cylindre de travail formant des unités de connexion respectives et qui définissent une distance entre eux en corrélation avec une fente respective (118) entre lesdits cylindres de travail, dans lequel ladite fente (118) et par conséquent ladite distance sont variables et dans lequel au moins l'un desdits accouplements (111a, 111b) avec la broche respective (114a, 114b) et le cylindre de travail respectif est variable en hauteur de sorte que :

(i) l'accouplement supérieur (111a) avec sa broche respective (114a) et son cylindre de travail respectif est variable en hauteur; et/ou
(ii) l'accouplement inférieur (111b) avec sa broche respective (114b) et son cylindre de travail respectif soit variable en hauteur; **caractérisé en ce que** le système de récupération du lubrifiant et de protection comprend en outre

(b) un boîtier (120) dans lequel lesdits accouplements (111a, 111b) sont logés au moins partiellement de sorte que lesdites broches (114a, 114b) et lesdits cylindres de travail puissent tourner et dans lequel dans deux parois opposées du boîtier (120) des ouvertures sont prévues pour le passage des parties respectives de l'unité de connexion entrant dans le boîtier (120),
dans lequel ledit boîtier (120) comprend dans la paroi respective pour chaque partie de l'unité de connexion passant dans le boîtier (120) un élément de paroi (122a, 122b, 122c, 122d) avec ladite ouverture pour contenir la partie passante de ladite unité de connexion, dans lequel au moins un élément de paroi (122c, 122d) du côté de la broche (114a, 114b) et l'élément de paroi respectif du côté du cylindre de travail est variable en hauteur et donc mobile dans la direction qui définit la distance entre les deux éléments de paroi (122a, 122b ; 122c, 122d) disposés l'un au-dessus de l'autre.

2. Système de récupération de lubrifiant et de protection selon la revendication 1, dans lequel

(I) entre deux éléments de paroi (122a et 122b,

122c et 122d) disposés l'un au-dessus de l'autre est disposé un premier élément déformable (124b, 124d); et dans lequel
(II) entre la partie supérieure de la paroi contenant lesdits éléments de paroi (122a, 122b; 122c, 122d) et/ou la partie inférieure de la paroi contenant lesdits éléments de paroi (122a, 122b ; 122c, 122d) et l'élément de paroi mobile consécutif (122a, 122c) est disposé un autre élément déformable (124a, 124c).

3. Système de récupération de lubrifiant et de protection selon la revendication 2 **caractérisé en ce que** ledit élément déformable (124a et 124b, 124c et 124d) est un élément plié comme un accordéon.

4. Système de récupération de lubrifiant et de protection selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdites ouvertures sont réalisées en matériau antifriction et/ou comprennent dans les bords de l'ouverture au moins deux cylindres de glissement (134) faisant saillie dans l'ouverture.

5. Système de récupération de lubrifiant et de protection selon l'une quelconque des revendications précédentes **caractérisé en ce que** ledit boîtier (120) comprend un dispositif de lubrification desdits accouplements (111a, 111b) avec un lubrifiant.

6. Système de récupération de lubrifiant et de protection selon la revendication 5, **caractérisé en ce que** ledit boîtier (120) est muni d'une sortie (130) pour ledit lubrifiant.

7. Système de récupération de lubrifiant et de protection selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la paroi contenant les éléments de paroi (122a, 122b, 122c, 122d) fournit des guides (128) sur ses côtés, à l'intérieur desquels coulissent des patins ou des profils de guidage respectifs (132) créés sur les bords latéraux des éléments de paroi.

8. Système de récupération de lubrifiant et de protection selon l'une quelconque des revendications précédentes **caractérisé en ce que** chaque ouverture est réalisée en matériau antifriction et/ou comporte sur les bords de l'ouverture au moins deux cylindres de glissement (134) faisant saillie dans l'ouverture pour faciliter la rotation de l'élément cylindrique, de la broche ou du cylindre de travail.

9. Cage de laminoir ou train de laminoir comprenant un ou plusieurs systèmes de récupération du lubrifiant et de protection selon l'une quelconque des revendications précédentes.

