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

(11) **EP 2 695 844 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
**12.02.2014 Bulletin 2014/07**

(51) Int Cl.:
***B66C 23/28*** *(2006.01)* ***B66C 23/52*** *(2006.01)*

(21) Application number: **12006026.4**

(22) Date of filing: **23.08.2012**

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

(30) Priority: **09.08.2012 PL 40030412**

(71) Applicant: **PROTEA Sp. z o.o.**
**80/299 Gdañsk (PL)**

(72) Inventor: **Paszkiewicz, Tomasz**
**80-312 Gdañsk (PL)**

(74) Representative: **Passowicz, Marek**
**Kancelaria Patentowa**
**Ul. Mielzynskiego 27/29**
**P.O. Box 85**
**60-967 Poznan (PL)**

# (54) Mobile built-up folding crane

(57) Mobile built-up folding crane of modular construction contains at least one boom (1), rotary tower (2) with column (3) on foot (4) located on mobile foundation (5), lifting unit (6) connected with at least one top (7), wherein boom (1) is fitted out of boom modules (8) joined together by means of lifting units (9). Each boom module (8) is designed like framing construction composed of stringers (10) and bars (11) that connect them crosswise and, inclusively or exclusively, slantwise, wherein stringer (10) is composed of at least two parts. Modules of at least one boom (1) are dismantable into smaller and basically individual elements, which are mainly stringers (10) and bars (11). Each individual stringer (10) is fitted with at least two bosses (15) tipped with collars (16), wherein bosses (15) can be located at the ends or inside the stringer (10) length at right angle or acute angle in relation to the stringer, and single bar (11) is fitted at its ends with collars (16), wherein boss (15) and, inclusively or exclusively, collar (16) constitute element of linking unit (9).

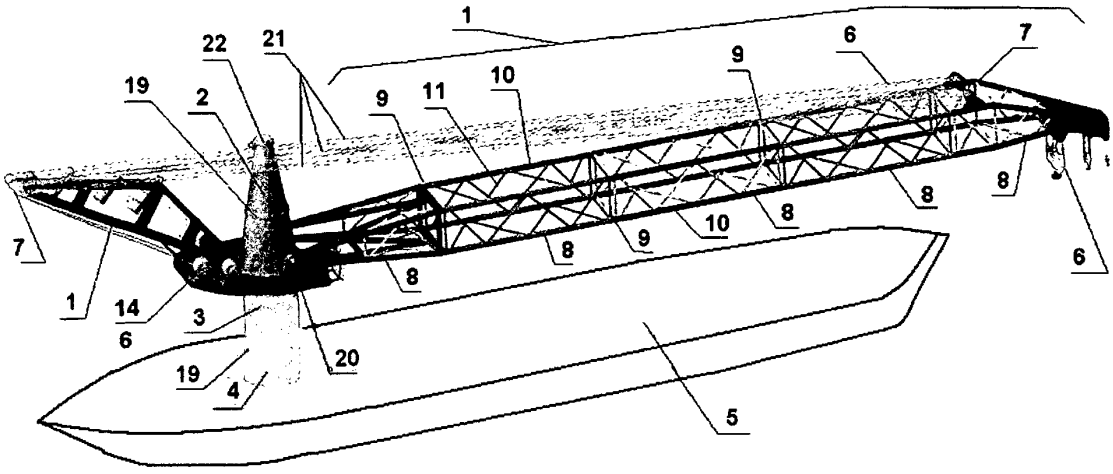


**Fig. 1**

EP 2 695 844 A1

## Description

**[0001]** The subject of this invention is a mobile built-up folding crane as a device to lift up the heaviest loads, even above 500 tons, which also means that it is used to lift up or transfer sizeable loads adequate to their weights.

**[0002]** It is know from generally available information that crane structures for such loads also require adequately large dimensions, and thereby above-average bending and torsional strength of the structure.

**[0003]** To ensure appropriate parameters, generally solid plate girder or section structures are used most often, and it is known that prefabricated elements are most often welded together in order to acquire appropriate size. This, in turn, creates essential inconvenience that consists in being unable to set up the structure but temporarily for the purposes of performing strength tests or checking up of standard operation of the device so that one could disassemble it, transport and set the structure up again at the place of destination.

**[0004]** Folding cranes are known that facilitate performing of final structure or transporting to the place of founding. Unfortunately, sizable hoist or crane structures need to be displaced to another target place of work as early as when being set up and operated on a standard basis. It is seldom possible, that there is no need to change the place of work.

