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(54) **ELECTRICALLY-POWERED INDUSTRIAL TRUCK**

(57) An electrically-powered industrial truck includes:

- a lifting assembly for lifting a load,
 - a counterweight (11) opposite to the lifting assembly for balancing the weight of the lifting assembly and of a load lifted by the lifting assembly,
 - a front frame portion (13) configured for supporting the lifting assembly, and
 - a battery assembly (12),
- characterized in that the battery assembly (12) includes:
- a housing (15) including a recess (16) for receiving one or more battery cells and
 - two longitudinal members (14) connected to the housing (15) on opposite lateral sides of the recess (16), wherein the longitudinal members (14) connect the counterweight (11) and the front frame portion (13) on opposite lateral sides of the electrically-powered industrial truck and are configured to transfer forces between the counterweight (11) and the front frame portion (13) during operation of the electrically-powered industrial truck.

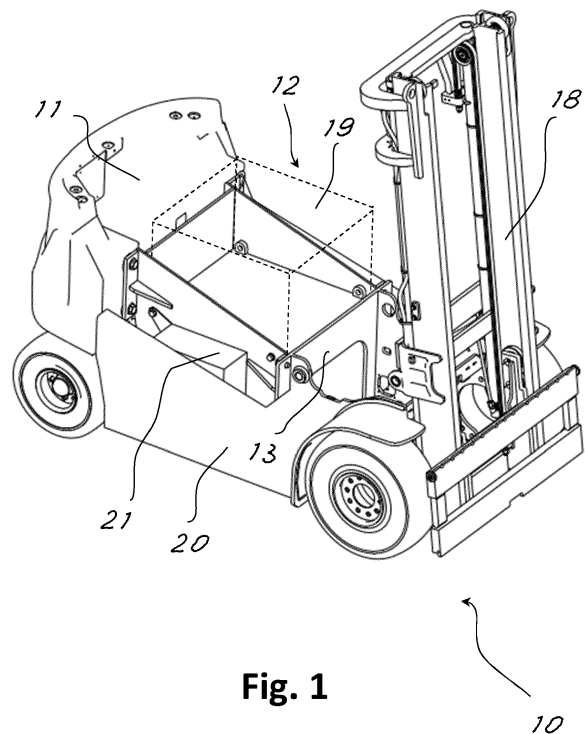


Fig. 1

Description

Technical Field

[0001] The present invention relates to an industrial truck, such as a forklift truck. More specifically, the present invention relates to a battery-driven industrial truck.

Background

[0002] Recently, the demand for industrial trucks, such as forklift trucks, that are battery-powered is more and more increasing. According to a known art, the industrial truck can have replaceable batteries configured to be replaced several times during the lifetime of the industrial truck during normal operation of the truck. In other implementations, lithium battery assemblies can be installed on the industrial truck in a permanent manner, so that the battery is not replaced during normal operation.

[0003] In order to achieve a satisfactorily long reach and power, lithium battery assemblies are rather bulky and heavy; accordingly, the frame of the industrial truck must be dimensioned and design to support the stresses induced by weight of the batteries, in addition to the usual forces that are caused by the operation for industrial truck, such as material handling. Accordingly, the structure and the frame of the industrial truck must be manufactured with a suitable dimensioning of the frame parts, this leading to an increase in the cost and a complex design.

[0004] There is therefore a need for improvement that may allow to reduce the complexity of the structure of the electrically-powered industrial truck and to possibly save manufacturing costs and material usage.

Summary

[0005] The mentioned problems are solved by the subject-matter of the main claim. Further preferred embodiments are defined in the dependent claims. Specifically, the embodiments of the present invention may provide substantial benefits that are described in part herein.