10. Méthode pour la lubrification et la protection continues des accouplements de broches (111a, 111b) comprenant les étapes suivantes :

(A) fourniture d'un système de récupération du lubrifiant et de protection selon la revendication 6, 7 ou 8;
(B) lubrification des accouplements (111a, 111b) contenus dans le boîtier (120) par ledit dispositif de lubrification;
(C) collecte dudit lubrifiant en excès dans ledit boîtier (120);
(D) récupération dudit lubrifiant collecté par ladite sortie (130);
(E) la réutilisation dudit lubrifiant drainé dans ledit dispositif de lubrification; et éventuellement, dans le cas d'un système selon la revendication 6 et l'une quelconque des revendications 2 à 4, la régulation de la distance entre lesdits accouplements (111a, 111b) comprimant/dilatant l'élément déformable (124b, 124d) entre deux éléments de paroi disposés l'un au-dessus de l'autre (122a et 122b, 122c et 122d) pour réduire/augmenter la distance et par conséquent dilater/compresser les autres éléments déformables (124a, 124d) présents dans la même paroi.

11. Méthode pour faire varier la fente (118) entre les cylindres de travail dans une cage de laminoir et protéger simultanément les accouplements (111a, 111b) reliant les broches (114a, 114b) aux cylindres de travail comprenant les étapes suivantes :

(A) fournir un système de récupération du lubrifiant et de protection selon l'une quelconque des revendications de 1 à 8 ; et
(B) faire varier la distance entre lesdits accouplements (111a, 111b) et faire varier la hauteur des éléments de paroi respectifs (122a, 122b, 122c, 122d) ;

dans lequel, dans le cas de la présence d'éléments déformables (124a, 124b, 124c, 124d), pendant la réduction de la distance, on ajoute l'étape de compression de l'élément déformable (124b, 124d) entre les broches respectives (114a, 114b) disposées l'une au-dessus de l'autre et entre les cylindres de travail respectifs disposés l'un au-dessus de l'autre en dilatant simultanément les autres éléments déformables (124a, 124c) présents dans la même paroi et, dans le cas d'une augmentation de la distance, on ajoute l'étape d'expansion de l'élément déformable (124b, 124d) entre les broches respectives (114a, 114b) disposées l'une au-dessus de l'autre et entre les cylindres de travail respectifs disposés l'un au-dessus de l'autre en comprimant simultanément les autres éléments déformables (124a, 124c) présents dans les mêmes parois.

12. Boîtier de protection (120) qui comprend au moins deux ouvertures disposées l'une au-dessus de l'autre dans chacune de deux parois opposées du boîtier formant une paire d'ouvertures supérieures opposées et une paire d'ouvertures inférieures opposées, **caractérisé en ce que** chaque ouverture est située dans un élément de paroi (122a, 122b, 122c, 122d) **et en ce qu'**au moins une paire d'éléments de paroi opposés (122a, 122c et 122b, 122d) est mobile en hauteur à l'intérieur de la paroi, **et en ce que** la paroi est formée dans les parties affectées par le mouvement des éléments de paroi (122a, 122b, 122c, 122d) de matériau déformable (124a, 124b, 124c, 124d).

13. Boîtier de protection (120) selon la revendication 12, **caractérisé en ce que** ladite au moins une paire d'éléments de paroi opposés (122a, 122c et 122b, 122d) est mobile en hauteur à l'intérieur de la paroi coulissant avec des patins ou des profils de guidage respectifs (132) à l'intérieur de guides (128) prévus dans les bords latéraux du côté respectif du boîtier (120).

