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

(11) EP 2 789 566 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.10.2014 Bulletin 2014/42

(51) Int Cl.:
B66C 23/00 *(2006.01)*

(21) Application number: **13163339.8**

(22) Date of filing: **11.04.2013**

(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

(71) Applicant: **HMF Group A/S**
8270 Hojbjerg (DK)

(72) Inventors:
- **Schmidt, Erling**
  8000 Aarhus C (DK)
- **Braendgaard, Gudmund**
  8660 Skanderborg (DK)

(74) Representative: **Pálsson, Ingólfur**
Chas. Hude A/S
Patent
H.C. Andersens Boulevard 33
1780 Copenhagen V (DK)

(54) **Foldable crane**

(57) A foldable crane assembly comprising a rotatably mounted post (2) having a proximal end and a distal end, a lift boom (3) having a proximal end and a distal end where the proximal end is pivotally connected to the post and the distal end comprises a bearing hub (25), an articulated boom (4) having a proximal end and a distal end where the proximal end comprises a forked coupling portion (16), where the forked coupling portion is pivotally connected to the bearing hub of the lift boom, where a first boundary of the lift boom abuts a second boundary of the articulated arm when the foldable crane is in its parked position, wherein in a second boundary of the lift boom comprises a receiving section (35) for receiving the proximal end of the articulated boom, when the articulated arm is pivoted into a position where the first boundary of the articulated arm faces the second boundary of the lift boom.

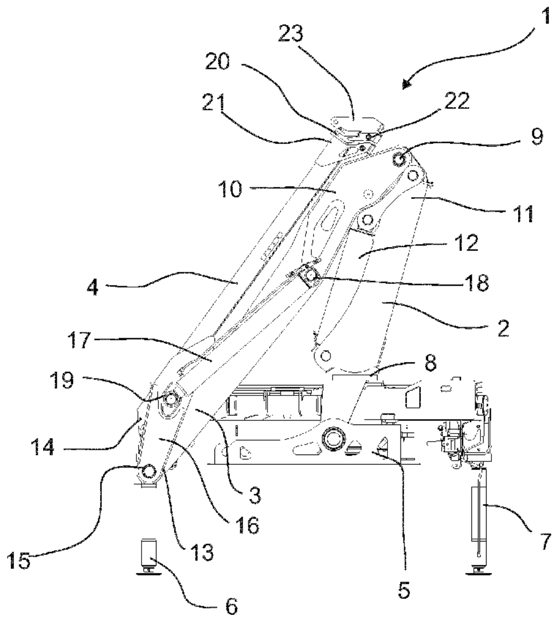

Fig.1

EP 2 789 566 A1

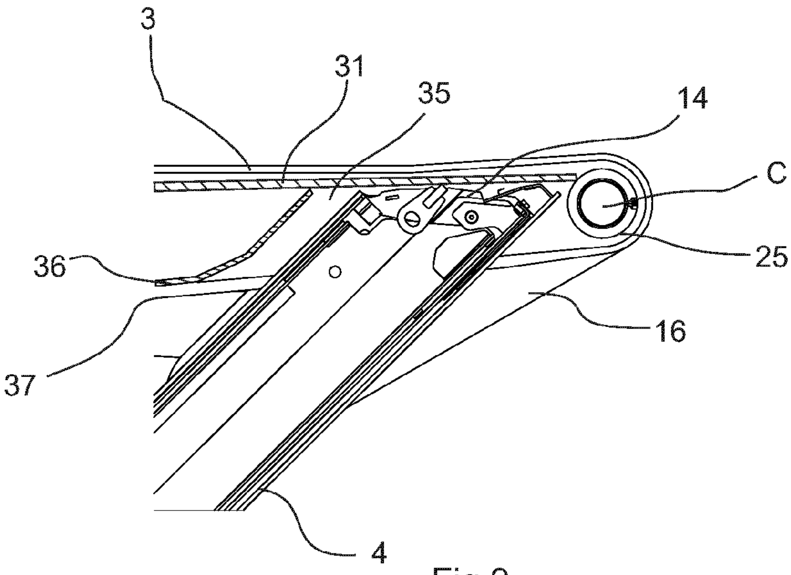

Fig.9

Description

[FIELD OF THE INVENTION]

[0001] A foldable crane assembly comprising a rotatably mounted post having a proximal end and a distal end, a lift boom having a proximal end and a distal end where the proximal end is pivotally connected to the post and the distal end comprises a bearing hub, an articulated boom having a proximal end and a distal end where the proximal end comprises a forked coupling portion, where the forked coupling portion is pivotally connected to the bearing hub of the lift boom, where a first boundary of the lift boom abuts a second boundary of the articulated arm when the foldable crane is in its parked position.

[BACKGROUND]

[0002] For cranes, that are mounted on vehicles, where the crane is mounted between the cab and a load carrier, there are specific size restrictions that have to be complied with, in order to make the crane fit and/or, if the crane and/or the vehicle in general is to comply with official regulation to be road legal. These size restrictions are often related to the size of the crane when the crane is in its parked position, i.e. when the crane is not in use, so that the crane does not exceed height, width and/or length requirements set by national traffic law which may be 2.55 m in width and approx.. 4 m in height, and may vary from one country to the other.. The standard dictates a number of different factors that relate to a vehicle mounted crane, where the size restrictions relate to the fact that the vehicle must be capable of travelling on roads that comprise bridges, tunnels, viaducts, etc. that have a limit towards height and/or width of the vehicle.

[0003] Thus, the height, width and/or length requirements of the crane in its parked position, are important factors on how the crane may be constructed, where the dimensions of the parked crane dictate or have an influence on the dimensions of the crane in its operating position, as it is important that the crane is capable of lifting heavy loads, while being able to extend considerably from the vehicle body.

[0004] Traditionally, this type of vehicle crane, that is mounted between a cab of a vehicle and a load carrier of the same vehicle, is an articulated crane, which does not extend significantly beyond the cab of the vehicle in its parked position, such as a loader crane, a.k.a. knucleboom crane or articulating crane, where the crane comprises a number of jointed sections that may be folded into a small space when the crane is not in use, i.e. in its parked position. For optimizing the small space, one or more of the jointed sections may be telescopic, in order to extend the length of the section when the crane is in use.

[0005] Vehicle mounted cranes, i.e. articulated cranes, may be constructed in different ways, where the operating position of the crane is similar or the same, in that the crane is unfolded in order to allow the different jointed sections of the crane to extend away from the crane. However, the cranes may differ considerably in their parked position, where one or more sections of the crane may be offset from each other, i.e. the sections are arranged side by side to each other, in a longitudinal axis of the vehicle, when the crane is in its parked position, and are not arranged in the same plane. This means that the crane may take up a significant space between the cab and a load carrier of a vehicle, which means that the size of the cab and/or the size of the load carrier have to be reduced in the longitudinal axis of the vehicle, to accommodate the crane.

[0006] A different type of articulated vehicle crane is a crane that may be folded so that the sections are a single plane, when the crane is in its parked position. I.e. the sections of the cane are arranged in such a way that the sections fold so that at least two of the sections abut each other, and may create a fold that resembles a Z. An example of this type of crane is disclosed in US 4,183,712. Such a crane is arranged in such a way that the crane in its parked position reduces the space requirements needed between the cab and the load carrier of a vehicle, compared to cranes having sections arranged side by side in their parked position.

[0007] A single-plane crane may comprise a post, a lifting boom and an extension arm that are connected by joints, where the extension arm may be telescopic to extend the reach of the crane. However, a common drawback to such cranes is that the size restrictions of the crane in its parked position dictates the maximum length of the cranes sections, i.e. the post, the lifting boom and the extension arm, and the reach of the crane in its operating position is predominately decided by the extended length of the extension arm when the telescoping arm is fully extended, as the each increased length in units of the extension arm when collapsed, may be multiplied when the telescoping arm is fully extended. I.e. an increased length of 10 cm in the collapsed position may be increased by approximately 40 cm, when there are 4 telescoping sections in the telescoping arm, as each telescoping section may be increased by a length of 10 cm.

