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(54) HEAVY DUTY MONOPILE FASTENING SYSTEM

SCHWERLAST-MONOPILE-BEFESTIGUNGSSYSTEM

SYSTÈME DE FIXATION DE MONOPIEU À CHARGE LOURDE

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EP 3 575 199 B1

Description

[0001] The invention relates to a heavy duty monopile fastening system for retaining a monopile of a windmill during transport, comprising a frame for supporting the monopile, which frame comprises supporting elements at a predetermined distance from each other, which distance is selected to enable the frame to receive and support the monopile.

[0002] EP 3 109 531 discloses such a system for retaining an elongated monopile during transport ashore or offshore on sea. The known system comprises two pivotable supporting elements which are arranged at a distance from each other that during use support the monopile. The monopile is secured against movement in the longitudinal direction by friction between the supporting elements and the monopile. The pivotable supporting elements are actuated by hydraulic cylinders to position them with the proper orientation to receive and support the monopile.

[0003] It is a disadvantage of the known system for retaining an elongated monopile that it requires ancillary equipment like the hydraulic cylinders which makes the system relatively costly and also subject to regular maintenance in order to secure its proper operation.

[0004] It is remarked that from DE 41 23 430 a retaining element of plastic is known, for holding at least one pipe or cable with a bearing portion mountable on a support and a holding portion with two opposing shell parts interconnected in a lower region of these parts, which are connected on both sides of said lower portion with a resilient intermediate piece, which merges into a storage area, wherein the shell parts in their upper region are connectable to each other via engagement elements, and wherein the shell parts each have an elastic web interconnecting and attached to an inner and an outer end of the shell parts for holding pipes of different diameters. This retaining element of DE 41 23 430 is obviously not suitable for the heavy-duty application to retain a monopile of a windmill during transportation. It therefore does not relate to the subject matter of the instant invention.

[0005] It is an object of the invention to provide a monopile fastening system of simpler and therewith cheaper design, which hardly requires maintenance, if any at all.

[0006] It is a further object of the invention to provide a monopile fastening system which is capable of receiving and supporting monopiles in a vast range of different diameters.

[0007] It is still a further object of the invention to provide a monopile fasting system which is equipped to be used with relatively large diameter monopiles and without damaging such monopiles that are more prone to be indented due to their disadvantageous ratio of wall thickness versus diameter.

[0008] Still a further object of the invention is to provide a monopile fasting system which is capable to compensate the limited capacity of cranes that are used to handle monopiles of relatively large weight.

[0009] The heavy duty monopile fastening system of the invention has the features of one or more of the appended claims.

[0010] According to a first aspect of the invention the supporting elements are embodied as vertically straight uprising standards, wherein at least a first vertically straight uprising standard is provided with at least one pivotable and upstanding substantially straight arm having its pivot in common with the first vertically straight uprising standard, and that at least one flexible element or band is provided to connect the first vertically straight uprising standard with a second vertically straight uprising standard, wherein the at least one flexible element or band is embodied with two extremities distant from each other, and that a first extremity of the at least one flexible element or band connects to the upstanding arm at a position distant from the pivot which the arm has in common with the first vertically straight uprising standard, and that a second extremity of the at least one flexible element or band connects to the second vertically straight uprising standard.

[0011] Since it concerns a heavy-duty system, same cannot be embodied in plastic. Usually the supporting construction of the system -except for the at least one flexible element or band- is embodied in a construction metal, preferably steel.

[0012] The construction of the heavy duty monopile fastening system of the invention provides that it is essentially a self-adjusting system which is capable to receive and support monopiles of different diameters, without need to make much adjustments to the system. The system employs gravity in that the heavy weight of the monopile itself arranges for a close engagement of the flexible element or band against the outer circumference of the monopile which secures that the monopile is safeguarded against longitudinal motion by friction, and secured against lateral motion by the suspension between the vertically straight uprising standards.

[0013] Although some variation is allowed it is preferable that the second extremity of the at least one flexible element or band has a point of engagement with the second vertically uprising standard at a height which is level or approximately level with a height at which the first extremity of the at least one flexible element or band connects to the upstanding arm when said arm is in an upright orientation.

[0014] The construction with the at least one pivotable and upstanding arm having its pivot in common with the first vertically uprising standard arranges that the flexible element or band will tightly engage and to the largest possible extent against the circumference of the monopile, which is beneficial for providing the largest possible frictional contact area between the at least one flexible element or band and the monopile.

[0015] It is further preferable that at or near the connection of the at least one flexible element or band with the upstanding arm of the first vertically uprising standard

and at or near the point of engagement of the at least one flexible element or band with the second vertically uprising standard, engagement blocks are provided for engaging and resting against the monopile. These engagement blocks are preferably of rubber or caoutchouc and can provide a further frictional contact with the monopile and may prevent damage to the monopiles, such as indents in the outer surface of the monopiles.

[0016] The functionality of the engagement blocks can be optimized by arranging that each engagement block is provided with a curved surface that approximately matches the curvature of the monopile to be supported.

[0017] Although the basic construction of the monopile fastening system as discussed hereinabove is already capable to receive and support monopiles of different diameters, this capability can be further promoted by arranging that the flexible element or band is length-adjustable.

[0018] In one embodiment the first standard and/or the second standard is provided with multiple connectors for the at least one flexible element or band. This feature provides an easy way when the length of the at least one flexible element or band is to be adjusted and tailored to the diameter of the monopiles to be supported.

[0019] The capability to receive and support monopiles of different diameters can be further promoted by arranging that the first and second vertically uprising standards are movable with respect to each other.

[0020] Particularly when the first and second vertically uprising standards are movable with respect to each other, but also in other situations, stability of the construction according to the invention can be promoted by arranging that the first and second vertically uprising standards are provided with at least one distance arm to secure a predetermined distance between the first and second vertically uprising standards.

[0021] It is beneficial that the distance arm has a feature selected from a group of features comprising an adjustable length by intermediate pieces, a telescopically extendable extension part, several connecting hooks at different locations along the length of the distance arm. Any such feature can be applied for arranging that a suitable distance arm or distance arms can be applied for promoting stability of the construction according to the invention.