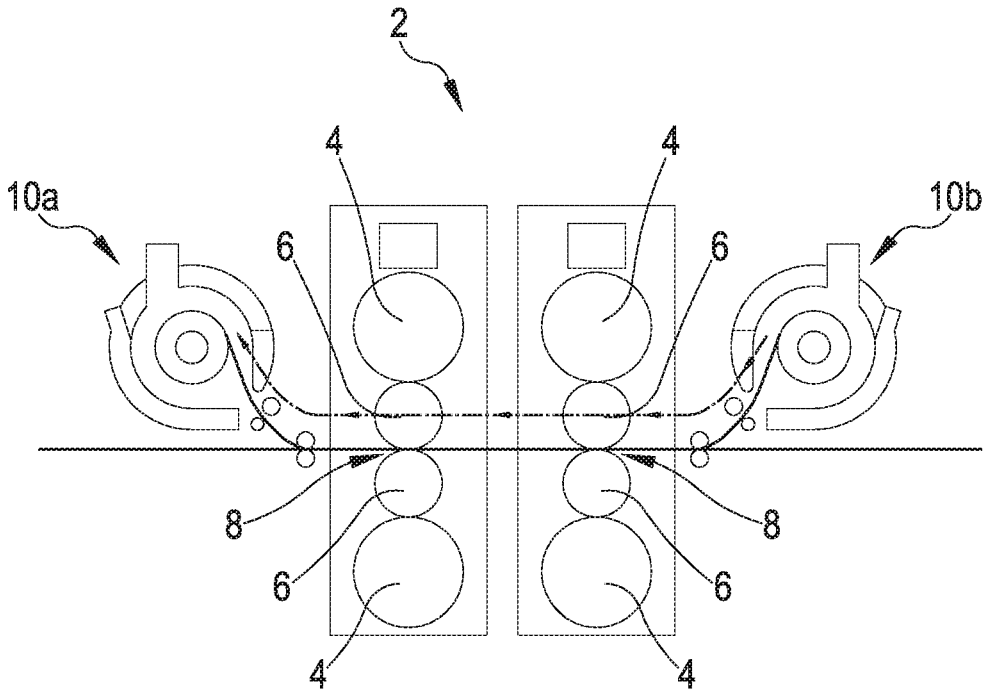


FIG.1 (PRIOR ART)

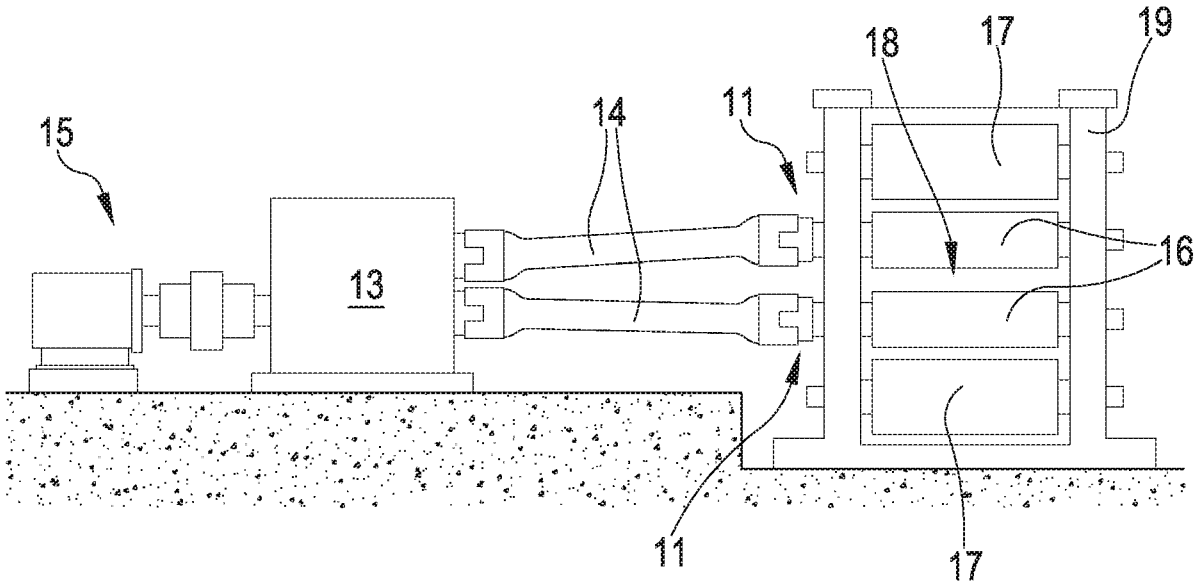


FIG.2 (PRIOR ART)

