(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
06 May 2021 (06.05.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/084496 A1

(51) International Patent Classification:
E04H 12/08 (2006.01) *E04H 12/34* (2006.01)
E04G 3/24 (2006.01)

(21) International Application Number:
PCT/IB2020/060213

(22) International Filing Date:
30 October 2020 (30.10.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
19206578.7 31 October 2019 (31.10.2019) EP

(72) Inventor; and
(71) Applicant: **ANDRESEN, Tom** [DK/PT]; Volta da Romanzeira, Edificio Villa Nature, apt. 03C, 8125-407 Vilamoura, Algarve (PT).

(74) Agent: **PLOUGMANN VINGTOFT A/S**; Strandvejen 70, 2900 Hellerup (DK).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) **Title:** TOWER PLATFORM

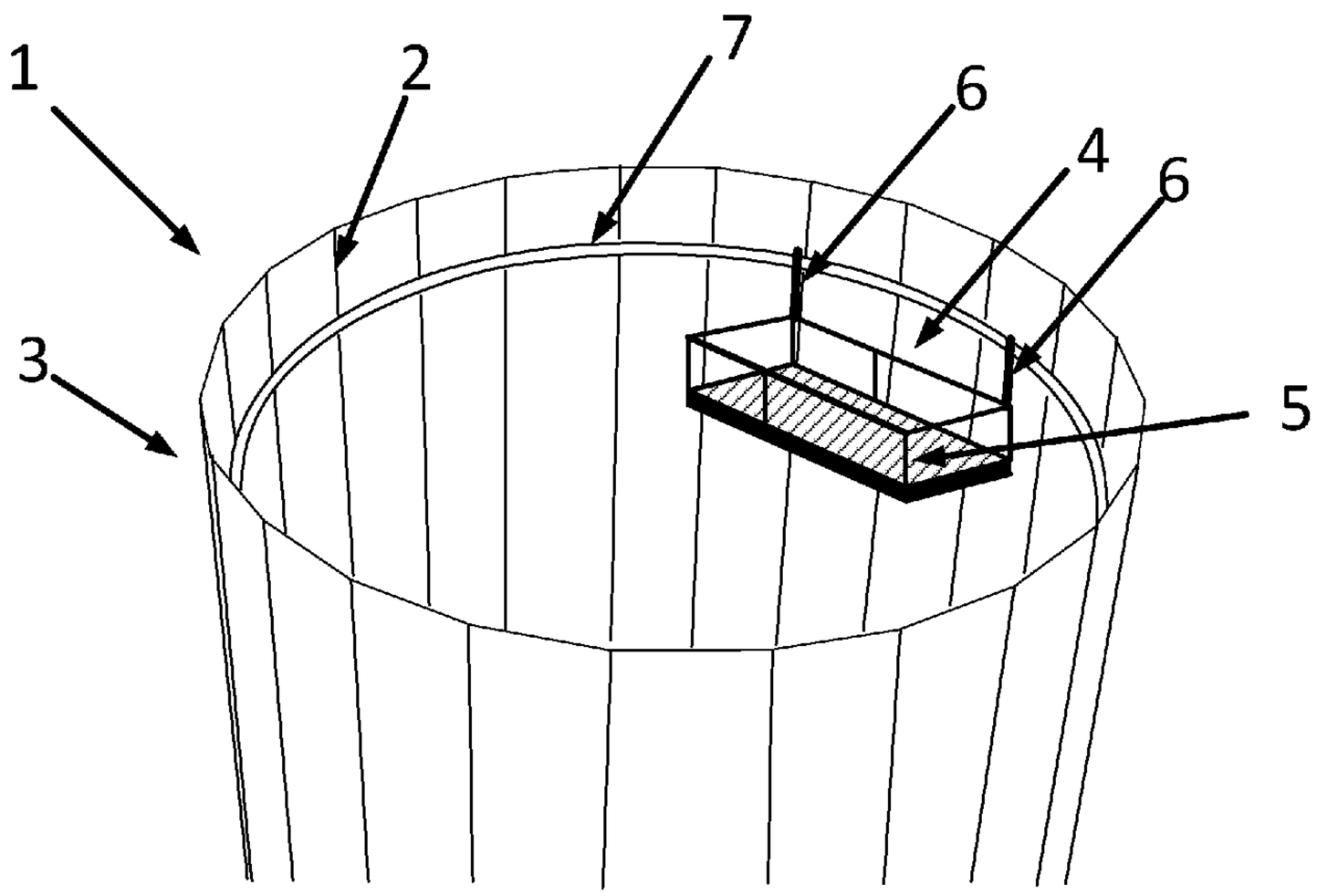

Fig. 1

(57) **Abstract:** The present invention relates a hollow tower with a platform construction arranged inside the hollow tower. The platform construction comprises, a platform (4) having a base (5) configured for supporting a load and/or human, the platform comprises an attachment member (6) connected to the platform and extending from the platform, a support structure (7) extending at least substantially along the circumference of the inner wall of the tower construction (1) and having the shape of a ring-shaped or polygonal annulus providing an opening interior to the support structure.

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WO 2021/084496 A1

Published:
— *with international search report (Art. 21(3))*

TOWER PLATFORM

FIELD OF THE INVENTION

The present invention relates a hollow tower with a platform construction arranged inside the hollow tower. The platform construction comprises, a platform having a base configured for supporting a load and/or human, the platform comprises an attachment member connected to the platform and extending from the platform, a support structure extending at least substantially along the circumference of the inner wall of the tower construction and having the shape of a ring-shaped or polygonal annulus providing an opening interior to the support structure.

BACKGROUND OF THE INVENTION

In tower construction, such as in windmill tower construction, modular constructions techniques are often utilized. This entails dividing the tower into separate vertical elements, which is hoisted, by crane, and joined during the construction phase. In order to join the tower elements vertically a platform is constructed across the area of the top opening of the tower element, thereby creating a flooring across the entire top cross section of the platform that can be used for joining the first and second tower element together. In other situations, a fixed platform is provided along the tower wall.

Such a platform floor enables the workers to join the tower elements. A first element of a tower section will at its top-end have a platform floor extending across the entire top opening of that tower element. The workers can then use the platform to join the next element and so forth, thereby creating a working area for the workers to join the elements together.

After the construction of the tower the platform is essentially made redundant, expect for occasionally maintenance and inspection related work.

There are two major drawbacks to having such platform during and after the construction period. Firstly, platform flooring that covers the tower entire opening (or fixed platforms along the tower wall) are expensive to construct and serve no

other purpose after the construction period and secondly, as the lifetime period of the platforms are normally less than the tower elements and joints, such as the bolts used in the joining process, the platform needs continuous or at least regular maintenance and inspection adding to the lifetime cost of the platforms and the tower.

Further, the platform occasionally being used in scheduled inspection of the flanged connections and health of the tower. These flanged connections are increasingly being constructed maintenance free, meaning that the only inspection needed in the construction is for the platforms themselves. A platform of a tower typically has a service time being smaller than the tower construction, in the case of a windmill, the certified lifetime can be as high as 25 years. Accordingly, a platform typically requires service, repair or even replacement during the certified lifetime of the tower, which clearly is an undesired feature. Further, the platform hinders the movement of goods and spare parts to the top of the tower, such as in the case of a windmill, repairs to the nacelle might entail lifting, on the inside of the tower, spare parts to be used in the generator at the top of the tower.

EP 3 425 136 A1 relates to transportation systems, elevator systems, kits, tower sections and method for performing assembly or maintenance operations towers.

KR 2018 0061923 relates to a platform fixed wind turbine plant with a fixing plate.

Hence, an improved tower platform would be advantageous, and in particular a more efficient and/or reliable platform to be used in the construction phase and/or maintenance phase would be advantageous. Further, a platform construction that can be certified to have a service free time span comparable to the tower construction would be advantageous.

OBJECT OF THE INVENTION

It is a further object of the present invention to provide an alternative to the prior art.

In particular, it may be seen as an object of the present invention to provide a tower platform that solves the above-mentioned problems of the prior art.

SUMMARY OF THE INVENTION

Thus, the above described object and several other objects are intended to be obtained in a first aspect of the invention by providing a hollow tower with a platform construction arranged inside the hollow tower, the hollow tower comprising an inner wall and an outer wall;

the platform construction preferably comprises,

- a platform having a base configured for supporting a load and/or human, the platform comprises an attachment member connected to the platform and extending from the platform,
- a support structure extending at least substantially along the circumference of the inner wall of the tower construction and having the shape of a ring-shaped or polygonal annulus providing an opening interior to the support structure,

wherein the support structure is fastened at or to the inner wall of the hollow tower, and the platform is attached, typically in a releasable manner, to the support structure by the attachment member.

The realising of the attachment member may in some embodiments be provided by dismantling some or more parts of the attachment member. In other embodiments, or in combination, the realising may be provided by lifting the attachment member off the support structure.

By the present invention, a relative inexpensive platform construction and in particular a relative inexpensive support structure may be provided.

In preferred embodiments, the platform may be described as hanging from the support structure by use of the attachment member.

In preferred embodiments, the support structure may be arranged above the platform and the platform may be suspended below the support structure by the attachment member.

Preferably, the attachment member and the support structure may be mutually shaped to attach to each other and provide the attachment, preferably the attachment member, a freedom of movement in the circumferential direction of the support structure, preferably while preventing movement of the attachment member in a radial direction of the support structure or preferably in general in a direction inwardly or outwardly relatively to the wall of the tower. Radial is to be considered to cover also the case of the support structure being in the shape of a polygonal annulus. Alternatively or in combination therewith, the attachment member may preferably be constructed to allow the attachment member to move along the support structure, thereby allowing the platform to be positioned at different position along the inside of the tower.

With a platform construction according to preferred embodiments, a releasable platform can obtained by releasing the attachment member from the support structure. This has inter alia the advantage that the platform may be removed from the tower construction after, for instance, being used during erecting the tower and used during erecting another tower. With the platform removed, the support structure is typically maintained in the tower. Such a support structure may be certified to have a certified lifetime as the tower construction thereby typically not requiring any attention and/or service during the certified lifetime of the tower. Further, upon dismantling of the tower and with the support structure still present, platform(s) can be connected to the support structure and the platform(s) can be used during dismantling of the tower.

Further, the attachment member is typically constructed to allow the attachment member to move along the support structure, thereby allowing the platform to be positioned at different position along the inside of the tower.

A further advantage of the invention is that the support structure may be prefabricated or even fabricated on the building site. When prefabricated, the support structure may be provided in sections, e.g. fitting into the interior of a standard container otherwise used for shipping of tower components. The sections may further more be provided in standard length and is cut, if necessary, to the particular length e.g. at the building site. The support structure may be made from a number of different materials such as metal(s), rubber, composites, such

as composites comprising carbon fibres, Kevlar fibres, glass fibres and combinations thereof, and/or composites of metal and rubber; however, the invention is not limited to these materials.

In a particular embodiment, the support structure is made from a pliable material, such as rubber and a composite material e.g. including rubber. Also in this case, the support structure may be provided as sections and, if necessary, cut into desired length e.g. at the building site. Alternatively or in combination thereto the support structure may be provide as a string of material e.g. reeled onto a reel delivered to the building site. Upon fabrication of the support structure a length of the pliable material is reeled of the reel, cut to have the desired length and attached to the tower construction, e.g. during production of a vertical segment of a tower.

If needed, the support structure may be mechanical strengthen at positions where the support structure is fasten at to the wall of the hollow tower. This could for instance be a bushing arranged in the support structure allowing a bolt or similar to go through the support structure inside the bushing and bolt the support structure to the wall of the tower wall. This is in particular useful when the support structure is made from a pliable material such as rubber as the bolting force may be released from the pliable material and applied on the bushing. Such bushing or strengthened elements in general may be made from metal or other suitable materials capable of strengthen the support structure.

In some preferred embodiments, the support structure may be of the following cross-sectional geometric shapes: round, square, cross, H-shaped, I-shaped or any combination thereof.

