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(54) **MAST SEGMENT FOR A LIFT-TRUCK AND A LIFT-TRUCK COMPRISING A MAST SEGMENT**

(57) A mast segment (130) for an extendable mast (110) of a lift-truck (1), said mast segment (130) comprising:
- a first vertical beam (131) having an upper end (132) and a lower end (133) and a second vertical beam (134) having an upper end (135) and a lower end (136);
- a first lifting chain attachment (220) and a second lifting chain attachment (230) for holding a respective end (51, 52) of a first and second lifting chain (50, 52) for raising or lowering the mast segment (130);
- a bottom beam (200) interconnecting the lower end (133) of the first vertical beam (131) and the lower end (136) of the second vertical beam (134); wherein the first lifting chain attachment (220) and the second lifting chain attachment (230) are integral with the bottom beam (200).

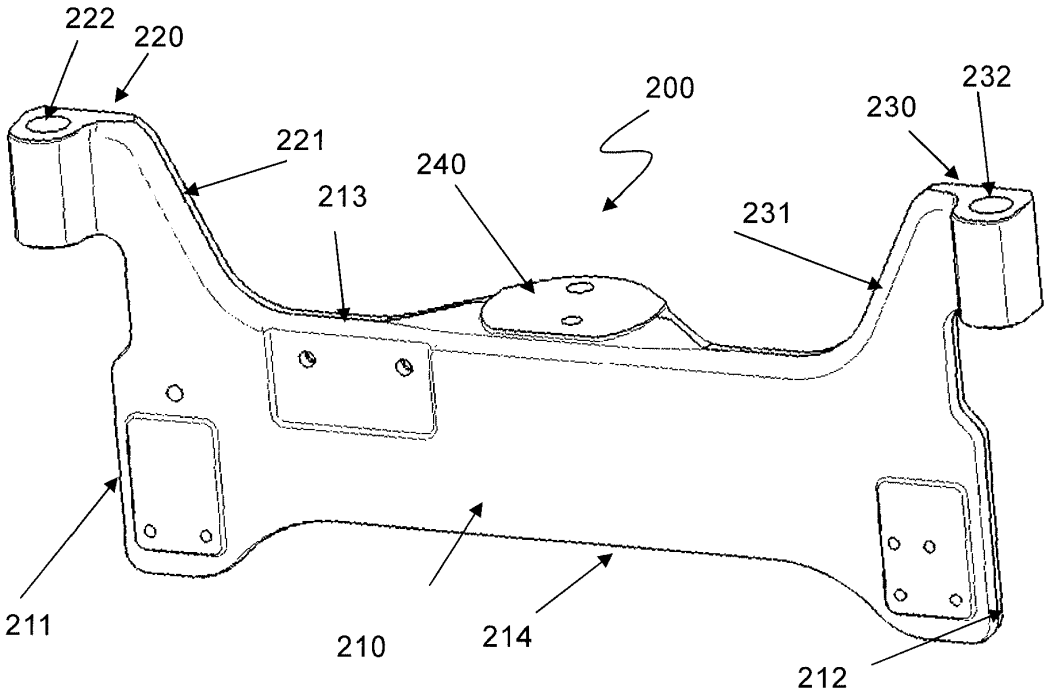

Figure 5

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Description

Technical field

[0001] The present disclosure relates to a mast segment for a lift-truck. The present disclosure also relates to a lift-truck comprising the mast segment.

Background art

[0002] A lift-truck may be provided with an extendable mast having two or more mast segments. The lifting mast may for example be a so called triplex mast comprising three mast segments or quad mast having four mast segments. A triplex mast comprises an outer mast segment which is supported on the mainframe of the truck, a middle segment which is journalled in the outer segment and an inner segment which is journalled in the middle segment. A load carriage for supporting load engagement means, is journalled in the inner segment such that it may be raised and lowered in the inner segment. The load engagement means may be a lifting fork or clamping means, a lift-truck comprising load engagement means in the form of a lifting fork is typically denominated a forklifttruck. A hydraulic cylinder, a so called free-lift cylinder, is provided to move the load carriage up and down in the inner mast segment. The free-lift cylinder is thereby supported on a transverse bottom beam, which connects the vertical beams of the inner mast segment. Further hydraulic cylinders, so-called main-lift cylinders, are supported on the main frame or the chassis of the truck and arranged to raise or lower the middle segment of the mast. Lifting chains are further connected to the inner mast segment and the outer mast segment over pulley arrangements on the middle segment. The lifting chains raises the inner mast segment on the middle mast segment when the main lift cylinders raise the middle mast segment in the outer mast segment.

[0003] In particular the area around the bottom beam of the inner mast segment is subjected to strong forces during lifting or lowering of a load on the extendable mast.

[0004] Figure 4, shows a schematic drawing of the lower portion of the inner mast segment 400 of a conventional lift-truck.

[0005] The inner mast segment 400 comprises two vertical beams 301, 302 and a bottom beam 300 which is arranged between the vertical beams 301, 302 and welded to each of the vertical beams by a respective weld seam 303. A free-lift cylinder 308 is supported on the bottom beam 300 and the upper end of the free-lift cylinder supports a load carriage (not shown). The mast segment 400 further comprises two chain attachments 305, 306 that are welded to a respective vertical beam 301, 302 of the mast segment by weld seams 307. An end of a first and a second lifting chain 309, 310 are attached to a respective chain attachment 305, 306. The other ends of the lifting chains are attached to an outer mast segment (not shown) as described above.