[0006] According to an embodiment of the present invention, there is provided an electrically-powered industrial truck including:

- a lifting assembly for lifting a load,
- a counterweight opposite to the lifting assembly for balancing the weight of the lifting assembly and of a load lifted by the lifting assembly,
- a front frame portion configured for supporting the lifting assembly, and
- a battery assembly,

characterized in that the battery assembly includes:

- a housing including a recess for receiving one or

more battery cells and

- two longitudinal members connected to the housing on opposite lateral sides of the recess,

- 5 wherein the longitudinal members connect the counterweight and the front frame portion on opposite lateral sides of the electrically-powered industrial truck and are configured to transfer forces between the counterweight and the front frame portion during operation of the electrically-powered industrial truck.
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Brief description of the drawings

- [0007]** Embodiments of the present invention, which are presented for better understanding the inventive concepts but which are not to be seen as limiting the invention, will now be described with reference to the figures in which:
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- 20 Figure 1 shows a view of an industrial truck according to an embodiment of the invention, in which the user seat and cabin is removed;

- 25 Figure 2 shows a view of the counterweight, the battery assembly and the front part of the frame in assembled state, according to an embodiment of the present invention;

- 30 Figure 3 shows the counterweight, the battery assembly and the front part of the frame in an exploded view.

Detailed description

- 35 **[0008]** In figure 1 an industrial truck 10, such as a forklift truck, is shown including a counterweight 11 on the rear side and a lifting assembly 18 on the front part; the user seat and the user cabin are omitted to make the relevant parts of the industrial truck more visible. The lifting assembly 18 may include a known mast and actuating means configured to lift a plate on which a fork (not shown in the figure) can be mounted; according to known arts, also other material handling devices other than a fork could be mounted on the lifting assembly 18. The lifting assembly 18 can be used to lift and carry loads, e.g. on an industrial or logistic site. The counterweight 11 is positioned opposite to the lifting assembly 18 on the rear part of the truck to balance the weight of the load during operation of the truck. The counterweight 11 may be formed in one piece according to known techniques.
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- [0009]** The industrial truck 10 is electrically-powered and includes a battery assembly 12 positioned between the counterweight 11 and the lifting assembly 18. The battery assembly 12 may include one or more battery modules or packs 19, 21 (in figure 1, the battery module 19 is shown in dashed lines); however, the battery assembly 12 may be provided also without the battery modules, in this case the battery assembly may only include
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a structure for supporting the one or more battery modules; in this latter case, the battery modules may be installed subsequently in the battery assembly 12. Preferably, the battery modules 19, 21 may include lithium battery elements or cells.

[0010] In the example of figure 1, the battery assembly 12 includes a recess for receiving a central battery module 19 and further recess for receiving a lateral battery module 21 on the side of the industrial truck. A further lateral battery module may be mounted on the other side of the truck 10. However, the lateral battery module 21 as well as the corresponding housing in the battery assembly 12 may be absent. A lateral outer element 20 may cover the lateral battery module 21 to protect it from external agents. The lateral outer element 20 has no structural function in the sense that it is not configured to transfer the operational forces that are induced in the truck due to the material handling and the driving operation. The lateral battery module 21 is mounted between one of the longitudinal members (described later with reference to figure 2) and the lateral outer element 20. The lateral battery module 21 may include a housing that is fixed, e.g. by means of releasable fastening means, to the lateral outer surface of the longitudinal member 14. A second lateral outer element may be provided on the other side of the truck to cover the additional lateral battery module, with a similar arrangement as the lateral battery module 21.

[0011] The industrial truck includes also a front frame portion 13 configured for supporting the lifting assembly 18; preferably, the front frame portion 13 also supports the front axle structure of the industrial truck 10. In one embodiment, the lifting assembly 18 may be mounted on the front axle structure of the truck. The front frame portion 13 also serves for performing the tilting of the mast of the lifting assembly 18, according to known techniques, by carrying corresponding actuating means.