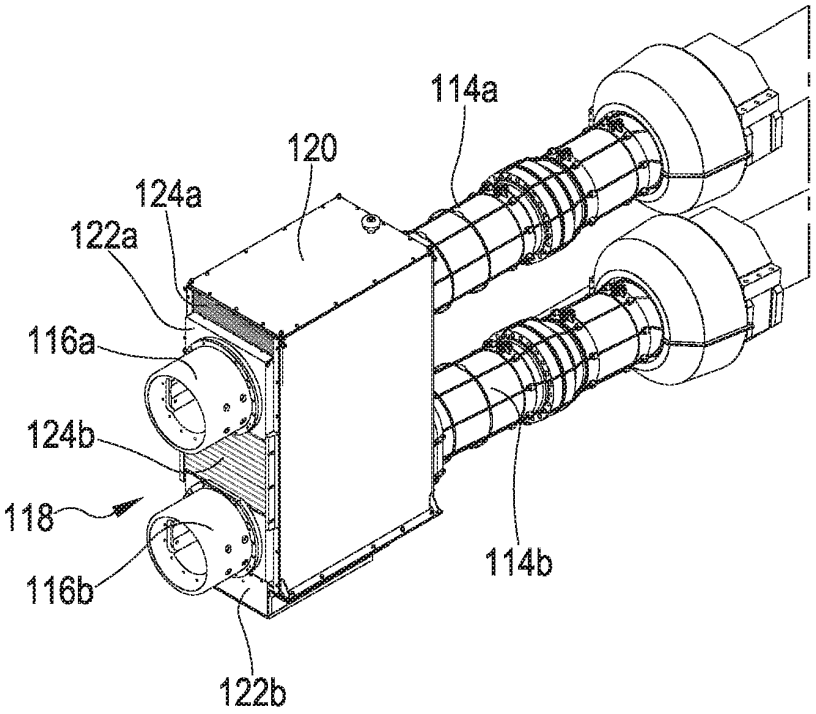

114a
120
124a
122a
116a
124b
118
116b
114b
122b

FIG.3

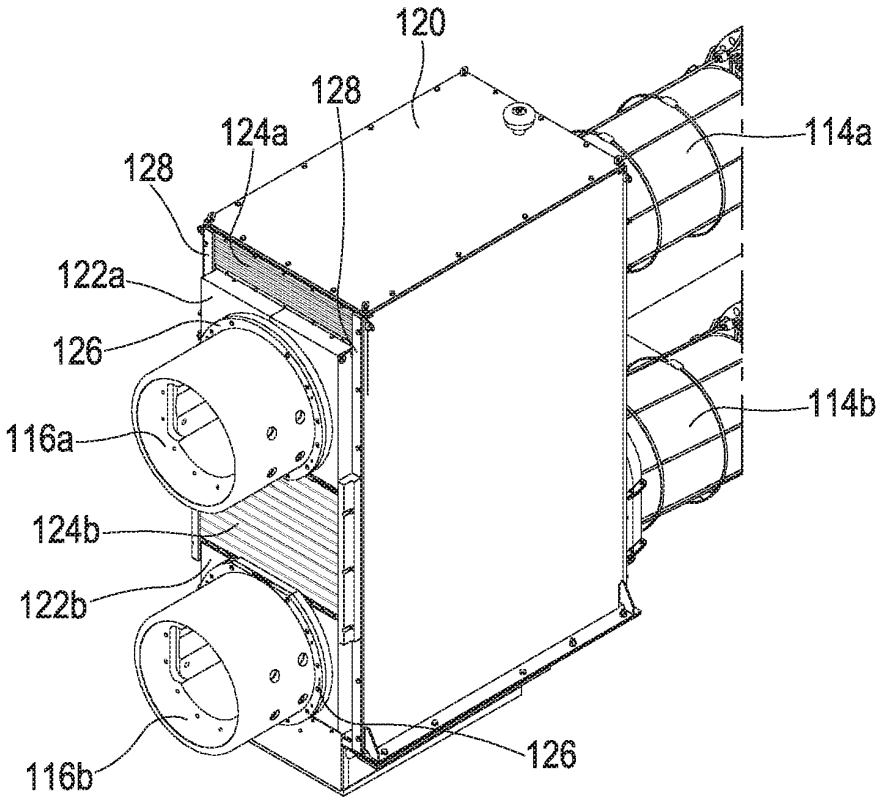

120
128
124a
114a
128
122a
126
114b
116a
124b
122b
126
116b

FIG.4

FIG.5

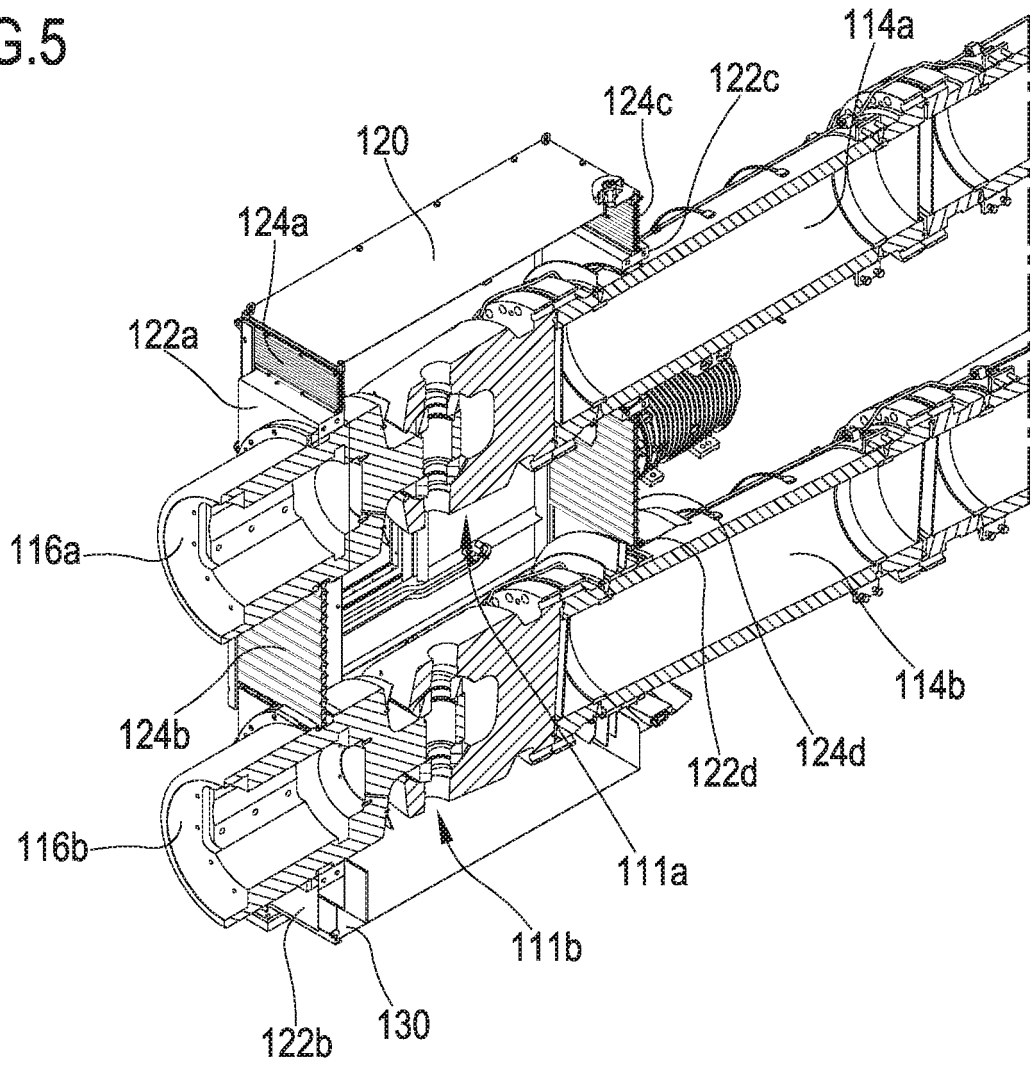
