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(54) **SHOE PRESS FOR PAPER AND RELATED METHOD**

SCHUHPRESSE FÜR PAPIER UND ENTSPRECHENDES VERFAHREN

PRESSE À SABOT POUR PAPIER ET PROCÉDÉ ASSOCIÉ

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Description

TECHNICAL FIELD

[0001] The invention relates to improvements to paper-making machinery. Embodiments disclosed herein specifically concern improvements to the shoe presses utilized to reduce the amount of water in cellulose plies for producing paper.

BACKGROUND ART

[0002] In wet paper-making processes, a thin layer of an aqueous suspension of cellulose fibers is formed on a forming wire. The layer of aqueous suspension is dispensed from headboxes arranged along the cross direction of the forming wire and initially contains a very low percentage by weight of fibers, typically in the order of the 2-10%. Along a feed path the water content is gradually reduced so as to form a cellulose ply with a gradually increasing content of the solid part, i.e., of cellulose fibers.

[0003] Typically, the first part of water removal takes place by drainage through the forming wire, optionally with the aid of suction rollers or boxes. When the percentage of dry material is sufficiently high to give suitable mechanical strength to the cellulose ply formed by gradual removal of water from the suspension of cellulose fibers, the cellulose ply is passed through drying presses and finally over heating members, for example rollers of a drier or a Yankee cylinder.

[0004] In recent times, in order to obtain a more delicate treatment of the paper, which preserves the thickness thereof as much as possible during the step of removing water by pressing, shoe presses have been developed. Examples of shoe presses and their uses are disclosed in US10697120, US8986506, US7150110, US6517672, US7291249, US6158333, WO2007/123457.

[0005] Generally, shoe presses comprise a flexible cylindrical sleeve with two rigid heads supported by support bearings to rotate around a rotation axis transverse to the feed path of a felt, on which the cellulose ply is adhering. Inside the flexible cylindrical sleeve a stationary beam extends parallel to the rotation axis of the flexible cylindrical sleeve and orthogonally to the path of the cellulose ply to be dried. Mounted on the support beam is a suitably shaped shoe, coacting with the inner surface of the flexible cylindrical sleeve and pressed radially outward against the inner surface of the flexible cylindrical sleeve by a plurality of actuators. The flexible cylindrical sleeve coacts with a rigid opposing roller or cylinder, having a rotation axis parallel to the rotation axis of the sleeve. The sleeve and the opposing roller or cylinder form an extended pressure nip through which an endless flexible element, typically a felt, passes with the cellulose ply adhering thereto. The shoe presses the sleeve against the opposing roller or cylinder, exerting a pressure on the felt and on the cellulose ply, by means of which water is expelled from the cellulose ply.

[0006] Between the inner surface of the sleeve and the surface of the shoe coacting therewith, a fluid, typically oil, is dispensed to form a gap that reduces friction between sleeve and shoe.

[0007] The opposing roller or cylinder can consist of a counter-pressure roller or by a Yankee cylinder.

[0008] Historically, the shoe press was used to develop relatively high linear loads in the pressure nip, in the order of around 1500 kN/m for the production of paper and cardboard. These high thrusts are usually generated by hydraulic actuators that use high pressure oil supplied by a specific hydraulic circuit with related pumps.

[0009] In more recent times the shoe press was introduced into the field of tissue paper production. In these applications the shoe press generally acts directly on the Yankee cylinder. The linear loads applied in the pressure nip are substantially lower, in the order of 90-120 kN/m. These loads can be developed by pneumatic rather than hydraulic actuators, with noteworthy simplification of the structure of the press and of its drive means.

[0010] An important feature of the shoe press in the tissue paper sector is the possibility of imparting a load profile in the pressure nip in cross direction, i.e., orthogonally to the direction of feed of the cellulose ply, in particular in the lateral areas, i.e. in proximity of the heads of the Yankee cylinder. This makes it possible to offset, by means of the pressure profile, any deformations of the Yankee cylinder.

[0011] Another important feature consists in the possibility of regulating the resultant force in the pressure nip in machine direction, i.e., in the direction of feed of the flexible cylindrical sleeve and of the felt, in order to modify the specific pressure profile along the nip. This feature has implications in the water removal process.

[0012] WO2004/079090 discloses a shoe press according to the preamble of present claim 1, in which the shoe is rigidly fixed on a lever hinged to a support beam inside a flexible cylindrical sleeve, coacting with a counter- pressure roller. The geometry of this shoe press is not efficient, as it allows only one angular operating position.

[0013] WO2019/138349 discloses a shoe press comprising an opposing roller against which an endless flexible element is pressed by means of a shoe, which defines, together with the endless flexible element and with the opposing roller, a pressure nip. The shoe is supported by a beam inside the endless flexible element and has a radial movement toward the opposing roller. Moreover, to maintain the endless flexible element in tension, a support element is also provided inside the endless flexible element, positioned at a distance from the shoe and from the pressure nip. The internal support element is radially and angularly movable, by means of a double actuator system, to modify its position with respect to the position of the shoe. The shoe, i.e., the member that presses against the opposing member, is provided with only a radial movement with respect to the endless flexible element.

[0014] It would therefore be beneficial to provide a shoe press that allows greater efficiency and that completely or partially overcomes the problems of prior art shoe presses.

SUMMARY

[0015] According to one aspect, there is provided a shoe press comprising an endless flexible element movable along a closed path. The endless flexible element can be a sleeve or shell substantially cylindrical in shape, although this is not essential. Moreover, the press comprises a support beam housed inside the endless flexible element. A shoe is supported by the support beam and extends parallel to the support beam inside the endless flexible element. An opposing member is provided outside the endless flexible element, which defines with the endless flexible element a pressure nip for the passage of a cellulose ply. Moreover, the press comprises a plurality of actuators aligned along the support beam and adapted to generate a thrust of the shoe against the opposing member, acting on the inner surface of the endless flexible element. The shoe is supported by a lever hinged to the support beam around a first hinge axis extending parallel to the support beam. The actuators are arranged to act on the lever to rotate the lever around the first hinge axis. Characteristically, the shoe is hinged to the lever around a second hinge axis.

[0016] The opposing member can be a rotating counter-roller or counter-cylinder, in particular having substantially the same peripheral speed as the peripheral speed of the cellulose ply which is pressed in contact against it by means of the shoe press. As will be clarified below, in embodiments disclosed herein the opposing member can be a Yankee cylinder, in particular for the production of tissue paper.

[0017] With respect to prior art shoe presses, and in particular to the one described in WO2004/079070, an important technical effect is obtained with the shoe press according to the invention.

[0018] In fact, in the operating principle of the shoe press, two parameters that define the operating position of the shoe are relevant, i.e.:

- the distance between the operating surface of the shoe and the surface of the opposing member, for example of the counter-cylinder or counter-roller;
- the angular orientation of the shoe, i.e., its inclination.

[0019] These two parameters must be kinematically independent from each other, as each depends in a different manner on the compressibility of the means interposed between shoe and opposing member (polyurethane sleeve forming the endless flexible element, cellulose ply, felts for feeding the cellulose ply) and on the hydraulic counter-pressure generated by the dynamic conditions of the water contained in the materials (felts, cellulose ply) and of the lubricating oil or other bearing fluid in the gap between the shoe and the inner surface of the endless flexible element. These latter are determined by the speed and by the physical properties of the oil. In other words, at each given distance of the shoe from the opposing member, the shoe must be free to take any angular position, to self-adapt to the dynamic conditions. This condition is essential to ensure functioning of the hydrodynamic lubrication of the shoe and very important from the process point of view to obtain the desired pressure profile in machine direction for correct removal of the water.

[0020] The arrangement illustrated in the prior art patent application WO2004/079090 limits angular positioning of the shoe to its distance from the counter-cylinder through the lever to which the shoe is rigidly fixed, and therefore would not function and is not suitable for the purpose. This problem is solved with the shoe press of the present invention.