[0022] Preferably the at least one distance arm is mounted adjacent to a lowest part of the at least one flexible element or band.

[0023] Further it is preferable that at ground-level the first and second vertically uprising standards are connected with harmonica arms. This is not only beneficial for securely moving the first and second vertical standards into a selected distance from each other, but is also beneficial for arranging that the vertically uprising standards are collectively movable to and fro a crane for handling monopiles. This enables that even a crane of limited capacity can be used for handling relatively heavy monopiles.

[0024] Preferably the vertically uprising standards are mounted on rails. The rails can like the crane be mounted on a ship or be mounted on shore.

[0025] The invention will hereinafter be further elucidated with reference to the drawing of some exemplary embodiments of a monopile fastening system according to the invention that is not limiting as to the appended claims.

[0026] In the drawing:

- figure 1 shows a monopile fastening system according to the invention as mounted on a ship;
- figure 2 shows the monopile fastening system of figure 1;
- figure 3 schematically shows the use of a monopile fastening system of the invention with different diameter monopiles;
- figure 4 shows an embodiment of the monopile fastening system of the invention suitable for adjusting to different length of flexible element or bands;
- figure 5 shows several distance arms for use with a monopile fastening system of the invention; and
- figure 6 shows the mobile fastening system of the invention embodied with harmonica arms at ground-level.

[0027] Whenever in the figures the same reference numerals are applied, these numerals refer to the same parts.

[0028] Making reference to figure 1 a monopile fastening system 1 is shown at the railings at opposite sides of a ship 2 for retaining monopiles 3 during transport.

[0029] As is better shown in figure 2 the system 1 of the invention comprises a frame 4 for supporting the monopile or monopiles, which frame 4 comprises supporting elements 5, 6 at a predetermined distance from each other, which distance is selected to enable the frame 4 to receive and support the monopiles. The supporting elements 5, 6 are embodied as separate vertically straight uprising standards 5', 6', wherein at least a first vertically uprising standard 5' is provided with one or more pivotable and upstanding substantially straight arms 7. Each arm 7 has its pivot 8 in common with the first vertical standard 5'.

[0030] Further figure 2 shows that one or more flexible element or bands 9 are provided to connect the first vertically straight uprising standard 5' with a second vertically straight uprising standard 6'. For each flexible element or band 9 it holds that it is embodied with two extremities 9', 9" distant from each other, and that a first extremity 9' of the at least one flexible element or band 9 connects to the upstanding arm 7 at a position distant from the pivot 8 which the arm 7 has in common with the first vertically uprising standard 5'. A second extremity 9'' of the at least one flexible element or band 9 which is distant from the first extremity 9' connects to the second vertically uprising standard 6'.

[0031] Figure 3 schematically shows in a side view a

part of the monopile support system of the invention wherein different diameter monopiles 3 are supported, notably monopiles 3 of 8 m, 8.5 meters and 9 m diameter. With reference to both figure 3 and figure 4 is shown that the second extremity 9" of the at least one flexible element or band 9 has a point of engagement with the second vertically uprising standard 6' at a height which is level or approximately level with a height at which the first extremity 9' of such at least one flexible element or band 9 connects to the upstanding arm 7 when said arm 7 is in an (approximately) upright orientation.

[0032] Figures 2, 3 and 4 show that at or near the connection of the at least one flexible element or band 9 with the upstanding arm 7 of the first vertically uprising standard 5' and at or near the point of engagement of the at least one flexible element or band 9 with the second vertically uprising standard 6', engagement blocks 10, 11 are provided for engaging and resting against the monopile 3. The engagement blocks 10, 11 can be flat or have a curved surface.

[0033] Figures 3 and 4 show that each engagement block 10, 11 is provided with a curved surface 10', 11' that approximately matches the curvature of the monopile 3.

[0034] To match different length of the flexible element or band or flexible element or bands 9 it is shown in figure 4 that the second standard 6' is provided with multiple connectors 12 for the at least one flexible element or band 9. This could likewise be embodied on the upstanding arm 7 or another part of the first standard 5'.

[0035] Figure 6 depicts that the first and second vertically uprising standards 5', 6' are movable with respect to each other. This is in this example embodied with harmonica arms 13, 14 connecting the separate first and second vertically uprising standards 5', 6' at ground-level. Going from left to right in figure 6 the harmonica arms 13, 14 are shown in a collapsed situation, a half angled orientation, and in a straight orientation in each-others extended direction, thus providing for less or more room between any combination of first vertical standard 5' and second vertical standard 6' of the frame.

[0036] Turning back to figure 2 it is shown that the first and second vertically uprising standards 5', 6' are provided with at least one distance arm 15 to secure a predetermined distance between the first and second vertically uprising standards 5', 6'. The at least one distance arm 15 is mounted adjacent to a lowest part of the at least one flexible element or band 9 to provide best results in stability. Figure 2 also shows that when multiple flexible element or bands 9 are used, the flexible element or bands 9 can cross each other.

[0037] Particularly but not only in relation to the movability of the first and second vertically uprising standards 5', 6', the distance arm 15 has a feature selected from a group of features comprising an adjustable length by intermediate pieces 15' (see figure 5 - in the middle), a telescopically extendable extension part 15" (see figure 5 - top), several connecting hooks 15"' at different locations along the length of the distance arm 15 (see figure 5 - bottom). With any one of these features stably maintaining the distance between the first and second vertical standards 5', 6' can be maintained over their entire height.

[0038] Turning back to figure 1 it is remarked that the frame 4 comprising the vertically uprising standards is movable to and fro a crane 16 for handling the monopiles 3. For this purpose it is appropriate that the vertical standards of the frame 4 are mounted on and movable over rails 17.

