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(54) **Jib device for a crane comprising a sail unit, crane and method for operating the crane**

Auslegervorrichtung für einen Kran die eine Segeleinheit aufweist, Kran und Verfahren zum Betreiben des Krans

Dispositif de flèche d'une grue comportant une voile, grue et procédé de fonctionnement de la grue

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Description

[0001] The invention is directed on a jib device for a crane, a crane comprising such jib device and a method for operating such crane.

[0002] WO 2011/101132 A1 discloses a luffing jib tower crane. For safety reasons such tower crane can operate for a maximum wind speed, which is according to current safety requirements 72 km/h. However, different safety requirements may lead to a different maximum wind speed. For higher wind speeds, the crane must be taken out of service. According to WO 2011/101132 A1, the tower crane is rotated actively in a safe position using a wind-safe-position-control. Such concept is laborious and cost-intensive. In particular, in case of emergency, the active wind-safe-position-control may not work. A danger of collision increases.

[0003] CN 203 667 857 U discloses a wind shield device for a boom of a tower crane. The wind shield device comprises several wind shields, which are articulated with each other and which are articulated to a lower chord of the boom.

[0004] CN 103 086 280 A discloses an automatic retractable sail for a tower crane, wherein the sail is automatically retractable between shafts by rotating a wheel via a wire rope system and a winding drum.

[0005] Taking a tower crane with a luffing jib out of service means that the jib is parked up at a specific out of service angle, corresponding to a specific out of service radius. In this condition, the slew brake is released. This out of service condition is also called weathervane condition, i.e. wind will force the crane's upper part to turn into the wind direction. Thus, the loads on the crane as well as on the crane's supporting structures are minimized. According to the European standard EN 14439 "cranes-safety-tower cranes", the weathervane must be achieved at a wind speed of 40 km/h. However, a torque on the rotational part of the crane provided by the wind force corresponds to the out of service radius of the jib. Thus, if a reduced out of service radius is required - e.g. due to site constraints such as neighbouring properties and/or presence of other cranes - the resulting torque may not be large enough to guarantee weathervaning, in particular at 40 km/h wind speed.

[0006] It is an object of the invention to provide a jib device for a crane which can be brought into a safe out of service position, wherein in particular an active rotation of the jib device is expendable.

[0007] This object is achieved according to the invention by a jib device for a crane comprising the features of independent claim 1, a crane comprising the features of independent claim 13 and a method comprising the features of independent claim 14.

[0008] According to the invention, it was recognized that a jib device comprising a sail unit with a surface area which is variably adjustable, guarantees weathervaning even at reduced wind speed. In particular, even for a reduced out of service radius of a jib of said jib device,

weathervaning is guaranteed by the sail unit, as a windage can be enlarged. A windage is defined by the size of a surface area which is forced by wind. Thus, a safe, i.e. reduced, out of service radius for the jib can be maintained. Such reduced out of service radius is predefined by site constraints, in particular by a steep arrangement of the jib device for reducing a collision risk. Due to the enlargement of the windage, the torque caused by wind force is enlarged, even for the reduced out of service radius. The sail unit of the inventive jib device enables sufficient increase of the surface area such that the torque is sufficient for weathervaning, in particular at a reduced wind speed of at least 40 km/h. Further, an enlarged windage, i.e. a wind attack area, may cause a problem once the upper part of the crane is slewing in a direction against the wind force. Thus, the sail unit is variably adjustable, such that the surface area of the sail unit is decreased, e.g. once the out of service position is left, i.e. during an operation of the crane. In particular, the sail unit is operable, in particular retractable, between a so-called out of service, parking, configuration of the jib device, in which the sail unit has a first, i.e. maximum, surface area, and an operative configuration of the jib device, in which the sail unit has a second, i.e. minimum, surface area. The second surface area is smaller than the first surface area. In particular, the jib device is intended for a crane, in particular for a tower crane. The jib device is connectable to a base unit, in particular a tower, of said crane. Further, the jib device is rotatable about a longitudinal axis of said base unit. Retracting means that the wind sail is retractable in particular in a direction parallel to the longitudinal axis of the jib. Of course, it is also possible to provide the retracting with a retracting direction perpendicular to the longitudinal axis of the jib. The sail unit comprises at least one wind sail. Thus, it is possible that the sail unit comprises several wind sails. It is possible to individually and/or collectively operate the wind sails. It is also possible to provide a wind sail with a fixed wind sail surface, wherein the wind sail is rotatable about the longitudinal axis of the jib. In the parking configuration, the wind sail is arranged parallel to the luffing plane, i.e. perpendicular to the luffing axis of the jib. In the operative configuration, the wind sail is oriented parallel to the luffing axis, i.e. perpendicular to the luffing plane.

[0009] A jib device comprising a control unit for controlling the adjustment area of the sail unit enables an automatized, in particular by closed loop control, operation of the jib device on the crane.

[0010] A jib device having a sensor unit comprising at least one sensor element for sensing actual loading conditions of the jib device, enables the consideration of a priori unknown loading conditions, i.e. a wind force, a luffing angle, actual size of the surface area of the sail unit. These data is preferably used as input data for a close-loop control for adjusting the surface area of the sail unit, in particular continuously. However, the loading conditions can be monitored. Generally, it is possible that

the sail unit is retracted between the parking configuration and the operative configuration, in particular without any configuration in between.

[0011] A crane with such jib device comprises the advantages of the jib device itself. Such crane can be a luffing jib tower crane as generally known from WO 2011/101132 A1. Such crane can also be a saddle jib crane. In particular, it is possible to operate such crane easily with safe conditions.

[0012] A jib device with a supporting unit to which the jib is luffably attached, simplifies the handling of the jib device. The supporting unit itself is preferably rotatable about the longitudinal axis of the base unit. The supporting unit is a rotatable base of the jib device. The jib is luffable about a luffing axis, which is preferably horizontally oriented.

A jib device, wherein the jib is a lattice jib, is of stable and light weight design. A lattice jib can be foldable, i.e. for a self-erecting crane.

A jib device, wherein the sail unit is arranged, in particular at least partly, inside a lattice frame of the lattice jib, comprises enhanced functionality. In particular, the arrangement of the sail unit is robust and provided with minimum space requirements.