In some preferred embodiments, the support structure may be made from metal, rubber or a combination thereof.

In some preferred embodiments, the support structure may be fastened to the inner wall by an intermediate connector protruding from a lower position of the support structure.

In some preferred embodiments, the platform's attachment member further comprises wheels configured for rolling attachment with support structure and/or the attachment member together with the support structure may preferably be provided a sufficient low friction for moving the platform along the support structure.

In some preferred embodiments, the platform's attachment member may further comprises a motor to run the wheels and/or to move the attachment member.

In some preferred embodiments, the support structure may comprise one or more flanges and may have a cross section configured such that wheels may be moveable between the flanges of the cross section.

In some preferred embodiments, the tower may further comprising fastening sections each preferably formed as a reinforced section of the inner wall of the hollow tower, such as the constructional joints of the tower elements.

In some preferred embodiments, the support structure may be sectionalized along the circumference of the support structure and may comprise flexible joints, configured for compression and expansion in response to movements of the hollow tower, arranged in-between sections.

In some preferred embodiments, the fastening of the support structure to the hollow tower (1) may be provided by a magnetic force, bolting, welding and/or gluing. The support structure may preferably fastened at discrete positions, preferably every 2.5 meter, more preferably every 1.5 meter, preferable every 1.0 meter.

In some preferred embodiments, the platform may further comprise a horizontal supporting member (15) for horizontally supporting the platform preferably by the horizontal support member abutting the inner wall of the hollow tower preferably at a position below the support structure.

In some preferred embodiments, the base of the platform may be tilted, preferably such that when the horizontal supporting member may be engaged,

such as abutting the inner wall, the base of the platform may be levelled in respect to the ground.

In some preferred embodiments, a winch may be located at the top of the tower and preferably adapted for being connected to the platform, preferably such that the winch can winch down the platform, when the attachment member is detached from the support structure.

In some preferred embodiments, the platform may be modular, such that the platform can be disassembled.

In some preferred embodiments, the platform comprises sides hinged to a base, said hinging may be provided so as allow the sides to be folded inwardly and towards the base to provide a flat-packaged platform.

In some preferred embodiments, one or more guiding rails may be vertically placed on the inner wall of the tower, such that the one or more guiding rails may guide the platform when being winched down.

In some preferred embodiments, the platform may be attached to the guiding rails by a cable.

In some preferred embodiments, the platform may be attached to the guiding rails by use of a connector located on the platform preferably enabling positioning control of the platform e.g. during vertical movement.

In another aspect, the invention relates to a method for construction a tower preferably comprising the steps of

- assembling on the ground a first section of the tower,
- securing on a top inner section of the first section of the tower, as detailed in any of the preceding claims, the support structure and the platform,
- assembling the first section of the tower to a foundation and assembling a second tower section on the ground attached to the second tower section the support structure and platform,

- assembling the second section on top of the first section by use of the platform on the first section,
- preferably when the tower is fully erected, winching the platforms down to the base of the tower, preferably leaving one platform remaining,
- preferably dismantling the platforms at the bottom of the tower.

Further aspects and embodiments are presented in the accompanying claims as well as in the detailed description of preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE FIGURES

The tower platform according to the invention will now be described in more detail with regard to the accompanying figures. The figures show ways of implementing the present invention and are not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 shows an embodiment of the invention,

Figure 2 shows an embodiment of an intermediate connector the support structure and the wall of the tower are shown in a cross sectional view,

Figure 3 shows in a cross sectional view an embodiment of the connecting between the support member and the attachment member,

Figure 4 shows an embodiment of intermediate connectors,

Figure 5 shows an embodiment of the platform with supporting members,

Figure 6 shows an embodiment in which the platform is winched down the tower, in fig. 6, the faces of the tower is drawn transparent to reveal interior details,

Figure 7 shows an embodiment, wherein guiding rails are attached to the inside of the tower,

Figure 8 shows in a cross section view an embodiment, where the supporting member is engaged and wherein the base of the platform may be slightly tilted, such that the person is level,

Figure 9 shows a construction timeline for a tower according to an embodiment of the present invention,

and

Figure 10 shows in a cross sectional view of an embodiment in which the support structure is shaped as an I-beam which is attached to the wall of the tower by an intermediate connector.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is made to fig. 1 schematically illustrating a hollow tower 1 with a platform construction 1. As schematically illustrated, the hollow tower comprises a platform construction arranged inside the hollow tower 1.

The hollow tower is typically formed as a shell construction (although the invention is not limited to such constructions) and the construction has an inner wall 2 and an outer wall 3. Obviously, the inner wall faces towards the inner void of the tower 1. In the embodiment shown, the tower is made from assembling a number of plate shells along their vertical and horizontal edges to form a cross sectional view being polygonal.

As illustrated the platform construction comprises a platform 4 having a base 5 configured for supporting a load and/or human. The platform 4 is, as illustrated, typically, formed as a basket with sides and a bottom forming the base 5. Thus, personnel as well as equipment may be accommodated in the platform in a secure manner. The actual size of the platform 4 is typically selected so as to be sufficiently large to accommodate personnel and equipment while as the same time allow the platform to be manoeuvred into different positions within the tower (this latter aspect will be detailed below).

In a preferred embodiment (not shown in the figures) the platform 4 comprises sides hinged to the base 5. The hinging is provided to allow the sides to be folded inwardly and towards the base 5 so as to provide a flat-packaged platform. By this, the flat-packaged platform 4 may be more easily transported when not in use. In such embodiments, the attachment member(s) 6 may either be dismantable connected to the platform, or may be hinged to the platform 4 so that it/they can be arranged in position where they do not represent essentially protruding elements. In a further embodiment, the sides and/or the attachment member(s) 6 may be releasable, e.g. by dismantling, connected to each other.

The platform 4 is in some instances used in connection with tools, typically being heavy tools, representing a load to be carried by a worker. To limit the amount of lifting for the workers, the platform 4 may be equipped with tool carrying assisting member, which may be a spring or other element mechanically connected to the tool to reduce the weight experienced by the worker. Such tool carrying assisting member is typically arranged on some kind of a rail allowing the worker to use the tool at different positions.

Although the platform in the embodiment shown is illustrated as a rectangular box shape, the platform 4 may be shaped to mimic the interior rounded shaped of the tower to allow the platform to be accommodated throughout its horizontal extension in close proximity to the inner wall 2.

The platform 4 has (at least) two attachment members 6 connected to the platform 4 and extending from the platform 4. The attachment members 6 are used to suspend the platform from the illustrated support structure 7.

In the embodiment shown in fig. 1, only two such attachment members 6 are illustrated, although it is often preferred to have at least two attachment members 6 to provide a stable suspension and operation of the platform 4. In such embodiments, the two attachment members 6 are typically disposed symmetrically in horizontal directions, and typically one at each horizontal end of the platform.

The platform construction further has a support structure 7 extending at least substantially along the circumference of the inner wall 2 of the tower construction 1 and having the shape of a ring-shaped or polygonal annulus providing an opening 11 interior to the support structure 7. The opening 11 is not labelled with a reference number in fig. 1, since it is represented by the void inside the annulus.

This support structure 7 is fastened at or to the inner wall 2 of the hollow tower 1. This can be done in numerous ways, including using already available bolted joints used for bolting together segments and elements of the hollow tower. This could in an embodiment be the bolts used to bolt together vertically neighbouring segments in the tower.

In another embodiment, the tower comprises a number of vertical segments, each typically formed by elements welded together. Such vertical segments are typically bolted together by bolting together inwardly protruding flanges. In such tower constructions, the support structure may be attached to the inwardly protruding flanges, e.g. by bolting the structure directly to the flanges or by suspending the support structure, e.g. by a wire, from the flanges.

In one embodiment, the support structure is attached to the inner wall 4 of the hollow tower 1 by use of magnets.

Some towers are made up by sections being welded together along perimeters of the tower. In such welded constructions, through going openings may be provided in the tower wall for attaching the support structure to the wall of the tower. If considered necessary, a lining may be provided to the through going openings, e.g. to relieve stress induced by the attachment of the support structure 7.

The may be provided a space between the inner wall 2 and the platform 4. To avoid, or at least attempting to avoid, material and/or tools falling from the platform 4 to the bottom of the tower, this space may be occupied by a member mimicking the outlined of the space.

The platform 4 is attached to the support structure 7 via the attachment member 6.

Such a configuration, as described above, allows for a design of the platform for use in the construction process which minimizing the material use and overall maintenance needed in a hollow tower 1. Attaching the platform 4 on a support structure 7 by means of an attachment member 6 gives the possibility of inspecting and maintaining the inner wall 2 or other installation present on the inner wall 2 of the tower construction as well as during assembly of the tower.

The support structure 7 may be provided numerous different cross sections and the actual choice is often made in dependency of how the attachment member(s) 6 is to be attached to the support structure 7. Such shapes may be of the following cross-sectional geometric shapes: round, square, cross, H-shaped, I-shaped or any combination thereof.

Further, it also makes a platform floor spanning across the entire cross-sectional top opening of a tower element redundant. This will in turn reduce the overall maintenance cost of the construction, as well as having fewer inspection of the construction during the tower's lifetime.

As illustrated in fig. 2, one possible way to attach the support structure 7 to the inner wall 4 is to make use of an intermediate connector 14 protruding from a lower position of the support structure 7. That the intermediate connector 14 is protruding from a lower position is found advantageously since it does not take up space in upper position typically used to attach the attachment member 6 to the support structure.

Further, this intermediate connector 14 can be connected to the bolt connection located on the tower. These bolt connections 25 are used to join tower segments together during the construction period. The bolts connections 25 can be seen in figure 8.

In a preferred embodiment, the support structure 7 is made from string of rubber, such as an elongated rubber shaped element, preferably having a constant cross

section. However, other materials than rubber can be used for the manufacturing of the support structure. Such a string may be attached to the inner wall 4 by use of such intermediate connectors 14. Alternatively, the string of rubber may have magnets embodied and used for attaching the string to the inner wall 4. It is noted that the number of intermediate connectors 14 or magnets should be selected preferably to limit the flexion of the support structure 7 when carrying the load of the platform 4.

With reference to fig. 3, in embodiments where the support structure 7 is made from material(s) which may need strengthening at the attachment positions, a bushing (not shown) may be arranged co-axially with the connecting member 28 in the support structure 7 with the connecting member 28 protruding inside the bushing. The bushing may typically extend the whole width of the support structure and the space 27 may be left out. In case a space is needed between the wall 2 and the support structure 7, the bushing may extend beyond the surface of the support structure so as to provide a spacing. While this is particular useful in embodiments where the support structure is made from a pliable material, such bushing may be used in general to provide a local strengthening of the support structure 7.

Embodying the support structure from a string of rubber has inter alia the advantage that the support structure 7 may be fabricated on-site by reeling-out and cutting of a sufficient length of rubber (from a reel holding the rubber), as well as lowering the maintenance required for the platform.

In order for the platform 4 to move along the support structure 7 the attachment member 6 and the support structure 7 are mutually shaped to attach to each other and provide the attachment a freedom of movement in the circumferential direction of the support structure 7 while preventing movement of the attachment member 6 in a radial direction of the support structure 7. This has the effect that in order to access sections of the inner wall 4, the platform 4 can be move along the support structure 7, thereby not requiring a deck extending along the entire circumference.

Not needing a deck along the entire circumference greatly reduces the material use and the stress experienced by the tower. Furthermore, a tower normally requires several decks heigthwise in a tower construction, to be able to inspect different segments of the inner wall and during the construction phase, as a tower is normally manufacturing in a modular fashion.

Referring to fig. 3 an embodiment could also comprise wheels 12 on the attachment member 6, or the attachment member together with the support structure is provided a sufficient low friction, enabling it to move along the support member 7.