[0012] According to the invention, as well illustrated in figures 2 and 3, the battery assembly 12 includes a housing 15 that forms a recess 16 for receiving battery cells and two longitudinal members 14 connected to the housing 15 on opposite lateral sides of the recess 16. The housing 15 is configured to support the weight of the battery cells during operation of the truck. The longitudinal members 14 connect the counterweight 11 and the front frame portion 13 on opposite lateral sides of the electrically-powered industrial truck. The longitudinal members 14 are configured to transfer forces between the counterweight 11 and the front frame portion 13 during operation of the electrically-powered industrial truck. In other words, the longitudinal members 14 are configured and designed to withstand the forces that must be transferred from the front frame portion 13 to the counterweight 11 during the normal operation of the truck, due for example to a load lifting operation or the driving of the truck while transporting a load.

[0013] The battery assembly 12 forms a battery supporting structure including the housing 15 and the longi-

tudinal members 14. The housing 15 can have a box-like shape and can be made of metal sheets. The two longitudinal members 14 can be jointed together by a plate member 17 so as to form an U-shaped structure that is open towards the front frame part 13. The plate member 17 is positioned close to the counterweight 11 in assembled state. In this embodiment, accordingly, the battery assembly 12 includes a U-shaped structure or member 14, 17 surrounding the housing 15 for the battery cells. The U-shaped member includes the plate member 17 and the longitudinal members 14. This configuration allows to achieve a stable structure of the truck while reducing the usage of material for supporting the battery cells. In an alternative embodiment, the plate member 17 may be replaced by another connecting member that is not in the form of a single plate, but may include e.g. a plurality of bar members. Preferably, the U-shaped member may be formed in one piece, may be connected to the counterweight 11 by means of releasable fastening means (such as screws) and may be connected to the front frame portion 13 by means of releasable fastening means (such as screws).

[0014] The housing 15 includes two opposite lateral sides (or walls) fixed to the two longitudinal members 14 on opposite sides of the recess 16. Preferably, the longitudinal members 14 are formed in the shape of plates having substantially planar shape oriented according to a substantially vertical plane; the connecting plate member 17 is also advantageously oriented along a substantially vertical plane. Accordingly, the two opposite lateral sides of the housing 15 are substantially vertical and contact the longitudinal members on a vertical surface thereof. The lateral sides of the housing 15 are fixed to the longitudinal members 14 by means of known fastening means 22, e.g. releasable fastening means, such as by nut and bolt.

[0015] In a preferred embodiment, the surface of the battery assembly 12 facing downwards is not in contact with parts of a frame of the industrial truck 10. In other words, the weight of the battery assembly 12 is not supported by portions of the frame of the industrial truck positioned under the battery assembly. In a preferred embodiment, the lower part of housing 15 extends downwardly at a height below the longitudinal members 14; the lower part of housing 15 may also extend downwardly at a height below the counterweight 11 formed in one piece. This structure of the battery assembly 12 allows to reduce the usage of material while achieving a suitable robustness of the industrial truck to withstand operational stresses. The weight of the battery assembly is supported by the connection of the longitudinal members 14 to the counterweight 11 and the front frame portion 13. The housing 15 and the battery cells contained in the housing 15 are fully supported laterally by the longitudinal members 14. Hence, the space available for the battery assembly is increased, as the battery assembly can extend downwardly relatively close to ground. This allows to increase in turn the space available for the battery cells

and, hence, to increase the reach and the power of the industrial truck.

[0016] As shown in figure 2, the longitudinal members 14 may preferably have a substantially trapezoidal shape; however, also other shapes could be conceived. The longitudinal members 14 may advantageously have a generally diagonal (or rectilinear) orientation; for example, a rear end of the longitudinal members 14 connected to the counterweight 11 may be at a higher level compared to a front end of the longitudinal members 14 connected to the front portion 13 of the frame. The upper edge of the connecting members 14 may be inclined of an angle of at least 10° with respect to a horizontal plane. This configuration may contribute to achieve suitable mechanical robustness and material savings.