[0006] In a lifting operation, as described above, the free-lift cylinder 308 lifts the load carriage (and the load thereon) and the main-lift cylinder raises the middle mast segment and thereby indirectly also the inner mast segment 400 via the lifting chains 309, 310.

[0007] During the lifting operation the force F of the load on the load carriage follows the path through the free-lift cylinder 308 => the bottom beam 300 =>, the welds 303 at each end of the bottom beam => into the vertical beams 301, 302 => through the welds 307 between the vertical beams and the chain attachments 305, 306 => to the lifting chains 309, 310. In figure 4, the force F is indicated by the dashed arrows.

[0008] It has shown that repeated lifting/lowering operations may cause fatigue of the material in the welds between the bottom beam and the vertical beams and between the vertical beams and the chain attachments. Fatigue of the material in the welds may lead to cracks and increased downtime of the lift-truck due to maintenance. In particular the welds between the vertical beams and the chain attachments are heavily affected by fatigue.

[0009] Thus, it is an object of the present disclosure to provide an improved mast arrangement for a lift-truck which solves or at least mitigates the drawbacks of the prior-art. In particular it is an object of the present disclosure to provide a mast arrangement for a lift-truck which mast arrangement is robust and allows for long operational lifetime. A further object of the present disclosure is to provide a mast arrangement which is of simple design and compact and which may be installed in the truck in few working operations.

Summary of the disclosure

[0010] According to a first aspect of the present disclosure at least one of the aforementioned objects is achieved by a mast segment 130 for an extendable mast 110 of a lift-truck 1, said mast segment 130 comprising:

- a first vertical beam 131 having an upper end 132 and a lower end 133 and a second vertical beam 134 having an upper end 134 and a lower end 136;
- a first lifting chain attachment 220 and a second lifting chain attachment 230 for holding a respective end 51, 52 of a first and second lifting chain 50, 52 for raising or lowering the mast segment 130;
- a bottom beam 200 interconnecting the lower end 133 of the first vertical beam 131 and the lower end 136 of the second vertical beam 134;

characterized in that the first lifting chain attachment 220 and the second lifting chain attachment 230 are integral with the bottom beam 200.

[0011] Since the two chain attachments are integral with the bottom beam, the force path from a load will run directly through the material of the bottom beam from the free-lift cylinder to a respective chain attachment and into

the lifting chains without traversing any welds. This in turn results in less risk of failure of the mast segment due to material fatigue and thus increased operation life length of the mast segment.

[0012] A second aspect of the present disclosure is a lift-truck comprising an extendable mast 110 wherein said extendable mast 110 comprises at least one mast segment 130 according to any one of claims 1 - 7.

[0013] Further alternatives of the present disclosure are disclosed in the appended claims and the following detailed description.

Brief description of drawings

[0014]

Figure 1: A schematic side view drawing of a lift-truck according to one preferred embodiment of the present disclosure.

Figure 2: A schematic rear view drawing of the mast of the lift-truck of the preferred embodiment.

Figure 3: A schematic partially exploded side view drawing of the mast of the lift-truck of the preferred embodiment.

Figure 4: A schematic perspective drawing of a lower section of a mast segment of the Prior-Art.

Figure 5: A schematic perspective front view of a bottom beam of a mast segment according to a preferred embodiment the present disclosure.

Figure 6: A schematic perspective back view of a bottom beam of a mast segment according to a preferred embodiment the present disclosure.

Figure 7: A schematic perspective drawing of a lower section of a mast segment according to a preferred embodiment of the present disclosure.

Definitions

[0015] By the term "integral with" in the expression "the first lifting chain attachment (220) and the second lifting chain attachment (230) are integral with the bottom beam (200)" is meant that the bottom beam and the first and the second chain attachment form one single piece of continuous material free of any joints between the chain attachments and other parts of the bottom beam.

[0016] References made to the directions "up" or "upwards" or to "down" or "downwards" are meant to be relative the lifting direction of the lift-truck. A lift-truck lifts objects in direction away from the ground and lowers objects in direction towards the ground. Thus, "up" or "upwards" is in the lifting direction of the lift-truck and "down" or "downwards" is opposite the lifting direction. Consequently, in a mast segment "up" or "upwards" is in the lifting direction of the mast segment.

Detailed description of the disclosure

[0017] The mast segment and a lift-truck according to the present disclosure will now be described more fully hereinafter. The embodiment described hereinafter is provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the present disclosure to those persons skilled in the art. Same reference numbers refer to same elements throughout the description.

[0018] Figure 1 shows schematically a lift-truck 1 according to the present disclosure in side view. The lift-truck is typically known as a reach lift-truck. However, the lift-truck may also be a stacker lift-truck or an order picker lift-truck or any other type of lift-truck having an extendable lifting mast.