As an alternative embodiment, it is possible to provide the jib as a telescopic jib with closed, hollow profiles. In such case, the sail unit is attached to the telescopic jib, in particular, at an outer surface of the telescopic jib.

A jib device, wherein the sail unit comprises a wind sail simplifies the variable adjustment of the surface area of the sail unit.

A jib device, wherein the wind sail is made from light weight material, guarantees reduced slewing resistance of the jib device. In particular, it is possible that the wind sail comprises more than one light weight material, in particular a compound of more than one light weight materials. A light weight material can be for instance a fibre reinforced plastic material, in particular carbon fibre plastic material.

A jib device wherein the wind sail is made from at least one of the group consisting of a rigid material and a textile enhances variable adjustments of the surface area of the sail unit. In case of a textile, it could be provided on a coil, wherein the textile is retractable by pulling a free end from the coil.

[0013] The coil can be spring-loaded, such that automatically retracting of the coil is enabled. Alternatively it is possible to provide a cover around the coil, such that the coil is protected inside the cover. The cover comprises a, in particular slid-shaped, opening, through which the free end of the coil is retractable. In case of a rigid material, it could be stored in a folded arrangement in a space-saving manner and is retractable by unfolding in a planar manner.

[0014] A jib device, wherein the sail unit comprises a drive for retracting the wind sail, i.e. for variably adjusting the surface area of the sail unit, simplifies the handling of the sail unit.

[0015] A jib device with an operation unit for adjusting the surface area of said sail unit enables immediate handling of the adjustment of the surface area. In particular, the operation unit is arranged in an operator's cabin of the crane. In particular, the operation unit comprises a display unit for monitoring the size of the surface area of the sail unit.

[0016] A jib device with an emergency back-up unit guarantees a stable and safe condition of the crane even in case of emergency. A case of emergency is for instance if the primary energy system of the crane is in fold. In such case, the back-up unit guarantees opening/closing of the sail unit, i.e. retracting the wind sail. In particular, it is guaranteed that the wind sail is retracted, i.e. brought into the parking configuration with maximum surface area. In particular, the emergency back-up unit can comprise an automatic actuator induced by self-weight. The automatic actuator is usually in a locked arrangement. In case of emergency, the emergency back-up unit provides unlocking of said automatic actuator by self-weight such that for instance a brake of a retracting drive is unlocked and thus the retracting drive enables retracting the wind sail.

[0017] Embodiments of the invention will be described in more detail below with the add of the drawings:

Fig. 1 shows a side view of a tower crane forced by wind load,

Fig. 2 shows the crane of Fig. 1 in a parking configuration after weathervaning due to the wind load,

Fig. 3 shows a side view of a jib device according to the invention in a parking configuration,

Fig. 4 shows a schematic side view according to arrow IV in Fig. 3,

Fig. 5 shows a side view of the jib device in Fig. 3 in an operative configuration,

Fig. 6 shows a schematic side view according to arrow VI in Fig. 5,

Fig. 7 shows a schematic side view according to Fig. 4 of a sail unit according to another embodiment and

Fig. 8 shows a schematic side view according to Fig. 4 of the sail unit of Fig. 7.

[0018] Fig. 1 shows a side view of a tower crane 1 having a base unit 2 in form of a vertical tower. The base unit 2 has a longitudinal axis 3, which is oriented vertically. On an upper end of the base unit 2, a jib device 4 is provided. The jib device 4 is rotatable about the longitudinal axis 3 of the base unit 2. The rotatability is illustrated by an arrow 5.

[0019] The jib device 4 comprises a jib 6. The jib 6 is a lattice jib. The jib 6 is luffable about a luffing axis 7 attached to a supporting unit 8. The luffing axis 7 is oriented horizontally. The luffing axis 7 is perpendicular to the drawing plane in Fig. 1. The jib 6 comprises a jib longitudinal axis 13. The luffing angle α is defined by the jib longitudinal axis 13 and the horizontal 12. The drawing plane in Fig. 1 is oriented parallel to the luffing plane of the jib 6. The jib device 4 comprises an operator's cabin 9, counterweight means 10 and suspension means 11. However, such means 9, 10, 11 are already known in the art.

[0020] The tower crane 1 according to Fig. 1 is in a parking configuration. The jib 6 is arranged with a luffing angle α regarding the horizontal 12.

[0021] In the parking position the luffing angle is at least 45° , in particular at least 55° , in particular at least 65° , in particular at least 70° and in particular at least 80° to 85° .

[0022] The jib device 4 comprises a jib radius r , which is defined as the projection of the overall jib length on the horizontal axis 12. The radius r is the smaller the larger the luffing angle α is. However, the smaller the radius is, the smaller is a torque caused by a wind load 14.

[0023] If the crane 1 is oriented with the jib device 4 ideally parallel and counter oriented to the wind load 14 as illustrated in Fig. 1, no rotation of the jib device 4 is expected. However, even a small kind of unbalanced arrangement and/or setup of the jib device 4 is sufficient to provide windage for the wind load 14 such that a rotation of the jib device 4 around the longitudinal axis 3 along the direction 5 takes place, if the slew brake is released. This situation enables weathervaning. A safe parking configuration is illustrated in Fig. 2. Regarding Fig. 1, the jib device 4 is rotated approximately 180° about the longitudinal axis 3 of the base unit 2.

[0024] Fig. 3 to 6 show a first embodiment of an inventive jib device 4, wherein the base unit 2 is shown merely in parts.

[0025] The jib device 4 comprises a sail unit 15. The sail unit 15 comprises two wind sails 16. The wind sails 16 are oriented perpendicular to the luffing axis 7. The wind sails 16 are operable, i.e. retractable. In the parking configuration according to Fig. 3 and 4, the wind sails 16 are maximally extended. The sail unit 15 has a first, maximum surface area, which is defined by the sum of the surface areas of each wind sail 16. Further, the sail unit 15 has a second, minimum surface area. According to the embodiment of Fig. 3 to 6, the first surface area is approximately three times larger than the second surface area. In the parking configuration, a first luffing angle α_1 is larger than a second luffing angle α_2 of the operative configuration. Thus, the first jib radius in the parking configuration is smaller than a second jib radius in the operative configuration. The wind sails 16 are each integrated inside a lattice frame 17 of the lattice jib 6. According to the embodiment of Fig. 3 to 6, the lattice frame 17 has a triangular cross section in a plane perpendicular to the jib longitudinal axis 13. However, other cross sections,

in particular of rectangular or square shape, are possible.