[0017] The battery assembly 12 (in particular the longitudinal members 14) can be fixed to the counterweight by means of releasable fastening means, such as screws 24. Similarly, the battery assembly 12 (in particular the longitudinal members 14) can be fixed to the front frame portion 13 by means of releasable fastening means such as screws. The longitudinal members 14 include flanges 23, 25 at opposite ends that are joined to the counterweight 11 and the front frame portion 13, respectively, e. g. by means of the releasable fastening means 24. The battery assembly 12, in addition to supporting the battery cells, serves as bearing structure in the industrial truck; accordingly, the longitudinal members 14 are dimensioned to withstand the operational stresses transferred between the lifting means 18 and the front axle on the one hand, and the counterweight 11 on the other hand. As shown above, the longitudinal members 14 are fixed to the counterweight 11 and to the front portion 13 of the frame by means of releasable fastening means. This allows to manufacture industrial trucks of different sizes while using always the same design for the counterweight and the front frame portion, by simply preparing battery assemblies of different size in the longitudinal direction. Hence, different wheel bases can be achieved in a cost-effective manner.

[0018] As shown in the figures, the rear ends of the longitudinal members 14 can be preferably located at an height entirely above rear wheels of the industrial truck and the front ends of the longitudinal members 14 are at least partly at the height of front wheels of the industrial truck.

Although detailed embodiments have been described above, these only serve to provide a better understanding of the invention defined by the independent claims and are not to be seen as limiting.

[0019] Alternative embodiments of the invention can be conceived without departing from the scope of the claims. For example, in view of the above discussion, an industrial truck according to the invention may further include at least a lateral battery housing fixed to one of the longitudinal members 14 on a side opposite to a central housing 15 for receiving the central battery module 19.

Claims

1. An electrically-powered industrial truck including:

- a lifting assembly (18) for lifting a load,
- a counterweight (11) opposite to the lifting assembly for balancing the weight of the lifting assembly and of a load lifted by the lifting assembly,
- a front frame portion (13) configured for supporting the lifting assembly, and
- a battery assembly (12),

characterized in that the battery assembly (12) includes:

- a housing (15) including a recess (16) for receiving one or more battery cells and
- two longitudinal members (14) connected to the housing (15) on opposite lateral sides of the recess (16),

wherein the longitudinal members (14) connect the counterweight (11) and the front frame portion (13) on opposite lateral sides of the electrically-powered industrial truck and are configured to transfer forces between the counterweight (11) and the front frame portion (13) during operation of the electrically-powered industrial truck.

2. An industrial truck according to claim 1, wherein the longitudinal members (14) are fixed to the counterweight (11) by means of releasable fastening means.

3. An industrial truck according to claim 2, wherein the longitudinal members (14) are fixed to the front frame portion (13) by means of releasable fastening means.

4. An industrial truck according to claim 3, wherein the longitudinal members (14) include flanges (23, 25) at opposite ends that are joined to the counterweight (11) and the front frame portion (13), respectively.

5. An industrial truck according to any of claims 1-4, wherein the battery assembly (12) includes a U-shaped member (14, 17) that is open towards the front frame portion (13), the U-shaped member comprising the two longitudinal members (14) and a connecting member (17) that connects the rear ends of the longitudinal members (14) close to the counterweight (11).

6. An industrial truck according to claim 5, wherein the U-shaped member is formed in one piece, is connected to the counterweight (11) by means of releasable fastening means and is connected to the front frame portion (13) by means of releasable fastening

means.