[0019] The lift-truck 1 comprises a mainframe 6 which in its forward portion extends into two forward support legs 2 carrying support wheels 3. A drive wheel 4 is arranged in the rear of the main frame 6. In figure 1 only one of the support legs 2 and the support wheels 3 are shown. The mainframe 6 supports a chassis 7 in which an electrical drive motor for propelling the drive wheel and a hydraulic system for providing hydraulic power to movable parts on the lift-truck is accommodated (the motor and hydraulic system are not shown in figure 1). The chassis 7 further comprises a driver's compartment 5, comprising a seat and controls for driving and controlling the lift-truck (not shown in figure 1). The lift-truck 1 further comprises an extendable lifting mast 100. The lifting mast 100 shown in figure 1 comprises three mast segments: a first outer mast segment 110 which is supported on the mainframe 6 of the lift-truck, a second middle mast segment 120 which is movable in the outer mast segment 110 and a third inner mast segment 130 which is movable in the middle mast segment 120. The mast segments 110, 120, 130 are journalled in each other by guide-rolls 40. A load carriage 30 is journalled in the inner mast segment 130 such that it may be raised and lowered in the inner mast segment 130. Different load engagement means may be attached to the load carriage 30, for example a lifting fork or clamping means such as gripping arms that are arranged movable towards each other for gripping and holding a load. In the lift-truck of figure 1 a lifting fork is attached to the load carriage 30.

[0020] The lifting mast may comprise further mast segments, such as a fourth and a fifth mast segment.

[0021] As described, the lift-truck 1 of figure 1 is a reach lift-truck, i.e. a lift-truck having the capability of moving the lifting mast 100 parallel to the mainframe 6 of the lift-truck. The outer mast segment 110 is thereby supported on a lifting mast carriage 8, which is arranged movable in the support legs 101 of the lift-truck such that the lifting mast may be moved relative the support legs 2 back and forth in direction from the rear of the lift-truck towards the support wheels 3. However, the lifting mast 100 may also be directly supported on the mainframe 6 of the lift-truck, i.e. the outer mast segment 110 of the lifting mast may be firmly fixed to the mainframe 6 of the lift-truck.

[0022] Figure 2 shows a rear view of the lifting mast 100. The inner mast segment 130 comprises a first ver-

tical beam 131 and second vertical beam 134. The vertical beams may be I-beams and have a respective upper end 132, 135 and a respective lower end 133, 136. A bottom beam 200 interconnects the first and the second vertical beam 131, 134 at the respective lower ends 133, 136 thereof. A hydraulic cylinder 60, i.e. a free-lift cylinder, is supported on the bottom beam 200 and arranged such that its piston 61 supports the load carriage 30. In operation the hydraulic cylinder 60 actuates the piston 61 to raise and lower the load carriage 30 in the inner mast segment 130.

[0023] The middle mast segment 120 and the outer mast segment 110 also comprise vertical beams. The middle mast segment 120 and the outer mast segment 110 may also comprise transverse beams which connect the respective vertical beams of each segment to each other. Also the inner mast segment 130 may comprises additional traverse beams which interconnects the vertical beams 131, 134 (the beams described above are not shown in figure 2).

[0024] Two hydraulic lifting cylinders 70 and at least two lifting chains (not shown in figure 2) are provided to raise the middle and inner mast segments 120, 130 in order to extend the lifting mast 100.

[0025] The lifting cylinders 70 are arranged on a respective side of the lifting mast 110. The pistons of the lifting cylinders are attached to the middle mast segment 120 in order to raise and lower the middle mast section 120.

[0026] The lifting chains are shown in figure 3, which shows a partially exploded side view of the lifting mast 100 of figure 2. The lifting mast 110 comprises first and second lifting chains 51, 52 which extend between first and second lifting chain attachments 115 in the outer mast segment 110 and first and second lifting chain attachments 220, 230 comprised in the bottom beam of the inner mast segment 130. The lifting chains 51, 52 extend through a respective chain guiding means 80 which is arranged in the upper end of the middle mast segment 120. The chain guiding means 80 may be a pulley arrangement. Since figure 3 is a side view, only one of the lifting chains 51, the chain guide 80 and the lifting chain attachments 115, 220 are visible. When the middle mast segment 120 is raised by the lifting cylinders 70 (see figure 2) the lifting chains 51, 52 raise the inner mast segment 130.

[0027] According to the present disclosure, the lifting chain attachments 220, 230 of the mast segment 130 are integral with the bottom beam 200.

[0028] Figure 5 shows a front view of the bottom beam 200. The bottom beam 200 comprises a central section 210 which extends between a first end 211 and a second end 212 of the bottom beam 200. The first end 211 and the second end 212 of the beam 200 are configured to be attached to a respective first and second vertical beam of a mast segment of a lift-truck.

[0029] The central section has an upper central edge portion 213 which in operation is directed upwards in the mast segment with regards to the lifting direction of the mast segment. The central section 212 further has a lower central edge portion 214 which is directed away from the upper central edge portion 213. The upper central edge portion 213 and the lower central edge portion 212 are parallel.

[0030] The bottom beam 200 further comprises a support 240 for supporting a hydraulic cylinder, such as a hydraulic free-lift cylinder. The support 240 is positioned in the centre of the central section, i.e. between the first and the second ends 211, 212 of the central section. The support 240 thereby projects orthogonally from the upper central edge portion 213 of the central section 240 such that it forms a plane support surface for supporting a hydraulic cylinder. Figure 6 shows the back side of the bottom beam 200 of figure 5.

[0031] The bottom beam 200 further comprises a first lifting chain attachment 220 and a second lifting chain attachment 230. Each lifting chain attachment is configured to receive and hold an end of a respective lifting chain. The respective lifting chain attachment 220, 230 thereby comprises a through going opening 222 and 223. In operation, an end of a lifting chain is attached to a lifting chain attachment 222, 223 by inserting a bolt, attached to the end of the lifting chain, through one of the openings 222, 223 and locking the bolt in the opening 222, 223 by a nut (not shown).