[0026] The wind sails 16 according to the preferred embodiment are provided as textiles, which are rolled on a coil or axis 21. The coil or axis 21 is oriented perpendicularly to the longitudinal axis 13 of the jib 6. The wind sail 16 is provided as a textile and rolled on or packed on said axis 21. A free end of the textile of the wind sail 16 is attached to a retracting rod 18. The retracting rod is oriented vertically. The retracting rod is laterally guided in guiding rails 19. The guiding rails 19 can be part of the lattice frame 17 or are firmly attached to the lattice frame 17. The setup and in particular the attachment of the wind sail 16 to the lattice jib 6 is robust. The wind sails 16 are oriented in parallel to the luffing plane, i.e. perpendicular to the luffing axis 7.

[0027] Even in case of a small jib radius, as apparent in the parking configuration, it is possible to provide enhanced windage, i.e. an enlarged surface area such that torque as caused by a wind load guarantees weathervaning of the jib device 4. In particular, it is possible to leave the jib 6 at the luffing angle α_1 , which may be necessary due to side constraints. A drive 20, which is schematically shown in Fig. 4 and 6, is attached to the retracting rod 18. Thus, it is possible to automatically adjust the surface area of the wind sails 16 by moving the retracting rod 18. The textile is rolled on and off the coil 21 depending on the moving direction of the retracting rod 18. The moving direction of the retracting 18 is along the jib longitudinal axis 13.

[0028] The drive 20 is in signal connection with an operation unit, which is not shown in the figures. The operation unit is preferably arranged in the operator's cabin 9 such that an operator is able to monitor and/or adjust the surface area of the sail unit 15. In particular, the operation unit comprises a display.

[0029] Further, a control unit is provided, which is not shown in the figures. The control unit is in signal connection with the operation unit and the drive 20. Further, a sensor unit is provided. The sensor unit is not illustrated in the figures. The sensor unit comprises at least one sensor element, i.e. a wind sensor for sensing the wind speed and the direction of the wind, a luffing sensor for sensing the luffing angle α and/or a surface area sensor for sensing a current surface area of the sail unit 15. As the sail unit is operable, it is possible to provide a reduced surface area in the operative configuration according to Fig. 5 and 6. Thus, the resistance of the jib device 4 with the sail unit 15 for a rotation against the wind load 14 is reduced. A rotation of the jib device 4 in the operative configuration is possible.

[0030] The jib device 4 with the sail unit 15 is resistant to a maximum wind speed of 240 km/h if the wind load 14 is directed parallel to the luffing plane, i.e. as illustrated in Fig. 1 and 2. The jib device 4 with the sail unit 15 is resistant to a maximum wind speed 100 km/h with a wind load perpendicularly to the luffing plane.

[0031] A further embodiment of a jib device for a crane according the invention is illustrated in Fig. 7 to 8. Com-

ponents that correspond to those as described in the previous Fig. 1 to 6 have identical reference signs.

[0032] The jib device 22 comprises a lattice jib 6 identical to that of the jib device 4. However, the sail unit 23 is provided with a wind sail 24 made of a rigid material. The rigid material is for instance carbon fibre, which is provided in plate form. Several carbon fibre plates 25 are connected via a film hinge 26.

[0033] In the retracted configuration, i.e. the parking configuration, the retracting rod 18 is provided at a maximum distance of a C-shaped container 27. The container 27 is provided for storing the plates 25 in a folded arrangement of the operative configuration. In the parking configuration of Fig. 7, an inclined angle between two neighbouring plates 25 is maximum, in particular 180°. In such arrangement, the plates 25 are arranged in one plane, parallel to the luffing plane. In the arrangement of Fig. 7, the orthogonal projection of the wind sail 24 into the luffing plane is maximum.

[0034] In the operative configuration as illustrated in Fig. 8, the inclined angle between neighbouring plates 25 is reduced and is in particular at most 130°, in particular at most 120°, in particular at most 90° and in particular at most 75°. However, it is also possible, that the inclined angle is nearly 0°. In such arrangement, the plates 25 are parallel to each other arranged inside the container 27. In such arrangement, the plates 25 are each perpendicularly arranged regarding the luffing plane.

Claims

1. A jib device for a crane comprising a jib (6) and a sail unit (15; 23), wherein a surface area of said sail unit (15; 23) is variably adjustable, the jib device comprising a control unit for controlling the adjustment of the surface area of said sail unit (15; 23), **characterised by** a sensor unit comprising at least one sensor element for sensing actual loading conditions of the jib device (6; 22), wherein said actual loading conditions being used as input data for a close-loop control for adjusting the surface area of the sail unit (15; 23).
2. The jib device according to claim 1, **characterised by** a supporting unit (8), wherein the jib (6) being luffably attached to the supporting unit (8).
3. The jib device according to one of the preceding claims, **characterised in that** the jib (6) is a lattice jib.
4. The jib device according to claim 3, **characterised in that** the sail unit (15; 23) is arranged, in particular at least partly, inside a lattice frame (17) of the lattice jib.
5. The jib device according to one of the preceding claims, **characterised in that** the sail unit (15; 23)

comprises a wind sail (16; 24).