7. An industrial truck according to any of claims 1-6, wherein the housing (15) includes two opposite lateral walls, a first one of said two opposite lateral walls being fixed to a first one of the two longitudinal members (14) and a second one of said two opposite lateral walls being fixed to a second one of the two longitudinal members (14). 5
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8. An industrial truck according to claim 7, wherein the lateral walls of the housing (15) are fixed to the longitudinal members (14) by means of releasable fastening means (22). 15
9. An industrial truck according to claims 7 or 8, wherein the two opposite lateral walls of the housing (15) are substantially vertical and abut against a vertical surface of the longitudinal members (14). 20
10. An industrial truck according to any of claims 1-9, wherein the surface of the battery assembly (12) facing downwards is not in contact with parts of a frame of the industrial truck. 25
11. An industrial truck according to any of claims 1-10, wherein a lower part of housing (15) extends downwardly at a height below the longitudinal members (14). 30
12. An industrial truck according to any of claims 1-11, wherein the longitudinal members (14) have a substantially planar shape and are oriented according to a substantially vertical plane. 35
13. An industrial truck according to claim 5 and 12, wherein the connecting member (17) has a substantially planar shape and is oriented according to a substantially vertical plane. 40
14. An industrial truck according any of the preceding claims, wherein the battery assembly includes a lateral battery module (21) mounted on the side of the industrial truck between one of the longitudinal members and a lateral outer element (20) of the industrial truck configured to protect the lateral battery module (21) from external agents. 45
15. An industrial truck according to any of the preceding claims, wherein the rear ends of the longitudinal members (14) are located at a height entirely above rear wheels of the industrial truck and the front ends of the longitudinal members (14) are at least partly at the height of front wheels of the industrial truck. 50
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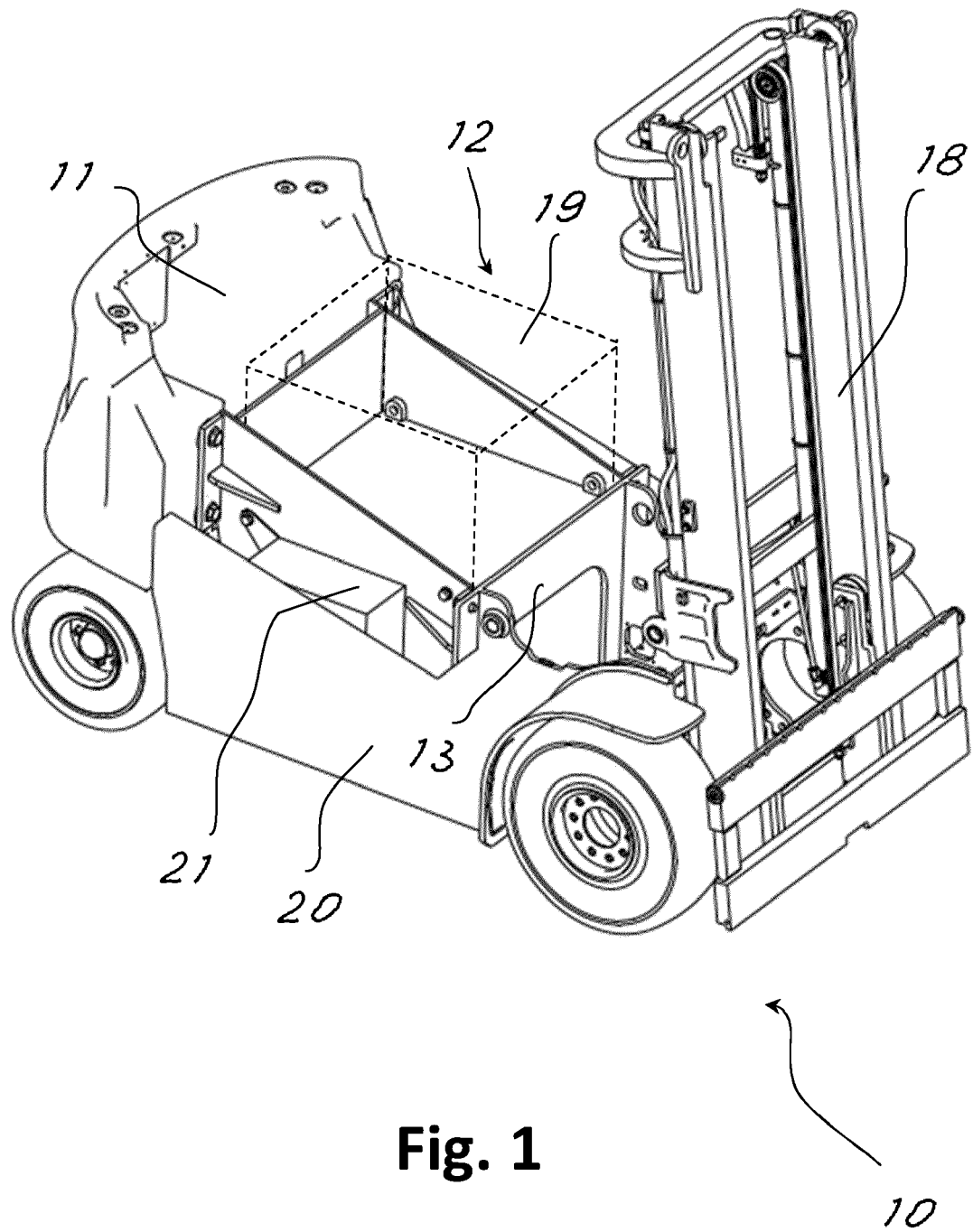