[0021] Conveniently, the second hinge axis can be located on the opposite side of the lever with respect to the side facing the support beam, i.e., on the side facing the pressure nip. Moreover, advantageously the second hinge axis can be positioned in an intermediate position of the lever, between the first hinge axis and the coupling point of the actuators that control the movement of the lever around the first hinge axis.

[0022] The opposing member can be an endless flexible element, or preferably a rigid roller. The terms "rigid" and "flexible" are meant as relative and referring to normal operating conditions of the shoe press. Therefore, an opposing member is a more rigid member (i.e., less deformable under load) with respect to the endless flexible element. While the latter deforms during operation, to take the shape defined by the active surface (usually concave) of the shoe, the opposing member does not normally undergo any appreciable deformations under the load conditions normally applied in the shoe press.

[0023] In embodiments disclosed herein, the opposing member can consist of a Yankee cylinder, or of another roller of a drier of the paper-making machine.

[0024] In general, the opposing member has a peripheral movement at substantially the same speed as the feed speed of the cellulose ply through the pressure nip.

[0025] According to a further aspect, disclosed herein is a method for pressing a cellulose ply, wherein the cellulose ply is guided through a pressure nip formed between an endless flexible element, movable around a support beam, and an opposing member outside the endless flexible element by means of a shoe extending parallel to the support beam and supported on a lever. This latter is hinged to the support beam around a first hinge axis and is pressed against an inner surface of the endless flexible element by a plurality of actuators aligned along the support beam. The shoe is hinged to the lever around a second hinge axis.

[0026] Further advantageous features and embodiments of the method and of the shoe press according to the invention are described below and defined in the appended claims, which form an integral part of the present description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The invention will be better understood by following the description and accompanying drawings, which illustrate non-limiting exemplary embodiments of the invention. More in particular, in the drawing:

Fig. 1 shows a schematic side view of an endless paper-making machine, with a Yankee cylinder coacting with a shoe press;
Fig. 2 shows a schematic side view of the shoe press;
Figs. 3, 4 and 5 show embodiments of the shoe press; and
Fig. 6 shows a partial view according to VI-VI of Fig.3 in an improved embodiment.

DETAILED DESCRIPTION

[0028] Fig. 1 shows a schematic side view of a tissue paper-making machine 2. The paper machine 2 is known per se and can take different configurations that are known to those skilled in the art. Therefore, the features thereof will not be described in detail.

[0029] It is sufficient to mention that the paper machine 2 comprises headboxes 201 that form a layer of cellulose slurry on forming wires or other endless flexible members permeable to water, comprising wires and/or felts and indicated generically with 203. The cellulose slurry is gradually drained to reduce its water content with known means until reaching a Yankee cylinder 205 that coacts with a shoe press 1. A felt 203 or other endless flexible element passes between the shoe press 1 and the Yankee cylinder 205, and downstream of the shoe press the ply of cellulose fibers is detached from the felt 203 and adhered to the Yankee cylinder to be dried. A doctor blade 207 detaches the dried ply, indicated with V, from the Yankee cylinder 205.

[0030] A schematic view according to a section according to a plane orthogonal to the axis of the shoe press 1 is shown in Fig. 2. In this figure, the shoe press 1 coacts with a Yankee cylinder 205. However, it is understood that the shoe press 1 could, for example, be arranged upstream of the Yankee cylinder 205, or used in a paper machine 2 that does not have a Yankee cylinder 205, but is provided with a series of drying rollers or other drying means. Therefore, the component indicated with 205 in Fig.2 and in the subsequent figures, besides being a Yankee cylinder, can be any other anvil member, preferably in the form of rotating roller or cylinder.

[0031] As shown schematically in Fig. 2, the shoe press 1 comprises a support beam 3 extending in a cross direction with respect to a direction of feed F of a cellulose ply V on which the shoe press 1 must act. The support beam 3 is attached at the ends thereof to a load-bearing structure, not shown. A flexible cylindrical sleeve 5, having a rotation axis A substantially parallel to the longitudinal extension of the support beam 3 and hence parallel to the cross machine direction (orthogonal to the direction F of feed of the cellulose ply V through the shoe press 1) extends around the support beam 3.

[0032] A shoe 7, which has an active surface 7A in contact with the inner surface of the flexible cylindrical sleeve 5, is arranged between the support beam 3 and the flexible cylindrical sleeve 5. The active surface 7A has a profile shaped so as to form a pressure nip 8 with a suitable shape and extension between the outer surface of the flexible cylindrical sleeve 5 and an opposing surface, for example formed by the cylindrical surface of the Yankee cylinder 205. In a manner known per se, a lubrication gap into which a bearing fluid, for example oil, is fed, is formed between the active surface 7A of the shoe 7 and the inner surface of the flexible cylindrical sleeve 5.

[0033] In some embodiments, lubrication can be of hydrostatic type, as is typical in prior art shoe presses. In this case, the bearing fluid is dispensed under pressure by means of ducts that end into cavities located on the active surface 7A of the shoe 7 of the press 1. The pressure of the bearing fluid is provided by a supply circuit.

[0034] Characteristically, in embodiments described herein, the bearing fluid can be fed from outside the gap and the pressure can be generated through hydrodynamic effect, i.e., through the difference in speed between the inner (movable) surface of the flexible cylindrical sleeve and the (stationary) active surface 7A of the shoe 7. In this case the lubrication that is obtained in the gap between shoe 7 and flexible cylindrical sleeve is a lubrication of hydrodynamic type.

[0035] It would also be possible to combine the two types of lubrication.

[0036] The opposing surface formed by the Yankee cylinder 205 or other opposing member rotates in the opposite direction with respect to the direction of rotation of the cylindrical sleeve 5. The peripheral speeds of the flexible cylindrical sleeve 5 and of the opposing surface are substantially identical in modulus. The shape of the active surface 7A of the shoe 7 and the shape of the opposing surface of the Yankee cylinder 205 are substantially complementary to each other, so as to form the extended pressure nip 8 of approximately constant height (dimension orthogonal to the opposing surface) along the path of the cellulose ply through the nip 8.

[0037] The Yankee cylinder 205 or other opposing roller rotates at substantially the same feed speed as the speed of one of the endless flexible members 203 that passes through the pressure nip 8 formed between the Yankee cylinder 205 and the portion of flexible cylindrical sleeve 5 pressed against this latter by the shoe 7.

[0038] Characteristically, the shoe 7 is connected to a lever 21 that has a first end 21A hinged to the support beam 3 by means of a hinge that defines a first hinge axis 25 parallel to the support beam 3 and the rotation axis A. The lever 21 is thus hinged to the support beam 3 so as to pivot around the first hinge axis 25.

[0039] The shoe 7 is hinged to the lever 21 by means of a hinge that forms a second hinge axis 23. In practice, the shoe 7 is therefore hinged to the lever 21 so as to rotate around the second hinge axis 23. The hinge axis 23 is approximately parallel to the rotation axis A of the flexible cylindrical sleeve 5 and to the first hinge axis 25. At the opposite end 21B, the lever 21 is connected to thrust actuators 27, which generate a thrust of the shoe 7 against the opposing surface 9. The thrust actuators 27 are represented schematically in Fig. 2 and can take various forms, some of which are described below with reference to the remaining figures.

[0040] In practice, the shoe press 1 comprises a plurality of actuators 27 aligned along the longitudinal extension of the shoe 7 and of the support beam 3, i.e., parallel to the rotation axis A of the flexible cylindrical sleeve 5.

[0041] Fig. 3 schematically indicates two series of thrust actuators 27A and 27B, each of which comprises a plurality of actuators aligned in the direction of the longitudinal extension of the support beam 3 and of the shoe 7.