[0008] Such a crane is disclosed in EP 1 770 050, where the crane comprises a crane support, a lift arm and an articulated telescopic arm, where the lift arm comprises a forked receiving section for the articulated arm. The articulated arm is adapted to receive a telescoping section close to or directly to the pivotal connection between the break arm and the hub arm, in order to increase the length of the articulated arm and therefore the length of the telescopic sections.

[0009] The drawback to the crane disclosed in EP 1 770 050 is that the pivotal connection, having a forked receiving section on the lift arm, limits the movement of the articulated arm, when the crane is moved into a lifting position that is close to the crane. This means that due to the angle of the forked receiving section and the positioning of the end of the lift arm, the end of the lift arm limits the movement of the passed a certain angle.

[0010] EP 1 475 345 discloses another type of single-plane crane, where the articulated arm is provided with a forked receiving section and a bearing hub on the lift arm is joined to the forked section of the articulated arm. Due to the construction of this crane, the shape and form of the lift arm and the fact that the forked section is located on the articulated arm, the proximal end of the articulated arm abuts the distal end of the lift arm when the crane is in a lifting position that is close to the crane. This abutment limits the angle of the lift, so in order to allow the articulated arm to come closer to the crane in its lifting position, the proximal end of the articulated arm has to be moved away from the pivotal connection.

[GENERAL DESCRIPTION]

[0011] In accordance with the invention, there is provided a foldable crane assembly comprising a rotatably mounted post having a proximal end and a distal end, a lift boom having a proximal end and a distal end where the proximal end is pivotally connected to the post and the distal end comprises a bearing hub, an articulated boom having a proximal end and a distal end where the proximal end comprises a forked coupling portion, where the forked coupling portion is pivotally connected to the bearing hub of the lift boom, where an first boundary of the lift boom abuts a second boundary of the articulated arm when the foldable crane is in its parked position, wherein in that a second boundary of the lift boom comprises a receiving section for receiving the proximal end of the articulated boom, when the articulated arm is pivoted into a position where the first boundary of the articulated arm faces the second boundary of the lift boom.

[0012] The provision of a receiving section, for receiving the proximal end of the articulated boom, the articulated boom may be pivoted closer to the lift boom when the articulated boom has been pivoted into a close lift position. The receiving section may be seen as an area of the lift boom where the structural elements of the lift boom have been removed, in order to allow the distal end of the articulated boom to traverse with the lift boom, without having structural elements of the lift boom to intersect the distal end of the articulated boom.

[0013] A conventional lift boom, having a bearing hub at its distal end, may prevent the articulated arm to pivot beyond a predefined degree, where the proximal end of the articulated arm intersects the distal end of the lift arm. Thus, in order to achieve a position of the articulated arm where the arm is pivoted into a close lift position, the proximal end of the articulated arm has to be spaced away from the pivot point between the lift arm and the articulated arm, in order to achieve a larger pivot angle.

[0014] The spacing between the proximal end of the articulated arm and the bearing hub, together with the size requirements of the crane in its parked position, means that the articulated arm must be shortened, so that the length of the arm does not exceed the size requirements. Thus, should the articulated arm be a telescopic arm, the decrease in length affects the telescopic length of the telescopic arm considerably. I.e. a decrease in length will be multiplied with the number of telescopic sections, e.g. a decrease in length of 200 mm will mean a shortened length of 800 mm in reach for a telescopic arm having 4 telescopic sections.

[0015] Thus, by allowing the articulated arm to extend close to or directly up to the bearing hub of the lift arm, the length of the articulated arm may be increased, and by having a receiving section on the lift arm, the articulated arm may be pivoted to a predefined angle that is considered to be sufficient for a close lift.

[0016] Within the meaning of the present invention, a single-plane crane is a crane having articulated sections that extend linearly from each other. I.e. each section is in direct continuation from the closest articulated section, and a two dimensional plane intersects each section at its substantial longitudinal central axis.

[0017] Within the meaning of the present invention, the articulated boom may be pivoted relative to the lift boom. The angles of the pivot may be defined as starting at 0 degree, where the articulated boom is in its parked position, and the articulated boom may be pivoted in a rotational movement away from the lift boom. The full pivotal extension of the booms may be seen as approximately plus/minus 180 degrees, and when the articulated boom pivots beyond 180 degrees, the articulated arm pivots in a direction towards the lift boom, at the opposite side from the parked position. Within the meaning of the present invention the starting position of 0 degrees may be relative to the parking position of the crane, and the actual starting position may be negative, ca. -2 degrees, in relations to the full pivotal extension of the booms.

[0018] Within the meaning of the present invention, the dimensions of crane sections, such as the post, the lift arm and the articulated arm may be seen as length, width and height. The length may be seen as the dimensions of the section along their longitudinal axis, the width may be seen as the dimensions along the horizontal axis and the height may be seen as the dimensions along the vertical axis. The longitudinal, horizontal and the vertical axis are orthogonal to each other in at least one, two dimensional planes that intersect at least two of the axis. The longitudinal, horizontal and the vertical axes may be seen as X, Y, Z axes in three-dimensional geometry.

[0019] In one embodiment the receiving section comprises a gap between a first side wall and a second side wall of the lift boom. The lift boom may be constructed of tubular section that extends along the longitudinal axis of the lift boom. The tubular section may comprise a first side wall and a second side wall, where the side walls define the width of the lift boom. The side walls of the lift boom may define the constructional element of the lift boom that gives the lift boom its structural integrity, in order to ensure that the lift boom is capable of supporting the articulated arm, during lifting. By providing the lift boom with a receiving section in the form of a gap between the side walls of the lift boom, the articulated arm may be pivoted into a position where the proximal end of the articulated arm accesses the gap between the side walls, and thereby intersects the outer dimensions of the lift arm. Thus, the gap in the lift arm, allows the articulated arm to pivot further than on conventional cranes, where the proximal end of the articulated arm would intersect the lift arm. This allows the articulated arm to be pivoted into a close lift position, even though the proximal end of the articulated arm is positioned close to or directly up to the bearing hub of the lift arm.

[0020] In one embodiment, the lift boom comprises a second boundary, and where the receiving section comprises a gap, where the gap is offset from the second boundary. The second boundary of the lift boom may be the bottom boundary of the lift boom, which defines the height of the lift boom, along with the first boundary of the lift boom. The second boundary may be a part of the tubular structure of the lift boom, where the second boundary extends in a longitudinal direction of the lift boom from substantially the proximal end to the distal end. The gap may be arranged as a discontinuation in the second boundary of the lift boom, where the second boundary does not extend fully towards the distal end of the lift boom. Alternatively, the receiving section, in form of a gap, may be arranged as a curve in the second boundary, where the second boundary curves inwards away from from lower periphery of the lift boom and towards the upper periphery of the lift boom, and thereby creating a gap that is close to the distal end of the lift boom, capable of accommodating the proximal end of the articulated arm when the articulated arm is pivoted into a close lift position.

[0021] In one embodiment the receiving section is arranged close to the distal end of the lift boom. When the articulated arm is pivoted into a close lift position, the proximal end of the articulated arm may move closer and closer to the lift boom. In order to allow the proximal end of the articulated arm to be positioned close to the bearing hub of the lift boom, the receiving section may be positioned close to the distal end of the lift boom, as the proximal end of the articulated boom may intersect that part of the lift boom fist. By arranging the receiving section in the area where the distal end of the articulated boom intersects the lift boom, it is ensured that the distal end of the articulated boom will pivot beyond the angle where the articulated boom would intersect the lift boom, as the receiving section accommodates the distal end of the articulated boom.

[0022] In one embodiment the width of the receiving section is larger than width of the articulated arm. The receiving section may be arranged on/in the lift boom as having a predetermined width, where the width of the receiving section is larger than the width of the articulated arm, in the area where the articulated arm traverses the lift boom and/or the receiving section. This means that when the articulated arm traverses the lift boom, the proximal end of the articulated arm is pivoted into the receiving section, where the receiving section may encapsulate the proximal end of the articulated arm. Thus, the articulated arm may intersect the lift boom, in order to pivot into its close lift position, and the proximal end of the articulated arm may be positioned close to or up to the bearing hub of the lift boom.