6. The jib device according to claim 5, **characterised in that** the wind sail (16; 24) is made from at least one light weight material.
7. The jib device according to claim 5 or 6, **characterised in that** the wind sail (16; 24) is made from at least one of the group consisting of a rigid material and a textile.
8. The jib device according to one of the claims 5 to 7, **characterised in that** the sail unit (15; 23) comprises a drive (20) for retracting the wind sail (16; 24).
9. The jib device according to one of the preceding claims, **characterised by** an operation unit for adjusting the surface area of said sail unit (15; 23).
10. The jib device according to one of the preceding claims, **characterised by** a emergency back-up unit for leaving the jib device (4; 22) in a safe condition in case of emergency.
11. A crane (1) comprising
 - a. a base unit (2) having a longitudinal axis (3) and
 - b. a jib device (4; 22) according to one of the preceding claims, wherein said jib device (4; 22) being connected to said base unit (2) rotatably about said longitudinal axis (3).
12. A method for operating a crane comprising the method steps
 - providing a crane (1) according to claim 11,
 - detecting an operating condition,
 - detecting external loads,
 - adjusting the surface area of the sail unit (15; 23) of the jib device (4; 22), wherein adjusting comprises the method steps

- controlling the adjustment of the surface area of said sail unit (15; 23) using the control unit,
- sensing actual loading conditions of the jib device (6; 22) using the sensor unit comprising at least one sensor element,
- using actual loading conditions as input data for the close-loop control for adjusting the surface area of the sail unit (15; 23).

Patentansprüche

1. Auslegervorrichtung für einen Kran umfassend einen Ausleger (6) und eine Segeleinheit (15; 23), wo-

- bei die Oberfläche dieser Segeleinheit (15; 23) variabel einstellbar ist, die Auslegervorrichtung eine Bedieneinheit zur Steuerung der Einstellung der Oberfläche der Segeleinheit (15; 23) umfasst, **gekennzeichnet durch** eine Sensoreinheit, die mindestens ein Sensorelement zur Erkennung der tatsächlichen Ladungsbedingungen der Auslegervorrichtung (4; 22) umfasst, wobei die tatsächlichen Ladungsbedingungen als Eingabedaten für eine geschlossene Regelung zur Einstellung der Oberfläche der Segeleinheit (15; 23) verwendet werden.
2. Auslegervorrichtung nach Anspruch 1, **gekennzeichnet durch** eine Unterstützungseinheit (8), wobei der Ausleger (6) wippbar an der Unterstützungseinheit (8) angebracht ist.
3. Auslegervorrichtung nach einem der vorherigen Ansprüche, **dadurch gekennzeichnet, dass** der Ausleger (6) ein Gitterausleger ist.
4. Auslegervorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** die Segeleinheit (15; 23), insbesondere mindestens teilweise, innerhalb eines Gitterrahmens (17) des Gitterauslegers angeordnet ist.
5. Auslegervorrichtung nach einem der vorherigen Ansprüche, **dadurch gekennzeichnet, dass** die Segeleinheit (15; 23) ein Windsegel (16; 24) umfasst.
6. Auslegervorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** das Windsegel (16; 24) aus mindestens einem leichten Material hergestellt ist.
7. Auslegervorrichtung nach Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** das Windsegel (16; 24) mindestens aus einem Material der Gruppe bestehend aus einem starren Material und einem textilen Material hergestellt ist.
8. Auslegervorrichtung nach einem der Ansprüche 5 bis 7, **dadurch gekennzeichnet, dass** die Segel-einheit (15; 23) einen Antrieb (20) umfasst, um das Windsegel (16; 24) einzufahren.
9. Auslegervorrichtung nach einem der vorherigen Ansprüche, **gekennzeichnet durch** eine Bedieneinheit zur Einstellung der Oberfläche der Segeleinheit (15; 23).
10. Auslegervorrichtung nach einem der vorherigen Ansprüche, **gekennzeichnet durch** eine Notfall-Absicherungseinheit, um die Auslegervorrichtung (4; 22) im Falle eines Notfalls in einem sicheren Zustand zu hinterlassen.
11. Kran (1) umfassend
- a. eine Basiseinheit (2) mit einer Längsachse (3) und
- b. eine Auslegervorrichtung (4; 22) nach einem der vorherigen Ansprüche, wobei die Auslegervorrichtung (4; 22) mit der Basiseinheit (2) drehbar um die Längsachse (3) verbunden ist.
12. Verfahren zum Betrieb eines Krans umfassend die Verfahrensschritte
- Bereitstellen eines Krans (1) nach Anspruch 11,
 - Ermitteln eines Betriebszustands,
 - Ermitteln externer Lasten,
 - Einstellen der Oberfläche der Segeleinheit (15; 23) der Auslegervorrichtung (4; 22), wobei Einstellen die Verfahrensschritte umfasst
 - Steuern der Einstellung der Oberfläche der Segeleinheit (15; 23) unter Verwendung der Bedieneinheit,
 - Erkennen tatsächlicher Ladungsbedingungen der Auslegervorrichtung (4; 22) unter Verwendung der Erkennungseinheit, die wenigstens ein Sensorelement umfasst,
 - Verwenden tatsächlicher Ladungsbedingungen als Eingabedaten für eine geschlossene Regelung zur Einstellung der Oberfläche der Segeleinheit (15; 23).

Revendications

1. Dispositif de flèche pour une grue comprenant une flèche (6) et une unité de voile (15; 23), dans lequel une surface de ladite unité de voile (15; 23) est réglable de manière variable, le dispositif de flèche comprenant une unité de commande pour commander le réglage de la surface de ladite unité de voile (15; 23), **caractérisé par** une unité de détection comprenant au moins un élément détecteur pour détecter les conditions de charge réelles du dispositif à flèche (6; 22), dans lequel lesdites conditions de charge réelles sont utilisées comme données d'entrée pour un contrôle en boucle fermée pour régler la surface de ladite unité de voile (15; 23).
2. Le dispositif de flèche selon la revendication 1, **caractérisé par** une unité de support (8), dans lequel la flèche (6) est fixée de manière pivotante à l'unité de support (8).
3. Le dispositif de flèche selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la flèche (6) est une flèche en treillis.
4. Le dispositif de flèche selon la revendication 3, **ca-**