[0032] The chain attachment means 220, 230 are arranged adjacent the respective ends 211 and 212 of the bottom beam 200. In the described embodiment, the bottom beam 200 comprises a first and a second arm 221, 231 which extends upwards from the respective ends 211 and 212 of the beam 200. The first and the second arm 221, 231 thereby extend, respectively, in the same plane as the middle section 210 of the bottom beam 200. In particular the first and the second arm 221, 231 extend in a direction away from the upper edge 213 of the bottom beam 200. Preferably, the arms 221, 231 are configured such that the lifting chain attachments 220, 230, in operation, extend over a respective vertical beam of the mast segment. The arms are thereby configured, as shown in figure 6, such that they extend beyond the respective first and second end 211 and 212 of the bottom beam 200. However, the lifting chain attachments 220 and 230 may also be arranged at the respective first and second ends 211, 212 of the bottom beam 200 or at a position between the first and second ends 211 and 212 of the bottom beam 200.

[0033] The bottom beam 200, including the first and second lifting chain attachment 220, 230 and the support 240 for a hydraulic cylinder, is one single piece, free of any joints. Thus the bottom beam is free of joints, i.e. does not comprise any joints, between the chain attachments 220, 230 and the central section 210, or between the arms 221, 231 and the chain attachments 220, 230 and the central section 210 or between the support 240 and central section 210. By "joints" is meant that interfacing surfaces of different parts of the bottom beam de-

scribed above have been joined, i.e. attached, to each other. Examples of such joints are weld joints, bolt joints or other joints.

[0034] Typically, the bottom beam 200 is formed into one single piece by forging or casting of steel. The bottom beam 200 including the first and second lifting chain attachment 220, 230, the first and second arms 221, 231 and the support 240 for a hydraulic cylinder may thus be a forged piece or a cast piece. Preferably, the bottom beam 200 is a forged piece. The material of the bottom beam 200 is preferably steel.

[0035] Figure 7 shows the lower portion of a mast segment 130 for a lift-truck according to the present disclosure. The above described bottom beam 200 is thereby attached by the opposing first and second ends 211, 212 to a respective vertical beam 131, 134 of the mast segment 130. The first end 211 of the bottom beam 200 is thereby attached to the lower end 133 of the first vertical beam 131 and the second end 212 of the bottom beam 200 is attached to the lower end 136 of the second vertical beam 134. The bottom beam 200 thereby extend horizontally between the vertical beams 131, 134 and the upper central edge portion 213 of the bottom beam 200 is directed in the lifting direction of the mast segment 130, i.e. towards the upper ends 132, 135 of vertical beams of the mast segment.

[0036] Attachment of the bottom beam 200 to the vertical beams 131, 134 may be achieved by welding. The lifting chain attachments 220 and 230 extend over a respective vertical mast segment 131, 134, this position is selected such that the lifting chain attachments 220 and 230 are oriented in line with chain guiding means on other mast segments (not shown). To ensure stability of the mast segment, the respective lifting chain attachments 220, 230 are attached by welding to the respective vertical beam 131, 134. However, it is appreciated that there are no welds or other joints between the lifting chain attachments and the arms or other parts of the bottom beam.

An end 51 of a first lifting chain 50 is held in, i.e. attached to, the first lifting chain attachment 220 and an end 53 of a second lifting chain 52 is held in, i.e. attached to, the second lifting chain attachment 230. A lifting cylinder 60 is supported on the support 240 for a lifting cylinder.

[0037] Figure 5 shows further the path of the force F when the mast segment 130 is engaged in a lifting operation. When a load (not shown) is lifted on a load carriage along the lifting mast of the lift-truck, the force F from the load follows the closest path from the free-lift cylinder, which supports the load, through the material of the bottom beam 200 to the respective lifting chain attachments 220, 230 and into the lifting chains 50, 52.

[0038] Figure 5 also illustrate a further advantage of the bottom beam of the present disclosure. Since the force F of the load follows the closest path through the material of the bottom beam to the lifting chains essentially the entire force F of the load will go through the material of the bottom beam 200 in the direction of the lifting chain attachments 220, 230. Consequently, the welds between the ends 211, 212 of the bottom beam 200 and the vertical beams 131, 134 will essentially not be subjected to the force F of the load but essentially only to the weight of the vertical beams 131, 134 themselves.

Claims

1. A mast segment (130) for an extendable mast (110) of a lift-truck (1), said mast segment (130) comprising:

   - a first vertical beam (131) having an upper end (132) and a lower end (133) and a second vertical beam (134) having an upper end (135) and a lower end (136);
   - a first lifting chain attachment (220) and a second lifting chain attachment (230) for holding a respective end (51, 52) of a first and second lifting chain (50, 52 for raising or lowering the mast segment (130);
   - a bottom beam (200) interconnecting the lower end (133) of the first vertical beam (131) and the lower end (136) of the second vertical beam (134);

   characterized in that the first lifting chain attachment (220) and the second lifting chain attachment (230) are integral with the bottom beam (200).

2. The mast segment (130) according to claim 1, wherein the bottom beam (200) comprises a first end (211) which is attached to the first vertical beam (131) and a second end (212) which is attached to the second vertical beam (132) and a central section (210) extending between said first and second ends (211, 212) of the bottom beam (200), wherein the first lifting chain attachment (220) is arranged in the first end (211) of the bottom beam (200) and the second lifting chain attachment (230) is arranged in the second end (212) of the bottom beam (220).