[0023] In one embodiment the lift boom comprises a U - or an I shaped profile, where the inner boundary of the side walls define the receiving section of the lift boom. The lift boom is constructed to have a high tolerance for twisting and bending, in that the lift arm must be able to transfer the weight of the items to be lifted to the post of the crane without collapsing or, bending or twisting. By forming the lift boom in the form of a U- or an I- shaped profile, the profiles will have a first and a second side wall, extending in the vertical direction and at least one horizontal wall extending in the horizontal direction. The horizontal wall may thus either be positioned at the top of the side walls, i.e. at their vertical peripheral edge, or substantially in the vertical centre of the side walls. Thus, the lift boom may have a gap between the side walls of the lift boom at the bottom peripheral edge of the side walls, allowing the receiving section to be positioned within the gap, and allowing the distal end of the articulated arm to pass past the bottom peripheral edge of the side walls of the lift boom.

[0024] In one embodiment the articulated arm comprises a tubular section capable of receiving a telescopic section. The articulated arm may be formed in such a way, that the inner volume of the arm may be substantially hollow, from the proximal end and towards the distal end, and where the distal end is open. This means that at least one telescopic section may be positioned into the inner volume of the articulated arm, allowing the articulated arm to be extended during lifting operation. The articulated arm may be capable of receiving a plurality of telescopic sections that are extensible or compressible by or as if by the sliding of overlapping telescopic section. This allows the articulated arm to be relatively small in its parked position, but where the arm is capable of extending a multiplication of its collapsed length. By allowing the proximal end of the articulated arm to extend closed to or up to the bearing hub, the length of the articulated arm may be increased, compared to conventional cranes, and the increased length of the articulated arm may result in an equal increase of length of each telescopic section, allowing the articulated arm to extend further than conventional cranes.

[0025] In one embodiment the positioning of the post, the lift boom and the articulated boom in relation to each other is substantially in the form of a Z-shape, when the crane is in its parked position. This means that the crane is a single-plane foldable crane that allows the articulated arm to abut the lift boom in its parked position, and where the articulated arm pivots past approximately 180 degrees to come into its working position. The articulated arm and the post of the crane define the free ends of the Z-shape, while the lift boom connects the opposite ends of the articulated arm and the post to form the Z shape. The Z-shape fold of the crane, allows the length of the articulated arm to extend substantially the length of the lift boom, and allows the crane to be designed so that the crane does not take up extensive space between the cab and the load carrier of the vehicle. Thus, the vehicle may either have a larger cab, a larger load carrier or additional equipment, compared to a conventional crane having the lift boom and the articulated boom offset from each other in the horizontal direction.

[0026] In one embodiment the proximal end of the articulated arm is positioned between 0, 1 and 250 mm from the bearing hub of the lift arm, or specifically between 1 and 150 mm from the bearing hub of the lift arm, or more specifically between 1, 5 and 100 mm from the bearing hub of the lift arm, or more specifically between 2 and 50 mm from the bearing hub of the lift arm. By positioning the proximal end of the articulated arm as close as possible to the bearing hub, it is possible to increase the length of the articulated boom, and thereby increasing the telescopic length of the articulated arm, when the arm is arranged with telescopic sections. As bearing hub of the lift boom provides the pivoting point of the crane, it may be preferred to ensure that the distal end of the articulated arm is not completely extended towards the bearing hub, but leaving a small space between the two. This may be advantageous, as this allows dirt and contamination to come in between the two parts, without risking the breakdown of the pivotal connection, or unwanted stress to the connection, should some contamination be positioned in between the sections. This may be an issue, as the cranes are often used in terrains and areas where debris and other contaminants could affect the connection, such as when the crane is used for lifting lumber, recycling material, etc.

[0027] The proximal end may also be the proximal end of the first telescopic section, and does not necessarily have to be the articulated arm. Talk about the support surface of the telescopic section that allows the telescopic section to have enough force not to pivot when extended.

[0028] Conventional cranes, that are provided with a forked coupling portion on the articulated arm have the proximal end of the articulated arm positioned at a distance from the bearing hub of the lift arm, as the space between the bearing hub and the proximal end of the lift arm allow the articulated arm to be pivoted in the close lift position. Thus, a conventional crane having a small distance between the bearing hub and the proximal end of the articulated arm, will have a reduced pivoting capability, as the distal end abuts the lift boom and prevents the articulated arm from pivoting further.

[0029] In one embodiment, the crane comprises an articulation cylinder operating between the post and the lift boom. The articulation cylinder may be attached at one end onto the post and the other end at the lift boom, so that the movement of the articulation cylinder are translated into pivotal movement of the lift boom, in relation to the post. The articulation cylinder may be attached to the post and the lift boom in such a way that the distance from the attachment point on the post to the pivotal connection is larger than the distance from the attachment point on the lift boom to the pivotal connection.

[0030] In one embodiment, the crane comprises at least one articulation cylinder operating between the lift boom and the articulation arm where the at least one articulation cylinder is attached to a peripheral area of the lift boom and the articulation arm. The articulation cylinder between the lift boom and the articulation arm is adapted to provide pivotal movement of the articulated arm in relation to the lift arm. The articulation cylinder may be attached to the lift boom and the articulation arm at attachment points that are arranged on the sides of the lift boom and the articulation arm. This means that the articulation cylinder is offset from the pivoting plane of the lift boom and the articulation arm, so that the pivoting movement of the articulation arm does not intersect the articulation cylinder. In a preferred embodiment, the crane may comprise two articulation cylinders operating between the lift boom and the articulation arm, where the articulation cylinders are positioned on opposite sides of the lift boom and the articulation arm.

[0031] In one embodiment, the articulation arm and/or the forked coupling portion comprise a coupling element for attaching at least one articulation cylinder to the articulated boom. The coupling element may be attached to the outer surface of the articulation arm and/or the forked receiving section, so that the coupling element does not intersect or translate into the inner volume of the articulated arm. I.e. the coupling element may be arranged on the outer surface of the articulated arm or the forked coupling portion, so that the coupling element does not interfere with the volume to which the articulation arm may receive a telescopic section. This ensures that a telescopic section may extend along the entire longitudinal axis of the articulation arm, ensuring that the length of the telescopic section may be directly proportional to the length of the articulation arm, and does not depend on where an articulation cylinder is coupled to the articulation arm.

[0032] In one embodiment, a spacing element is positioned between the forked coupling section and the articulation arm and creating a separation between the forked receiving section and the articulation arm. The forked coupling section may be positioned so that the coupling section is offset in the horizontal direction relative to the lift boom. I.e. the forked coupling section is coupled to lift boom on the side of the bearing hub of the lift boom. The forked coupling section may be connected to the sides of the articulated arm, so that that the central axis of the articulated arm is on the same plane as the central axis of the lift boom. However, the receiving section of the lift boom may be formed in such a way that tit is advantageous to have the width dimensions of the articulation arm smaller than the lift boom. Thus, by placing spacing elements between the articulation arm and the forked coupling section, the forked coupling section may be displaced sideways in such a manner that the inner width dimensions of the forked coupling section is equal to or larger than the outer dimensions of the bearing hub.

[0033] In alternative embodiments, the forked coupling section may be curved inwardly in the direction from the bearing hub and towards the articulation arm, in order to allow the articulation arm to have a smaller dimension in the width direction, than the receiving section of the lift boom.

[0034] Yet in a further embodiment, the part of the lift boom comprising the receiving section may have a reduced height of the side walls, in order to allow the proximal end of the articulation arm to manoeuvre into the receiving section where the articulation arm has a width that is equal to or larger than the dimensions of the lift boom. Thus, the part of the lift boom that interacts with the articulation arm may be cut away or removed from the lift arm, i.e. that the side walls of the lift boom and/or receiving section is provided with a cut-out or a depression to accommodate the proximal end of the articulation arm.