**[0005]** For sizeable structures, displacement is often done by sea, river or road transport. It is inconvenient for structures already completed to be displaced under bridges, overhead railway lines or power lines.

**[0006]** From utility design PL63368 a folding crane is known with rotary mechanism of boom inclination change. In that crane, column and side plates combined permanently with the boom have holes distributed so that they enable placing it in two positions: working or transport one. It is possible when using a rotation pin inserted in these holes.

**[0007]** From application EP0408111, a structure of self-winching crane is known, which is set up in the form of U-shaped arm that rests through a pin on a support tower, preferably rotary one, on which or in which a winching mechanism with winching and lifting ropes is mounted. Angle range of arm rotation is up to 90 degrees vertically and up to 360 degrees horizontally, with the support tower height much lower than the arm range.

**[0008]** The structures presented eliminate the problem related to displacement of ready-made crane, however, they do not decide about the possibility of easy transportation prior to final setting up of final crane structure. In structures designed for hoisting above 500 tons, arm lowering itself seems to be insufficient because of considerable crane size.

**[0009]** From application US2008173605, a large lattice mobile crane is known, whose arms include modules joined together. The modules are composed of corner posts to which bars joining together the corner posts are mounted by means of flat fork and finger-like bosses. The bars hang on a pin that runs through the fork and finger-like bosses so that it is possible for them to rotate around it. The bars by means of a mounting with rotation capability enable folding of a simple latticed module structure, whereas adjacent latticed modules are joined together rigidly and separably through a pin located in each post end, which end is the flat fork and finger-like post bosses. The bars are preferably folded telescopically.

**[0010]** The structure enables transportation of the modules after folding and disconnecting them, however, it seems that the method of mounting together of elements that consists in inserting of the pin inside the flat fork and finger-like bosses is insufficient to ensure appropriate breaking strength or that of torsion of the module structure itself or among the modules during crane operation.

**[0011]** An almost identical structure is also known from application US2012031868, where an additional stiffening bar is added to reinforce the structure in its folded position. However, mutual mounting of the modules among themselves is still based on a single pin which hangs on flat bosses, and thus it does not provide sufficient protection from breaking and torsion forces as in the example above.

**[0012]** From application US2004238471, a tower crane of lattice construction is known, in which ready-made and unconvertible modules are connected with one another as previously by means of a pin located separably and rigidly in holes of flat module-end bosses. The pin is wedged by a cotter or a flat wedge that runs through the pin.

**[0013]** From application PCT/NL98/00313, a device for lifting up of big loads is known, which contains at least one lifting mast, a foot located on the bottom side and a lifting unit connected with at least one top, wherein the lifting device is fitted out of mast elements joined together by means of linking units, and each mast element is designed as framing construction composed of squares and bars that connect them crosswise. The squares are composed of two parts in the shape of a right-angled triangle, each one of different dimensions, that are supported by feet, where the linking units get inside the squares and are adjusted to that interior tightly and slidingly. Each linking unit as independent module contains two identical plate elements with filler placed between them, wherein at least two holes are made in the plate element, on its edge opposite the holes of the other plate elements, and these holes, after inserting of the linking unit inside the square, correspond axially to the holes on the square ends, and thereby adjacent elements of the mast are connected with each other with pins through the elements. The filler is preferably located between the plate element holes.

**[0014]** The presented solution assumes, however, that single element of the mast is made inseparably, and does not exceed dimensions of a typical container or matches

them accurately at best.

**[0015]** Therefore, the structure facilitates considerably neither transportation prior to installation nor displacement of ready-made, set-up, and operative form of the structure as device.

**[0016]** None of the mentioned structures, however, achieves both aspects of mobility to a sufficiently high degree, namely mobility prior to building up of the final structure, and possibility of displacing the already complete structure, wherein the degree of modular construction of the crane is considerable, and even if they did, they do not make it possible to set up such a modular construction allowing for its highest possible strength in built-up form during its operation, while obtaining the lightest possible form of such structure.

**[0017]** The objective of the solution according to an embodiment of the present invention is obtaining such a structure which will at the same time satisfy the need of structure mobility understood in two ways, namely, easy transportation of structure elements of a big crane to its place of destination irrespective of how long an in what condition the transport route is, while obtaining mobility of the set-up structure already as operative big crane. Another purpose is for the structure to have the highest possible breaking and torsion strength while maintaining possibly the lightest weight of masts in the form or arms. Attaining of the set objectives is particularly difficult for big cranes of lifting capacity above 500 tons, located on a mobile base, mostly afloat one, which nonetheless turned out to be feasible thanks to the present invention.