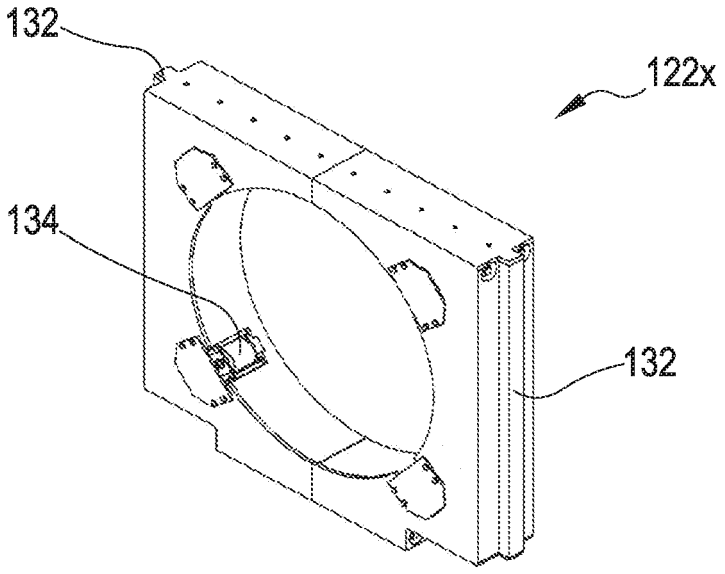

114a
122c
124c
120
124a
122a
116a
114b
124b
122d
124d
116b
111a
111b
122b
130

FIG.6


132
122x
134
132

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 19711609 A1 **[0001] [0011]**
- US 7383712 B2 **[0001] [0011]**
- DE 1902894 A1 **[0011]**