3. The mast segment (130) according to claims 1 or 2, wherein the first lifting chain attachment (220) extends over the first vertical beam (131) and the second lifting chain attachment (230) extends over the second vertical beam (134).

4. The mast segment (130) according to anyone of claims 1 - 3, wherein the bottom beam (200) comprises a first and a second arm (221, 231) extending respectively from the first and the second ends (211, 212) of the bottom beam (200), wherein the first lifting chain attachment (220) is arranged on the first arm (221) and the second lifting chain attachment is arranged on the second arm (231).

5. The mast segment (130) according to anyone of claims 1 - 4, wherein the bottom beam (200) comprises a support (240) configured to support a free-lift cylinder (60)

6. The mast segment (130) according to anyone of claims 1 - 5, wherein the bottom beam (200), the first lifting chain attachment (220) and the second lifting chain attachment (230) is a single piece, free of joints.

7. The mast segment (130) according to anyone of claims 1 - 6, wherein the bottom beam (200), the first lifting chain attachment (220) and the second lifting chain attachment (230) is a forged piece or a cast piece.

8. A lift-truck (1) comprising an extendable mast (110) wherein said extendable mast (110) comprises at least one mast segment (130) according to any one of claims 1 - 7.

9. The lift-truck (1) according to claim 8, wherein the extendable mast (110) comprises an outer mast segment (110), at least one middle mast segment (120) and an inner mast segment (130) according to anyone of claims 1 - 7, wherein the inner mast segment (130) and the outer mast segment (110) are joined by lifting chains (50) for lifting the inner mast segment (130).

10. The lift-truck (1) according to claim 9, wherein a first and a second lifting chain (50, 52) extends from a respective chain attachments (220, 230) in the bottom beam (200) of the inner mast segment (130) over a respective first and second chain guiding means (80, 80) in the at least one middle mast segment (120) to a respective chain attachment (115, 115) in the outer mast segment (110).