Such a design is illustrated in fig. 3, wherein the connection between the platform and the tower is shown in a cross sectional view. In this embodiment, the support structure 7 is in the shape of an H-shaped beam, such that the attachment members' 6 wheels 12 fits in between the flanges of H-shaped beam flanges 16 and can move along the H-beam.

In the embodiment shown in fig. 3, the wheels 12 are each arranged on a shaft 30 allowing the wheels to rotate. The shafts 30 are arranged in a downwardly protruding member 35 of the attachment member 6 (the protruding member 35 may extend to the base 5). The support structure 7 is attached to the wall of the tower by a bolt 28 secured by nuts 29, typically made from metal, such as steel. The H-shaped part is typically made from rubber (or other material) and this H-shaped (or I-shaped depending on the viewing direction) part may be distanced from the wall of the tower by the shown spacer 27. However, the invention is not limited to such H-shape since other shapes such as round, square, cross, H-shaped, I-shaped or any combination thereof. The attachment/de-attachment of the attachment member to/from the support member 7 may e.g. be provided by removing the lower wheel 12 though e.g. disconnecting the lower shaft 30 from the downwardly protruding member 35 of the attachment member 6.

In a preferred embodiment, the platform's 4 attachment member 6 further comprises a motor to run the wheels 12. This motor may be present in the attachment member 6 or located elsewhere on the platform construction.

In an embodiment fastening sections are each formed as a reinforced section 13 of the inner wall 2 of the hollow tower 1, such as the constructural joints of the tower elements, which is the connection points of the plate shells comprising the tower. This will ensure that the forces exerted by platform on the tower does not structurally compromise the tower. The intermediate connector or the support structure can then advantageous be attached to the reinforced section. In normal tower construction, fastening sections, bolts connections, are normally provided at the top of each tower element for joining of the vertical tower elements together. These fastening sections can in an embodiment be used to fasten the intermediate connector or the support structure to the tower construction.

In some preferred embodiments, the support structure 7 is sectionalized along the circumference of the support structure 7 and comprises flexible joints 14 as illustrated schematically in fig. 4. The flexible joints are typically configured for compression and expansion in response to movements of hollow tower and are arranged in-between sections.

In an embodiment the fastening of the support structure 7 to the hollow tower 1 is provided by magnetic force, bolting, wielding and/or gluing. The support structure 7 is preferably fastened at discrete positions, preferably every 2.5 meter, more preferably every 1.5 meter, preferably every 1.0 meter.

The magnetic force may preferably be embodied as embedding magnets in the support structure 7, such as embedded in a support structure made from pliable material such as rubber. The magnetic force is then typically obtained by the tower being made from or a magnetisable material or made from a material comprising a magnetisable material. The magnets may be embedded at those discrete position mentioned above, or the magnets may be a row of discrete magnets arranged side-by-side along the support structure with alternating polarity so that the support structure is fastened to the wall along its length.

Referring to figure 5, the platform 4 further comprises a horizontal supporting member 15 for horizontally supporting the platform 4 by the support member 15 abutting the inner wall 2 of the hollow tower 1 at a position below the support structure 7.

Such a horizontal supporting member 15 may have one or more wheels abutting the inner wall. The supporting member 15 may be is extendable in a longitudinal direction (in the direction away from the inner wall) wherein the horizontal supporting member 15 is configured to extend, so as to push or force the suspended platform away from the inner wall, creating a horizontal force on the wheel(s) of the horizontal supporting member 15.

The main feature of the supporting member 15 may in an embodiment provide or increase the stability of the platform, when hung from the support structure 7.

Reference is made to fig. 10 schematically illustrating a further embodiment according to the invention. The embodiment is shown in a cross sectional view in vertical plane perpendicular to the tower wall. In the disclosed embodiment, the support structure 7 is shaped as a I-beam which is connected to the intermediate connector 14 by use of a bolt assembly 25, 29. The intermediate connector 14 has a triangular shape with two flanges at the end of the legs. These flanges assist in bolting the intermediate connector 14 to the inside of the tower wall by use of a bolt assembly 25, 29 as shown.

In a specific preferred embodiments where the tower is made up by bolting together plate shells along their vertical and horizontal edges, the intermediate connector 14 is advantageously bolted to the tower by use of these bolt connections.

Although only one intermediate connector 14 is shown in fig. 10, a plurality of individual intermediate connectors 14 are distributed along the inner wall of the tower, typically at the same vertical position and in a number and with a spacing sufficient to carry the load to be applied on the support structure 7.

The platform construction shown in fig. 10 comprises a set of wheels 12 arranged on opposite sides of the support structure 7. Each wheel 12 is recessed where the recess is shaped so as to receive a flange of the I-beam, typically in a fit that allows the wheel to travel along the flange and at the same time prevents substantial sideway movements of the wheel. The two wheels 12 are rotatably connected to the downwardly protruding member 35 which holds the base 5 (not

shown). In the embodiment shown, the wheels are arranged on a shaft 30 bolted to the downwardly protruding member 35 at one end and having a nut in the other end. It is in general preferred to have at least to sets of wheels 12 with attachment member to allow for a stable suspension of the base 5 (e.g. as illustrated in fig. 1). The attachment/de-attachment of the attachment member to/from the support member 7 may e.g. be provided by removing the lower wheel 12 though e.g. disconnecting the lower shaft 30 from the downwardly protruding member 35 of the attachment member 6.

The use of an I-beam may render a horizontal supporting member 15 (as disclosed e.g. in fig. 5) superfluous as the two recessed wheels 12 each receiving a flange or the I-beam may provide sufficient stability to prevent tilting. However, it is within the scope of the invention to include one or more horizontal supporting members 15 to decrease the risk of tilting.

Within scope of the invention is embodiments not having the lower wheel 12. In such embodiments, the gravity forces are typically sufficiently large to prevent the upper wheel 12 from derailing. However, measure may be implemented to prevent derailing such as safety hooks engaging with the underside of the upper flange of the I-beam.

Further, when the lower wheel(s) 12 is(are) not present, a T-beam may be used instead of an I-beam.

The support structure 7 is made from a material as otherwise disclosed herein, such as rubber, metal of a combination thereof.

After the construction of the tower, it may be advantageous to remove the platforms from the support structure, such as to be able to reuse the platform in the construction of a different tower. In such a situation, an embodiment as shown in figure 6 is advantageous. In this embodiment, a winch is located at the top of the completed tower, which is able to winch the platform down to the base of the tower.

Normally tower constructions have a winch located at the top of the tower. Such winches are placed there during the construction period in order for materials and people to be moved to the top and vice versa. In the case of a windmill, such a winch is placed in the nacelle. This winch can be used to winch down the platform, used during the construction, such that they can be reused. In such cases, the cable of the winch is connected to the platform and the platform is detached from the support structure.

In such an embodiment, all the platforms except one will be winched down and reused. The remaining platform can be used to inspect the support structure and tower connection. This last platform can then be winched, using the winch, to the different locations on the tower using the support structures on the platform. This one platform can then be used to inspect the entire inner construction of the tower.

The platforms can in an embodiment be constructed in a modular manner, wherein the platform can be disassembled and transported out of the tower. At the base of the tower is normally a small opening to the inside, so by being able to disassemble the platform, the platform is able to be transported out of the inside of the tower, through the small opening at the bottom.

When winching down the platforms from the support structure a guiding rail 8 can in an embodiment be provided, as shown in figure 7, where a guide rail 8 is provided along the vertical tower segment. In other embodiment more than one guide rail, such as two, are arranged running parallel with a distance, such as a a constant distant in between them, in the vertical direction of the tower.

The platform can be attached to the guiding rail(s) 8 with by a cable or a moveable connection. As the winching cable is in an embodiment flexible, the platform does not need to be centred in the middle of the tower construction, but is also able to be at the surface of the inner wall. A guiding rail fixating the platform to the inner wall of the tower could, in an embodiment, be envisioned. The main function of the guiding rail is to ensure that the platform does not hit the inner wall, thereby potentially causing damage to the structure, thus enabling positioning control of the platform e.g. during vertical movement.

In such embodiments, a supporting member may also be present in order to stabilize the platform, such that a worker can be supported and work on the platform. Such platforms, may primary be used in the construction phase of the tower, and as depicted in figure 8 may be constructed such that a worker has the ability and reach to fastened the next second tower segment 17. In these embodiments, the platform flooring that normally covers the entire cross-section of the tower can be eliminated.

In such embodiments, the base 5 of the platform 4 may be tilted, such that when the horizontal supporting member 15 is engaged, the base 5 of the platform 4 is levelled 26 in respect to the ground.

Further, in fig. 8 the support structure 7 or the intermediate connector is connected at a bolt connection hole 24, which in some embodiment is also used for the joining of the vertical tower elements and in other embodiments a separate hole 24 used only for connecting support structure 7 or the intermediated connector to the tower. The figure further shows the worker having unhindered access, by using the platform to join the tower elements together, by applying the bolts 25.

In figure 9, the use of the tower platform in an embodiment is shown. In this embodiment, construction of the tower comprises the steps of

- assembling on the ground a first section of the tower,
- securing on the top inner section of the first section of tower, as disclosed herein, the support structure and the platform,
- assembling the first section of the tower to the foundation and assembling a second tower section 17 on the ground with the support structure and the platform,
- assembling the second section on top of the first section by use of the platform on the first section,
- when the tower is fully erected winching the platforms down to the base of the tower, preferably leaving one platform remaining,
- dismantling the platforms at the bottom of the tower.

As shown in figure 9, the construction of a tower, such as a windmill tower starts by constructing on the ground a vertical segment of the tower. In that vertical segment the support structure 7 and the platform 4 is assembled, as shown in fig. 9, details 18, 19 and 20. When the first vertical segment is completed, the next second tower segment 17 is constructed to fit upon the first tower segment and includes the platform construction. The walls of the front side of the tower has been removed to show the inner workings of the platform and method for constructing a tower using the platform.

The worker can use the platform on the first segment to fasten together the first and second tower element. This is repeated until the tower has reach its full height. The last segment may not need the platform in the case of a conventional tower, but in a windmill in order to install the nacelle, the last tower segment still requires the last tower segment to have the platform construction for joining the nacelle and the last tower segment.

When the tower is fully constructed the platform can be detached from the support member, such as to reuse the platform themselves and their attachment members, as shown in figure 9, detail 23, the platforms are removable from the tower construction and can accordingly be reused in the construction of another tower, lowering both the material needed, cost and maintenance in the construction of multiple towers. The platforms are, as described earlier in the application, winched down using the tower winch, which in the case of a windmill is located in the nacelle, dissembled and reused.

Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms “comprising” or “comprises” do not exclude other possible elements or steps. Also, the mentioning of references such as “a” or “an” etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in

different claims does not exclude that a combination of features is not possible and advantageous.

References

1. Hollow Tower
2. Inner Wall
3. Outer Wall
4. Platform
5. Base
6. Attachment member
7. Support Structure
8. Guiding Rails
9. Winch
10. Cable
11. Opening
12. Wheels
13. Reinforced section
14. Intermediate Connector
15. Horizontal Supporting Member
16. Flanges
17. Second Tower Segment
18. First phase in construction
19. Second phase in construction
20. Third phase in construction
21. Fourth phase in construction
22. Fifth phase in construction
23. Sixth phase in construction
24. Bolt connection hole
25. Bolts
26. Level flooring
27 Spacer
28 Connecting member (bolt)
29 Nut
30 Shaft
31 Horizontal Platform elements

32 Crane
33 Completed tower
34 Reusable platform(s)
35 Downwardly Protruding Member.

Itemized list of embodiments

Item 1. A hollow tower with a platform construction arranged inside the hollow tower (1), the hollow tower comprising an inner wall (2) and an outer wall (3); the platform construction comprises,

- a platform (4) having a base (5) configured for supporting a load and/or human, the platform (4) comprises an attachment member (6) connected to the platform (2) and extending from the platform (2),
- a support structure (7) extending at least substantially along the circumference of the inner wall (4) of the tower construction (1) and having the shape of a ring-shaped or polygonal annulus providing an opening (9) interior to the support structure (7),

wherein the support structure is fastened at or to the inner wall (2) of the hollow tower (1), and the platform (4) is attached to the support structure (7) by the attachment member (6).