[0042] Each actuator 27 can be a hydraulic actuator. In preferred embodiments, in particular in the case in which the shoe press 1 is associated with a Yankee cylinder 205, the actuators 27 are pneumatic actuators, which have a simpler construction and do not require a hydraulic drive circuit.

[0043] The arrangement of two series of actuators 27A, 27B ensures the generation of a sufficiently high linear pressure in the pressure nip 8.

[0044] The actuators 27A, 27B can comprise actuators utilizing synthetic materials, such as synthetic rubber. Actuators of this type can comprise air springs, torpresses or equivalent actuators.

[0045] In other embodiments, the actuators can comprise piston-cylinder actuators. Fig. 4 shows an embodiment in which multi-stage pneumatic piston-cylinder actuators are used, in which each actuator comprises a cylinder divided into two chambers 28A, 28B, in which two pistons 29A, 29B connected to a single rod 31 move. The double actuator, again indicated with 27, thus obtained generates a thrust that is the sum of the thrusts generated on the two pistons 29A, 29B by the pressurized fluid in the two chambers 28A, 28B. In this way, a high thrust is obtained by means of a compact and simple arrangement.

[0046] Using a lever 21 and a shoe 7 made of a sufficiently flexible material, by means of the use of a plurality of actuators 27 controlled independently to one another or in groups, it is possible to generate a linear pressure profile of the desired form along the longitudinal extension of the pressure nip 8, i.e., in cross direction with respect to the direction of feed F (machine direction) of the endless flexible element 203 and of the cellulose ply V adhering thereto.

[0047] This makes it possible to offset any local or general deformations of the opposing surface formed by the Yankee cylinder 205 or by another opposing cylindrical member. This is particularly advantageous in the case in which the opposing surface is formed by the outer surface of a Yankee cylinder 205, which can become deformed in use due to its large dimensions and to its internal temperature and pressure. For example, and in particular, the Yankee cylinder 205 can expand radially in the center more than it expands in proximity of the heads, consequently forming a crowning. Autonomous control of single actuators 27 makes it possible to offset this differential expansion, avoiding greater pressure in points in which expansion is higher with respect to points in which expansion is lower.

[0048] Although as a rule it is preferable for each actuator 27 or pair of actuators of the series of actuators 27A, 27B aligned along the rotation axis of the flexible cylindrical sleeve 5 to be independent from the others, this is not strictly necessary. For example, the actuators can be divided into a plurality of groups aligned along the longitudinal direction of the support beam 3 and of the shoe 7, i.e., parallel to the rotation axis A of the flexible cylindrical sleeve 5. The actuators of each group can be controlled together, and the single groups can be controlled independently to one another.

[0049] Fig.6 schematically shows an improved embodiment in which the lever 21 is divided into a plurality of sections or portions 21C, aligned along the longitudinal extension of the support beam 3 and therefore parallel to the hinge axes 23, 25. Fig. 6 is a view according to the line VI-VI of Fig. 3. The configuration of the lever in sections 21C can be adopted for any embodiment, also in Figs. 2, 4, and 5.

[0050] Each section 21C of the lever 21 is stressed by at least one respective thrust actuator 27, or by a couple of thrust actuators 27A, 27B. This division of the lever 21 into sections 21C allows a greater operating flexibility and greater independence of the single actuators in imparting to the shoe 7 a load that is variable along the extension of the pressure nip 8.

[0051] In improved embodiments, one or more secondary actuators 35 can be associated with the shoe 7, as schematically shown in Fig. 5. In practical embodiments, a series of secondary actuators 35 can be provided aligned along the linear extension of the shoe 7. Also in this case the secondary actuators 35 can preferably be pneumatic actuators.

[0052] The secondary actuators 35 can be independent from one another, or divided into groups that are independent from one another.

[0053] Each secondary actuator 35 is interposed between the shoe 7 and the lever 21. If the lever 21 is divided into portions or sections 21C, as shown in Fig.6, at least one secondary actuator 35 can be provided for each section 21C of the lever 21. The secondary actuators 35 allow rotation of the shoe 7 around the second hinge axis 23. In this way it is possible to modify the direction of the resultant of the pressures exerted by the shoe 7 on the opposing surface formed by the Yankee cylinder 205 or other opposing member. If the secondary actuators 35 are independent from one another singularly or in groups, it is possible to impart a resultant of the pressures in variable directions along the longitudinal extension of the shoe 7.

[0054] While the embodiment described above and illustrated in the accompanying drawings is provided with a cylindrical flexible sleeve 5, it would also be possible to use an endless flexible element that is not cylindrical in shape, for example formed by a belt driven around a series of rollers and forming a non-cylindrical closed path.

[0055] In any case, the endless flexible element defines a closed path around a support beam 3 on which the pressure shoe 7, is mounted with the double hinge around the axes 23, 25, the pressure shoe pressing against the inner surface of the endless flexible element thus forming an extended pressure nip between the outer surface of the endless flexible element and the opposing surface outside the endless flexible element.

[0056] In some embodiments, the shoe 7 can be made of a composite material. For example, the shoe 7 can be made of a material having a matrix consisting of a polymer resin, containing reinforcing fibers, such as glass fibers or, preferably, carbon fibers. In some embodiments, the polymer material can be an epoxy resin.

[0057] To obtain more efficient operation, the shoe 7 can have anisotropic properties, i.e., different physical properties in the different spatial directions. For example, the shoe 7 can have a different elastic modulus in machine direction (i.e., the direction of feed of the ply V through the pressure nip 8) and in cross machine direction (i.e., the direction parallel to the longitudinal extension of the support beam 3 and of the shoe 7).

[0058] In some embodiments, the shoe 7 can have an elastic modulus in the direction of feed F of the cellulose ply V through the pressure nip 8 that is higher than the elastic modulus in cross machine direction, i.e., parallel to the support beam 3 and transverse to the direction of feed F of the cellulose ply V.

[0059] Moreover, in the description above specific reference has been made to a configuration in which the shoe press is used mainly to reduce the content of water in the cellulose ply and which for this purpose coacts with a felt or other flexible conveying member that passes through the pressure nip supporting the cellulose ply thereon. However, it would also be possible to use features of the new shoe press disclosed herein in a calender, where the cellulose ply could pass through the pressure nip without the support of an endless member. In some embodiments, vice versa, it is also possible to use a double flexible conveying member, for example comprising two felts, between which the ply of cellulose material V is held.

Claims

1. A shoe press (1) comprising:

- an endless flexible element (5) movable along a closed path;
- a support beam (3) housed inside the endless flexible element (5);
- a shoe (7) supported by the support beam (3) and extending parallel to the support beam (3) inside the endless flexible element (5);
- an opposing member (205) outside the endless flexible element (5) and defining with the endless flexible element (5) a pressure nip (8) for the passage of a cellulose ply (V), the pressure nip being formed between the opposing member (205) and the shoe (7);
- a plurality of actuators (27; 27A, 27B) aligned along the support beam (3) and adapted to generate a thrust of the shoe (7) against the opposing member at the pressure nip (8);

wherein the shoe (7) is supported by a lever (21) hinged to the support beam (3) about a first hinge axis (25) extending parallel to the support beam (3), and wherein the actuators (27; 27A, 27B) are arranged to act on the lever (21) to rotate the lever around the first hinge axis (25);
characterized in that the shoe (7) is hinged to the lever (21) around a second hinge axis (23).

2. The shoe press (1) of claim 1, wherein the lever (21) comprises a first end (21A), hinged to the first hinge axis (25), and a second end (21B).

3. The shoe press (1) of claim 2, wherein the actuators (27; 27A, 27B) act in proximity of the second end (21B) of the lever (21).

4. The shoe press (1) of claim 2 or 3, wherein the second hinge axis (23) is positioned along the lever (21) between the first end (21A) and the second end (21B).