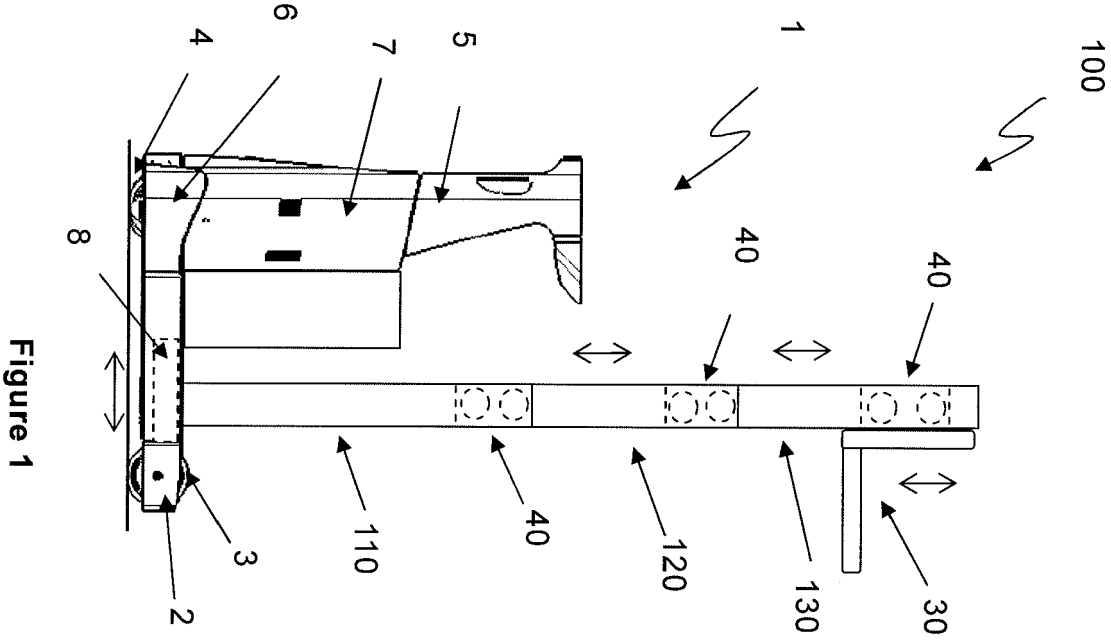

Figure 1

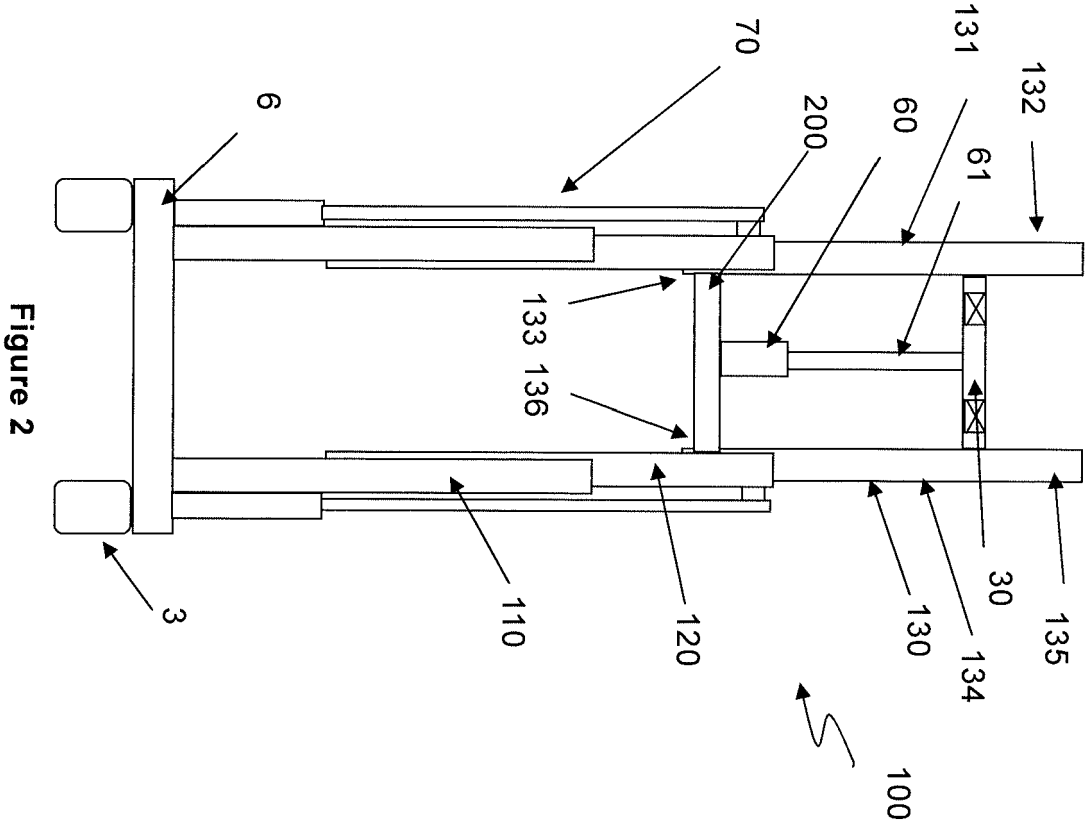

Figure 2

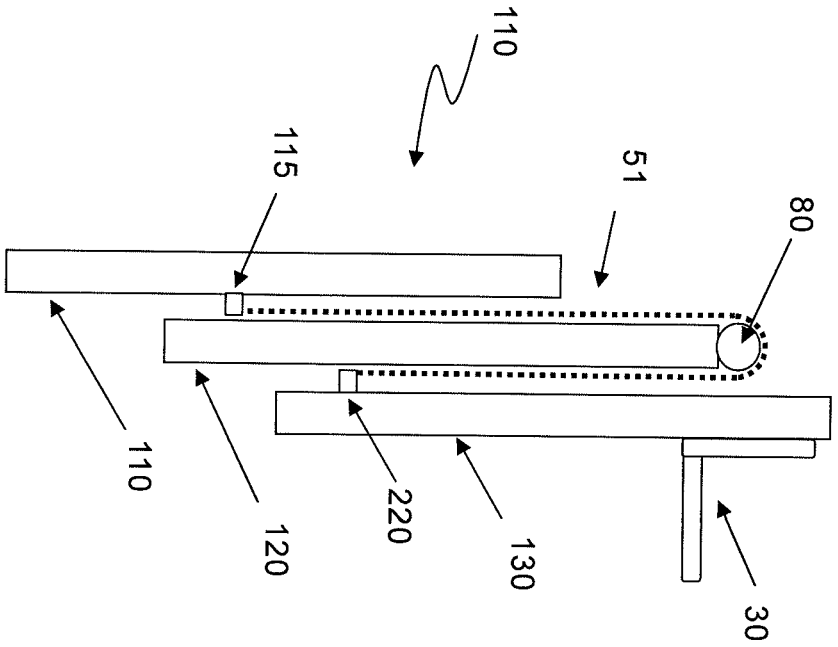

Figure 3

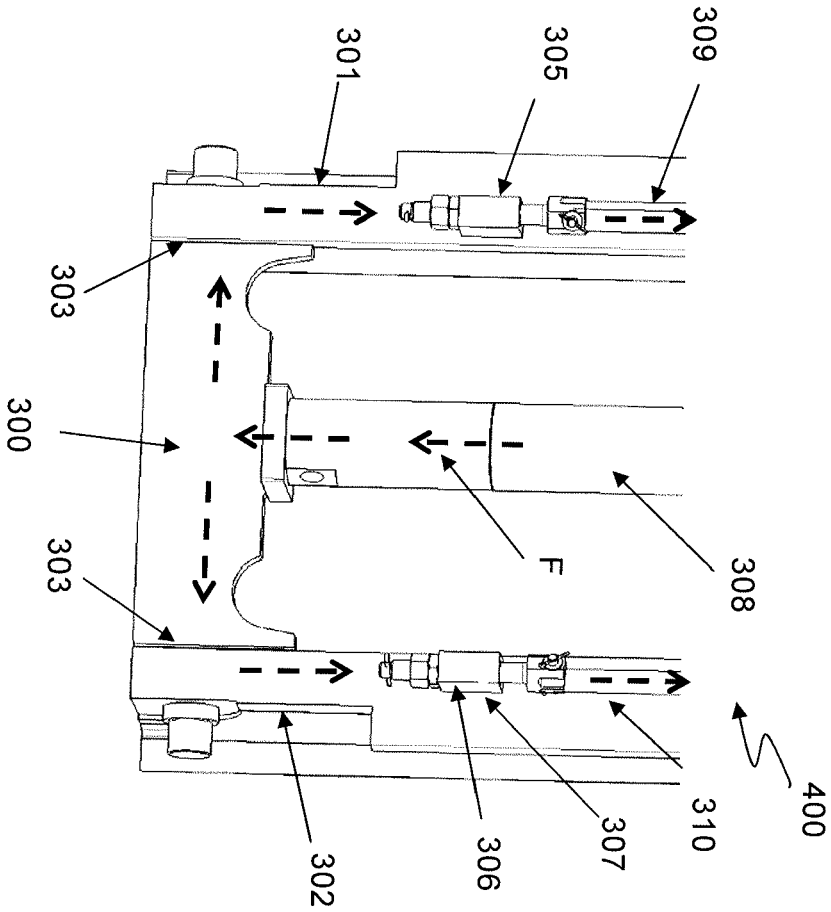

Figure 4 (Prior-Art)