Item 2. A hollow tower according to item 1, wherein the support structure (7) is of the following cross-sectional geometric shapes: round, square, cross, H-shaped, I-shaped or any combination thereof.

Item 3. A hollow tower according to any of the preceding items, wherein the support (7) structure is made from metal, rubber or a combination thereof.

Item 4. A hollow tower according to any of the preceding items, wherein the support structure (7) is fastened to the inner wall by an intermediate connector (14) protruding from a lower position of the support structure (7).

Item 5. A hollow tower according to any of the preceding items, wherein the attachment member (6) and the support structure (7) are mutually shaped to attach to each other and provide the attachment, preferably the member (6), a freedom of movement in the circumferential direction of the support structure (7)

while preventing movement of the attachment member (6) in a radial direction of the support structure.

Item 6. A hollow tower according to any of the preceding items, wherein the platform's (4) attachment member (6) further comprises wheels (12) configured for rolling attachment with support structure (7) and/or the attachment member together with the support structure is provided a sufficient low friction for moving the platform along the support structure (7)

Item 7. A hollow tower according to item 6, wherein the platform's (2) attachment member (6) further comprises a motor to run the wheels (12) and/or to move the attachment member.

Item 8. A hollow tower according to any of the preceding items, where the support structure (7) is has a cross section configured such that wheels (12) are moveable between the flanges (16) of the cross section.

Item 9. A hollow tower according to any of the preceding items, wherein the tower further comprising fastening sections (6) each formed as a reinforced section (13) of the inner wall (4) of the hollow tower (1), such as the constructional joints of the tower elements.

Item 10. A hollow tower according to any of the preceding items, wherein the support structure (7) is sectionalized along the circumference of the support structure (7) and comprises flexible joints (14), configured for compression and expansion in response to movements of hollow tower, arranged in-between sections.

Item 11. A hollow tower according to any of the preceding items, wherein the fastening of the support structure (7) to the hollow tower (1) is provided by a magnetic force, bolting, welding and/or gluing, the support structure (7) is preferably fastened at discrete positions, preferably every 2.5 meter, more preferably every 1.5 meter, preferable every 1.0 meter.

Item 12. A hollow tower according to any of the preceding items, wherein the platform (2) further comprises a horizontal supporting member (15) for horizontally supporting the platform (2) by the support (15) abutting the inner wall (4) of the hollow tower (1) at a position below the support structure (7).

Item 13. A hollow tower according to item 12, wherein the base (5) of the platform (4) is tilted, such that when the horizontal supporting member (15) is engaged the base (5) of the platform (4) is levelled (26) in respect to the ground.

Item 14. A hollow tower according to any of the preceding items, wherein a winch (9) is located at the top of the tower (1) and adapted for being connected to the platform (4), such that the winch (9) can winch down the platform, when the attachment member (6) is detached from the support structure (7).

Item 15. A hollow tower according to any of the preceding items, where the platform (3) is modular, such that the platform 4 can be disassembled.

Item 16. A hollow tower according to any of the preceding items, wherein one or more guiding rails (8) are vertically place on the inner wall (2) of the tower, such that the one or more guiding rails (8) can guide the platform (4) when being winched down.

Item 17. A hollow tower according to item 16, wherein the platform (4) is attached to the guiding rails (8) by cable (10).

Item 18. A hollow tower according to item 16 or 17, wherein the platform is attached to the guiding rails by use of a connector located on the platform enabling positioning control of the platform e.g. during vertical movement.

Item 19. A method for construction a tower comprising the steps of

- assembling on the ground a first section of the tower,
- securing on the top inner section of the first section of the tower, as detailed in any of the preceding items, the support structure and the platform,

- assembling the first section of the tower to the foundation and assembling a second tower section on the ground attached to it the support structure and platform,
- assembling the second section on top of the first section by use of the platform on the first section,
- when the tower is fully erected, winching the platforms down to the base of the tower, preferably leaving one platform remaining,
- preferably dismantling the platforms at the bottom of the tower.

Item 20. A method for dismantling a tower comprising a support structure as detailed in any of the preceding items 1-18, the method comprising the steps of

i) attaching a platform as detailed in any of the preceding items 1-18 to the support structure of an upper most tower section,

ii) dismantling and removing the upper most top section of the tower involving use of the platform, whereby the section below the upper most section becomes the upper most section

the method comprising a number of repetitions of steps i) and ii) typically until all sections of the tower are dismantled.

CLAIMS

1. A hollow tower with a platform construction arranged inside the hollow tower (1), the hollow tower comprising an inner wall (2) and an outer wall (3);
the platform construction comprises,
- a platform (4) having a base (5) configured for supporting a load and/or human, the platform (4) comprises an attachment member (6) connected to the platform (2) and extending from the platform (2),
- a support structure (7) extending at least substantially along the circumference of the inner wall (4) of the tower construction (1) and having the shape of a ring-shaped or polygonal annulus providing an opening (9) interior to the support structure (7),

wherein
- the support structure is fastened at or to the inner wall (2) of the hollow tower (1), and the platform (4) is attached to the support structure (7) by the attachment member (6),
- the support structure (7) is arranged above the platform (4) and the platform (4) is suspended below the support structure (7) by the attachment member (6), and
- the attachment member (6) and the support structure (7) are mutually shaped to attach to each other and provide the attachment, preferably the attachment member (6), a freedom of movement in the circumferential direction of the support structure (7) while preventing movement of the attachment member (6) in a radial direction of the support structure.

2. A hollow tower according to claim 1, wherein the support structure (7) is of the following cross-sectional geometric shapes: round, square, cross, H-shaped, I-shaped or any combination thereof.

3. A hollow tower according to any one of the preceding claims, wherein the support (7) structure is made from metal, rubber or a combination thereof.

4. A hollow tower according to any one of the preceding claims, wherein the support structure (7) is fastened to the inner wall by an intermediate connector (14) protruding from a lower position of the support structure (7).

5. A hollow tower according to any one of the preceding claims, wherein the platform's (4) attachment member (6) further comprises wheels (12) configured for rolling attachment with support structure (7) and/or the attachment member together with the support structure is provided a sufficient low friction for moving the platform along the support structure (7).

6. A hollow tower according to claim 5, wherein the platform's (2) attachment member (6) further comprises a motor to run the wheels (12) and/or to move the attachment member.

7. A hollow tower according to any one of the preceding claims, where the support structure (7) comprising flanges (16) and has a cross section configured such that wheels (12) are moveable between the flanges (16) of the cross section.

8. A hollow tower according to any one of the preceding items, wherein the tower further comprising fastening sections (6) each formed as a reinforced section (13) of the inner wall (4) of the hollow tower (1), such as the constructional joints of the tower elements.

9. A hollow tower according to any one of the preceding claims, wherein the support structure (7) is sectionalized along the circumference of the support structure (7) and comprises flexible joints (14), configured for compression and expansion in response to movements of the hollow tower, arranged in-between sections.

10. A hollow tower according to any one of the preceding claims, wherein the fastening of the support structure (7) to the hollow tower (1) is provided by a magnetic force, bolting, welding and/or gluing, the support structure (7) is preferably fastened at discrete positions, preferably every 2.5 meter, more preferably every 1.5 meter, preferable every 1.0 meter.

11. A hollow tower according to any one of the preceding claims, wherein the platform (2) further comprises a horizontal supporting member (15) for horizontally supporting the platform (2) by the horizontal support member (15)

abutting the inner wall (4) of the hollow tower (1) at a position below the support structure (7).

12. A hollow tower according to claim 11, wherein the base (5) of the platform (4) is tilted, such that when the horizontal supporting member (15) is engaged, the base (5) of the platform (4) is levelled (26) in respect to the ground.

13. A hollow tower according to any one of the preceding claims, wherein a winch (9) is located at the top of the tower (1) and adapted for being connected to the platform (4), such that the winch (9) can winch down the platform, when the attachment member (6) is detached from the support structure (7).

14. A hollow tower according to one any of the preceding claims, where the platform (3) is modular, such that the platform (4) can be disassembled.

15. A hollow tower according to any one of the preceding claims, wherein the platform (4) comprises sides hinged to a base (5), said hinging is provided so as allow the sides to be folded inwardly and towards the base (5) to provide a flat-packaged platform.

16. A hollow tower according to any one of the preceding claims, wherein one or more guiding rails (8) are vertically placed on the inner wall (2) of the tower, such that the one or more guiding rails (8) can guide the platform (4) when being winched down.

17. A hollow tower according to claim 16, wherein the platform (4) is attached to the guiding rails (8) by a cable (10).

18. A hollow tower according to claim 16 or 17, wherein the platform is attached to the guiding rails by use of a connector located on the platform enabling positioning control of the platform e.g. during vertical movement.

19. A method for construction a tower comprising the steps of

- assembling on the ground a first section of the tower,
- securing on a top inner section of the first section of the tower, as detailed in any of the preceding claims, the support structure and the platform,
- assembling the first section of the tower to a foundation and assembling a second tower section on the ground attached to the second tower section the support structure and platform,
- assembling the second section on top of the first section by use of the platform on the first section,
- when the tower is fully erected, winching the platforms down to the base of the tower, preferably leaving one platform remaining,
- preferably dismantling the platforms at the bottom of the tower.