**[0018]** Mobile built-up folding crane of modular construction according to an embodiment of the present invention contains at least one boom, a rotary tower with column on a foot located on a mobile foundation, a lifting unit connected with at least one top, wherein the boom is fitted out of boom modules joined together by means of the linking units. Each boom module is designed as framing structure composed of stringers and cross-bars and, inclusively or exclusively, bars connecting them slantwise that reinforce the framing structure, wherein stringer is made up of at least two parts, and the linking units are tightly adjusted and contain filler and holes. The lifting unit is equipped with at least one winch with ropes. The mobile built-up folding crane is characterized by that the modules of at least one boom can be dismantled into smaller and basically individual elements, which are mainly stringers and bars. Each individual stringer is fitted with at least two bosses tipped with collars, wherein the collars may be located at the ends or inside the stringer length at right angle or acute angle in relation to the stringer, and single bar is fitted at its ends with collars, wherein the boss, and, inclusively or exclusively, the collar constitute an element of the linking unit, because the bars to not need to have bosses. Each collar has a cavity in which hard, rigid and solid filler resistant to shearing and torsional forces is tightly placed, and a stiffening linking unit, wherein envelope-like distributed holes in collars are adjusted axially against one another, creating together with the pins that run through them a collar and pin connection, preferably a collar and bolt one. The filler also fulfils a function of guiding the elements during their installation. The stringers and bars are hollow inside, which makes the structure light, wherein at least the stringers are made as a closed welded element of metal plates of limited resistance to plastic deformation of at least 690MPa. The other boom is located symmetrically against the main boom on the other side of the rotary tower in the shape of a cone or cylinder to whose base booms are fitted rotationally by means of pins. The booms are connected with each other by means of the lifting unit ropes supported on their tops. The tower cone enables the lifting unit ropes supported on the boom tops to run unimpeded next to the cone top when the booms are in their maximum horizontal and outreached position, and to easily reach their maximum vertical position when they are in that position, even though they are supported on the cone. The shape of the tower cone also makes it possible for the boom to be considerably close (retracted) towards rotation axis of the crane, which is much advisable in order to acquire maximum outreaches of the crane. Elements of the foot are preferably linked by means of the collar and bolt connection, and may contain filler inside for stiffening or guiding while assembling or ensuring tightness. Similarly, elements of the column are preferably linked by means of the collar and bolt connection, and may contain filler inside for the same purpose. Also, the elements of the tower are preferably linked by means of the collar and bolt connection that preferably contains filler inside. This type of connection allows disassembly of these elements and assembly in another place, which hasn't been done to date. The tower and, inclusively or exclusively, the foot, and, inclusively or exclusively, the column, and inclusively or exclusively, the bars, can also be made of metal plates of limited resistance to plastic deformation of at least 690MPa. The column on the foot, and, inclusively or exclusively, the tower on the column, and, inclusively or exclusively, the tower on the foot can be mounted rotationally by means of slide bearing, which allows considerable lowering of their structure. The lifting unit can be equipped with at least one pair of winches, from which pair winching ropes of the lifting unit are wound on one winch, and drawing ropes of the lifting unit are wound on the other winch. The number of winch pairs can be multiplied. Boom modules in cross-section may have the shape of a triangle or rectangle through the top of which stringers run. The bars can be placed against the stringers at a 90-degrees, and, inclusively or exclusively, 45-degrees, and, inclusively or exclusively, 30-degrees, and, inclusively or exclusively, 60-degrees angle or at another angle. Cross-section of the stringers may have the shape of a triangle or rectangle or pentagon or hexagon or octagon or circle, and can be preferably reinforced inside. The stringer can be made of metal plates in the shape of squares, preferably rectangular ones. The stringer can be made of metal plates in the shape of a channel, preferably rectangular one,

and at least one flat bar, or it can be made of two metal plates in the shape of channels. The stringer can be made of metal plates in the shape of flat bars. The stringer can be made of metal plates in the shape of channel ad T-bar. The stringer can be made of a greater number of metal plates in the shape T-bars and flat bars. There can be at least 3 envelope-like distributed holes in the collar connection, wherein this distribution is preferably envelope-like even. The conical tower is preferably significantly lower than the position of the top of any boom set in its maximum vertical position, and at most equal to the position of the higher placed top of any of the booms in their lower position. Any collar connection is tight, and the stringers and bars are closed, thereby the elements are not exposed to rusting and decay. Stringer side in cross-section can be of dimension at least 150mm, preferably at least 250mm, and at best at least 600mm. The bar in cross-section can be of dimension at least 150mm, preferably at least 200mm, and at best at least 250mm. The boom module in cross-section can be of dimension at least 1.5m, preferably at least 3m, and at best at least 4.5m. Previously stated dimensions are preferable to attain the objective for big built-up and folding cranes, and with this assumption from the point of view of strength and cost effectiveness. The boom module can be preferably 25m long at most, preferably less than 12.5m, and this in turn allows easy transportation and length accommodation to means of transport. Overall length of the boom is preferably greater than 50m, and at best greater than 100m, which decides about usefulness and range of the device. A mobile foundation can be that of a vessel deck or wheeled vehicle or rail vehicle, which in turn definitely allows attaining of the objective in any conditions.