[0039] Although the invention has been discussed in the foregoing with reference to an exemplary embodiment of the monopile fastening system of the invention, the invention is not restricted to the particular embodiments as discussed herein, which can be varied in many ways without departing from the invention. The discussed exemplary embodiments shall therefore not be used to construe the appended claims strictly in accordance therewith. On the contrary the embodiments are merely intended to explain the wording of the appended claims without intent to limit the claims to these exemplary embodiments. The scope of protection of the invention shall therefore be construed in accordance with the appended claims only, wherein a possible ambiguity in the wording of the claims shall be resolved using these exemplary embodiments.

Claims

1. Heavy duty monopile fastening system (1) suitable for retaining a monopile (3) of a windmill during transport, comprising a frame (4) for supporting the monopile (3), which frame (4) comprises supporting elements (5, 6) at a predetermined distance from each other, which distance is selected to enable the frame (4) to receive and support the monopile (3), **characterized in that** the supporting elements (5, 6) are embodied as separate vertically straight uprising standards (5', 6'), wherein at least a first vertically straight uprising standard (5') is provided with at least one pivotable and upstanding substantially straight arm (7) having its pivot (8) in common with the first vertically straight uprising standard (5'), and that at least one flexible element or band (9) is provided to connect the first vertically straight uprising standard (5') with a second vertically straight uprising standard (6') which is separate from the first vertically straight uprising standard (5'), wherein the at least one flexible element or band (9) is embodied with two extremities (9', 9") distant from each other, and that a first extremity (9') of the at least one flexible element or band (9) connects to the upstanding arm (7) at a position distant from the pivot (8) which the arm (7) has in common with the first vertically straight uprising standard (5'), and that a second extremity (9") of the at least one flexible element or band (9) connects

to the second vertically straight uprising standard (6').

2. Monopile fastening system according to claim 1, **characterized in that** the second extremity (9") of the at least one flexible element or band (9) has a point of engagement with the second vertically uprising standard (6') at a height which is level or approximately level with a height at which the first extremity (9') of the at least one flexible element or band (9) connects to the upstanding arm (7) when said arm (7) is in an upright orientation.

3. Monopile fastening system according to claim 1 or 2, **characterized in that** at or near the connection of the at least one flexible element or band (9) with the upstanding arm (7) of the first vertically uprising standard (5') and at or near the point of engagement of the at least one flexible element or band (9) with the second vertically upright standard (6'), engagement blocks (10, 11) are provided for engaging and resting against the monopile (3).

4. Monopile fastening system according to any one of claims 1 - 3, **characterized in that** each engagement block (10, 11) is provided with a curved surface (10', 11') that approximately matches the curvature of the monopile (3).

5. Monopile fastening system according to any one of claims 1 - 4, **characterized in that** the flexible element or band (9) is length-adjustable.

6. Monopile fastening system according to any one of claims 1 - 5, **characterized in that** the first standard (5') and/or the second standard (6') is provided with multiple connectors (12) for the at least one flexible element or band (9).

7. Monopile fastening system according to any one of claims 1 - 6, **characterized in that** the first and/or second vertically upright standards (5', 6') are movable with respect to each other.

8. Monopile fastening system according to any one of claims 1 - 7, **characterized in that** the first and second vertically upright standards (5', 6') are provided with at least one distance arm (15) to secure a predetermined distance between the first and second vertically upright standards (5', 6').

9. Monopile fastening system according to claim 8, **characterized in that** the distance arm (15) has a feature selected from a group of features comprising an adjustable length by intermediate pieces (15'), a telescopically extendable extension part (15''), several connecting hooks (15''') at different locations along the length of the distance arm (15).

10. Monopile fastening system according to any one of claims 7 - 9, **characterized in that** the at least one distance arm (15) is mounted adjacent to a lowest part of the at least one flexible element or band (9).

11. Monopile fastening system according to any one of claims 7 - 10, **characterized in that** at ground-level the first and second vertically upright standards (5', 6') are connected to each other with harmonica arms (13, 14).

12. Monopile fastening system according to any one of claims 1 - 11, **characterized in that** the vertically upright standards (5', 6') are collectively movable to and fro a crane (16) for handling monopiles (3).

13. Monopile fastening system according to claim 12, **characterized in that** the vertically upright standards (5', 6') are mounted and movable on rails (17).

Patentansprüche

1. Schwerlast-Monopile-Befestigungssystem (1), welches zum Halten eines Monopiles (3) einer Windkraftanlage während des Transportes geeignet ist, umfassend einen Stützelemente (5, 6) in einem vorbestimmten Abstand voneinander aufweisenden Rahmen (4) zum Abstützen des Monopiles (3), wobei der Abstand so gewählt ist, dass der Rahmen (4) den Monopile (3) aufnehmen und stützen kann, **dadurch gekennzeichnet, dass** die Stützelemente (5, 6) als separate, vertikal gerade aufstrebende Ständer (5', 6') ausgebildet sind, wobei mindestens ein erster vertikal gerade aufstrebender Ständer (5') mit mindestens einem schwenkbaren und im aufrechten Zustand im Wesentlichen geraden Arm (7) versehen ist, dessen Drehpunkt (8) mit dem ersten vertikal aufstrebenden Ständer (5') zusammenfällt, und dass mindestens ein flexibles Element oder Band (9) vorgesehen ist, um den ersten vertikal gerade aufstrebenden Ständer (5') mit einem zweiten vertikal gerade aufstrebenden Ständer (6') zu verbinden, der von der ersten vertikal geraden aufstrebenden Ständer (5') getrennt ist, wobei das mindestens eine flexible Element oder Band (9) mit zwei voneinander beabstandeten Endabschnitten (9', 9") ausgebildet ist, und dass ein erster Endabschnitt (9') des mindestens einen flexiblen Elements oder Bandes (9) mit dem aufragenden Arm (7) an einer Position verbunden ist, die von dem Drehpunkt (8) entfernt ist, an dem der Arm (7) mit dem ersten vertikal gerade aufstrebenden Ständer (5') zusammenfällt, und dass ein zweiter Endabschnitt (9") des mindestens einen flexiblen Elements oder Bandes (9) mit dem zweiten vertikal gerade aufstrebenden Ständer (6') verbunden ist.