[0035] In one embodiment, the width of the spacing element is equal or larger than a width of a side wall of the lift boom. The spacing element may be dimensioned to ensure that when the articulated arm is pivoted into a close lift position, the side wall of the lift boom can interpose between a side wall of the articulated arm and the forked coupling section. This means that when the articulated arm is in a close lift position, at least the proximal end of the articulated arm can manoeuvre past the dimensions of the side wall and be received into the receiving section of the lift boom. Thus, a sectional view of the crane, taken across the receiving section, will reveal a structural sequence seen from the outside and in where the forked receiving section abuts the side wall of the lift boom which in turn abuts the side wall of the articulated arm.

[0036] In one embodiment, the articulation arm is positioned between an inner surface of a first and a second side wall of the lift boom when the crane is in its parked position.

[0037] In one embodiment of the present invention, the proximal end of the articulation arm may have an opening into the inner volume of the articulation arm, allowing a proximal end of the telescopic arm to extend beyond the proximal end of the articulation arm in a direction towards the bearing hub. By having an open proximal end of the articulation arm, the telescopic arm may be telescoped into its compacted position, and where the telescopic arm may be maneuvered so that the proximal end of the telescopic arm extends from the inner volume of the articulation arm and beyond the proximal end of the articulation arm. This allows the telescopic arm to have a length that may be greater than the articulated arm, and to be telescoped more than if the articulated arm has a closed end that provides a stop for the proximal end of the telescopic arm.

[0038] A foldable crane in accordance with the invention is particularly useful for waste management and logging, where the crane is used to collect debris, timber and similar items for loading and unloading to a load carrier. Thus, it may be important for the foldable crane to be fully assembled when parked, where the grappler is attached to the crane. Due to the fact that a vehicle having a vehicle mounted crane has maximum width and height dimensions in order to have the vehicle road legal, the size, shape and positioning of the grappler when the crane is parked is a major issue. The official size restrictions of a vehicle are mainly defined as height and width restrictions, so a mounted crane must not exceed the maximum height nor the maximum width of the vehicle, and the positioning of the grappler is no exception and the grappler must not exceed the size restrictions. Thus, the size restrictions of a vehicle may be viewed as a 2 dimensional plane having a maximum width and a maximum height, where the 2 dimensional plane is at a right angle (orthogonal) to the longitudinal axis of the vehicle. Furthermore, it may be advantageous for a foldable crane in its parked position to be of a length (in the longitudinal direction of the vehicle) that meets, corresponds to the space between the cab of a vehicle and a load carrier, so that a foldable crane can be installed to a vehicle without having to modify the positioning of the cab or the load carrier.

[0039] Thus, the maximum size and shape of the grappler is dictated on how effectively the foldable crane may be compacted in its parked position within the dimensions of the 2 dimensional plane defining the size restrictions.

[0040] In one embodiment of the present invention, the lift arm may comprise a profile of an I (H) beam, where lift arm may comprise a first side wall, a second side wall and a connecting part orthogonal to the first and/or the second side wall that interconnects the side walls to the connecting part. The connecting part may be positioned at a distance between the upper edges and the lower edges of the side walls. The lift arm may be constructed in such a way that the inner dimensions between the side walls are equal to or larger than the outer width dimensions of the articulated arm, so that the articulated arm may be fully or/partially introduced between the side walls when the crane is in its parked position.

[0041] Thus, the profile of the abutting lift arm and the articulation arm in parked position may be smaller than the outer radial dimensions of the lift arm and the articulation arm combined. I.e. if the radial dimensions of the lift arm is 400 mm and the radial dimensions of the articulation arm is 300 mm, the combined dimensions of the parked lift arm and articulation arm may be less than 700 mm due to the fact that the articulated arm may be inlayed into the I (H) profile of the lift arm.

[BRIEF DESCRIPTION OF DRAWINGS]

[0042] The invention is explained in detail below with reference to the drawings, in which

Fig. 1 shows a crane assembly in accordance with the invention, where the crane is mounted on a base,

Fig. 2 shows a lift boom and an articulation arm in its parked position,

Fig. 3 shows the same in perspective,

Fig.4 shows an exploded view of the same,

Fig. 5 shows the same in a lift position,

Fig. 6 shows the same in a close lift position,

Fig. 7 shows a sectional view of the pivotal connection between the lift boom and the articulation arm in its parked position,

Fig. 8 shows a sectional view of the lift arm and the articulation arm in a lift position, and

Fig. 9 shows a sectional view of the same in a close lift position,

Fig 10, shows a top view of the articulation between the lift arm and the articulation arm, and

Fig. 11 shows the 2 dimensional size restrictions of a foldable crane in accordance with the invention.

[DETAILED DESCRIPTION OF DRAWINGS]

[0043] Fig. 1 shows a crane assembly 1 in its parked position, where the crane assembly 1 comprises a post 2, and a lift boom 3 and an articulation arm 4 that are pivotally connected. The post 2 is connected to base 5, where the base 5 may comprise stabilisation legs 6, 7, and is adapted to be attached to a vehicle (not shown), and may be positioned on the vehicle between a cab and a load carrier. The post 2 may be rotatably connected to the base 5, via a rotational connection 8 that allows the post 2 to rotate along a horizontal plane.

[0044] A proximal end 10 of the lift boom 3 is connected to the distal end 11 of the post 2 across a pivotal connection 9, that allows the lift boom 3 to be pivoted, relative to the post in order maneuver the lift boom 3 in a direction away from the post 2, in order to position the lift boom 2 into a lift position of the crane assembly. A lift cylinder 12 may be connected between the post 2 to the lift boom 3, as an actuator of the pivotal movement between the post 2 and the lift arm. When the lift cylinder is extended, from the a contracted parked position, the lift arm will pivot across the pivotal connection 9, and the distal end 13 of the lift boom will move vertically away from its parked position and in a direction away from the ground.

[0045] The distal end 13 of the lift boom may pivotally connect 15 to the proximal end 14 of the articulation arm 4, via a forked coupling portion 16, that is attached to the articulation arm 4. The pivotal connection 15 between the lift boom 3 and the articulation arm 4, allows the articulation arm 3 to pivot from its parked position, where the articulation arm 4 abuts the lift boom 3, and is positioned substantially in a parallel position to the lift boom 3, and into its extended position (as shown in Fig. 5) and onwards to its close lift position (as shown in Fig. 6).

[0046] The pivoting movement of the articulation arm 4 relative to the lift boom 3 may be actuated by an articulation cylinder 17 that extends from the lift boom 3 side of the pivotal connection 15 to the articulation arm side of the pivotal connection. In a preferred embodiment, as shown in this embodiment, the distance from the pivotal connection 15 and an attachment point 18 of the articulation cylinder on the lift arm 3, may be larger than the distance from the pivotal connection 15 to an attachment point 19 of the articulation cylinder on the articulation arm 4. The attachment points 18, 19 of the articulation cylinder 17 may advantageously be positioned on the sides of the lift boom 3 and/or the articulation arm 4. Furthermore, the attachment points 18, 19 may be attached to the lift boom 3 and/or the articulation arm 4 in such a manner that the attachment points extend from the side walls of the lift boom 3 or the articulation arm 4 without penetrating an inner volume of the arm 4 or the boom 3. The attachment point 19 on the articulation arm 4 may advantageously be positioned on the forked coupling portion 16.

[0047] The articulation arm 3 may advantageously be provided as telescopic, so that at least one telescopic arm 22 may extend from an opening 20 in the distal end 21 of the articulated arm. The distal end 23 of the telescopic arm 22 may be provided with connection means, for connecting the telescopic arm 22 to the object to be lifted, or an intermediate lifting means for assisting in the lifting operation, such as a grappling hook, a hook, or similar constructions known in the art.