**[0019]** The solution according to an embodiment of the present invention allows to repeatedly unfold and fold the booms to transport and working positions respectively, without the necessity of taking apart of the mobile crane into modular elements or basic elements. The structure according to an embodiment of the present invention also allows to take apart the mobile crane into basic elements and their road transport to another place of work in general. Lightness of the elements makes transportation and assembly easy. Dismantling to basic elements allows assembly at test site right next to production plant, and then, after completing trials/tests, to disassemble and assemble in identical form at the site of target installation, for instance at shipyard or port.

**[0020]** The solution according to an embodiment of the present invention is demonstrated in the example of implementation on a drawing on which figures shows:

Fig. 1 - the mobile built-up folding crane in the unfolded position,
Fig.2 - the mobile built-up folding crane in the position of maximum vertical inclination of the booms,
Fig. 3 - details of installing the booms to the tower,
Fig. 4 - detail of the boom with the boom module brought out,
Fig. 5 - details of the boom module, and
Fig. 6 - details of exemplary linking unit.

**[0021]** Exemplary mobile built-up folding crane of modular construction contains two booms 1, rotary tower 2 with column 3 on foot 4 located on mobile foundation 5, this being vessel deck, lifting unit 6 connected with two tops 7 of booms 1, wherein boom 1 is fitted out of boom modules 8 joined together by means of linking units 9. Each boom module 8 is designed like framing construction composed of stringers 10 and bars 11 that connect them crosswise and slantwise and reinforce the framing structure, wherein stringer 10 is composed of at least four parts, and linking units 9 are tightly adjusted and contain filler 12 and holes 13. Lifting unit 6 is equipped with four winches 14 with ropes. Modules of both booms 1 can me dismantled into smaller and basically individual elements. Smaller elements of the longer boom 1 are mainly stringers 10 and bars 11. Each individual stringer 10 is fitted with at least two bosses 15 tipped with collars 16, wherein bosses 15 are located at the ends and inside the stringer 10 length at right angle or acute angle in relation to the stringer, and single bar 11 is fitted at its ends with collars 16. Boss 15 and, inclusively or exclusively, collar 16 constitute element of linking unit 9, because bars 11 do not have bosses 15. Each collar 16 of stringer 10 has cavity 17 in which hard, rigid and solid filler 18 resistant to shearing and torsional forces is tightly placed, and linking unit 9 that stiffens and guides, wherein envelope-like distributed holes 13 in collars 16 are adjusted axially against one another, creating together with pins 20 that run through them collar and pin connection 19. Stringers 10 and bars 11 are hollow inside, which makes the structure light, wherein stringers 10 are made as closed welded element of metal plates of limited resistance to plastic deformation of at least 900MPa. The other boom 1 is located symmetrically against the main boom on the other side of rotary tower 2 in the shape of a cone, to whose base booms 1 are fitted rotationally by means of pins 20. Booms 1 are connected with each other by means of the lifting unit ropes supported on their tops. Tower cone 2 enables ropes 21 of lifting unit 6 supported on tops 7 of booms 1 to run unimpeded next to cone top 2 when the booms are in their lower position, and to easily reach their maximum vertical position close to 90 degrees when they are in that position, even though they are supported on the cone. Elements of foot 4 are linked by means of collar and bolt connection 19. Similarly, elements of column 3 are linked by means of collar and bolt connection 19. Also, elements of tower 2 are linked by means of collar and bolt connection 19. This type of connection allows disassembly of these elements and assembly in another place, which hasn't been done to date. Tower 2 and inclusively foot 4 and inclusively column 3 are also made of metal plates of limited resistance to plastic deformation equal to 1100MPa. Tower 2 on column 3 is mounted rotationally by means of slide bearing, which allows considerable lowering of their