- ractérisé en ce que** l'unité de voile (15; 23) est agencée, en particulier au moins partiellement, à l'intérieur d'un cadre en treillis (17) de la flèche en treillis.
5. Le dispositif de flèche selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'unité de voile (15; 23) comprend une voile à vent (16; 24). 5
 6. Le dispositif de flèche selon la revendication 5, **caractérisé en ce que** la voile à vent (16; 24) est constituée d'au moins un matériau léger en poids. 10
 7. Le dispositif de flèche selon la revendication 5 ou la revendication 6, **caractérisé en ce que** la voile à vent (16; 24) est constituée d'au moins l'un du groupe consistant en un matériau rigide et un textile. 15
 8. Le dispositif de flèche selon l'une quelconque des revendications 5 à 7, **caractérisé en ce que** l'unité de voile (15; 23) comprend un mécanisme d'entraînement (20) pour rétracter la voile à vent (16; 24). 20
 9. Le dispositif de flèche selon l'une quelconque des revendications précédentes, **caractérisé par** une unité de fonctionnement pour ajuster la surface de ladite unité de voile (15; 23). 25
 10. Le dispositif de flèche selon l'une quelconque des revendications précédentes, **caractérisé par** une unité de secours d'urgence pour laisser le dispositif de flèche (4; 22) dans des conditions de sécurité en cas d'urgence. 30
 11. Grue (1) comprenant 35
 - a. une unité de base (2) ayant un axe longitudinal (3) et
 - b. un dispositif de flèche (4; 22) selon l'une quelconque des revendications précédentes, 40

dans lequel ledit dispositif de flèche (4; 22) est relié à ladite unité de base (2) de façon à pouvoir tourner autour dudit axe longitudinal (3). 45
 12. Procédé pour faire fonctionner une grue comprenant les étapes de
 - fournir une grue (1) selon la revendication 11,
 - détecter une condition de fonctionnement, 50
 - détecter des charges externes,
 - régler la surface de l'unité de voile (15; 23) du dispositif de flèche (4; 22), dans lequel le réglage comprend les étapes de
 - contrôler le réglage de la surface de ladite unité de voile (15; 23) en utilisant l'unité de commande, 55
 - détecter les conditions de charge réelles du

dispositif de flèche (6; 22) en utilisant l'unité de détection comprenant au moins un élément détecteur,

- utiliser les conditions de charge réelles comme données d'entrée pour le contrôle en boucle fermée pour régler la surface de l'unité de voile (15; 23).