2. Monopile-Befestigungssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der zweite Endabschnitt (9") des mindestens einen flexiblen Elements oder Bandes (9) einen Eingriffspunkt mit dem zweiten vertikal aufstrebenden Ständer (6') in einer Höhe aufweist, die genaus hoch oder annähernd genauso hoch wie die Höhe liegt, auf der der erste Endabschnitt (9') des mindestens einen flexiblen Elements oder Bandes (9) mit dem aufragenden Arm (7) verbunden ist, wenn sich dieser besagte Arm (7) in einer aufrechten Ausrichtung befindet.

3. Monopile-Befestigungssystem nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** an oder in der Nähe der Verbindung des mindestens einen flexiblen Elements oder Bandes (9) mit dem aufragenden Arm (7) der ersten vertikal aufstrebenden Ständers (5') und an oder in der Nähe des Eingriffspunktes des mindestens einen flexiblen Elements oder Bandes (9) mit dem zweiten vertikal aufstrebenden Ständer (6') Eingriffsblöcke (10, 11) vorgesehen sind, um in den Monopile (3) einzugreifen und an diesem anzuliegen.

4. Monopile-Befestigungssystem nach einem der Ansprüche 1 - 3, **dadurch gekennzeichnet, dass** jeder Eingriffsblock (10, 11) mit einer gekrümmten Oberfläche (10', 11') versehen ist, die ungefähr der Krümmung des Monopiles (3) folgt.

5. Monopile-Befestigungssystem nach einem der Ansprüche 1 - 4, **dadurch gekennzeichnet, dass** das flexible Element oder Band (9) längenverstellbar ist.

6. Monopile-Befestigungssystem nach einem der Ansprüche 1 - 5, **dadurch gekennzeichnet, dass** der erste Ständer (5') und/oder der zweite Ständer (6') mit mehreren Verbindern (12) für das mindestens eine flexible Element oder Band (9) versehen sind.

7. Monopile-Befestigungssystem nach einem der Ansprüche 1 - 6, **dadurch gekennzeichnet, dass** die ersten und/oder zweiten vertikal aufstrebenden Ständer (5', 6') relativ zueinander beweglich sind.

8. Monopile-Befestigungssystem nach einem der Ansprüche 1 - 7, **dadurch gekennzeichnet, dass** der erste und der zweite vertikal aufrechten Ständer (5', 6') mit mindestens einem Abstandsarm (15) versehen sind, um einen vorbestimmten Abstand zwischen dem ersten und dem zweiten vertikal aufrechten Ständer (5', 6') zu sichern.

9. Monopile-Befestigungssystem nach Anspruch 8, **dadurch gekennzeichnet, dass** der Abstandsarm (15) ein Merkmal aufweist, das aus einer Gruppe von Merkmalen ausgewählt ist, welches eine durch Zwischenstücke (15') längenverstellbare Länge, ein teleskopisch ausziehbares Verlängerungsteil (15"), und mehrere Verbindungshaken (15'") an verschiedenen Stellen entlang der Länge des Abstandsarms (15) umfasst.

10. Monopile-Befestigungssystem nach einem der Ansprüche 7 - 9, **dadurch gekennzeichnet, dass** der mindestens eine Distanzarm (15) neben einem untersten Teil des mindestens einen flexiblen Elements oder Bandes (9) angebracht ist.

11. Monopile-Befestigungssystem nach einem der Ansprüche 7 - 10, **dadurch gekennzeichnet, dass** in Bodenhöhe die ersten und der zweiten vertikal aufrechten Ständer (5', 6') durch Harmonikaarme (13, 14) miteinander verbunden sind.

12. Monopile-Befestigungssystem nach einem der Ansprüche 1 - 11, **dadurch gekennzeichnet, dass** die vertikal aufrechten Ständer (5', 6') kollektiv zu einem Kran (16) hin und von diesem weg bewegbar sind, um Monopile (3) zu handhaben.

13. Monopile-Befestigungssystem nach Anspruch 12, **dadurch gekennzeichnet, dass** die vertikal aufrechten Ständer (5', 6') auf Schienen (17) montiert und beweglich sind.

Revendications

1. Système de fixation de monopieu à charge lourde (1) approprié pour retenir un monopieu (3) d'une éolienne pendant le transport, comprenant un cadre (4) pour supporter le monopieu (3), lequel cadre (4) comprend des éléments de support (5, 6) à une distance prédéterminée les uns des autres, laquelle distance est choisie de manière à permettre au cadre (4) de recevoir et de supporter le monopieu (3), **caractérisé en ce que** les éléments de support (5, 6) sont réalisés sous forme de montants verticalement droits, levés séparés (5', 6'), où au moins un premier montant verticalement droit, levé (5') est pourvu d'au moins un bras (7) essentiellement droit, dressé et pivotant ayant son pivot (8) en commun avec le premier montant verticalement droit, levé (5'), et **en ce qu'**au moins un élément ou bande flexible (9) est prévu(e) pour relier le premier montant verticalement droit, levé (5') à un deuxième montant verticalement droit, levé (6') qui est séparé du premier montant verticalement droit, levé (5'), où l'au moins un élément ou bande flexible (9) est pourvu(e) de deux extrémités (9', 9'') éloignées l'une de l'autre, et **en ce qu'**une première extrémité (9') de l'au moins un élément ou bande flexible (9) se relie au bras dressé (7) à une position éloignée du pivot (8) que le bras (7) a en commun avec le premier montant verticalement droit, levé (5'), et **en ce qu'**une deuxième ex-

trémité (9") de l'au moins un élément ou bande flexible (9) se relie au deuxième montant verticalement droit, levé (6').

2. Système de fixation de monopieu selon la revendication 1, **caractérisé en ce que** la deuxième extrémité (9'') de l'au moins un élément ou bande flexible (9) a un point d'engagement avec le deuxième montant verticalement levé (6') à une hauteur qui est à niveau ou approximativement à niveau avec une hauteur à laquelle la première extrémité (9') de l'au moins un élément ou bande flexible (9) se relie au bras dressé (7) lorsque ledit bras (7) est dans une orientation debout.