structure. Lifting unit 6 is equipped with two pairs of winches 14, from which each pair winching ropes 21 of lifting unit 6 are wound on one winch 14, and drawing ropes 21 of lifting unit 6 are wound on the other winch 14. Boom modules 8 in cross-section have the shape of a rectangle through the top of which stringers 10 run. Some bars 11 are placed against stringers 10 at a 90-degrees, and other ones at 45-degrees angle. Cross-section of stringer 10 may have the shape of a rectangle and is reinforced inside. Stringer 10 is made of rectangular squares. Stringer 10 is reinforced with flat bar welded inside to the squares. There are 4 envelope-like distributed holes in the collar connection, wherein their distribution is envelope-like even. Conical tower 2 is significantly lower than the position of top 7 of any boom 1 set in its maximum vertical position, and at most equal to the position of the higher placed top 7 of any of booms 1 in their lower position. Boom collar connections are tight, and stringers 10 and bars 11 are closed, thereby the elements are not exposed to rusting and decay. Side of stringer 10 in cross-section is of dimension 600 mm. Bar 11 in cross-section is of dimension 300 mm. Boom module 8 in cross-section is of dimension 6 m and 8 m, and thereby creates a rectangle. Module of boom 8 is 24 m long. Overall length of boom 1 is greater than 100 m, which decides about usefulness and range of the device.

## Claims

1. A mobile built-up folding crane, of modular construction, containing at least one boom (1), rotary tower (2) with column (3), on foot (4) placed on mobile foundation (5), lifting unit (6) connected with at least one top (7), wherein the boom (1) is fitted out of boom modules (8) joined together by means of the linking unit (9), and each boom module (8) is designed like framing construction composed of stringers (10) and bars (11) that connect them crosswise and/or slantwise, wherein the stringer (10) is composed of at least two parts, and the linking units (9) are tightly adjusted and contain filler (18) and holes (13), whereas the lifting unit (6) is equipped with at least one winch (14), **characterized in that** modules of at least one boom (1) are dismantable into smaller and basically individual elements, which are mainly stringers (10) and bars (11), wherein each individual stringer (10) is fitted with at least two bosses (15) tipped with collars (16), and single bar (11) is fitted at its ends with collars (16), wherein boss (15) and/or collar (16) constitute element of linking unit (9), and each collar (16) has cavity (17), in which hard, rigid and solid filler (18) resistant to shearing and torsional forces is tightly placed, wherein envelope-like distributed holes (13) in collars (16) are adjusted axially against one another, creating together with pins (20) that run through them collar and pin connection (19'), preferably collar and bolt connection (19), whereas stringers (10) and bars (11) are hollow inside, wherein at least stringers (10) are made as a closed welded element of metal plates of limited resistance to plastic deformation of at least 690 MPa, whereas the other boom (1) is located symmetrically against main boom (1) on the other side of rotary tower (2) in the shape of a cone or cylinder, to whose base booms (1) are fitted rotationally by means of pins (20), booms (1) being connected with each other on their tops (7) by means of ropes (21) of lifting unit (6).

2. The mobile built-up folding crane according to claim 1, **characterised in that** elements of foot (4) are linked by means of collar and bolt connection (19), that preferably contains filler (18) inside.

3. The mobile built-up folding crane according to claim 1 or claim 2, **characterised in that** elements of column (3) are linked by means of collar and bolt connection (19), that preferably contains filler (18) inside.

4. The mobile built-up folding crane according to claim 1 or claim 2 or claim 3, **characterised in that** elements of tower (2) are linked by means of collar and bolt connection (19), that preferably contains filler (18) inside.

5. The mobile built-up folding crane according to any of claims 1 to 4, **characterised in that** tower (2) and/or foot (4) and/or column (3) and/or bars (11) are made of metal plates of limited resistance to plastic deformation of at least 690 Mpa

6. The mobile built-up folding crane according to any of claims 1 to 5, **characterised in that** column (3) on foot (4) and/or tower (2) on column (3) and or tower (2) on foot (4) is mounted rotationally by means of slide bearing

7. The mobile built-up folding crane according to any of claims 1 to 6, **characterised in that** lifting unit (6) is equipped with at least one pair of winches (14), from which pair winching ropes (21) of lifting unit (6) are wound on one winch (14), and drawing ropes (21) of lifting unit (6) are wound on the other winch (14)

8. The mobile built-up folding crane according to claim 7, **characterised in that** the number of winch (14) pairs is multiplied

9. The mobile built-up folding crane according to any of claims 1 to 8, **characterised in that** boom modules (8) in cross-section have the shape of a triangle or rectangle through the top of which stringers (10) run

**10.** The mobile built-up folding crane according to any of claims 1 to 9, **characterised in that** bars (11) placed against stringers (10) at a 90-degrees and/or 45-degrees and/or 30-degrees and/or 60-degrees angle.