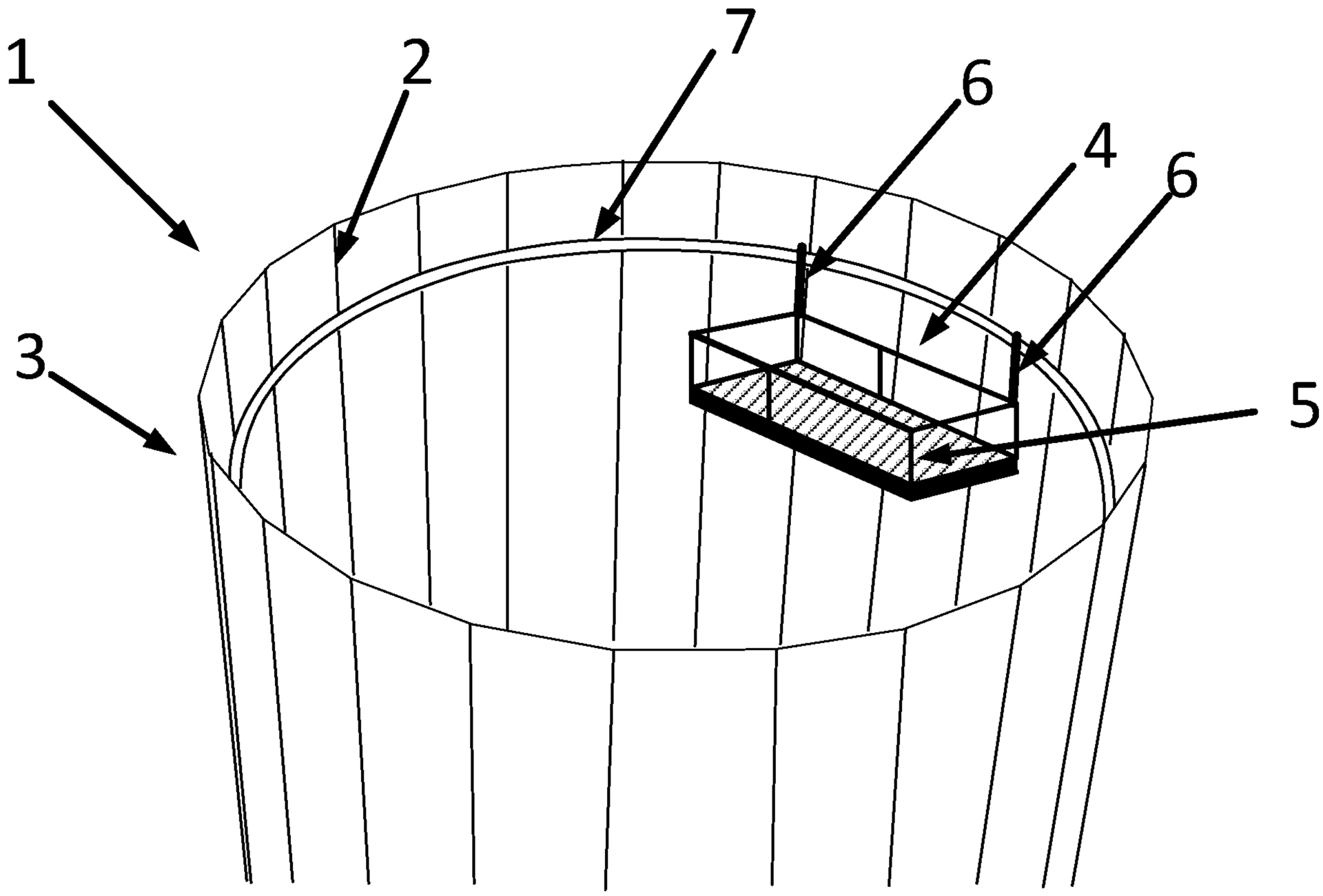

Fig. 1

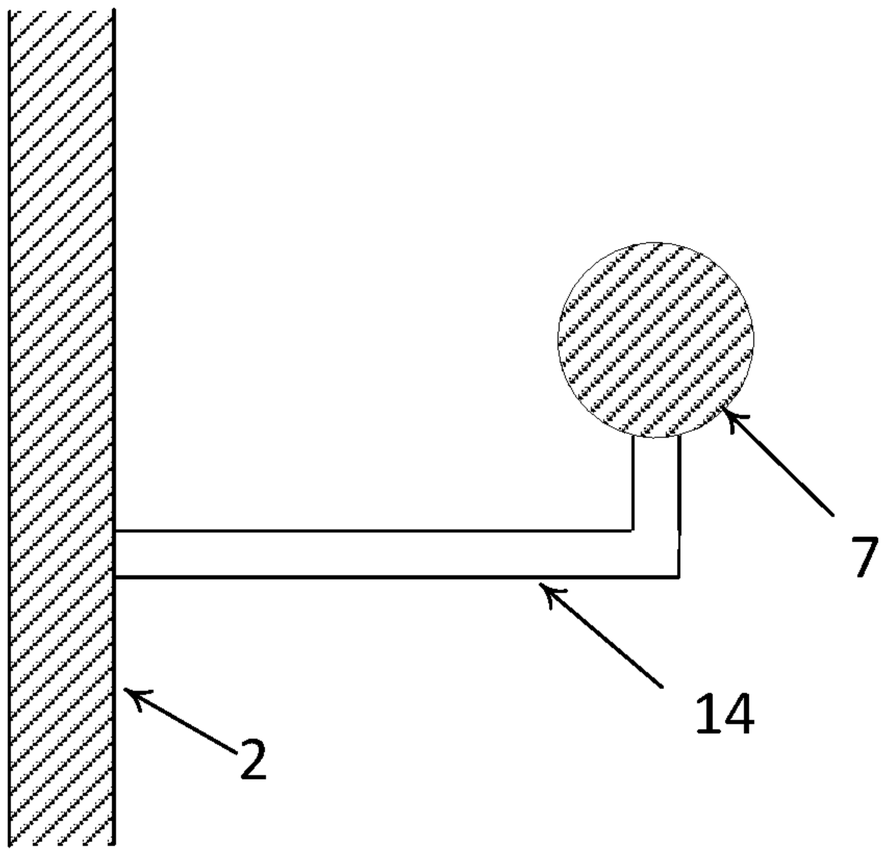

Fig. 2

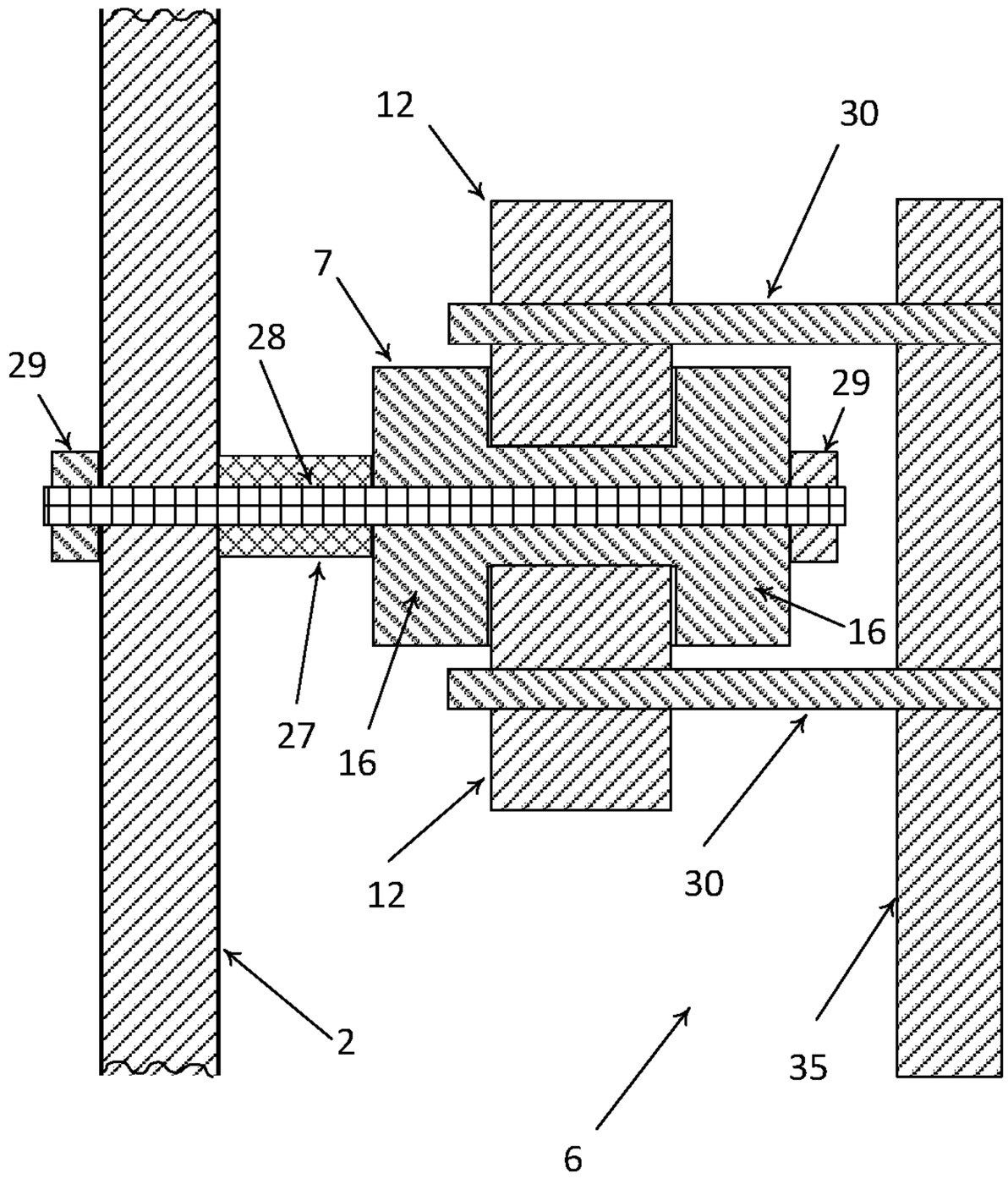

Fig. 3

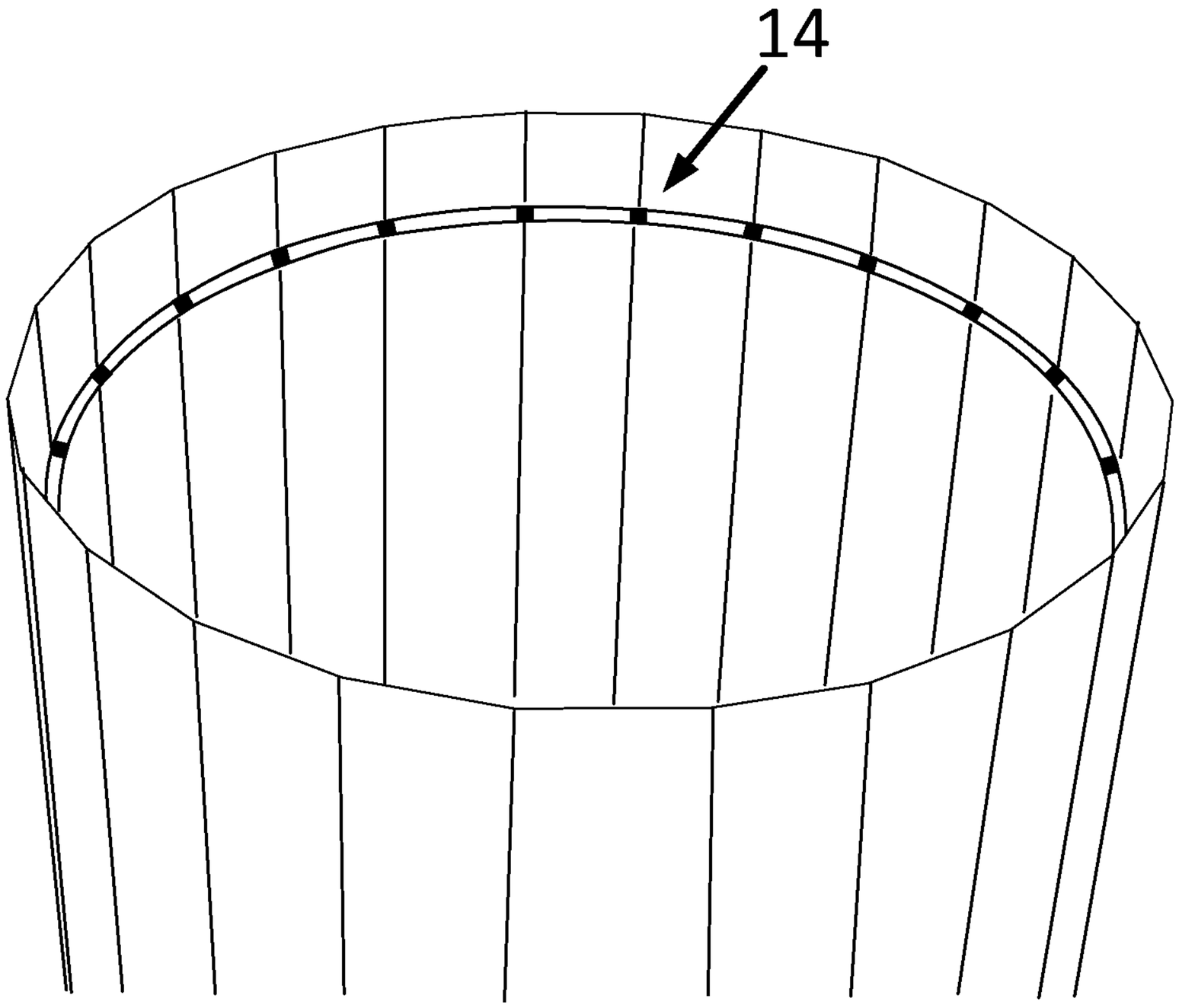

Fig. 4

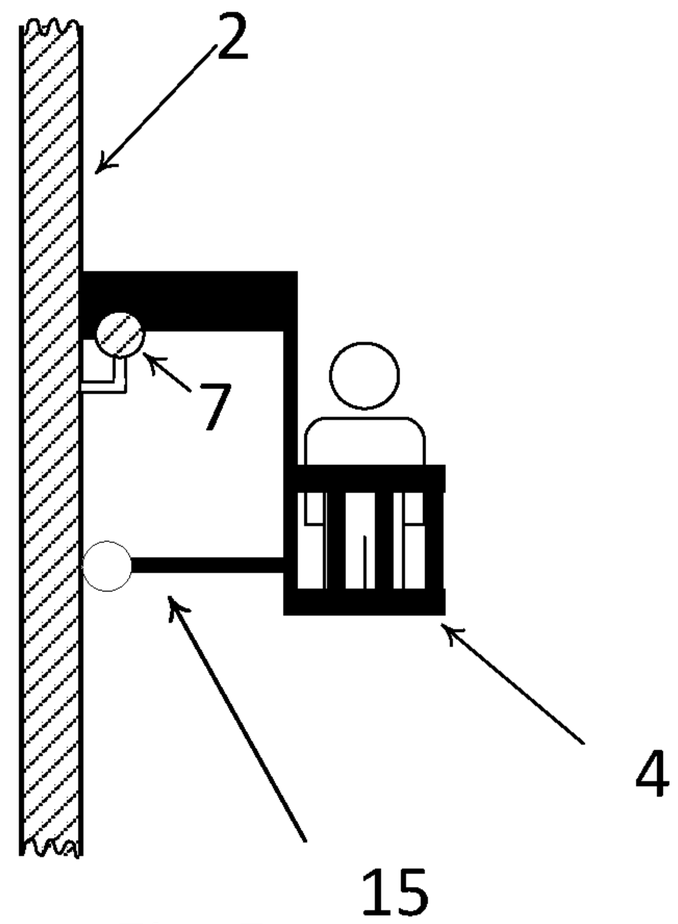

Fig. 5

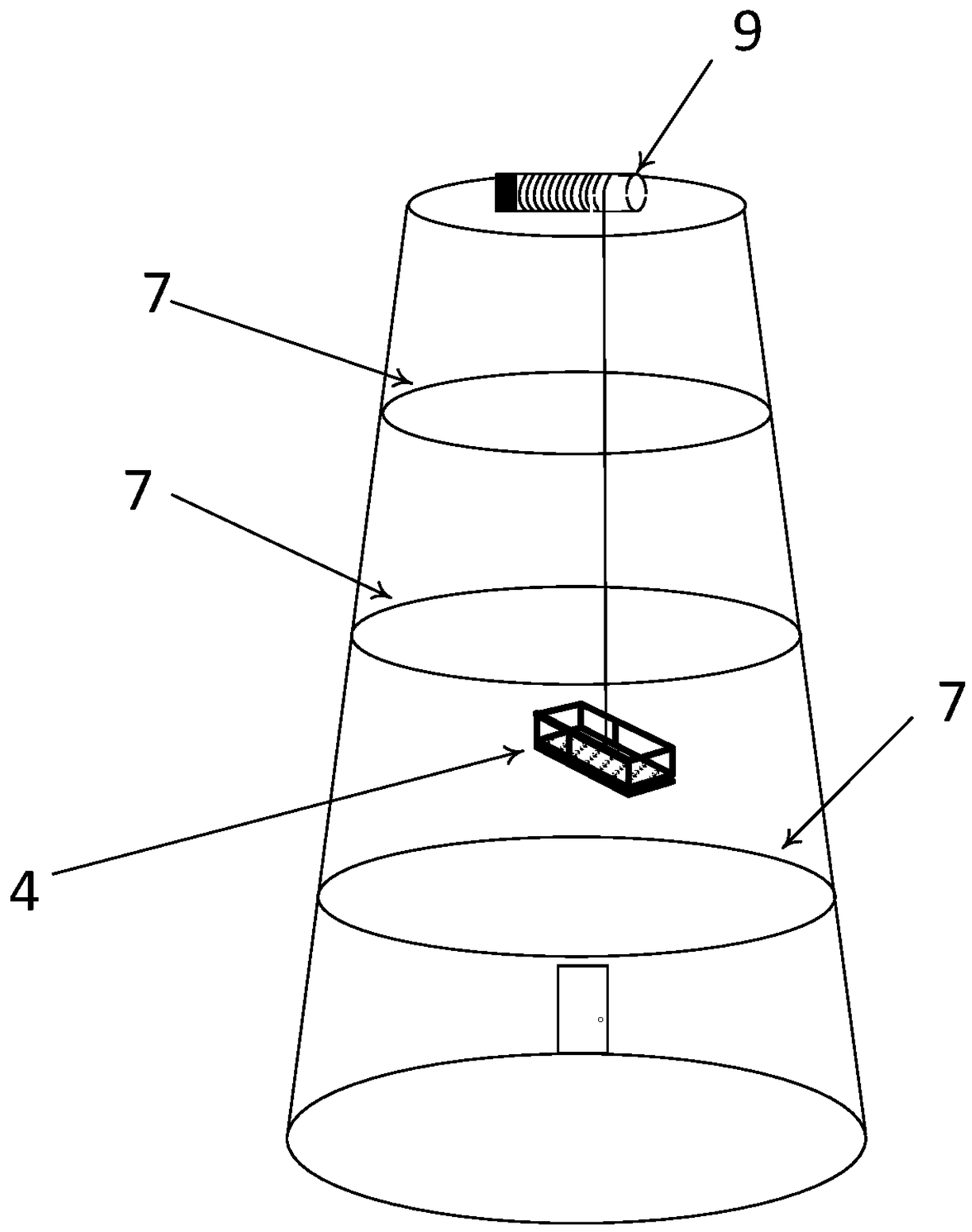

Fig. 6

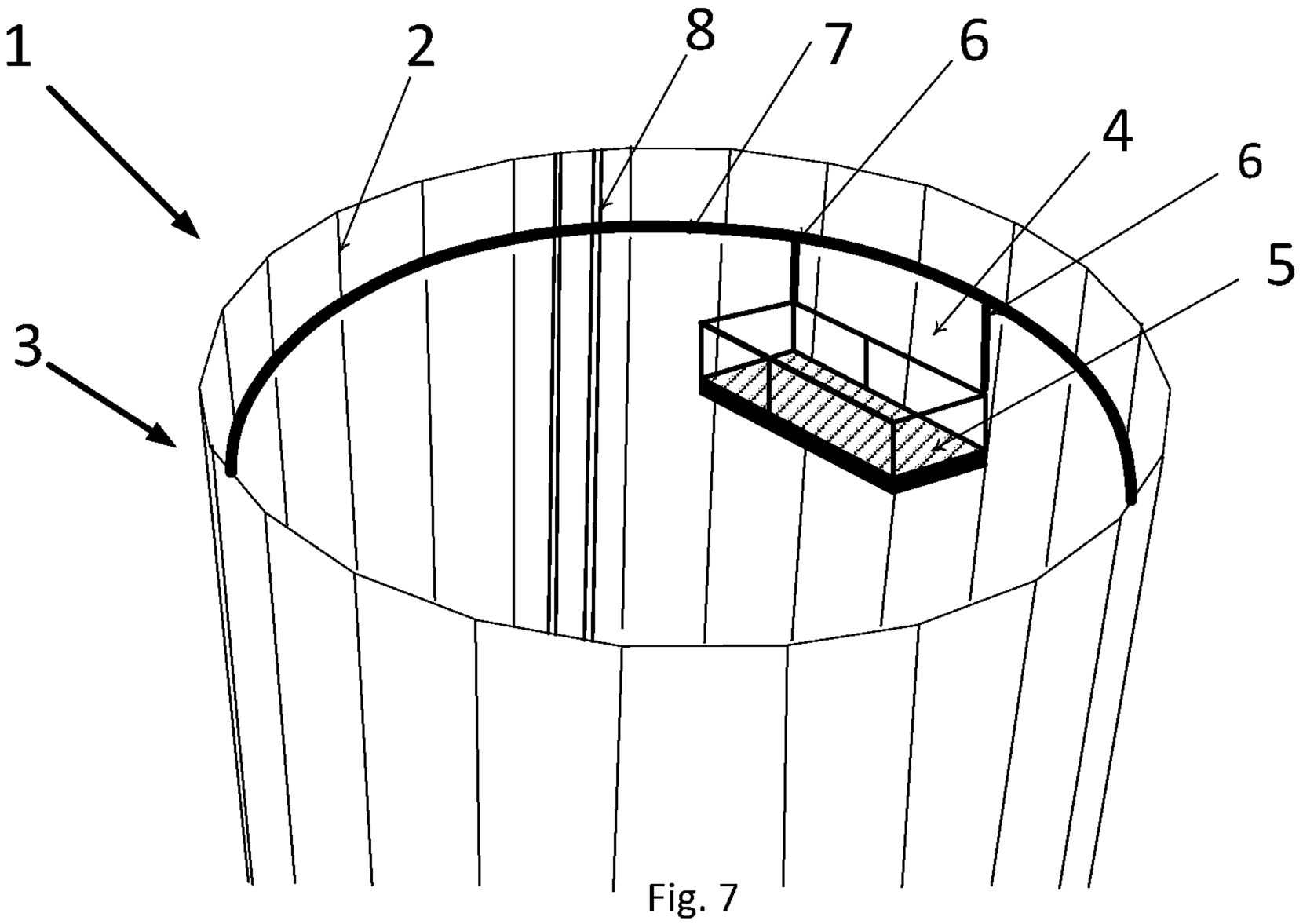

Fig. 7

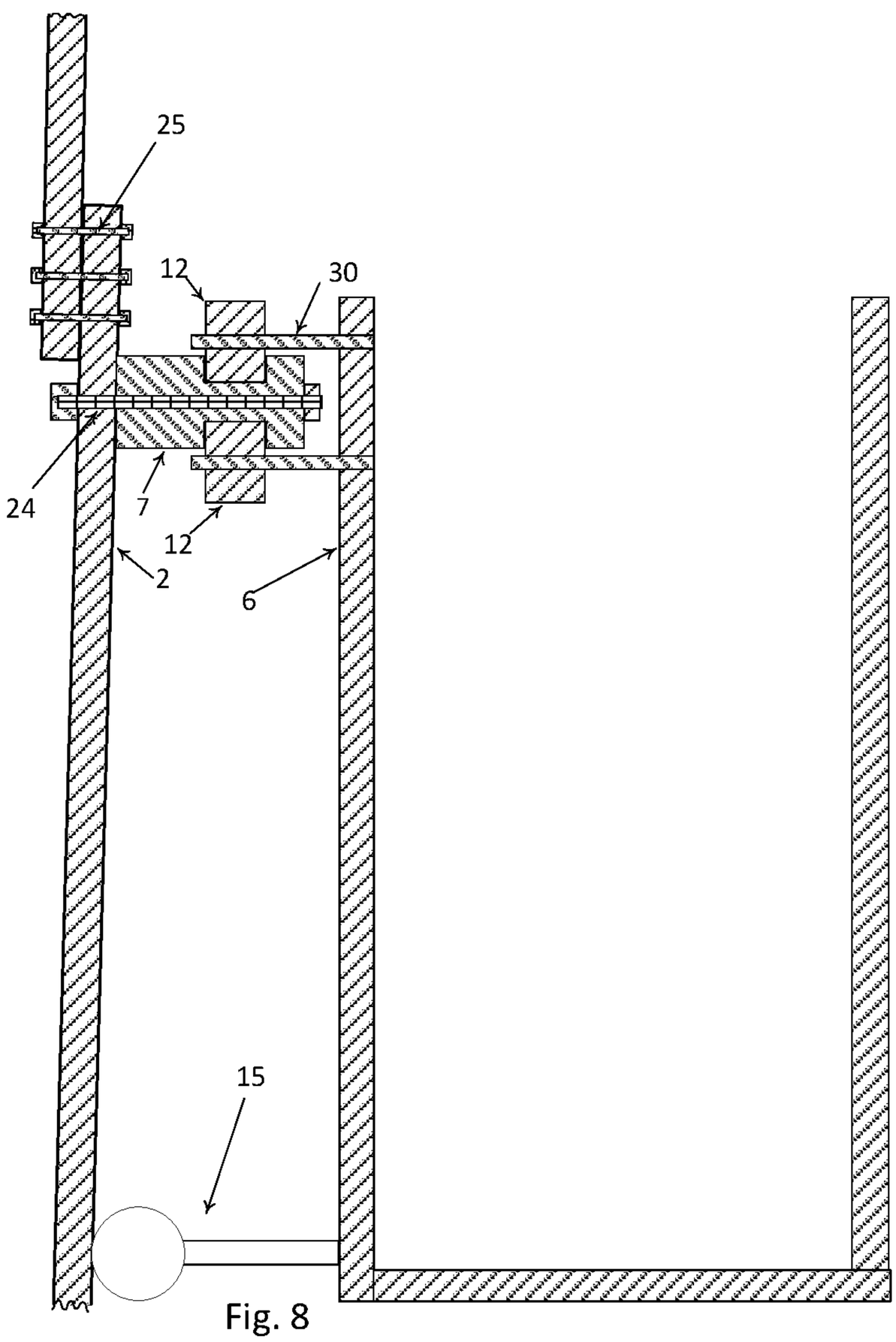

Fig. 8

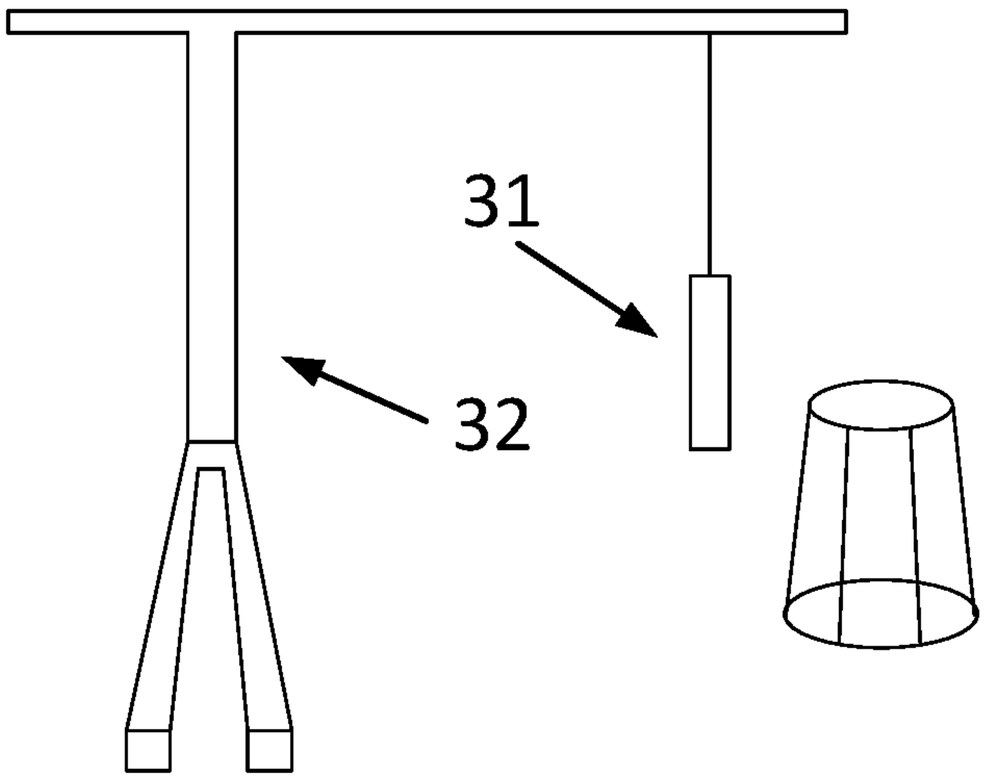

Fig. 9, detail 18

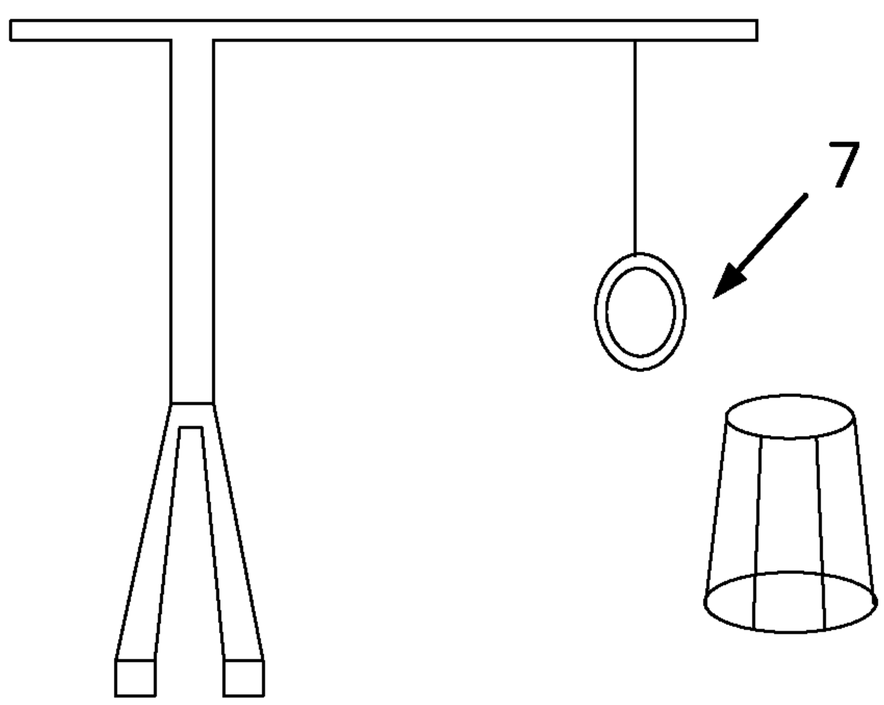

Fig. 9, detail 19

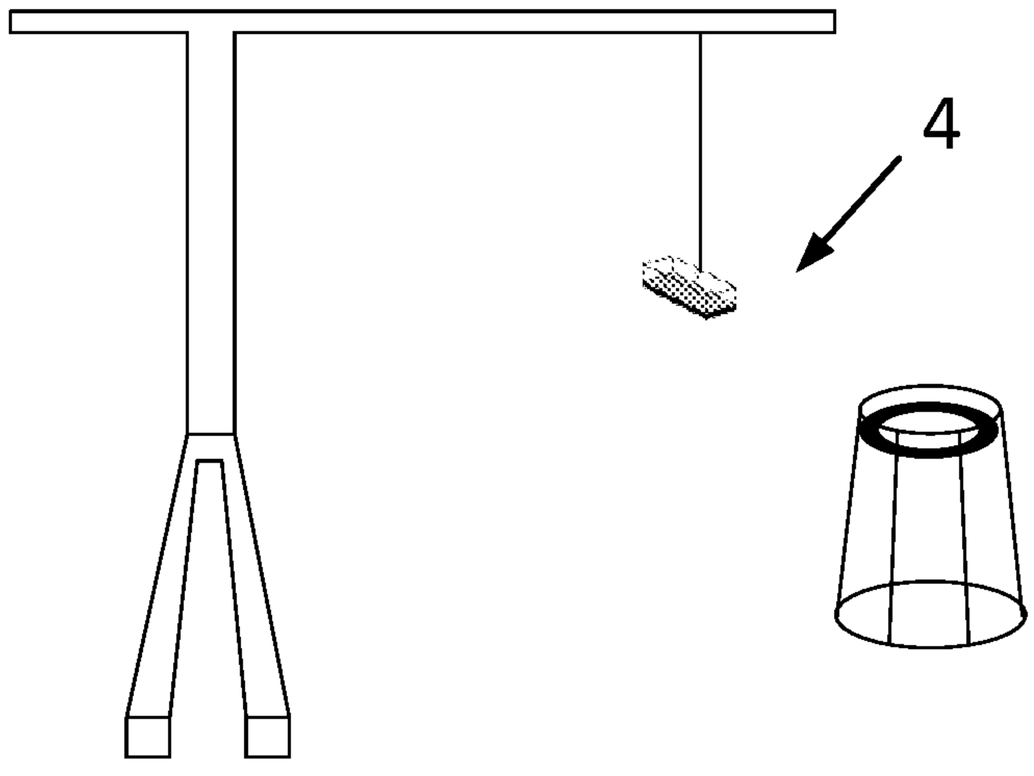

Fig. 9, detail 20

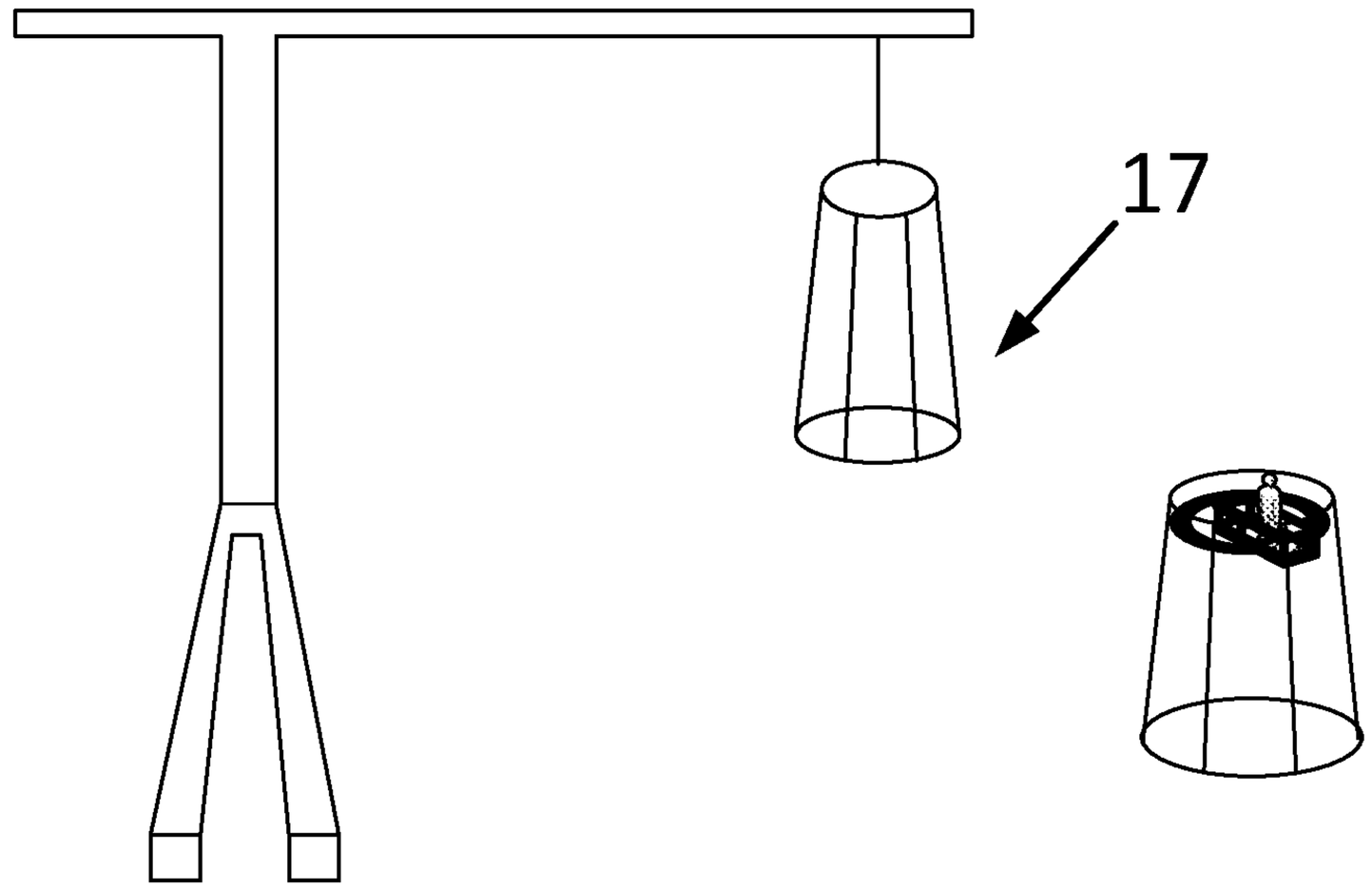

Fig. 9, detail 21

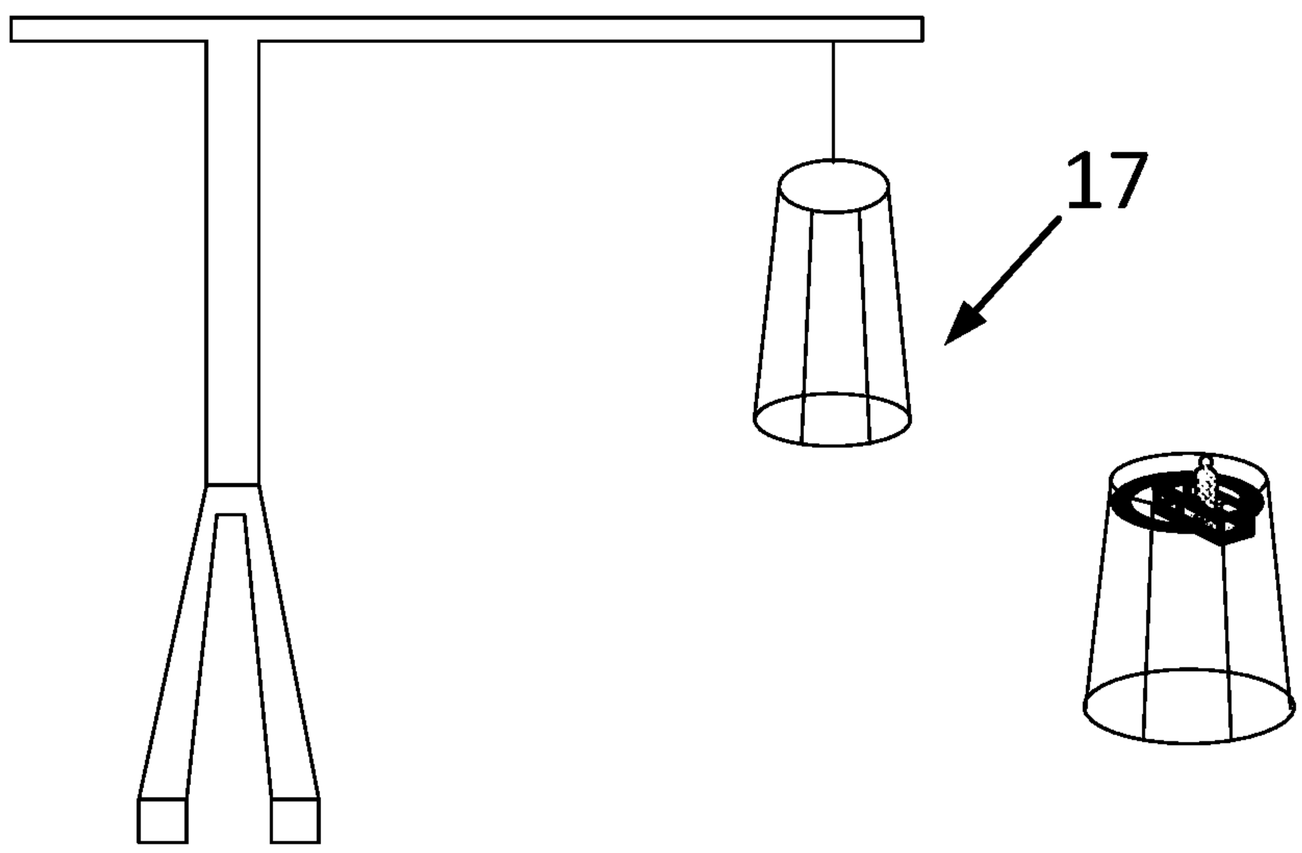

Fig. 9, detail 22

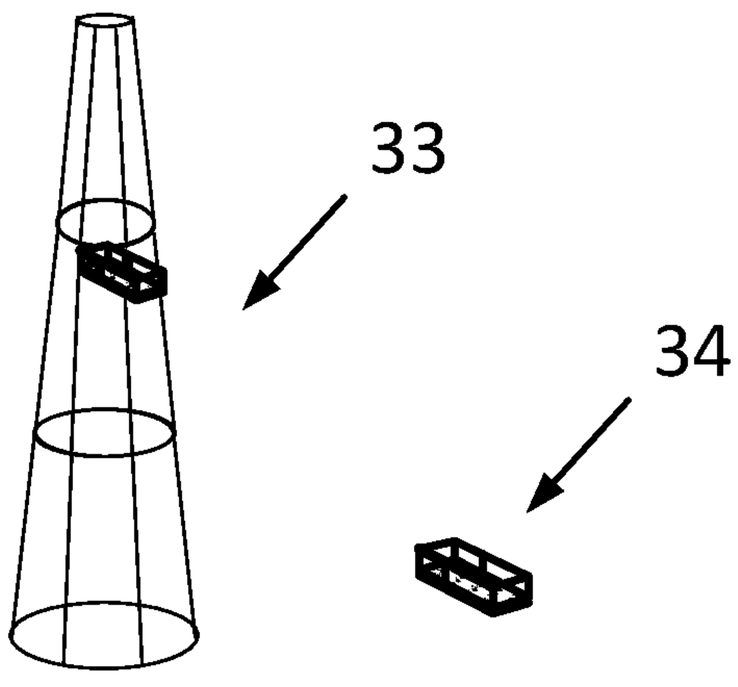