3. Système de fixation de monopieu selon la revendication 1 ou 2, **caractérisé en ce qu'**au niveau ou à proximité de la liaison de l'au moins un élément ou bande flexible (9) avec le bras dressé (7) du premier montant verticalement levé (5') et au niveau ou à proximité du point d'engagement de l'au moins un élément ou bande flexible (9) avec le deuxième montant verticalement debout (6'), des blocs d'engagement (10, 11) sont prévus pour s'engager avec le monopieu (3) et reposer contre celui-ci.

4. Système de fixation de monopieu selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** chaque bloc d'engagement (10, 11) est pourvu d'une surface incurvée (10', 11') qui correspond approximativement à la courbure du monopieu (3).

5. Système de fixation de monopieu selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** l'élément ou bande flexible (9) est réglable en longueur.

6. Système de fixation monopieu selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** le premier montant (5') et/ou le deuxième montant (6') sont pourvus de raccords multiples (12) pour l'au moins un élément ou bande flexible (9).

7. Système de fixation de monopieu selon l'une quelconque des revendications 1 à 6, **caractérisé en ce que** le premier et/ou le deuxième montants verticalement debout (5', 6') sont mobiles l'un par rapport à l'autre.

8. Système de fixation de monopieu selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** les premier et deuxième montants verticalement debout (5', 6') sont pourvus d'au moins un bras d'écartement (15) pour assurer une distance prédéterminée entre les premier et deuxième montants verticalement debout (5', 6').

9. Système de fixation monopieu selon la revendication 8, **caractérisé en ce que** le bras d'écartement (15) a un élément choisi dans un groupe d'éléments comprenant une longueur réglable par des pièces intermédiaires (15'), une partie d'extension télescopiquement extensible (15''), plusieurs crochets de liaison (15''') à différents emplacements sur la longueur du bras d'écartement (15).

10. Système de fixation de monopieu selon l'une quelconque des revendications 7 à 9, **caractérisé en ce que** l'au moins un bras d'écartement (15) est monté de manière adjacente à la partie la plus basse de l'au moins un élément ou bande flexible (9).

11. Système de fixation de monopieu selon l'une quelconque des revendications 7 à 10, **caractérisé en ce que**, au niveau du sol, les premier et deuxième montants verticalement debout (5', 6') sont reliés entre eux par des bras de type harmonica (13, 14).

12. Système de fixation de monopieu selon l'une quelconque des revendications 1 à 11, **caractérisé en ce que** les montants verticalement debout (5', 6') sont collectivement mobiles en va-et-vient vers et depuis une grue (16) pour la manutention de monopieux (3).

13. Système de fixation de monopieu selon la revendication 12, **caractérisé en ce que** les montants verticalement debout (5', 6') sont montés et mobiles sur des rails (17).