5. The shoe press (1) of one or more of the preceding claims, wherein the actuators (27; 27A 27B) are pneumatic actuators, in particular pneumatic piston-cylinder or pneumatic spring actuators.

6. The shoe press (1) of one or more of the preceding claims, comprising two series of actuators (27A; 27B), each comprising a plurality of actuators aligned along the direction of the support beam (3) and of the shoe (7).

7. The shoe press (1) of one or more of the preceding claims, wherein the lever is divided into a plurality of sections (21C) positioned side by side along the longitudinal extension of the support beam (3) and of the shoe (7).

8. The shoe press (1) of claim 7, wherein at least one actuator (27; 27A, 27B) acts on each section (21C) of the lever (21).

9. The shoe press (1) of claim 7, wherein at least two actuators (27A, 27B) act on each section of the lever.

10. The shoe press (1) of one or more of claims 7 to 9, wherein the actuators (27; 27A, 27B) of each section (21C) or of groups of sections of the lever (21) are controlled independently from one another.

11. The shoe press (1) of one or more of the preceding claims, wherein at least one of the actuators (27; 27A, 27B) comprises a multi-stage piston cylinder actuator in series.

12. The shoe press (1) of one or more of the preceding claims, comprising at least one secondary actuator (35) arranged to act between the lever (21) and the shoe (7).

13. The shoe press (1) of one or more of the preceding claims, comprising a series of secondary actuators (35), arranged to act between the lever (21) and the shoe (7).

14. The shoe press of claim 13, wherein the secondary actuators (35) are controlled independently from one another or in independent groups.

15. The shoe press of one or more of claims 12 to 14, wherein each secondary actuator (35) is a pneumatic actuator.

16. The shoe press (1) of one or more of the preceding claims, wherein the shoe (7) is made of anisotropic material having an elasticity modulus in the direction of feed (F) of the cellulose ply through the pressure nip (8) greater than the elasticity modulus in the direction transverse to the direction of feed (F) of the cellulose ply (V) through the pressure nip (8).

17. The shoe press (1) of one or more of the preceding claims, wherein the shoe (7) is made of a composite material, preferably a fiber filled, preferably carbon fiber filled, polymer material.

18. A method for pressing a cellulose ply (V), wherein the cellulose ply is guided through a pressure nip (8) formed between an endless flexible element (5) movable around a support beam (3) and an opposing member (205) outside the endless flexible element (5) by means of a shoe (7) extending parallel to the support beam (3) and supported on a lever (21) hinged to the support beam (3) around a first hinge axis (25) and pressed against an inner surface of the endless flexible element (5) by a plurality of actuators aligned along the support beam (3) at the pressure nip (8); wherein the shoe is hinged to the lever (21) around a second hinge axis (23).

19. The method of claim 18, wherein the shoe (7) is pressed by at least a secondary actuator (35) that acts between the shoe (7) and the lever (21).

20. The method of claim 18 or 19, wherein a lubrication gap between an active surface (7A) of the shoe (7) and an inner surface of the endless flexible element (5) is subjected to hydrodynamic lubrication, or to hydrostatic lubrication, or to combined hydrodynamic and hydrostatic lubrication.

Patentansprüche

1. Schuhpresse (1) mit:

- einem endlosen flexiblen Element (5), das entlang eines geschlossenen Weges bewegbar ist,
- einem Stützträger (3), der innerhalb des flexiblen Elements (5) aufgenommen ist,
- einem Schuh (7), der durch den Stützträger (3) gestützt wird und sich parallel zu dem Stützträger (3) innerhalb des endlosen flexiblen Elements (5) erstreckt,
- einem gegenüberliegenden Element (205) außerhalb des endlosen flexiblen Elements (5) und das mit dem endlosen flexiblen Element (5) einen Druckspalt (8) für den Durchlass einer Cellulose-Lage (V) definiert, wobei der Druckspalt zwischen dem gegenüberliegenden Element (205) und dem Schuh (7) gebildet ist,
- einer Anzahl von Aktuatoren (27; 27A, 27B), die entlang des Stützträgers (3) ausgerichtet sind und ausgebildet sind, um einen Druck auf den Schuh (7) gegen das gegenüberliegende Element an dem Druckspalt (8) auszuüben,

wobei der Schuh (7) durch einen Hebel (21) getragen wird, der an dem Stützträger (3) um eine erste Schwenkachse (25) angelenkt ist, die sich parallel zu dem Stützträger (3) erstreckt, und wobei die Aktuatoren (27; 27A, 27B) angeordnet sind, um auf den Hebel (21) zu wirken, um den Hebel um die erste Schwenkachse (25) zu drehen,
dadurch gekennzeichnet, dass der Schuh (7) an dem Hebel (21) um eine zweite Schwenkachse (23) angelenkt ist.

2. Schuhpresse (1) nach Anspruch 1, wobei der Hebel (21 ein erstes Ende (21A) aufweist, das an der ersten Schwenkachse (25) angelenkt ist, und ein zweites Ende (21B).

3. Schuhpresse (1) nach Anspruch 2, wobei die Aktuatoren (27; 27A, 27B) in der Nähe des zweiten Endes (21B) des Hebels (21) wirken.

4. Schuhpresse (1) nach Anspruch 2 oder 3, wobei die zweite Schwenkachse (23) entlang des Hebels (21) zwischen dem ersten Ende (21A) und dem zweiten Ende (21B) angeordnet ist.

5. Schuhpresse (1) nach einem oder mehreren der vorstehenden Ansprüche, wobei die Aktuatoren (27; 27A, 27B) pneumatische Aktuatoren sind, insbesondere pneumatische Kolben-Zylinder- oder pneumatische Feder-Aktuatoren sind.

6. Schuhpresse (1) nach einem oder mehreren der vorstehenden Ansprüche mit zwei Reihen von Aktuatoren (27A; 27B), mit jeweils einer Anzahl von Aktuatoren, die entlang der Richtung des Stützträgers (3) und des Schuhs (7) ausgerichtet sind.

7. Schuhpresse nach einem oder mehreren der vorstehenden Ansprüche, wobei der Hebel in eine Anzahl von Abschnitten (21C) unterteilt ist, die nebeneinander entlang der Längserstreckung des Stützträgers (3) und des Schuhs (7) positioniert sind.

8. Schuhpresse (1) nach Anspruch 7, wobei mindestens ein Aktuator (27; 27A, 27B) auf jeden Abschnitt (21C) des Hebels (21) wirkt.

9. Schuhpresse (1) nach Anspruch 7, wobei mindestens zwei Aktuatoren (27A, 27B) auf jeden Abschnitt des Hebels wirken.

10. Schuhpresse (1) nach einem oder mehreren der Ansprüche 7 bis 9, wobei die Aktuatoren (27; 27A, 27B) jedes Abschnitts (21C) oder Gruppen von Abschnitten des Hebels (21) unabhängig voneinander gesteuert werden.

11. Schuhpresse (1) nach einem oder mehreren der vorstehenden Ansprüche, wobei mindestens einer der Aktuatoren (27; 27A, 27B) einen mehrstufigen Kolben-Zylinder-Aktuator in Reihe aufweist.

12. Schuhpresse (1) nach einem oder mehreren der vorstehenden Ansprüche mit mindestens einem sekundären Aktuator (35), der ausgebildet ist, um zwischen dem Hebel (21) und dem Schuh (7) zu wirken.

13. Schuhpresse (1) nach einem oder mehreren der vorstehenden Ansprüche mit einer Reihe von sekundären Aktuatoren (35), die angeordnet sind, um zwischen dem Hebel (21) und dem Schuh (7) zu wirken.

14. Schuhpresse nach Anspruch 13, wobei die sekundären Aktuatoren (35) unabhängig voneinander in unabhängigen Gruppen gesteuert werden.