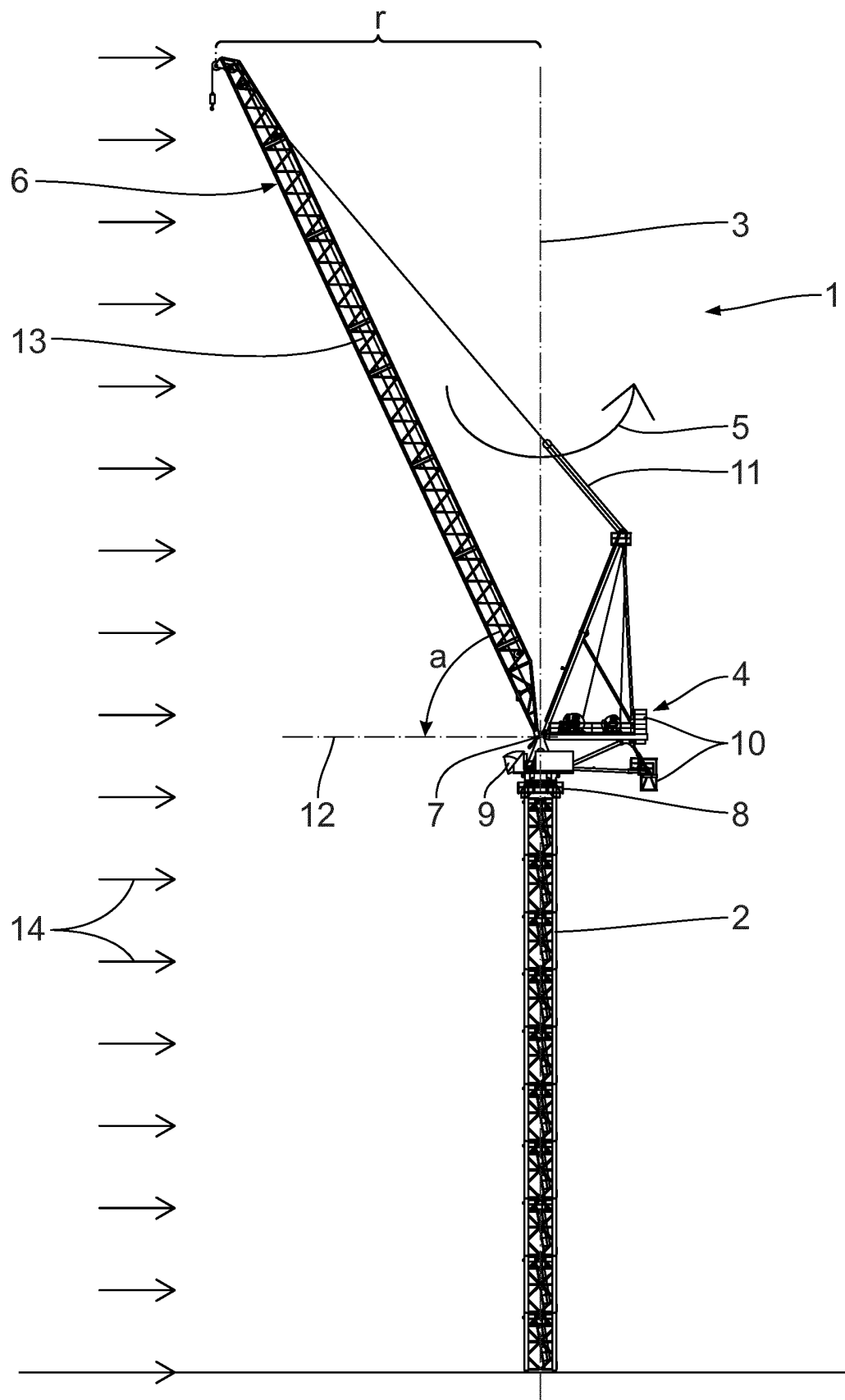


Fig. 1