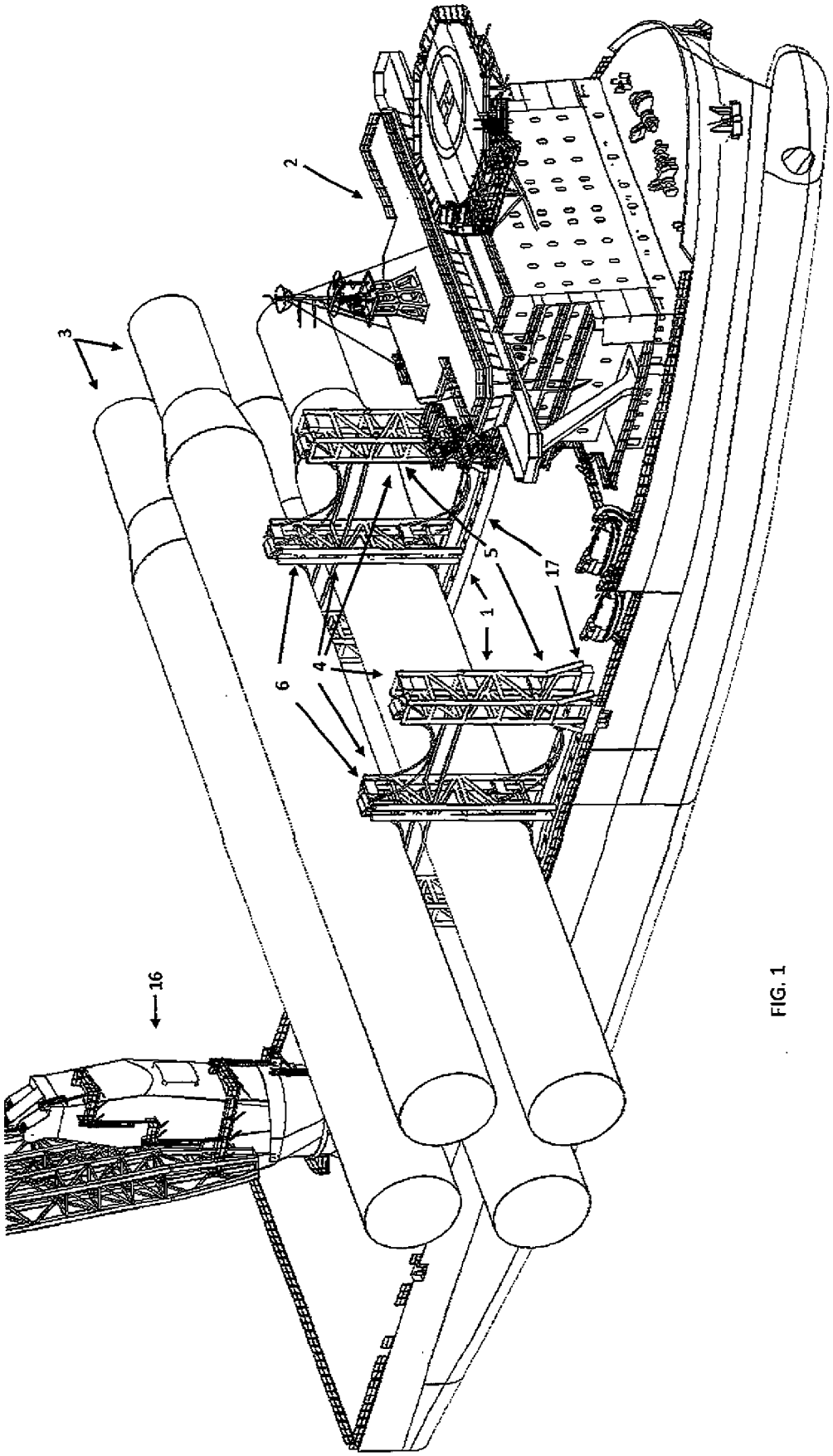


FIG. 1

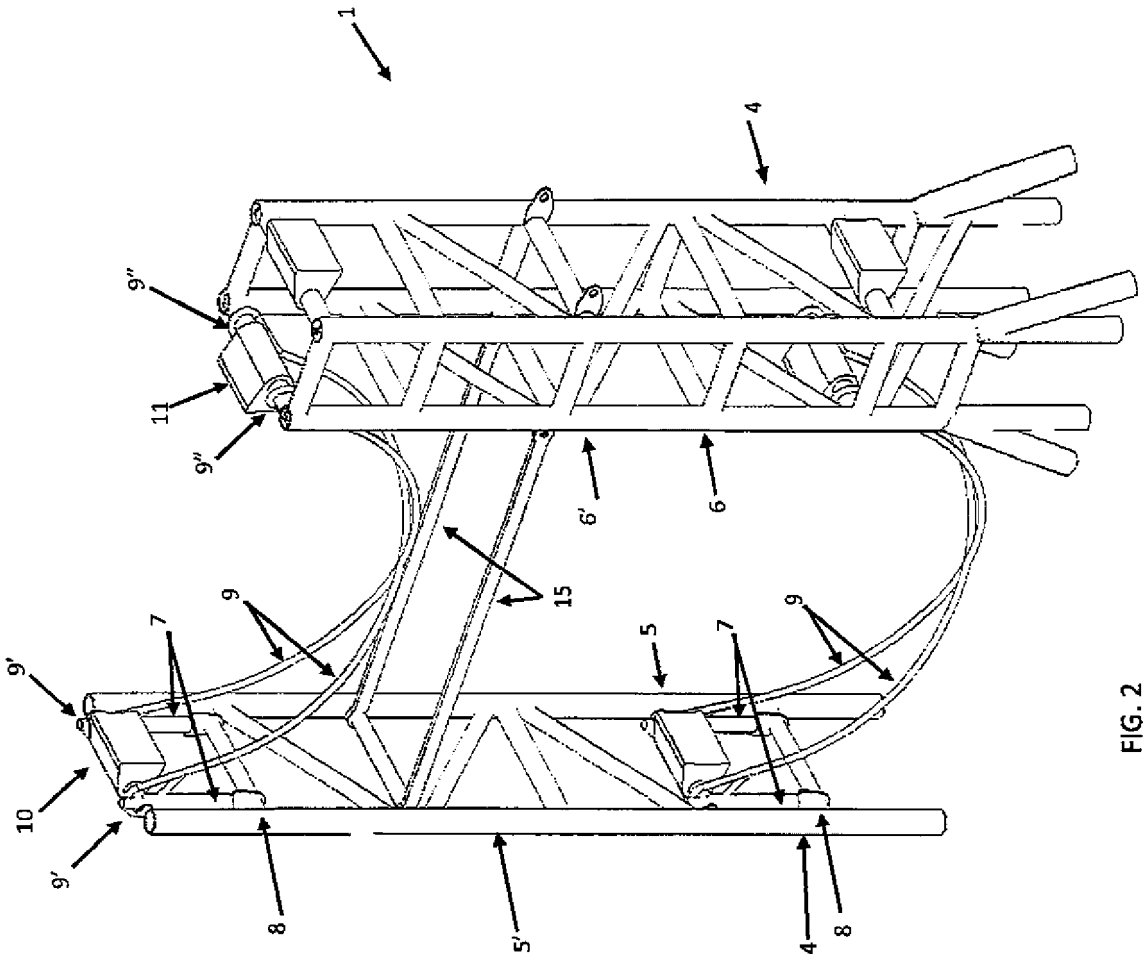


FIG. 2

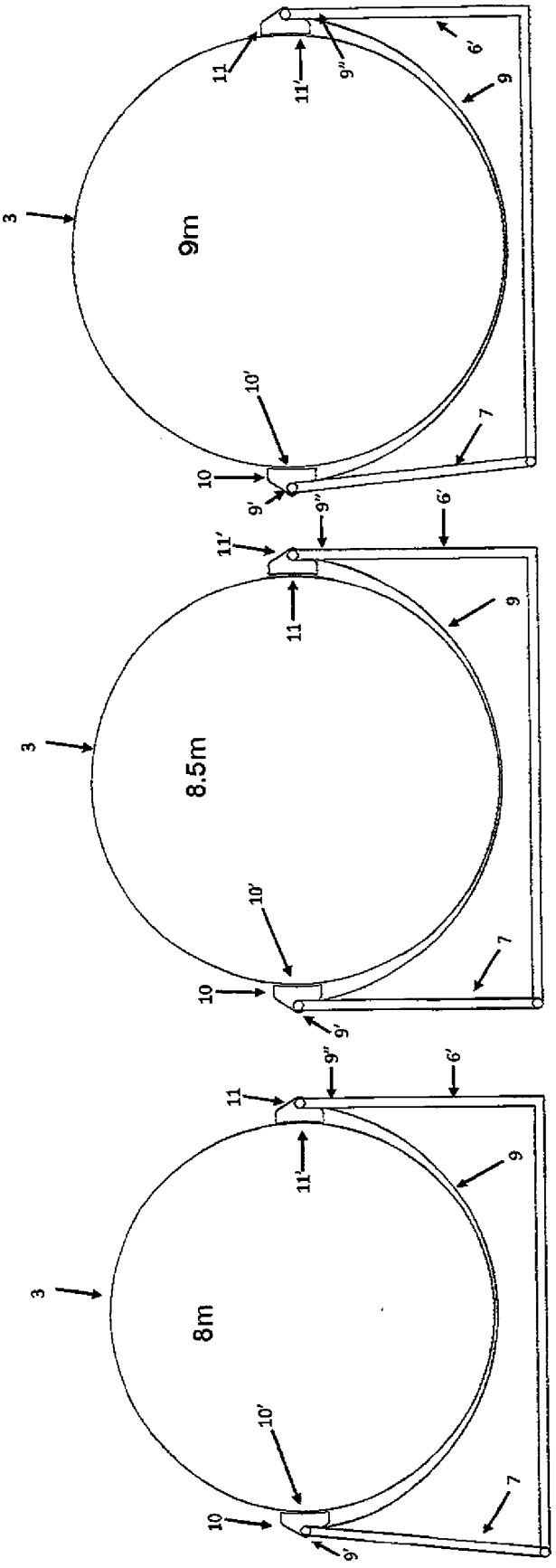