15. Schuhpresse nach einem oder mehreren der Ansprüche 12 bis 14, wobei jeder sekundäre Aktuator (35) ein pneumatischer Aktuator ist.

16. Schuhpresse (1) nach einem oder mehreren der vorstehenden Ansprüche, wobei der Schuh (7) aus einem anisotropen Material mit einem Elastizitätsmodul in Richtung der Förderung (F) der Cellulose-Lage durch den Druckspalt (8) gefertigt ist, der größer ist als der Elastizitätsmodul in Richtung quer zu der Richtung der Förderung (11) der Cellulose-Lage (V) durch den Druckspalt (8).

17. Schuhpresse (1) nach einem oder mehreren der vorstehenden Ansprüche, wobei der Schuh (7) aus einem Verbundmaterial gefertigt ist, vorzugsweise aus einem Faser-gefüllten, vorzugsweise einem Kohlefaser-gefüllten Polymermaterial.

18. Verfahren zum Pressen einer Cellulose-Lage (V), wobei die Cellulose-Lage durch einen Druckspalt (8) geführt wird, der zwischen einem endlosen flexiblen Element (5), das um einen Stützträger (3) bewegbar ist, und einem gegenüberliegenden Element (205) außerhalb des flexiblen Elements (5) mittels eines Schuhs (7) gebildet ist, der sich parallel zu dem gestützt Träger (3) erstreckt und von einem Hebel (21) getragen wird, der an dem Stützträger (3) um eine erste Schwenkachse (25) angelenkt ist und gegen eine innere Fläche des flexiblen Elements (5) durch eine Anzahl von Aktuatoren gepresst wird, die entlang des Stützträgers (3) an dem Druckspalt (8) ausgerichtet sind, wobei der Schuh an dem Hebel (21) um eine zweite Schwenkachse (23) angelenkt ist.

19. Verfahren nach Anspruch 18, wobei der Schuh (7) durch mindestens einen sekundären Aktuator (35) gepresst wird, der zwischen dem Schuh (7) und dem Hebel (21) wirkt.

20. Verfahren nach Anspruch 18 oder 19, wobei ein Schmierspalt zwischen der aktiven Fläche (7A) des Schuhs (7) und der inneren Fläche des endlosen flexiblen Elements (5) einer hydrodynamischen Schmierung oder einer hydrostatischen Schmierung oder einer kombinierten hydrodynamischen und hydrostatischen Schmierung ausgesetzt ist.

Revendications

1. Une presse à sabot (1) comprenant :

- un élément flexible sans fin (5) mobile le long d'un circuit fermé ;
- une poutre de support (3) logée à l'intérieur de l'élément flexible sans fin (5) ;
- un sabot (7) support par la poutre de support (3) et s'étendant parallèlement à la poutre de support (3) à l'intérieur de l'élément flexible sans fin (5) ;
- un organe opposé (205) à l'extérieur de l'élément flexible sans fin (5) et formant avec l'élément flexible sans fin (5) un espace de pressage (8) pour le passage d'une couche de cellulose (V), l'espace de pressage étant formé entre l'organe opposé (205) et le sabot (7) ;
- une pluralité d'actionneurs (27 ; 27A, 27B) alignés le long de la poutre de support (3) et aptes à exercer une pression sur le sabot (7) contre l'organe opposé au niveau de l'espace de pressage (8) ;

dans lequel le sabot (7) est supporté par un levier (21) articulé à la poutre de support (3) autour d'un premier axe d'articulation (25) s'étendant parallèlement à la poutre de support (3), et dans lequel les actionneurs (27; 27A, 27B) sont agencés pour agir sur le levier (21) pour le faire tourner autour du premier axe d'articulation (25) ;
caractérisée en ce que le sabot (7) est articulé au levier (21) autour d'un deuxième axe d'articulation (23).

2. La presse à sabot (1) selon la revendication 1, dans laquelle le levier (21) comprend une première extrémité (21A) articulée au premier axe d'articulation (25) et une deuxième extrémité (21B).

3. La presse à sabot (1) selon la revendication 2, dans laquelle les actionneurs (27 ; 27A, 27B) agissent à proximité de la deuxième extrémité (21B) du levier (21).

4. La presse à sabot (1) selon la revendication 2 ou 3, dans laquelle le deuxième axe d'articulation (23) est positionné le long du levier (21) entre la première extrémité (21A) et la deuxième extrémité (21B).

5. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle les actionneurs (27 ; 27A, 27B) sont des actionneurs pneumatiques, en particulier des cylindres à piston pneumatiques ou des actionneurs à ressort pneumatiques.

6. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, comprenant deux séries d'actionneurs (27A ; 27B), comprenant chacune une pluralité d'actionneurs alignés dans la direction de la poutre de support (3) et le sabot (7).

7. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle le levier est divisé en une pluralité de sections (21C) positionnées côté à côte suivant l'extension longitudinale de la poutre de support (3) et du sabot (7).

8. La presse à sabot (1) selon la revendication 7, dans laquelle au moins un actionneur (27 ; 27A, 27B) agit sur chaque section (21C) du levier (21).

9. La presse à sabot (1) selon la revendication 7, dans laquelle au moins deux actionneurs (27A, 27B) agissent sur chaque section du levier.

10. La presse à sabot (1) selon l'une ou plusieurs des revendications 7 à 9, dans laquelle les actionneurs (27 ; 27A, 27B) de chaque section (21C) ou des groupes de sections du levier (21) sont commandés indépendamment les uns des autres.

11. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle au moins l'un des actionneurs (27 ; 27A, 27B) comprend un actionneur de cylindre à piston à plusieurs étages en série.

12. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, comprenant au moins un actionneur secondaire (35) agencé pour agir entre le levier (21) et le sabot (7).

13. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, comprenant une série d'actionneurs secondaires (35), agencés pour agir entre le levier (21) et le sabot (7).

14. La presse à sabot selon la revendication 13, dans laquelle les actionnaires secondaires (35) sont commandés indépendamment les uns des autres ou en groupes indépendants.

15. La presse à sabot selon l'une ou plusieurs des revendications 12 à 14, dans laquelle chaque actionneur secondaire (35) est un actionneur pneumatique.

16. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle le sabot (7) est fait d'un matériau anisotropique ayant un module d'élasticité dans la direction d'avancement (F) de la couche de cellulose à travers l'espace de pressage (8) supérieur au module d'élasticité dans la direction perpendiculaire à l'avancement (F) de la couche de cellulose (V) à travers l'espace de pressage (8).

17. La presse à sabot (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle le sabot (7) est fait d'un matériau composite, de préférence rempli de fibres, de préférence rempli de fibres de carbone, ou un matériau polymère.

18. Un procédé pour presser une couche de cellulose (V), dans lequel la couche de cellulose est guidée à travers un espace de pressage (8) formé entre un élément flexible sans fin (5) mobile autour d'une poutre de support (3) et une organe opposé (205) à l'extérieur de l'élément flexible sans fin (5) au moyen d'un sabot (7) s'étendant parallèlement à la poutre de support (3) et supporté sur un levier (21) articulé à la poutre de support (3) autour d'un premier axe d'articulation (25) et pressé contre une surface interne de l'élément flexible sans fin (5) par une pluralité d'actionneurs alignés le long de la poutre de support (3) au niveau de l'espace de pressage (8) ; dans lequel le sabot est articulé au levier (21) autour d'un deuxième axe d'articulation (23).

19. Le procédé selon la revendication 18, dans lequel le sabot (7) est pressé par au moins un actionneur secondaire (35) qui agit entre le sabot (7) et le levier (21).

20. Le procédé selon la revendication 18 ou 19, dans lequel un interstice de lubrification entre une surface active (7A) du sabot (7) et une surface interne de l'élément flexible sans fin (5) est soumis à une lubrification hydrodynamique ou à une lubrification hydrostatique ou à une lubrification combinée hydrodynamique et hydrostatique.