[0048] Fig. 2 shows a side view of a lift boom 3 and an articulation arm 4, in their parked position. The longitudinal axis A of the articulation arm 4 and the longitudinal axis B of the lift boom 4 may be substantially parallel when parked, so that the sections (arm and boom) 3, 4 take up as little space as possible. The angle between the longitudinal axis A, B of the articulation arm 4 and the lift boom 3, respectively, is approximately 0°, when the assembly is in its parked position.

[0049] As mentioned earlier, there are specific requirements to the dimensions of the crane that must be met, in order to ensure that the crane is deemed road legal by the national motor vehicle authorities. These requirements state a maximum height and a maximum width of a crane, when the crane is in its parked position. As may be seen in Fig. 1, the lift boom 3 and the articulation arm extend diagonally from the left to right, and bottom to top, so that the distal end 13 of the lift boom and the proximal end 14 of the articulation boom define one end of the maximum width of the crane assembly 1 and the distal end of the articulation boom 21 or the distal end of the telescopic boom 23 define the maximum height of the crane assembly 1. Thus, in order to maximize the length of the articulation arm 4, in order to maximize the telescopic length of the articulation arm, it is advantageous to allow the articulation arm along with the telescopic arm 22 to extend from the maximum width definition to the maximum height allowed.

[0050] Fig 2 shows that the proximal end 14 of the articulation arm 3 is cut at an angle α from the vertical seen in this view, where the angle of the distal end is substantially vertical as seen in Fig. 1, when the crane assembly is in its parked position. Thus, by arranging the distal end at a predefined angle a, it is ensured that the distal end of the articulation arm has a substantially vertical disposition when the crane is in its parked position, and that no part of the proximal end 14 protrudes outside the maximum width limitation of the crane assembly. A similar consideration is done with the distal end 23 of the telescopic arm 22, in that the angle of the distal end 23 corresponds to the horizontal when the crane assembly is in its parked position, as shown in Fig. 1.

[0051] The proximal end 10 of the lift boom 3 may be provided with a second forked coupling portion 24, that is adapted to couple the proximal end of the lift boom to a bearing hub (not shown) on the post 2.

[0052] Fig. 3 shows a perspective view of the assembly shown in Fig. 2. The distal end 13 of the lift boom 3 comprises a bearing hub 25 that defines the rotational axis of the pivotal connection 9, between the lift boom 3 and the articulation arm 4. The forked coupling portion 16, 16' of the articulating arm 4 abuts the rotational axis of the bearing hub 25, and an axle 26 extends from on forked coupling portion 16 to the opposite coupling portion 16', holding the articulated arm 4 in a pivotal connection 9 with the lift boom 3. Furthermore, the articulated arm 4 may be open 28 in the proximal end 14 in order to allow a proximal end 27 of the telescopic arm 22 that is positioned within the articulated arm 4 to extend completely towards the peripheral edges of the opening 28, in the longitudinal direction.

[0053] Fig. 4 shows an exploded view of the lift boom 3 and the articulated arm 4, where the distal end of the lift boom 3 has a bearing hub 25, and the proximal end 14 of the articulated arm 4, comprises a forked coupling portion 16, 16' attached to the sides of the articulated arm. The forked coupling portion 16, 16' comprises openings 28 that are located near to the proximal end of the forked coupling portion 16, 16' and the openings are adapted to be arranged around the sides of the bearing hub 25, across the rotational axis C, to provide a pivotal connection when the lift boom 3 and the articulated arm 4 are assembled using an axle (shown in Fig. 3).

[0054] The lift boom 3 comprises a first side wall 29 and a second side wall 30, having an enforcement plate 31 extending between the first and the second side wall, where the enforcement plate may be orthogonal to the side walls 29, 30. The enforcement plate, may be offset from the upper peripheral edges 32, 33 of the side walls, so that the side walls and the enforcement plate form an I-shape and providing a recess 34 between the side walls for the articulated arm 4, when the articulated arm 4 is in its parked position. The recess 34 allows the articulated arm 4 to be inlayed into volume defined by the lift boom, when the articulated arm and the lift boom are in their parked position. This means that the 2 dimensional profile (corresponding to the size restrictions of a vehicle) of the parked crane the lift boom 3 may be minimized, so that more space may be left for a grapple to fit inside the 2 dimensional profile, as shown in Fig. 11.

[0055] Fig. 5 shows the lift boom 3 and the articulated arm 4 in a lift position, where the articulated arm has been pivoted at an angle β that is approximately 180° from its parked position, as shown in Fig. 2. I.e. the articulated arm has been pivoted from a first horizontal position, where the arm 4 abuts the lift boom 3, to a second horizontal position where the articulated arm 4 extends substantially directly from the lift boom 3. In this position the telescopic arm may be extended to increase the crane assembly's reach.

[0056] Fig. 6 shows the lift boom 3 and the articulated arm 4 in a close lift position, where the articulated arm has been pivoted past 180° (as shown in Fig. 5) and onwards so that the lower boundary of the articulated arm 4 faces the lower boundary of the lift boom 3, and is opposite to the parked position of the lift arm and the articulated arm, where the upper boundary of the articulated arm 3, faces the upper boundary of the lift boom 4. In this position, the articulated arm has been pivoted at an angle β that is approximately 320° from the parked position, and this allows the distal end of the articulated arm to be arranged close to the crane assembly, and thereby allow the crane to lift a load that is close to the crane assembly. The close lift position may be seen as the maximum pivot of the articulated arm 4 relative to the lift boom 3, and the articulated arm may be prevented from pivoting to a larger angle.

[0057] Fig. 7 shows a sectional view of the lift boom 3 and the articulated arm, in a parked position, similar to that shown in Fig. 2. The articulated arm 4 may be pivoted around the rotational axis C, relative to the lift boom 3. The articulated arm 4 has an inner volume that is adapted to receive a telescopic section 22, where the telescopic section can be extended substantially towards the distal end of the articulated arm 4.

[0058] The lift boom 3 is provided with a receiving section 35 that is positioned close to the distal end 13 of the lift boom 3. The receiving section is arranged witin the volume of the lift boom, between the enforcement plate, and the side walls 30 of the lift boom 3, allowing access into the receiving section 35 from below. The receiving section 35 may have a proximal boundary in the form of a lower plate 36, that extends along the longitudinal axis of the lift boom 3, close to the lower peripheral edge 37 of the side wall 30, and terminates in the receiving section, where the lower plate closes off a proximal inner volume 38 of the lift boom 3.

[0059] Fig. 8 shows a sectional view of the lift boom 3 and the articulated arm, in an extended position, similar to that shown in Fig. 5. In this figure, the receiving section 35 may be clearly seen, as being an opening in the lift boom 3, having access from the lower peripheral edge of the side walls 30 of the lift boom, and where the enforcing plate 31 defines the upper limit of the section 35 and the bearing hub 25 and the lower plate define the distal and the proximal limits to the receiving section 35, respectively.

[0060] Fig. 9 shows a sectional view of the lift boom 3 and the articulated arm, in a close lift position, similar to that shown in Fig. 6. In this view, it is clear to see that the proximal end 14 of the articulation arm 4 is pivoted into the receiving section 35, when the articulated arm 4 is pivoted into a close lift position. The receiving section 35, as a gap or an opening in the lift boom 3, allows therefore the articulated arm 3 to be pivoted further than a conventional crane, having a solid lift arm 3. A solid lift arm, is a lift arm where the lower boundary of the lift arm extends along the lower peripheral edge 37 of the side walls 30 in a longitudinal direction towards the bearing hub, and would therefore prevent the proximal end 14 of the articulated arm 4 from entering the volume defined by the side walls 30 of the lift boom 3. Thus, the articulated arm could only be pivoted substantially towards the lower edge 37 of the side walls 30, and would therefore prevent the articulated arm in pivoting into the volume defined by the side walls of the lift boom 3.