Fig. 1

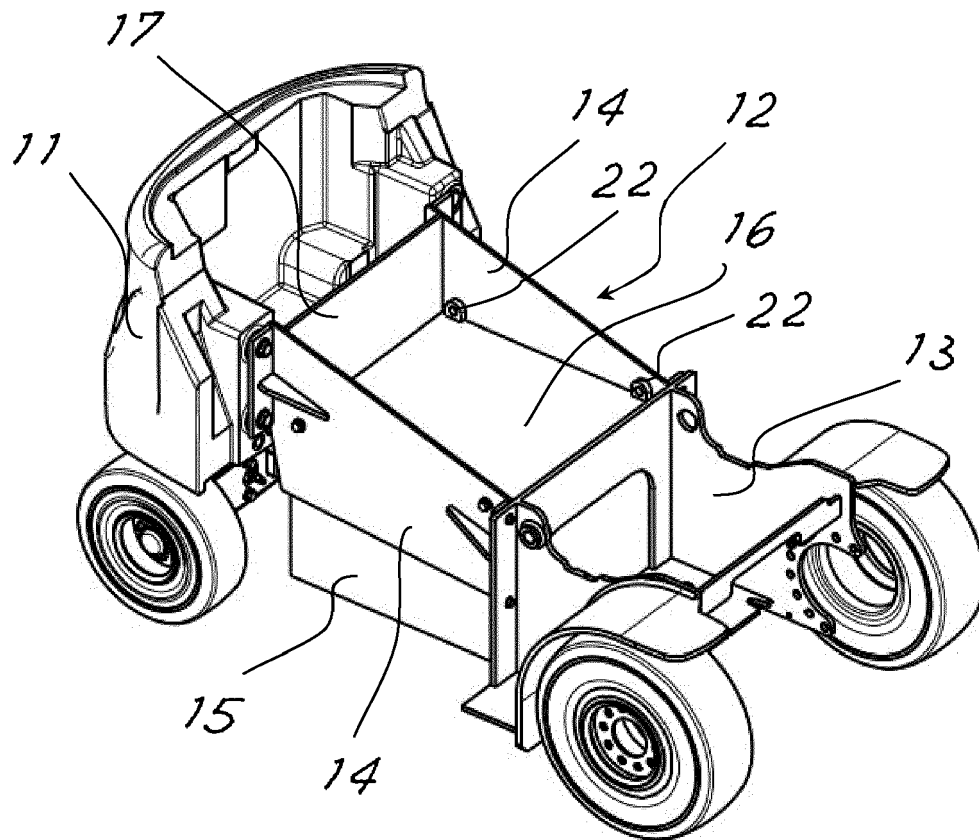


Fig. 2

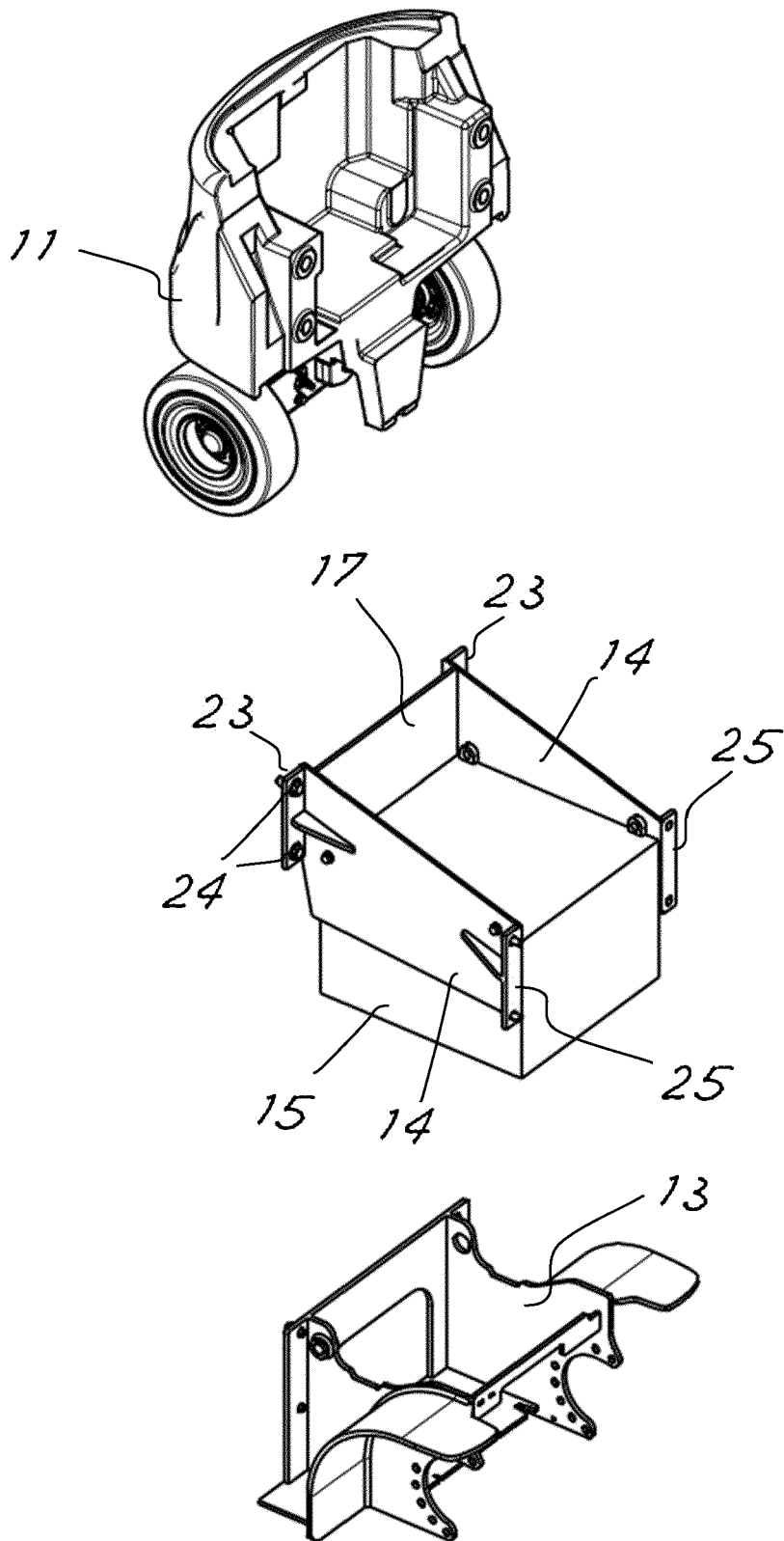


Fig. 3



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Application Number

EP 22 20 9788

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		27 January 2023	Delval, Stéphane
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention	
X : particularly relevant if taken alone		E : earlier patent document, but published on, or after the filing date	
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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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.

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