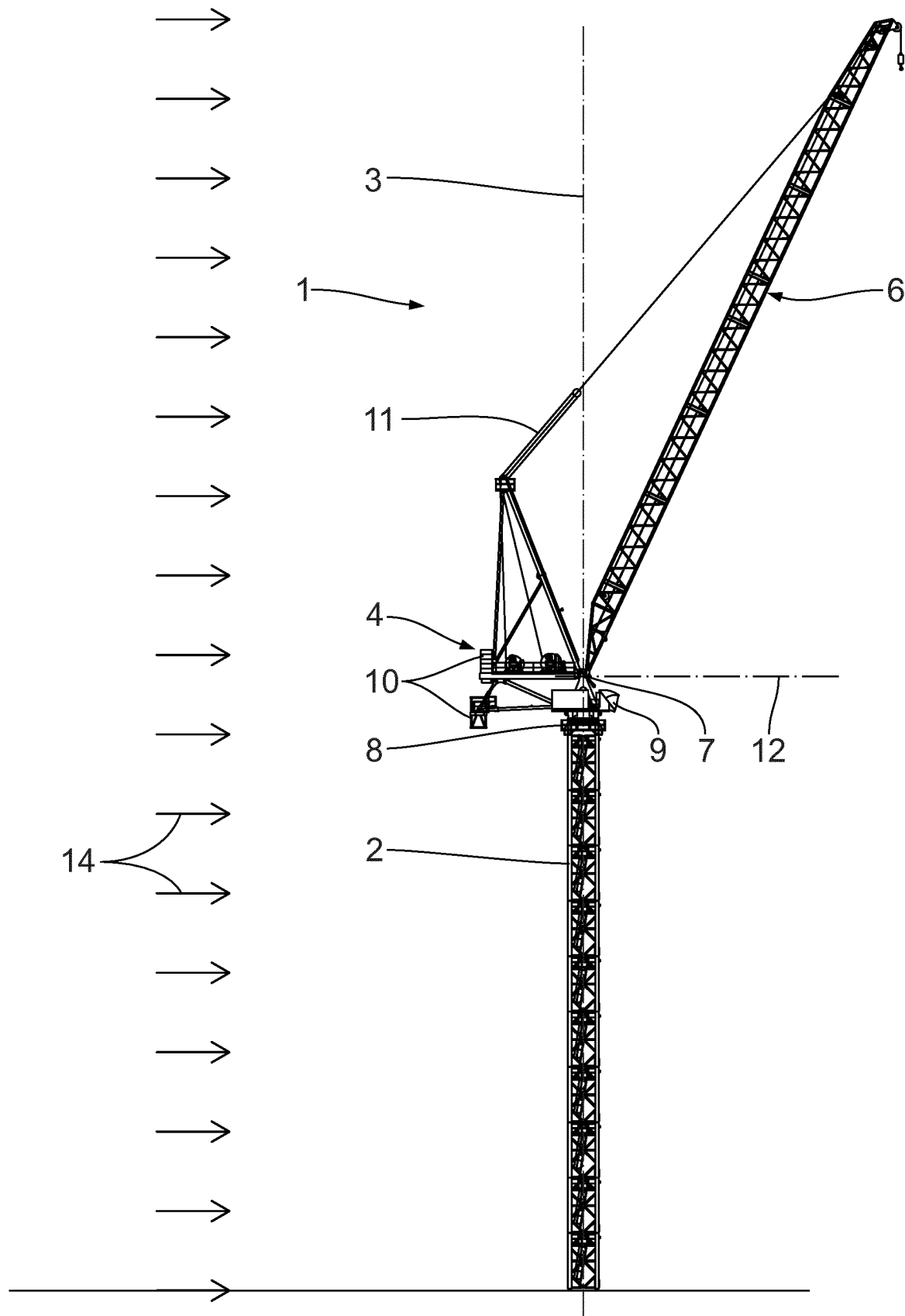
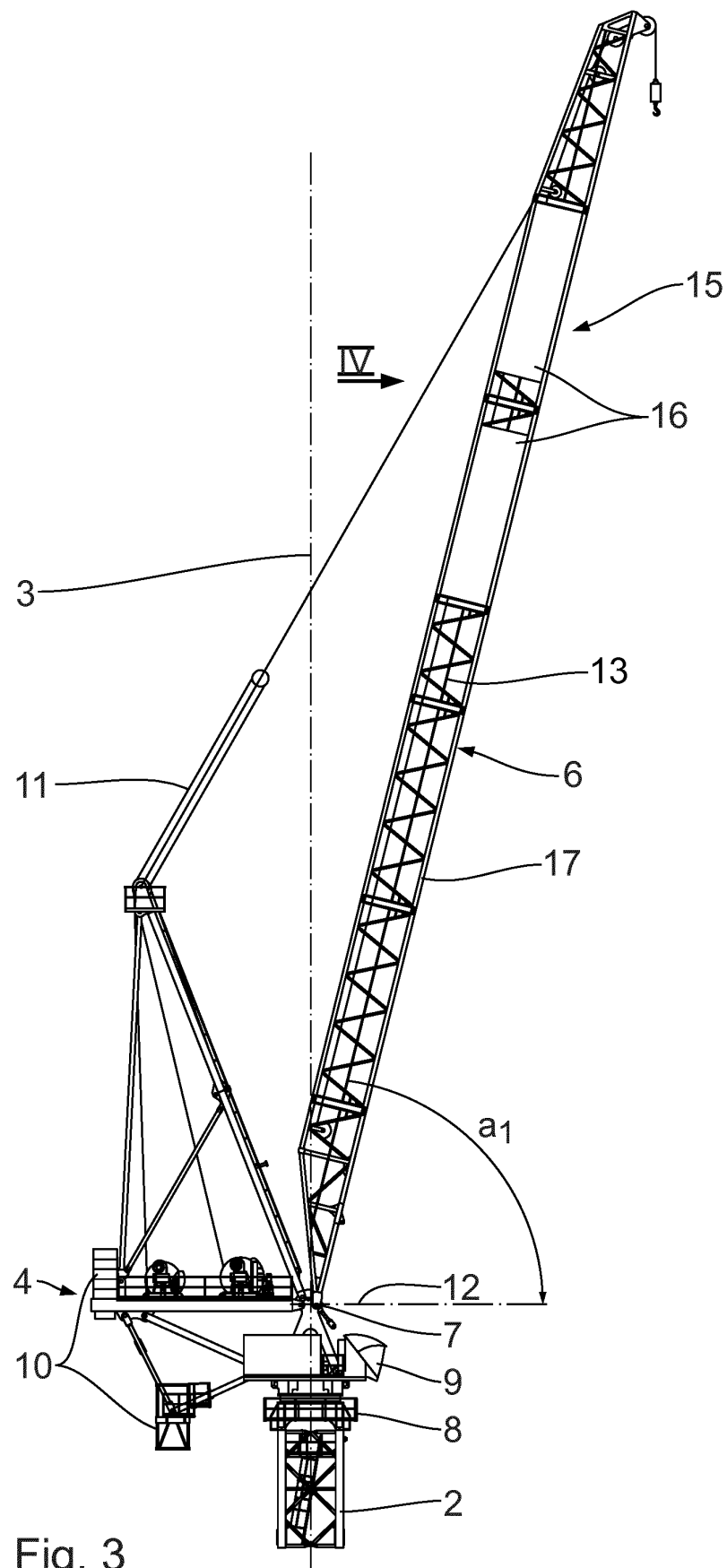