[0061] Fig. 10 shows a top view of the lift boom 3 and the articulated arm 4, across the pivotal connection 15, when the articulated arm 4 is extended approximately 180°. Here it may be seen that the width F of the articulated arm 4 is equal to or lower than the width E of the inner surface 38, 39 of the side walls 30, 31 of the lift boom 3. This means that when the articulation arm is in its parked position (Fig. 2) or in its close lift position (Fig. 6) the articulation arm may be positioned between the side walls 30, 31 of the lift boom, allowing the articulation arm to access the volume defined by the peripheral edges of the side walls of the lift boom 3.

[0062] In the embodiment shown in Fig. 10, the forked coupling portion 16, 16' has a width that is larger than the outer width of the lift boom, as the proximal ends of the forked coupling portion are fixed to the bearing hub on the sides of the bearing hub 25. However, in order to ensure that the forked coupling portion 16 allows the articulated arm in entering inside the volume defined by the peripheral edges of the side walls of the lift boom, the articulated arm 4 is connected to the forked coupling portion using a spacing element 40, 40' that creates a separation between the side walls of the articulated arm 4 and the inner walls of the forked coupling portion 16,16'. Advantageously, the spacing element has a width that is equal to or larger than the width (thickenss) of a side wall 30 of the lift boom 4.

[0063] Fig. 11 shows a foldable crane 1, where the dimensions of the crane in height and width may be seen vertically and horizontally, respectively. In order to meet the size restrictions of national traffic law, the crane 1 may not exceed a maximum height 43 and a maximum width 42, which is often about 2, 55 m in width and 4 m from surface level. These size restrictions may be seen as a 2 dimensional plane 41, which defines the boundaries to which a crane 1 in its parked position must comply with, and no parts of the crane may extend beyond the maximum width 42 or the maximum height 43.

[0064] Thus, it may be important to optimize the 2 dimensional plane 41, so that the dimensions of the crane in its extended position may be optimized without compromising the maximum width or height of the crane in its parked position. As shown in Fig. 11, the length of the telescopic articulated arm 45 depends on where the longitudinal axis M of the arm 45 intersects the maximum width boundary 42 and the maximum height boundary 43. Thus, by enabling the articulated telescopic arm 45 to be inlaid into the dimensions of the lift arm 3 (as disclosed in fig 4), the angle of the lift arm may be altered, so to that the length of the intersecting longitudinal axis may be increased, and therefore the length of the arm 45 may be increased. This length increase may then be multiplied with the number of telescopic sections, as the length increase may be applied to all sections of the telescopic arm, provided that the telescopic arm 45 does not exceed the boundary defined by the 2 dimensional plane 41.

[0065] Furhtermore, by inlaying the telescopic arm 45 into the lift arm 3, it is possible to increase the free space 44 that is within the 2 dimensional plane, where the free space 44 defines the 2-D space that is available for a grappler to be attached to the free end of the telescopic arm 44 without exceeding the boundary 41. Thus, by reducing the radial profile N of the lift arm 3 and the telescopic arm, the reduction may be directly linked to an increase in the size or dimensions of the grappler, if the grappler is intended to be attached to the telescopic arm 45 when the crane 1 is in its parked position.

Claims

1. A foldable crane assembly comprising

- a rotatably mounted post having a proximal end and a distal end,
- a lift boom having a proximal end and a distal end where the proximal end is pivotally connected to the post and the distal end comprises a bearing hub,
- an articulated boom having a proximal end and a distal end where the proximal end comprises a forked coupling portion, where the forked coupling portion is pivotally connected to the bearing hub of the lift boom,

where a first boundary of the lift boom abuts a second boundary of the articulated arm when the foldable crane is in its parked position,

characterised in that a second boundary of the lift boom, opposite to the first boundary of the lift boom, comprises a receiving section for receiving the proximal end of the articulated boom, when the articulated arm is pivoted into a position where a first boundary of the articulated arm faces the second boundary of the lift boom.

2. A foldable crane assembly according to claim 1, wherein the receiving section comprises a gap between a first side wall and a second side wall of the lift boom.

3. A foldable crane assembly according to any of the preceding claims, wherein the lift boom comprises a second boundary, and where the receiving section comprises a gap, where the gap is offset from the second boundary.

4. A foldable crane assembly according to any of the preceding claims, wherein the receiving section is arranged closely to the distal end of the lift boom.

5. A foldable crane assembly according to any of the preceding claims, wherein the width of the receiving section is larger than width of the articulated arm.

6. A foldable crane assembly according to any of the preceding claims, wherein the lift arm comprises a U - or a I-shaped profile, where the inner surface of the side walls define the receiving section of the lift boom.

7. A foldable crane assembly according to any of the preceding claims, wherein the articulated arm may be fully or/partially introduced between the side walls of an I (H) shaped profile of the lift boom when the crane is in its parked position.

8. A foldable crane assembly according to any of the preceding claims, wherein the articulated arm comprises a tubular section capable of receiving a telescopic section.

9. A foldable crane assembly according to any of the preceding claims, wherein the positioning of the post, the lift boom and the articulated boom in relation to each other is substantially in the form of a Z-shape when the crane is in its parked position.

10. A foldable crane assembly according to any of the preceding claims, wherein the proximal end of the articulation arm comprises an opening into the inner volume of the articulation arm, allowing a proximal end of a telescopic arm to extend beyond the proximal end of the articulation arm in a direction towards the bearing hub.11. A foldable crane assembly according to any of the preceding claims, wherein the crane comprises at least one articulation cylinder operating between the lift boom and the articulation arm where the at least one articulation cylinder is attached to a peripheral area of the lift boom and the articulation arm.

12. A foldable crane assembly according to any of the preceding claims, wherein the articulation arm and/or the forked receiving section comprises a coupling element for attaching at least one articulation cylinder to the articulated boom.

13. A foldable crane assembly according to any of the preceding claims, wherein a spacing element is positioned between the forked receiving section and the articulation arm and creating a separation between the forked receiving section and the articulation arm.

14. A foldable crane assembly according to claim 13" wherein the width of the spacing element is equal or larger than the width of the side wall of the lift boom.

15. A foldable crane assembly according to any of the preceding claims, wherein the articulation arm is positioned between the inner surface of the first and a second side wall of the lift boom when the crane is in its parked position.