FIG. 3

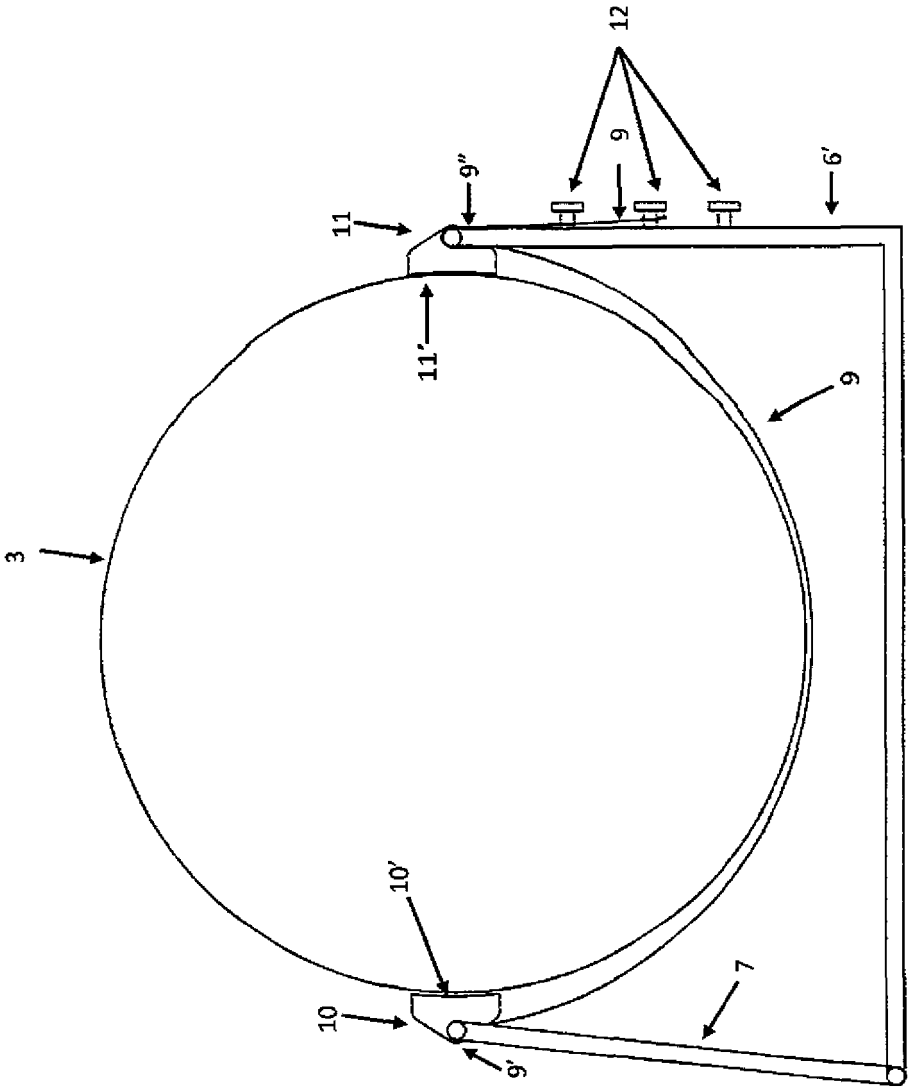


FIG. 4

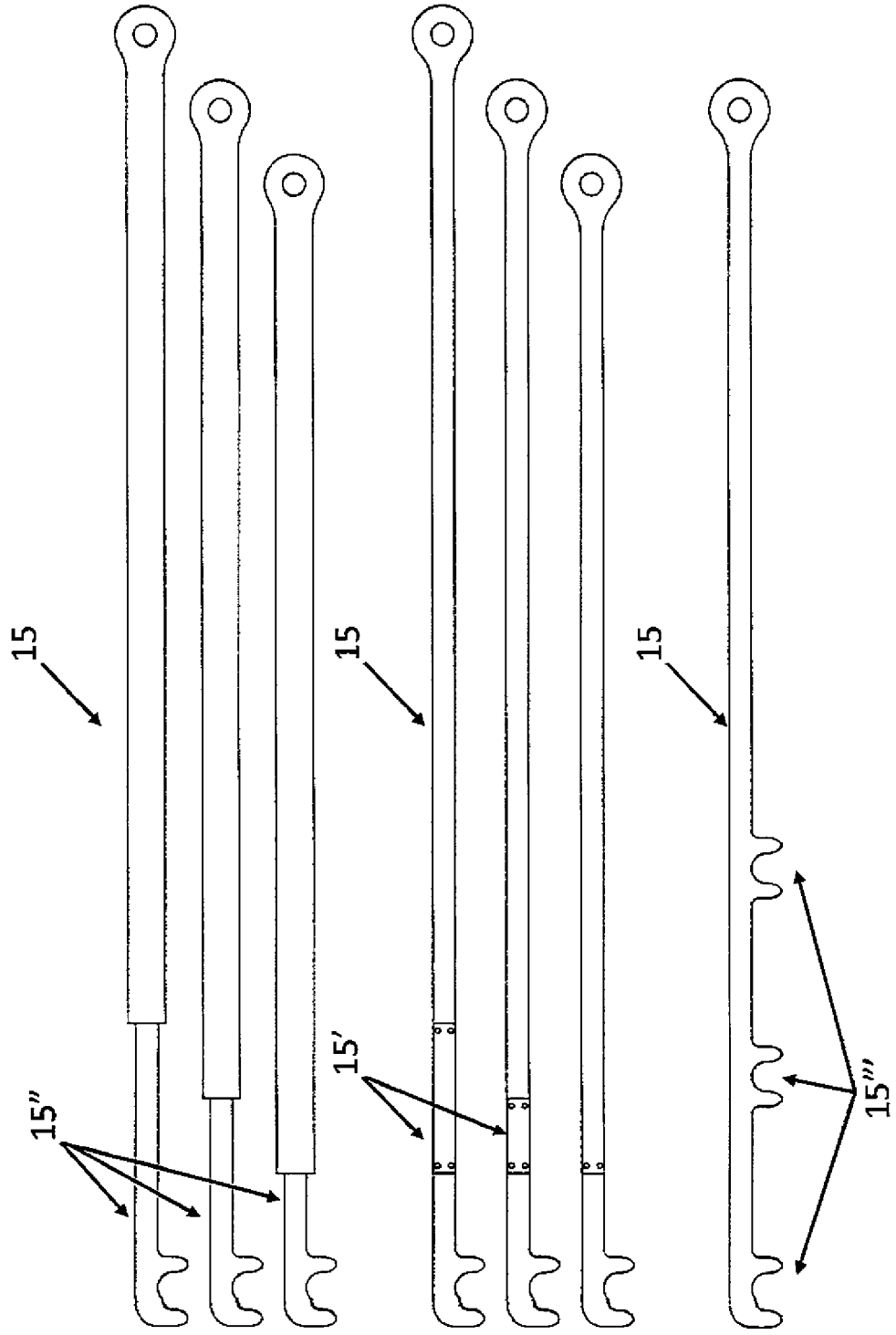


FIG. 5