**11.** The mobile built-up folding crane according to any of claims 1 to 10, **characterised in that** cross-section of the stringer (10) has the shape of a triangle or rectangle or pentagon or hexagon or octagon or circle, and preferably is reinforced inside

**12.** The mobile built-up folding crane according to any of claims 1 to 10, **characterised in that** stringer (10) is made of metal plates in the shape of squares, preferably rectangular ones

**13.** The mobile built-up folding crane according to any of claims 1 to 10, **characterised in that** stringer (10) is made of metal plates in the shape of a channel, preferably rectangular one, and at least one metal plate in the shape of one flat bar, or is made of two metal plates in the shape of channels

**14.** The mobile built-up folding crane according to any of claims 1 to 10, **characterised in that** stringer (10) is made of metal plates in the shape of flat bars

**15.** The mobile built-up folding crane according to any of claims 1 to 10, **characterised in that** stringer (10) is made of metal plates in the shape of channel and T-bar

**16.** The mobile built-up folding crane according to any of claims 1 to 10, **characterised in that** stringer (10) is made of several metal plates in the shape of T-bars and flat bars

**17.** The mobile built-up folding crane according to any of claims 1 to 16, **characterised in that** there are least 3 envelope-like spaced holes (13) in the collar connection, wherein their distribution is preferably even

**18.** The mobile built-up folding crane according to any of claims 1 to 17, **characterised in that** conical tower (2) is significantly lower than the position of top (7) of any boom (1) set in its maximum vertical position, and at most equal to the position of the higher placed top (7) of any of booms (1) in their lower position.

**19.** The mobile built-up folding crane according to any of claims 1 to 18, **characterised in that** any collar connection is tight, and stringers (10) and bars (11) are closed

**20.** The mobile built-up folding crane according to any of claims 1 to 19, **characterised in that** side of stringer (10) in cross-section is of dimension at least 150mm, preferably at least 250mm, and at best at least 600mm

**21.** The mobile built-up folding crane according to any of claims 1 to 20, **characterised in that** bar (11) in cross-section is of dimension at least 150mm, preferably at least 200mm, and at best at least 250mm

**22.** The mobile built-up folding crane according to any of claims 1 to 21, **characterised in that** boom module (8) in cross-section is of dimension at least 1.5 m, preferably at least 3mm, and at best at least 4.5m.

**23.** The mobile built-up folding crane according to any of claims 1 to 22, **characterised in that** boom module (8) in cross-section is 25m long at most, preferably less than 12.5m

**24.** The mobile built-up folding crane according to any of claims 1 to 23, **characterised in that** overall length of boom (1) is greater than 50 m, preferably greater than 100m

**25.** The mobile built-up folding crane according to any of claims 1 to 24, **characterised in that** mobile foundation (5) is that of a vessel deck or wheeled vehicle or rail vehicle

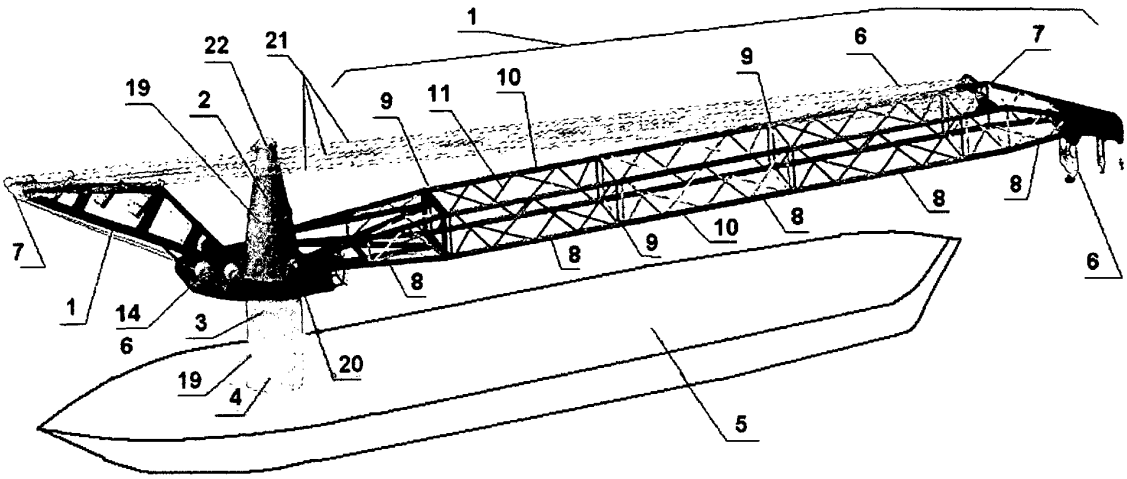
1
22
21
19
2
9
11
10
9
6
7
8
8
10
8
9
8
7
1
14
3
6
19
4
20
5
6