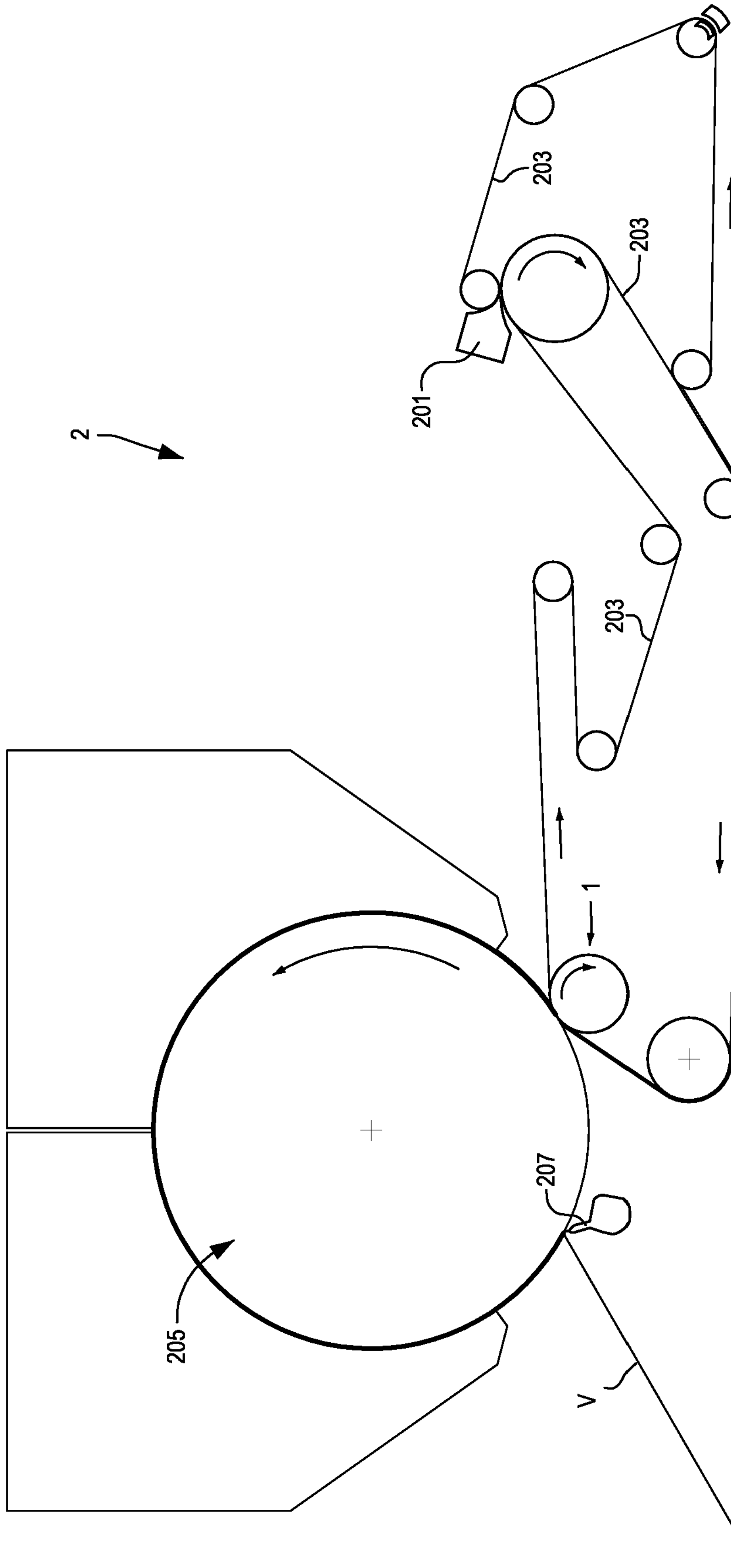

Fig.1

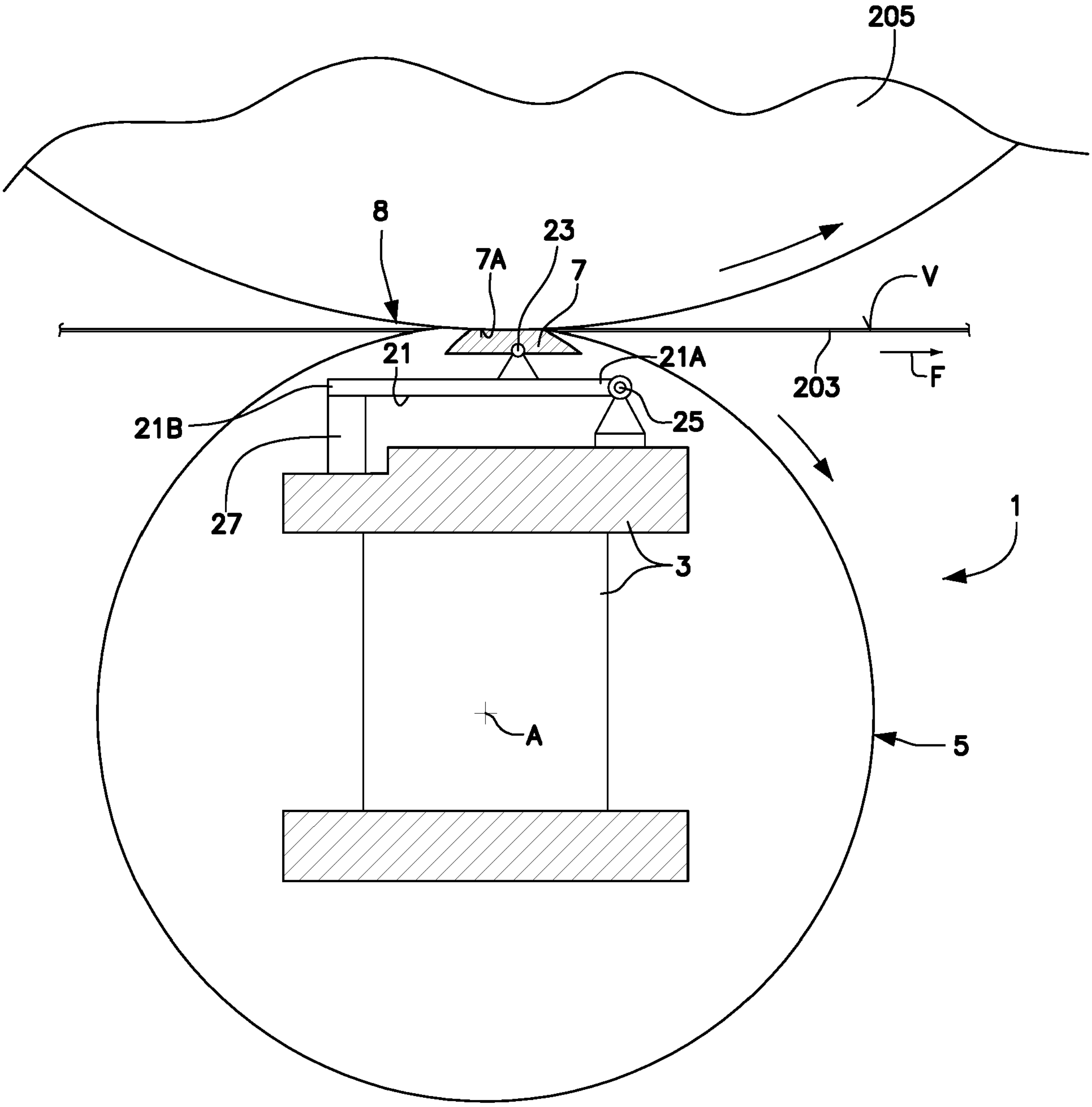

Fig.2

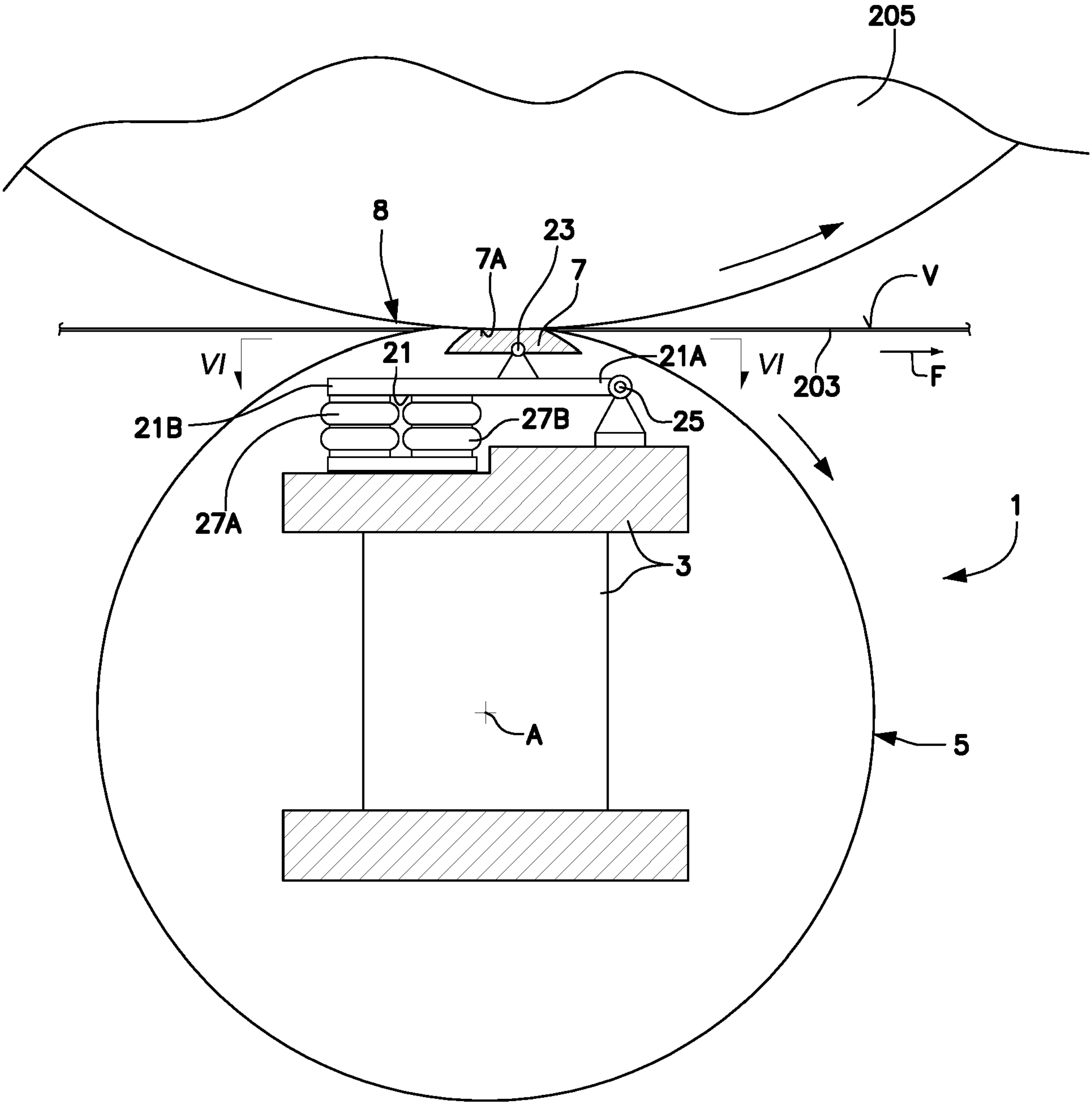