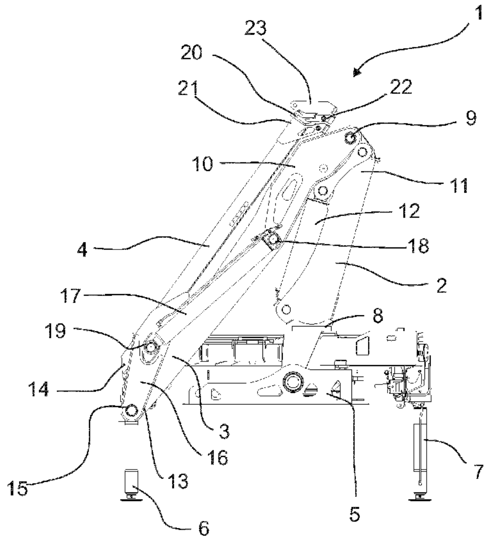

Fig.1

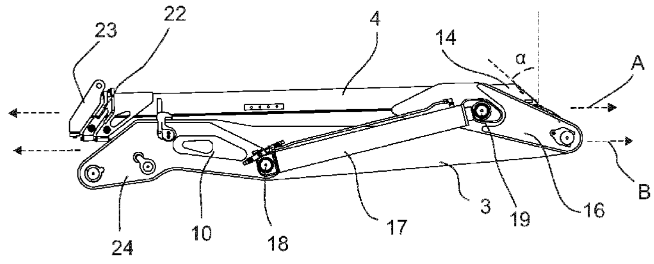

Fig.2

1/4

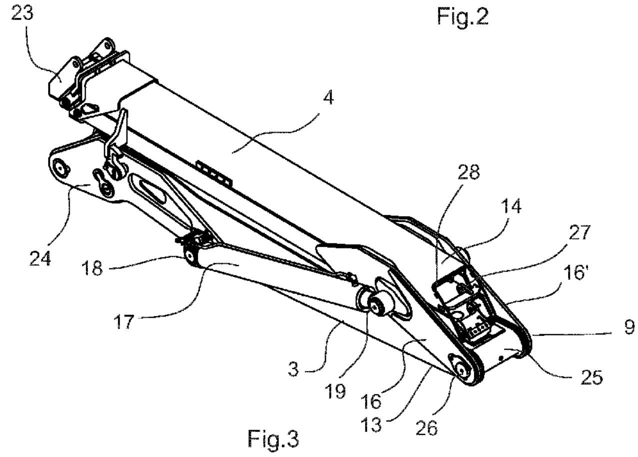

Fig.3

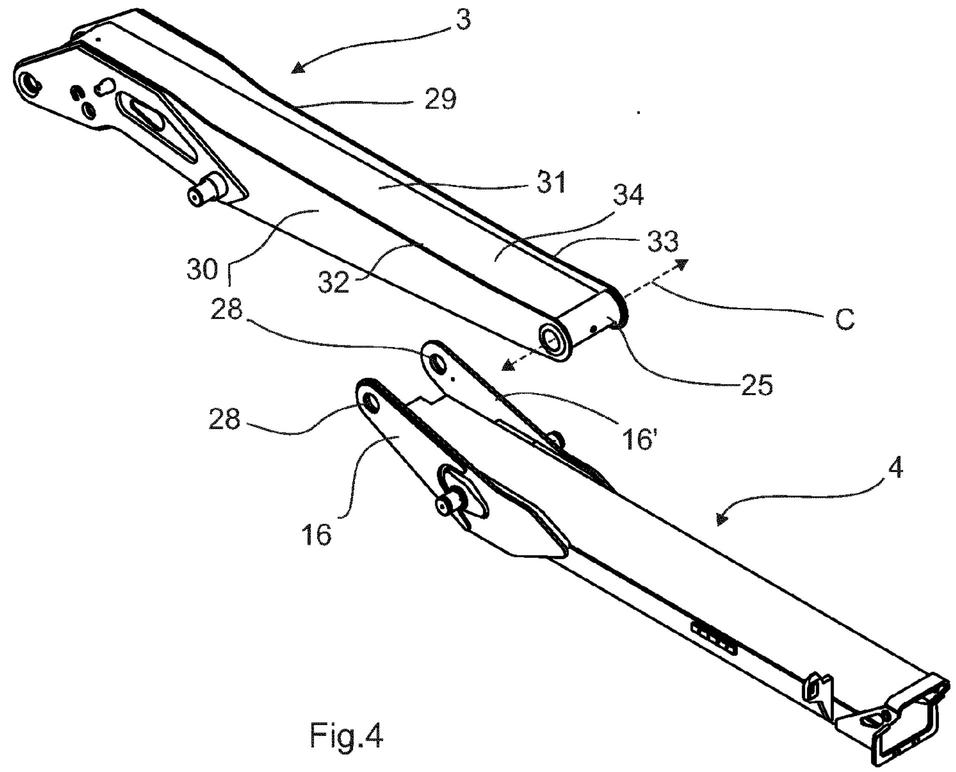

Fig.4

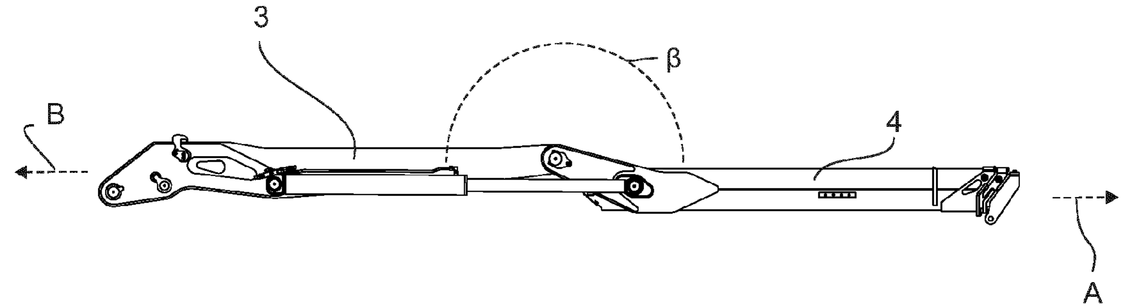

Fig.5

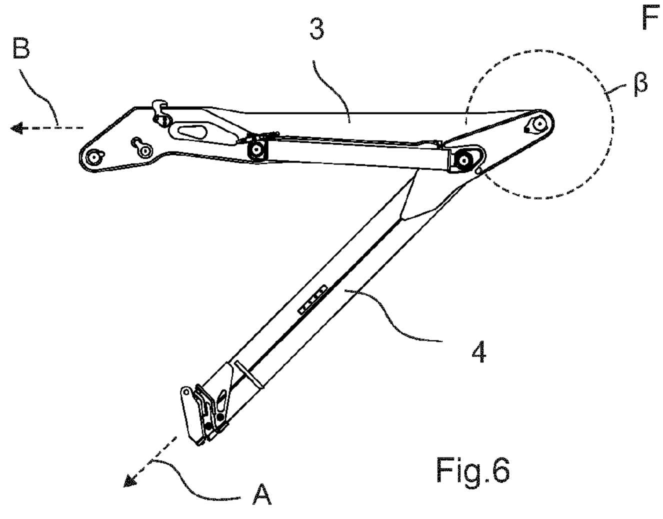

Fig.6

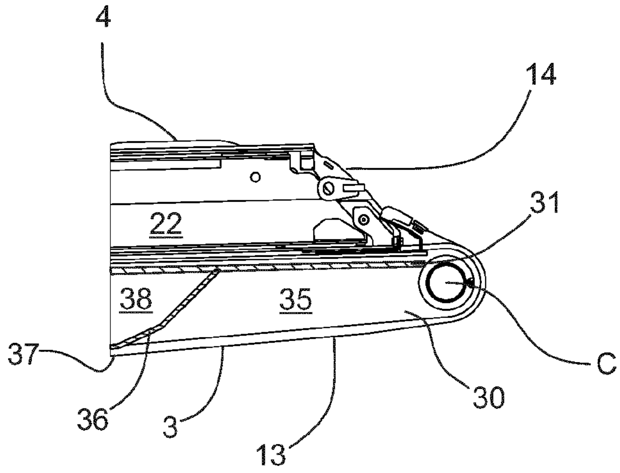

Fig.7

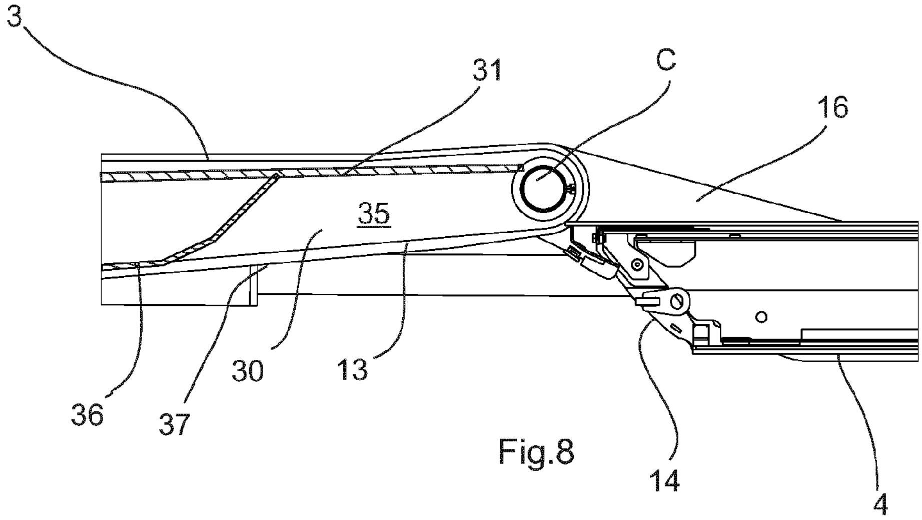

Fig.8

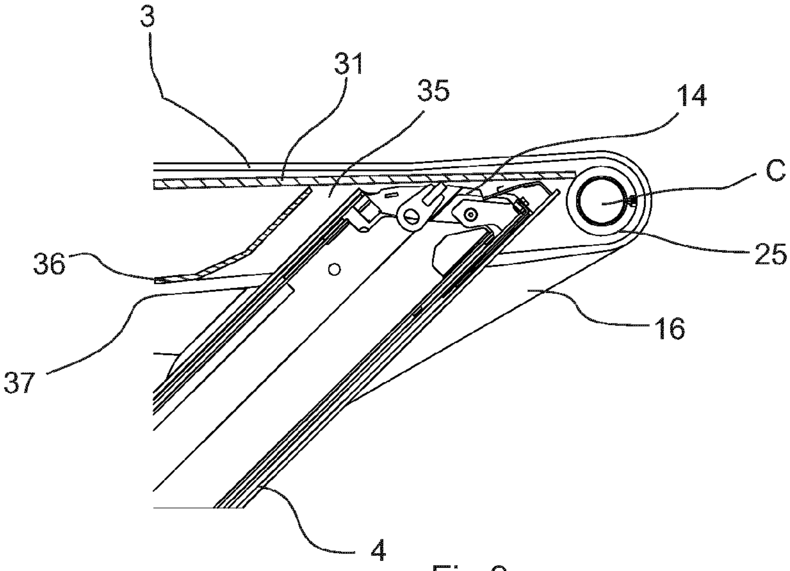

Fig.9

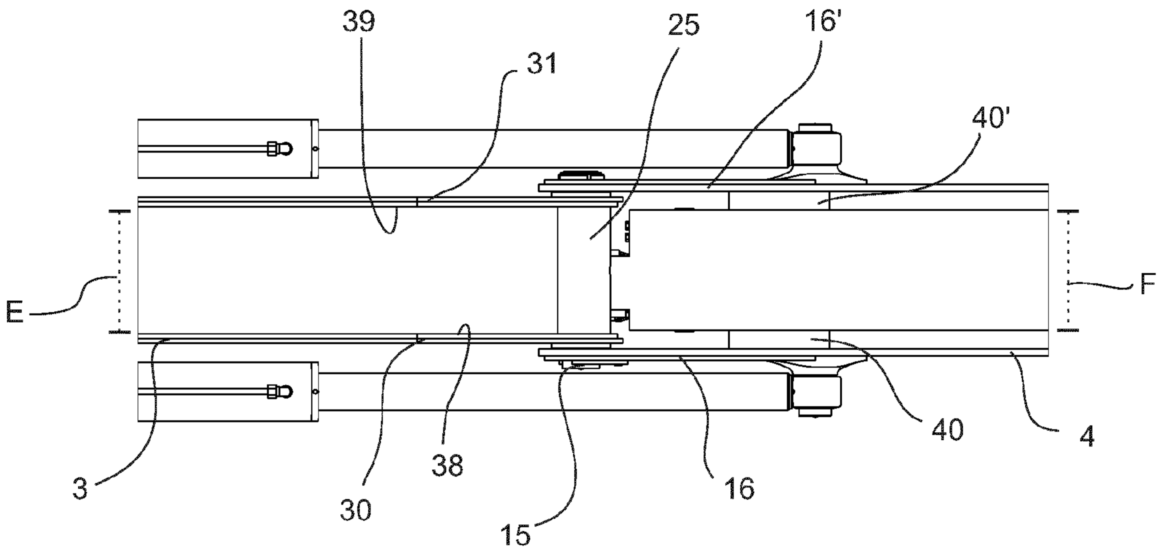

Fig.10

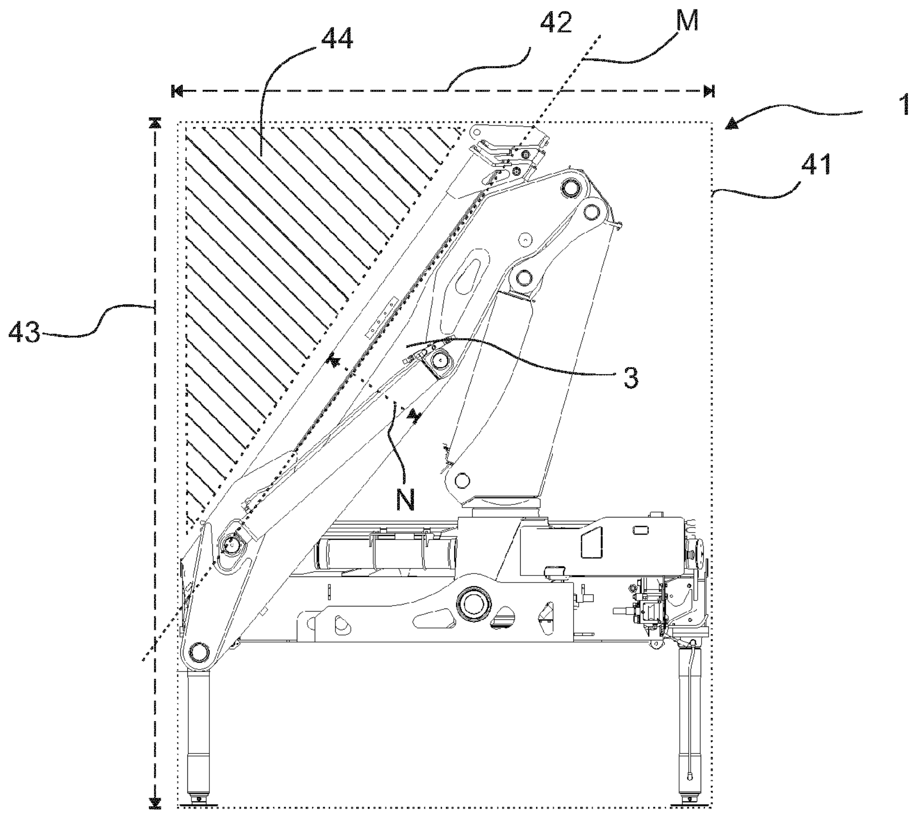

Fig.11

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 16 3339

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2 895 622 A (ERIC SUNDIN ANDERS) 21 July 1959 (1959-07-21) * column 2, lines 15-58; figures 2,3 *	1-6, 8-10,12 11,13,14	INV. B66C23/00
X	FR 1 548 863 A (UNKNOWN) 6 December 1968 (1968-12-06) * page 2; figures 3-5 *	1-6,8,9, 12	
X	WO 92/04270 A1 (HIAB AB [SE]) 19 March 1992 (1992-03-19) * pages 6-9; figures 1-3 *	1,4-7,9, 10,12,15	