Fig. 9, detail 23

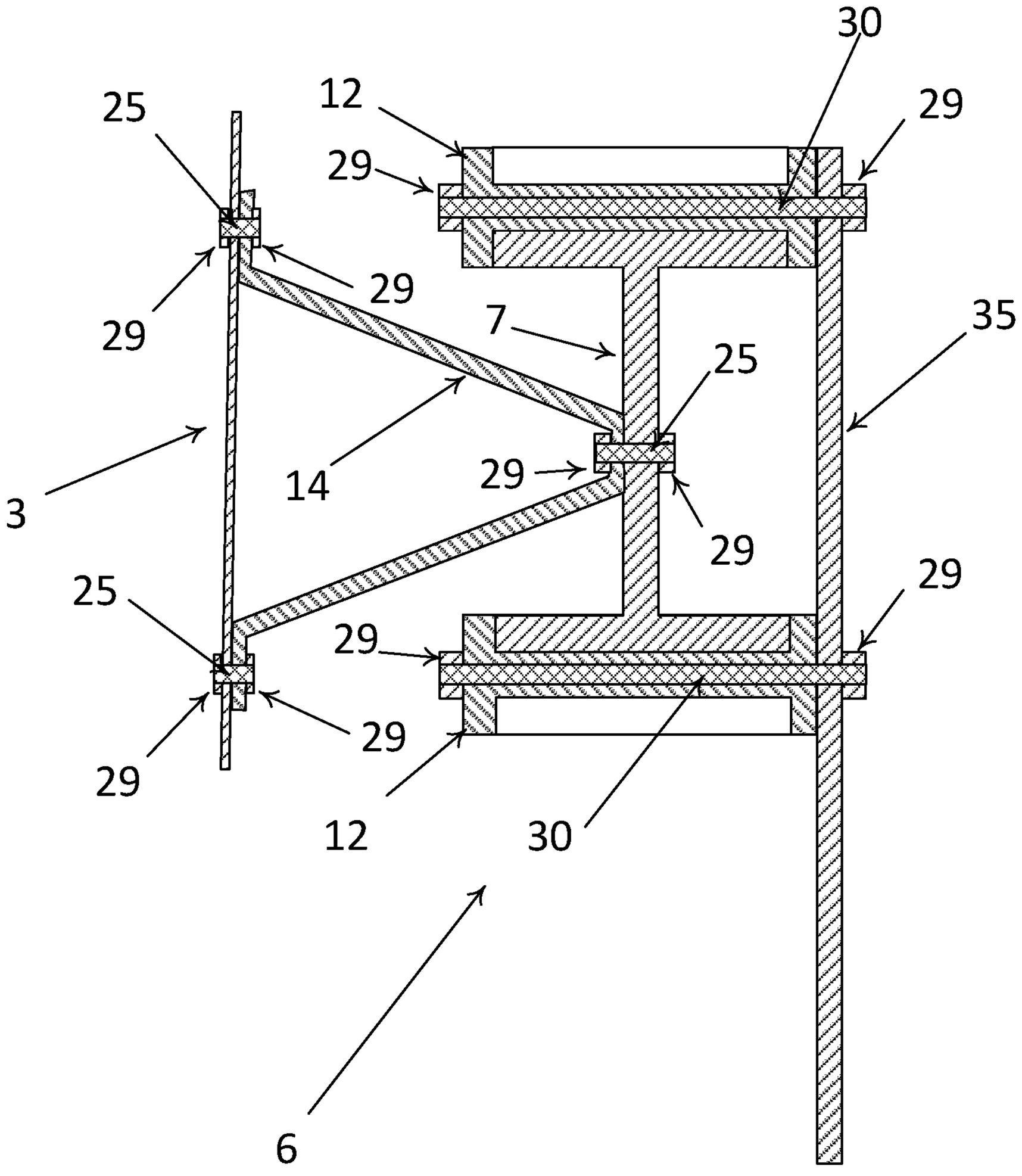

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/060213

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04H12/08 E04G3/24 E04H12/34
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04H E04G F03D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 20 2010 007565 U1 (ZARGES ALUMINIUM SYSTEME GMBH [DE]) 2 September 2010 (2010-09-02)	1-5,9-19
Y	paragraphs [0024] - [0026]; figure 1	8
A	EP 3 425 136 A1 (AIP APS [DK]) 9 January 2019 (2019-01-09) paragraphs [0043], [0047], [0054], [0074]; claims 1,4; figures 1,2,4,6	5-7
Y	DE 10 2015 110344 A1 (ENO ENERGY SYSTEMS GMBH [DE]) 29 December 2016 (2016-12-29) claim 1; figures 1a,2,4b	8