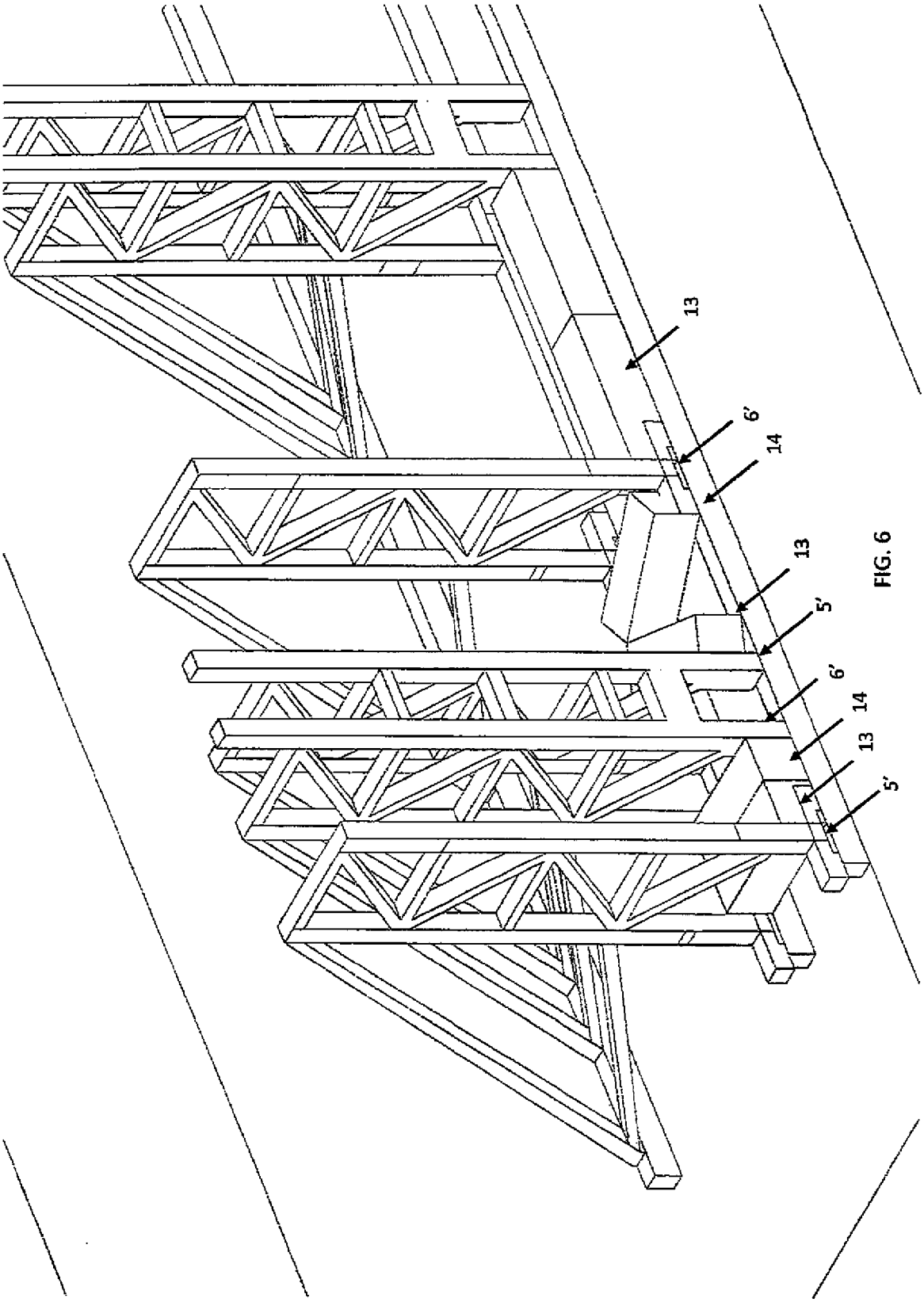


FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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