Y,D A	EP 1 770 050 A1 (STEINDL KRANTECHNIK GES M B H [AT]) 4 April 2007 (2007-04-04) * the whole document *	11,13,14 1	
A,D	EP 1 475 345 A1 (LOGLIFT OY AB [FI]) 10 November 2004 (2004-11-10) * the whole document *	1,11,13, 14	

TECHNICAL FIELDS SEARCHED (IPC)

B66C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	16 August 2013	Özsoy, Sevda

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 13 16 3339

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.

16-08-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2895622 A	21-07-1959	NONE	
FR 1548863 A	06-12-1968	NONE	
WO 9204270 A1	19-03-1992	AU 8494191 A	30-03-1992
		SE 466911 B	27-04-1992
		SE 9002764 A	01-03-1992
		WO 9204270 A1	19-03-1992
EP 1770050 A1	04-04-2007	AT 452853 T	15-01-2010
		DK 1770050 T3	15-03-2010
		EP 1770050 A1	04-04-2007
		ES 2337262 T3	22-04-2010
		SI 1770050 T1	30-04-2010
EP 1475345 A1	10-11-2004	CA 2466626 A1	09-11-2004
		EP 1475345 A1	10-11-2004
		FI 20030700 A	10-11-2004

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

- US 4183712 A **[0006]**
- EP 1770050 A **[0008] [0009]**
- EP 1475345 A **[0010]**