Fig. 1

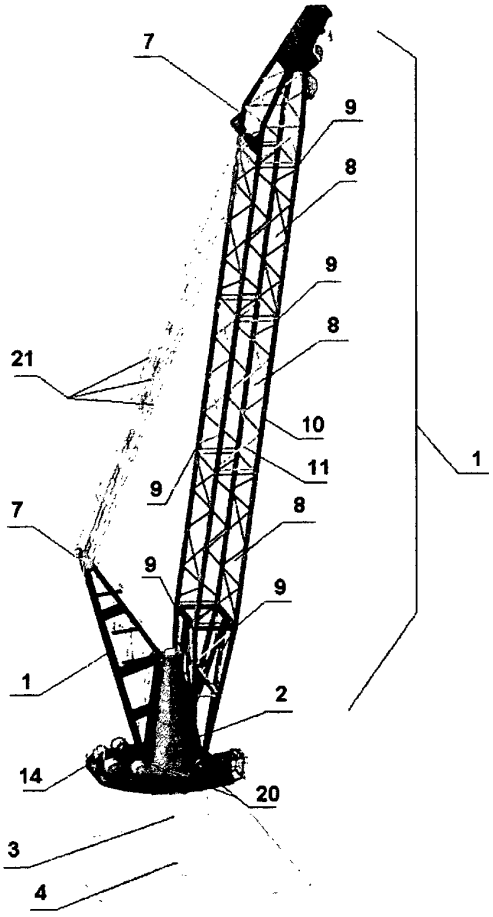
7
9
8
9
8
21
10
11
1
9
7
8
9
9
1
2
14
20
3
4