A	KR 101 524 158 B1 (SAMSUNG HEAVY IND [KR]) 29 May 2015 (2015-05-29) claim 1; figures 4,5,6	13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 January 2021	29/01/2021

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rosborough, John

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/060213

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10 2013 226536 A1 (WOBBEN PROPERTIES GMBH [DE]) 18 June 2015 (2015-06-18) claim 1; figures 3,4	19

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2020/060213

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 202010007565 U1	02-09-2010	NONE	
EP 3425136 A1	09-01-2019	CN 110998042 A	10-04-2020
		EP 3425136 A1	09-01-2019
		US 2020131786 A1	30-04-2020
		WO 2019008042 A1	10-01-2019
DE 102015110344 A1	29-12-2016	CA 2990090 A1	29-12-2016
		CA 3101288 A1	29-12-2016
		CN 108138509 A	08-06-2018
		DE 102015110344 A1	29-12-2016
		EP 3314076 A1	02-05-2018
		EP 3508669 A1	10-07-2019
		EP 3760815 A1	06-01-2021
		KR 20180019714 A	26-02-2018
		US 2019003199 A1	03-01-2019
		US 2020224442 A1	16-07-2020
		WO 2016207322 A1	29-12-2016
KR 101524158 B1	29-05-2015	NONE	
DE 102013226536 A1	18-06-2015	AR 098811 A1	15-06-2016
		CA 2930787 A1	25-06-2015
		CN 105829624 A	03-08-2016
		DE 102013226536 A1	18-06-2015
		DK 3092357 T3	22-06-2020
		EP 3092357 A1	16-11-2016
		ES 2792922 T3	12-11-2020
		PT 3092357 T	08-06-2020
		TW 201540921 A	01-11-2015
		US 2016312431 A1	27-10-2016
		WO 2015090861 A1	25-06-2015