Fig. 2



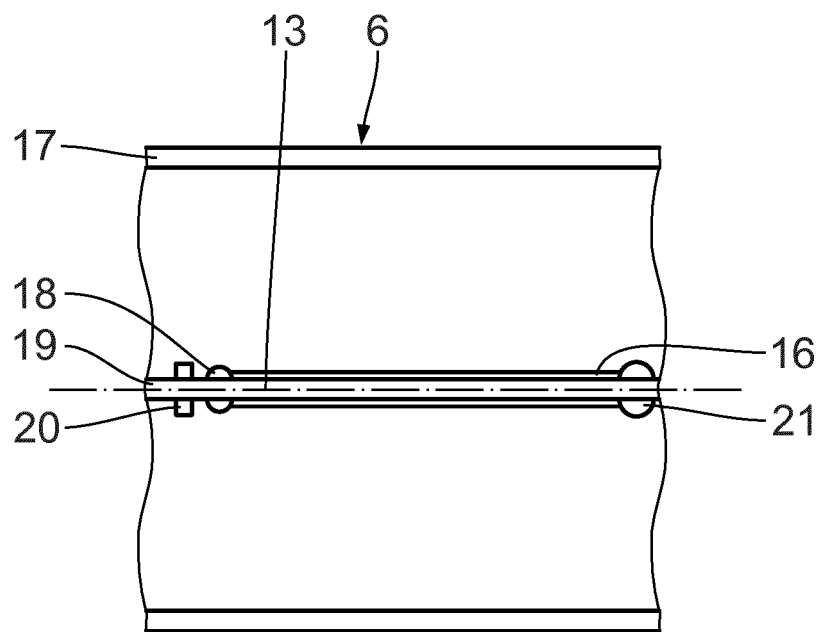


Fig. 4

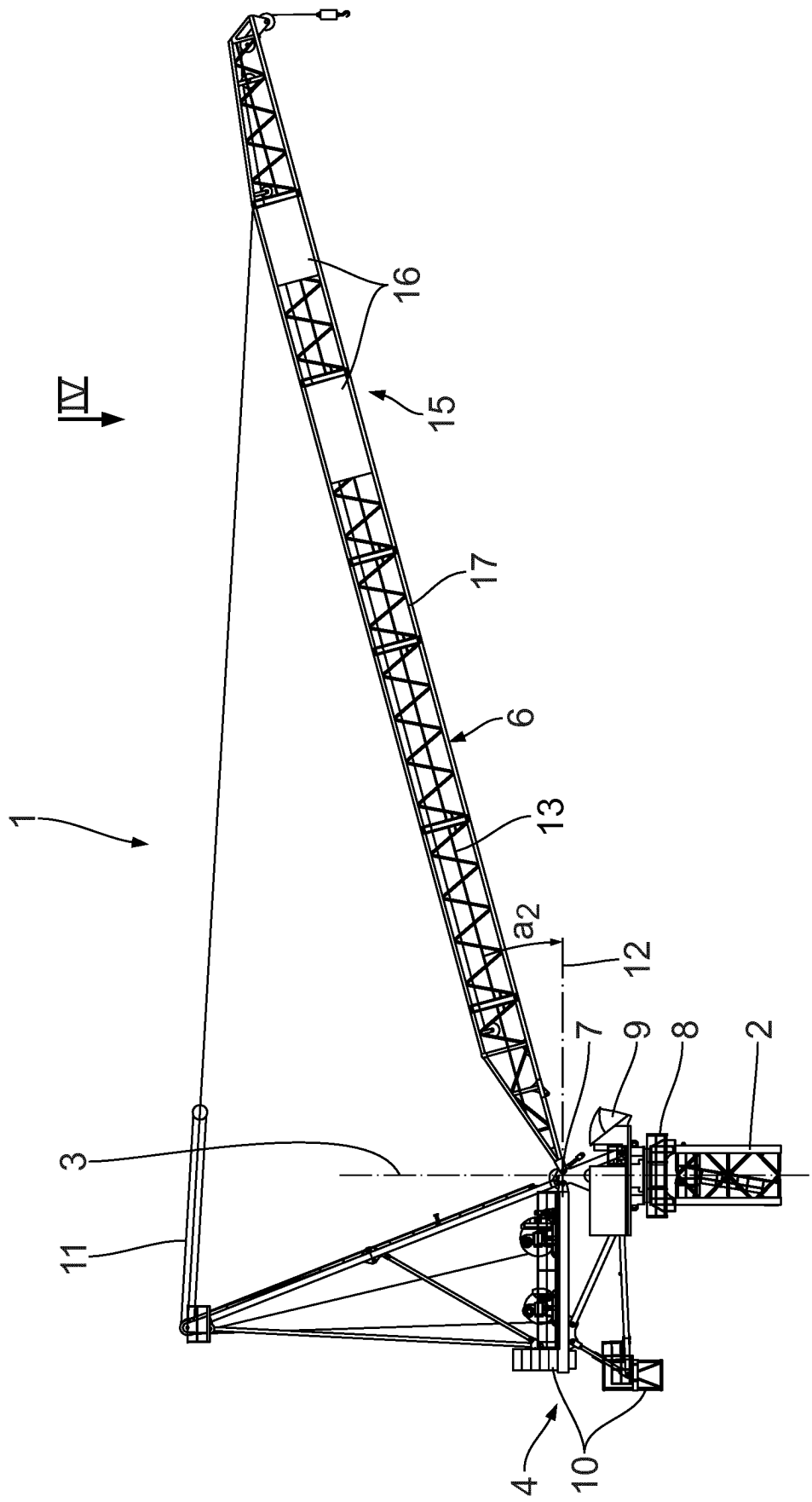


Fig. 5

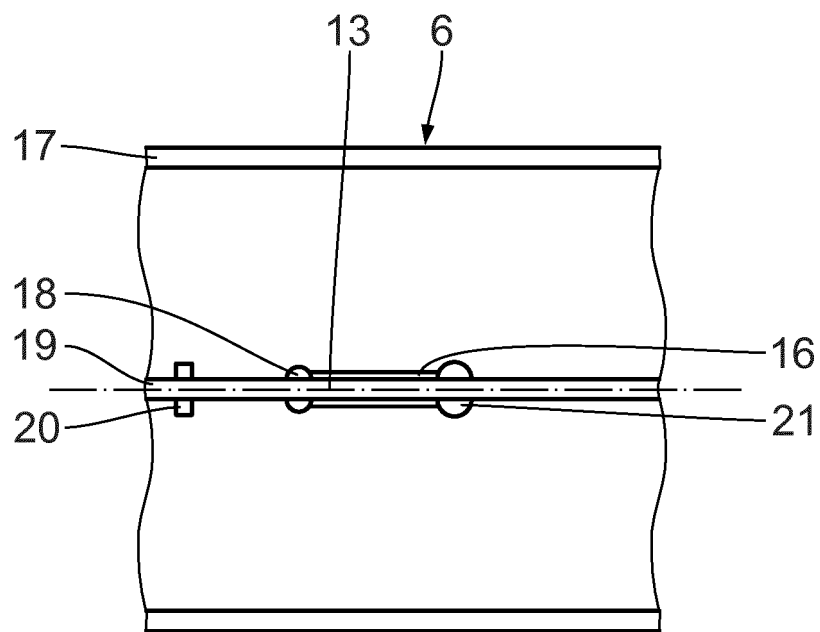


Fig. 6

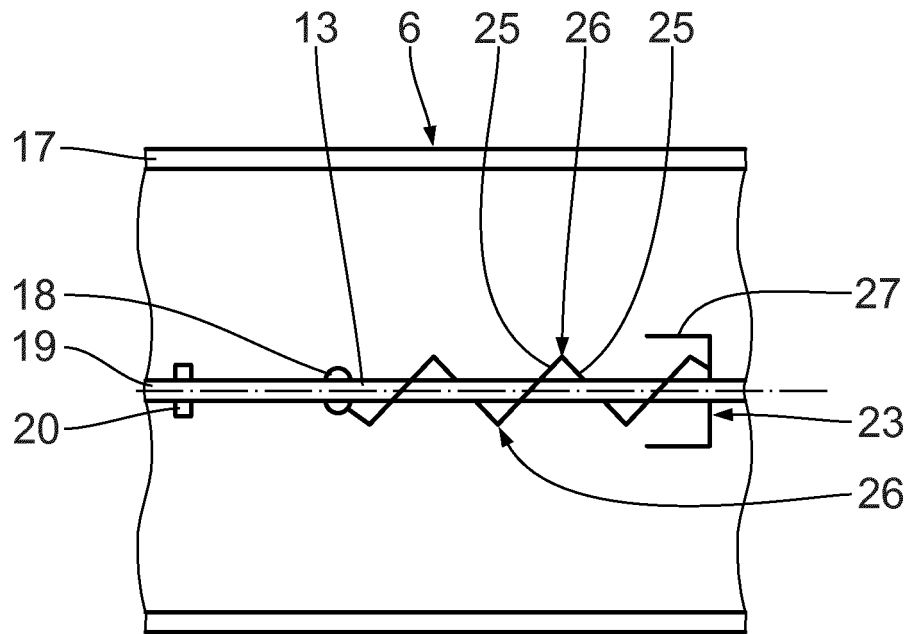


Fig. 7

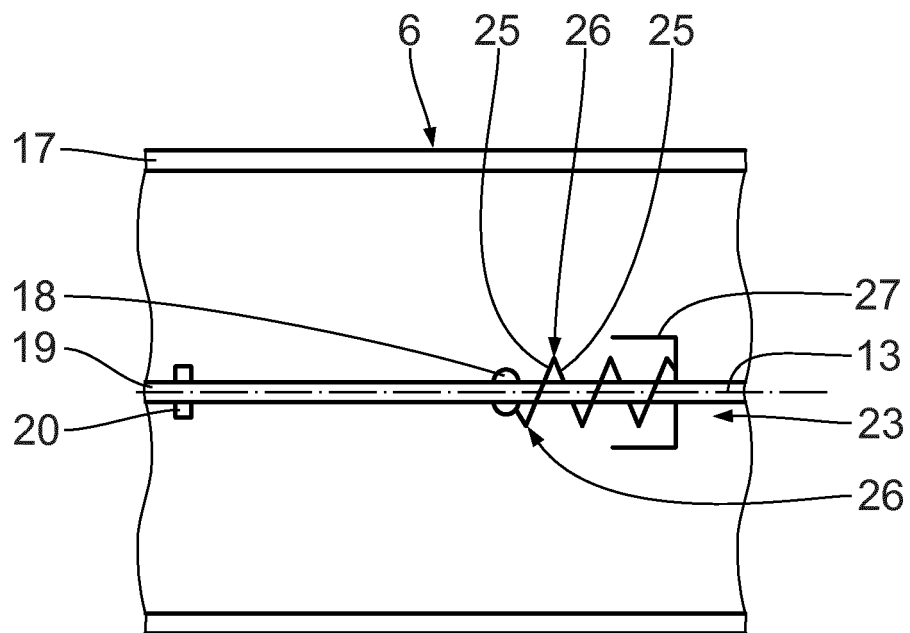


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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