Fig.3

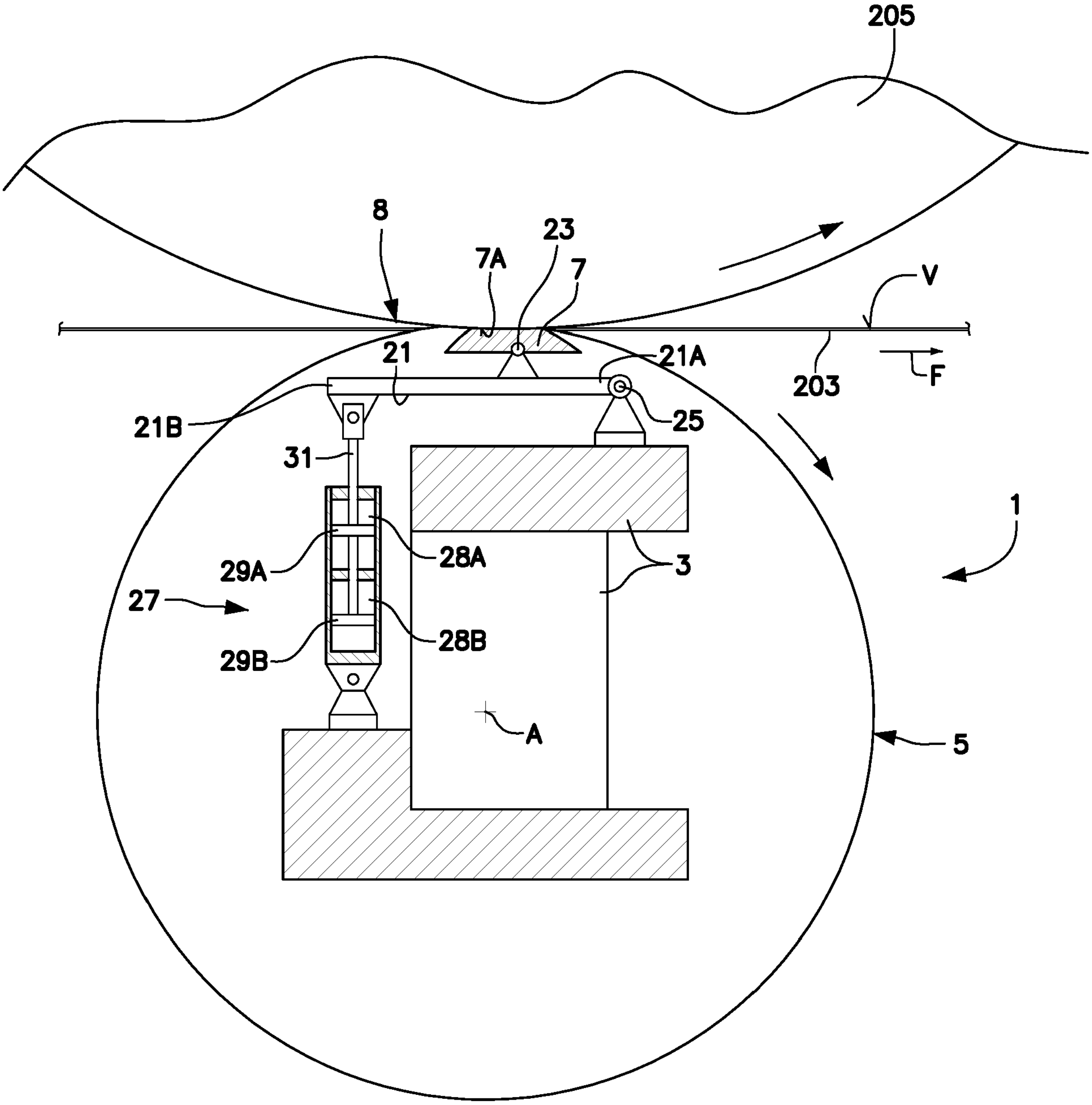

Fig.4

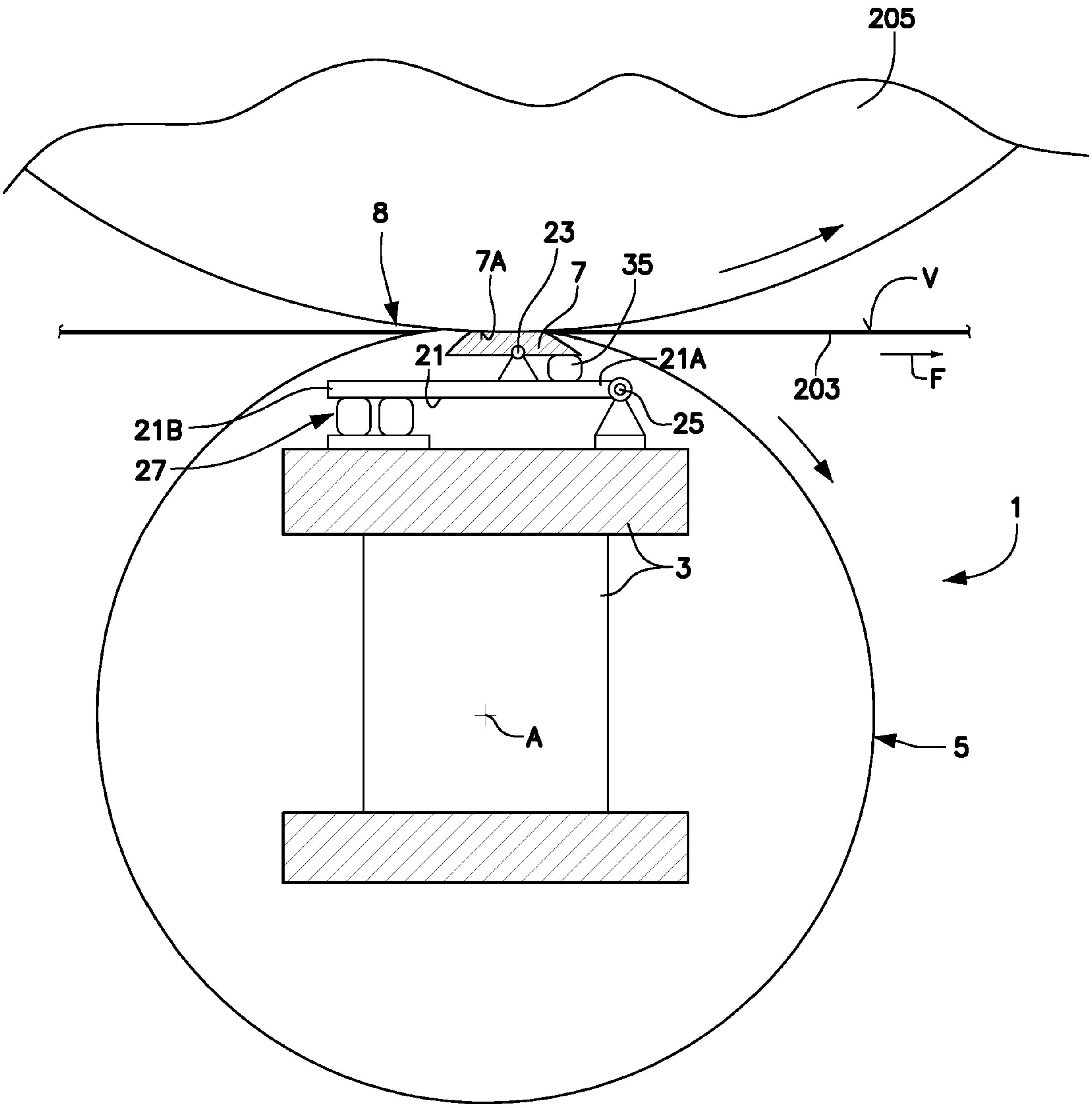

Fig.5