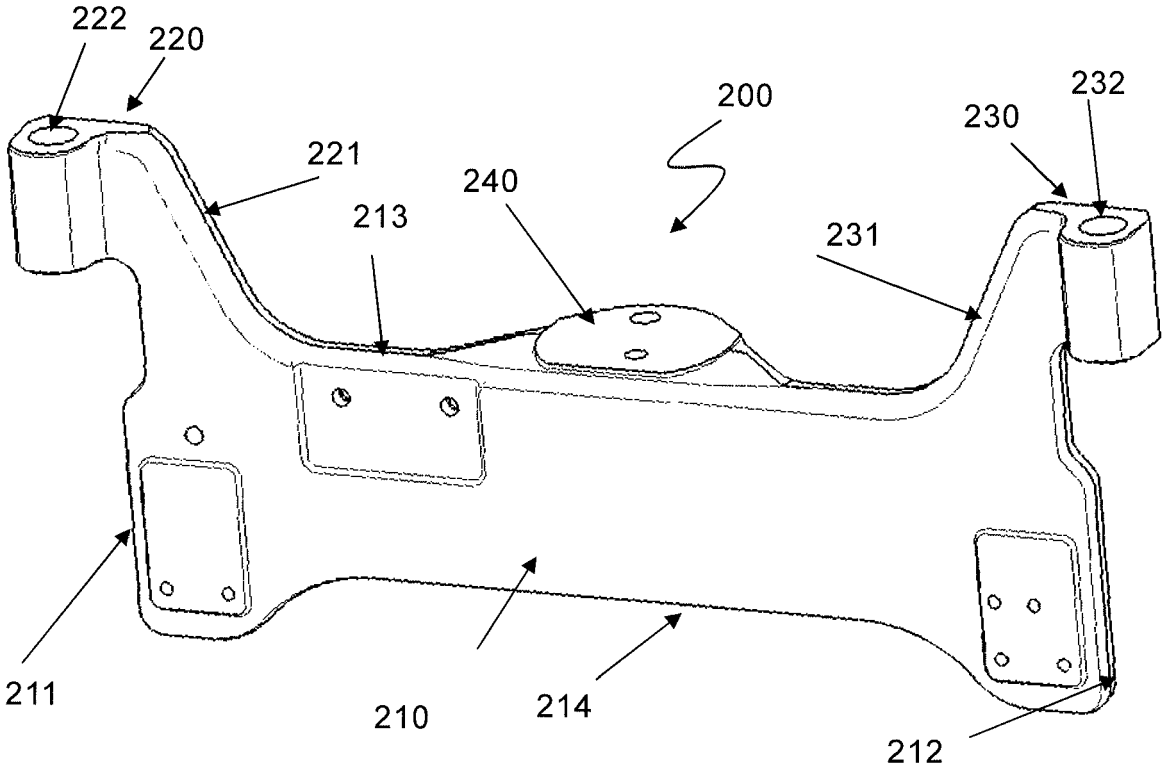

Figure 5

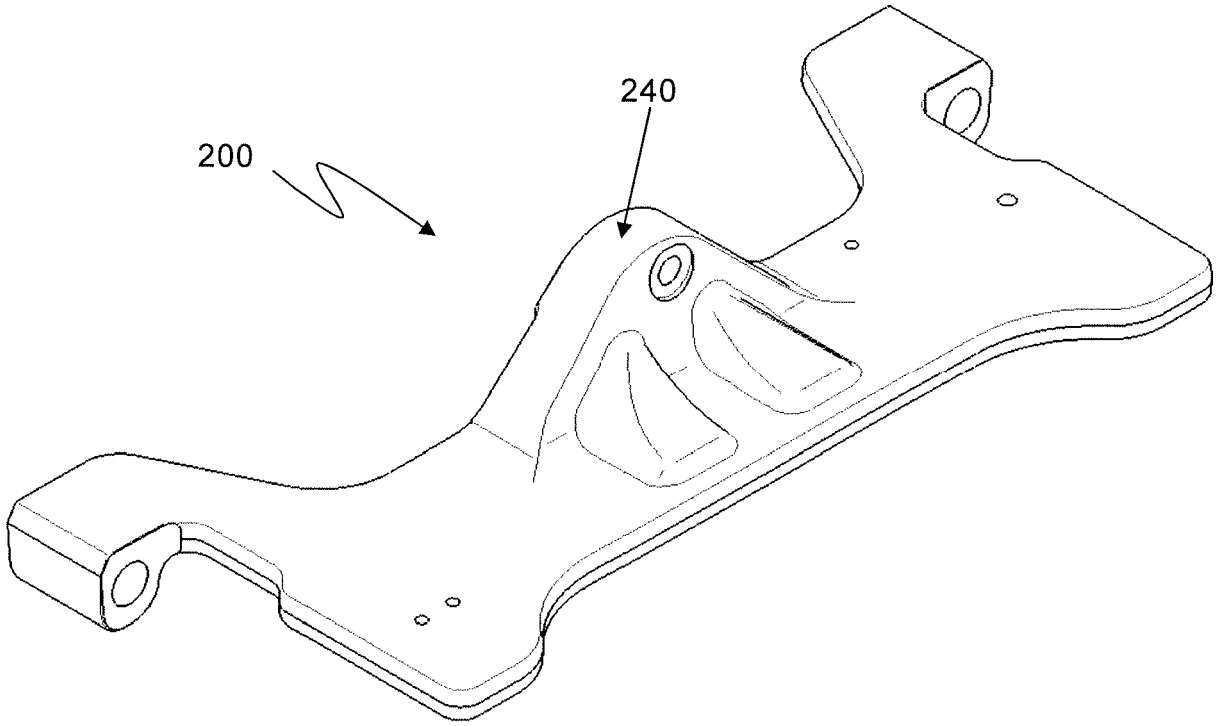

Figure 6

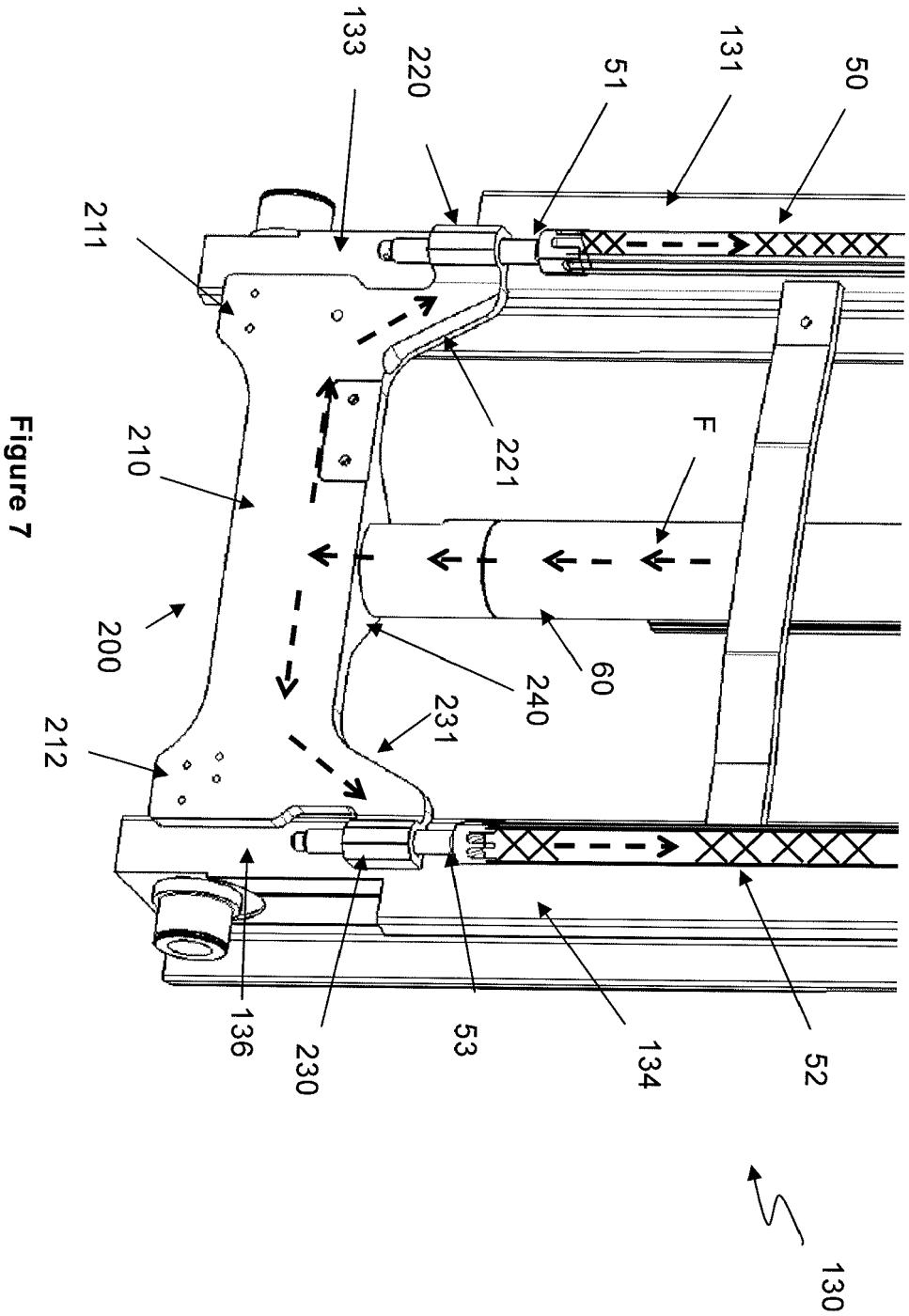
133
220
51
131
50
211
221
F
210
200
60
240
231
212
136
230
53
134
52
130

Figure 7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 8411

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC) B66F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 April 2017	Cabral Matos, A

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 19 8411

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