Fig. 2

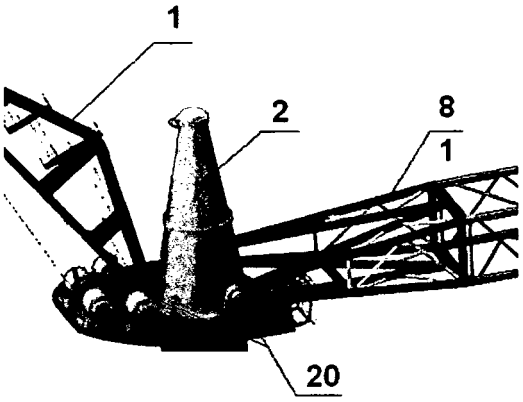


Fig. 3

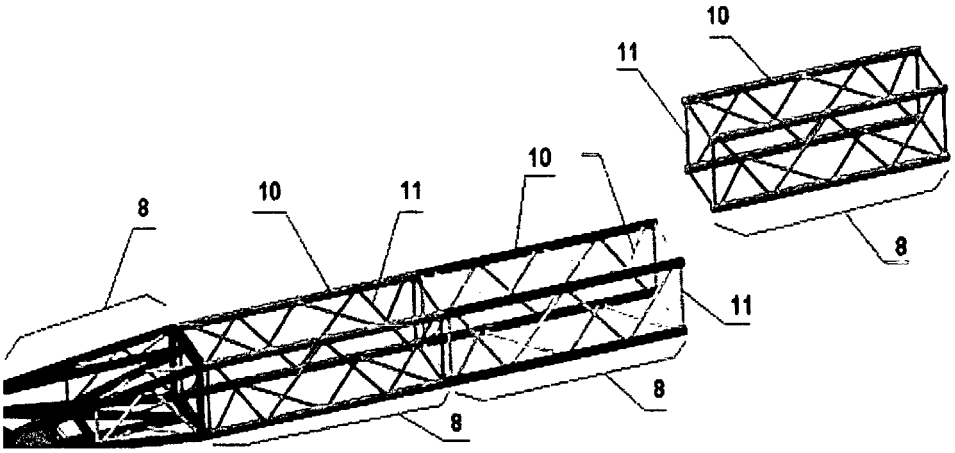


Fig. 4

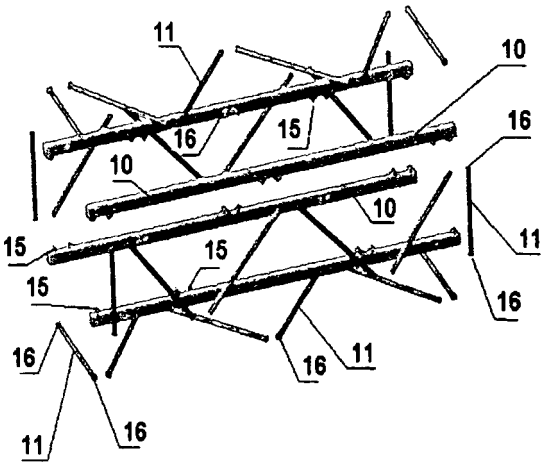
11
10
16
15
16
10
10
15
15
15
16
11
16
16
11
16
11

Fig. 5

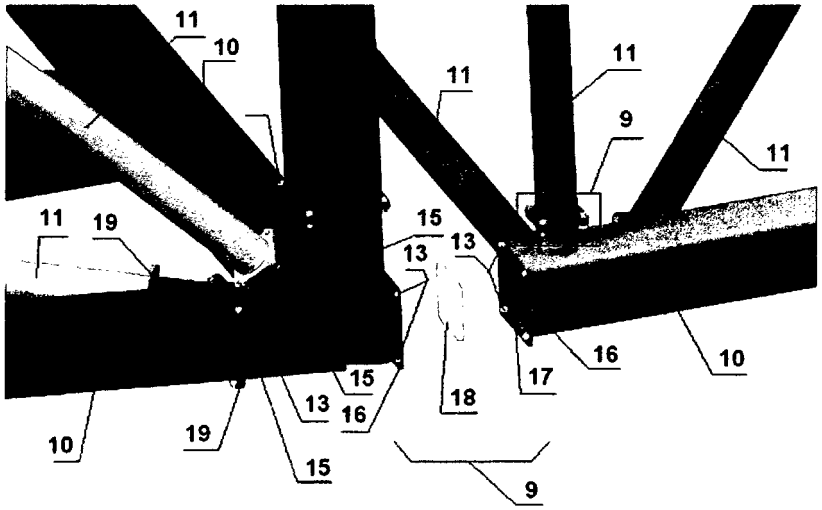
11
10
11
11
9
11
11
19
15
13
13
16
10
15
13
16
17
18
10
19
15
9

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

# EUROPEAN SEARCH REPORT

Application Number
EP 12 00 6026

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| A,D | EP 0 408 111 A1 (HUISMAN SPEC LIFTING EQUIP BV [NL])<br>16 January 1991 (1991-01-16)<br>* the whole document * | 1 | INV.<br>B66C23/28<br>B66C23/52 |
| A | CN 202 089 710 U (CHANGSHA ZOOMLION HEAVY IND) 28 December 2011 (2011-12-28)<br>* figures * | 1 | |
| A | NL 1 029 406 C2 (ITREC BV [NL])<br>4 January 2007 (2007-01-04)<br>* abstract; figures * | 1 | |
| A | EP 1 690 821 A1 (GROVE US LLC [US])<br>16 August 2006 (2006-08-16)<br>* abstract; figures 5, 7a,b * | 1 | |

TECHNICAL FIELDS SEARCHED (IPC)

B66C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 28 November 2013 | Verheul, Omiros |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 00 6026

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-11-2013

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| EP 0408111 A1 | 16-01-1991 | EP 0408111 A1 | 16-01-1991 |
| | | NL 8901815 A | 01-02-1991 |
| CN 202089710 U | 28-12-2011 | NONE | |
| NL 1029406 C2 | 04-01-2007 | NONE | |
| EP 1690821 A1 | 16-08-2006 | CA 2529415 A1 | 10-08-2006 |
| | | CN 1817778 A | 16-08-2006 |
| | | DE 102005006118 A1 | 24-08-2006 |
| | | EP 1690821 A1 | 16-08-2006 |
| | | ES 2317129 T3 | 16-04-2009 |
| | | JP 2006219301 A | 24-08-2006 |
| | | KR 20060090763 A | 16-08-2006 |
| | | US 2006226107 A1 | 12-10-2006 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## REFERENCES CITED IN THE DESCRIPTION

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

### Patent documents cited in the description


- PL 63368 **[0006]**
- EP 0408111 A **[0007]**
- US 2008173605 A **[0009]**
- US 2012031868 A **[0011]**
- US 2004238471 A **[0012]**
- NL 9800313 W **[0013]**