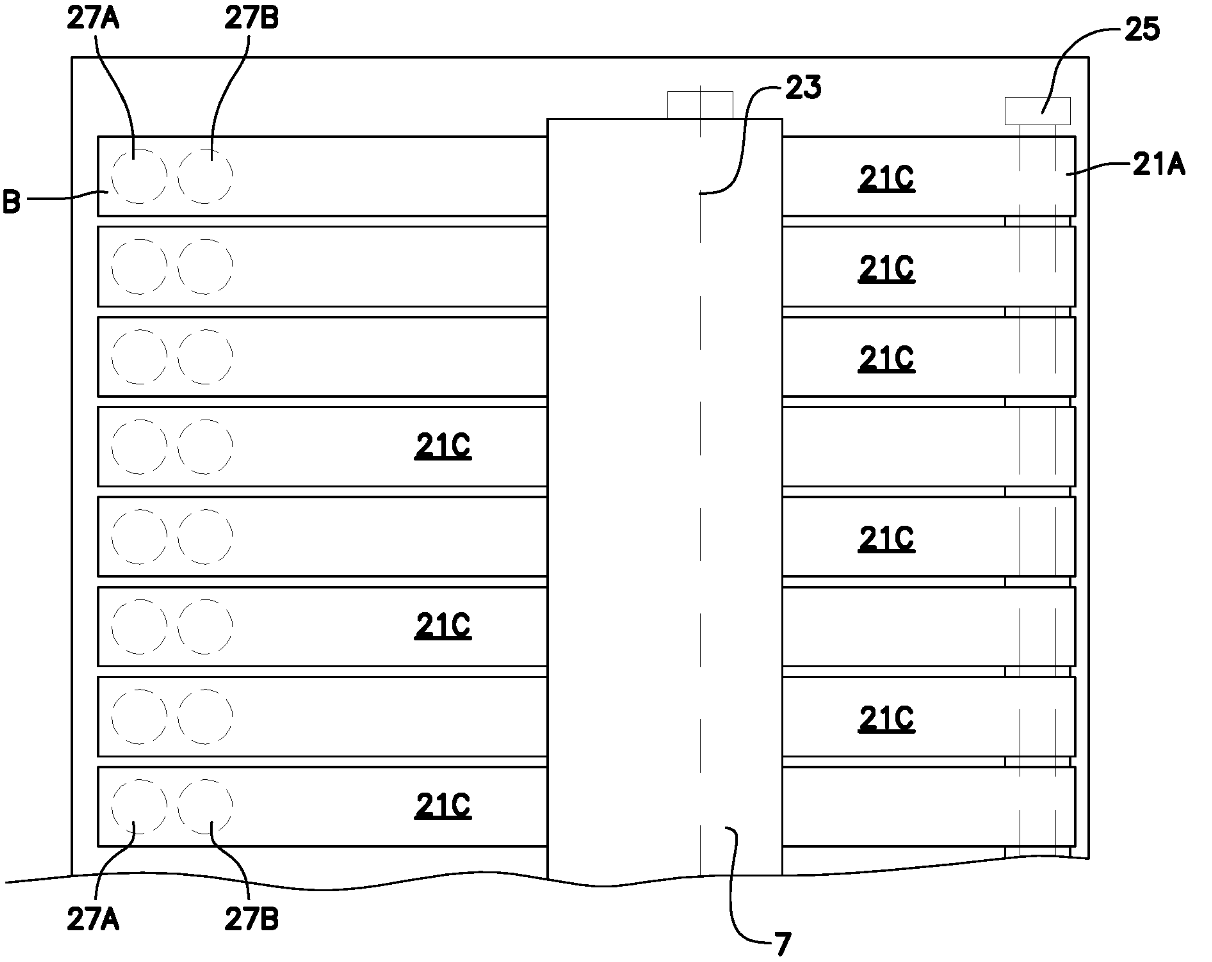

Fig.6

REFERENCES CITED IN THE DESCRIPTION

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