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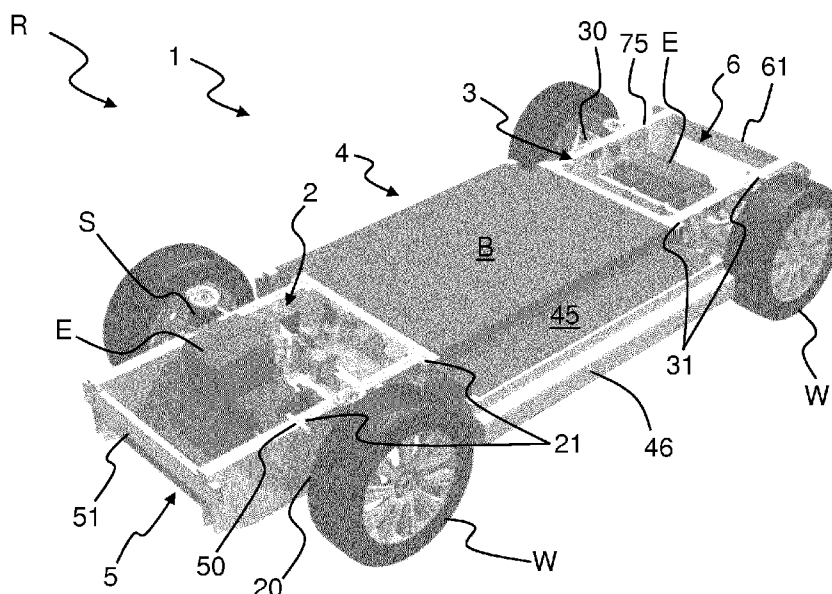


FIGURE 1

(57) **Abstract:** A modular chassis system (1) for a vehicle comprising: first and second modular chassis sections (2, 3), each comprising wheel attachment means (20), a pair of laterally spaced longitudinal beams (71, 81, 72, 82) and modular chassis coupling means (21, 31); and an intermediate modular chassis section (4) comprising energy storage means (B) and intermediate modular chassis coupling means (40) configured to structurally couple the intermediate modular chassis section (4) between the first and second modular chassis sections (2, 3). Each pair of laterally spaced longitudinal beams (71, 81, 72, 82) connect via correspondingly spaced apart longitudinal structures (73, 83) formed in the intermediate modular chassis section (4) when the intermediate modular chassis section (4) is disposed between the first and a second modular chassis sections (2, 3), forming a pair of co-linear, longitudinal beams (7, 8) that extend substantially the length of the vehicle. The longitudinal beams (7, 8) each have a centreline of constant height along the length of the



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**CHASSIS SYSTEM AND METHOD OF ASSEMBLY THEREOF**

## TECHNICAL FIELD

5 The present disclosure relates generally to a chassis system and to a method of assembly thereof. More particularly, but not exclusively, the present invention relates to a modular chassis system and to a method of assembling a modular chassis system. Aspects of the invention relate to a modular chassis system, a vehicle comprising the system, a method of assembling a vehicle chassis system, a kit of parts comprising components of a vehicle chassis system, a first modular chassis section, a second modular chassis section and an intermediate  
10 modular chassis section.

## BACKGROUND

15 It is typically the case in the automotive industry, for example, that a vehicle manufacturer will produce several different vehicle variants or types. Each vehicle variant or type is manufactured on its own platform, where each platform may comprise a particular vehicle chassis into and/or onto which other major vehicle components are mounted.

20 Traditionally, each vehicle variety or type requires its own production line and will have its own, unique, component requirements.

25 However, such separate production lines cause issues with space within manufacturing facilities and increase both the time and expense of manufacture. Such an approach also places significant restrictions on the ability of the manufacturer to produce design variants and/or make adjustments to the underlying vehicle platform or chassis structure.

30 Furthermore, the assembly of a vehicle on a single production line poses challenges with regard to movement and manipulation of vehicles within the production line (particularly towards the end of the production line), due to the weight and size of the partially assembled vehicles.

It is an object of embodiments of the invention to at least mitigate one or more of the problems of the prior art.

## SUMMARY OF THE INVENTION

35 Aspects and embodiments of the invention provide a modular chassis system, a vehicle comprising the system, a method of assembling a vehicle chassis system, a kit of parts comprising components of a vehicle chassis system, a first modular chassis section, a second modular chassis section and an intermediate modular chassis section as claimed in the appended claims.

40 According to an aspect of the invention, there is provided a modular chassis system for a vehicle comprising: a first and a second modular chassis sections, each comprising wheel attachment means, a pair of laterally spaced longitudinal beams and modular chassis coupling means; and an intermediate modular chassis section comprising energy storage means and intermediate modular chassis coupling means configured to structurally couple the intermediate modular chassis section between the first and second modular chassis sections, wherein: each pair  
45 of laterally spaced longitudinal beams connect via correspondingly spaced apart longitudinal structures formed in

the intermediate modular chassis section when the intermediate modular chassis section is disposed between the first and a second modular chassis sections so as to form a pair of co-linear, longitudinal beams that extend substantially the length of the vehicle, wherein the longitudinal beams each have a centreline of constant height along the length of the vehicle and a constant lateral separation from a longitudinal centreline of the vehicle.

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Advantageously, providing a modular chassis system according to the invention allows for a plurality of different chassis profiles (*e.g.* shapes, configurations and/or sizes) to be constructed from a relatively small range of modular chassis sections. Such an approach allows for vehicles of different types (*e.g.* different sizes and/or configurations) to be manufactured without requiring individual production lines for each vehicle type. Additionally, the modular chassis sections can be designed to be versatile, for example such that they are compatible with one or more vehicles or vehicle types. When the modular chassis system is assembled to form a base frame or structure suitable for supporting the body or top hat of a vehicle, the versatility of the system allows for the use of differently shaped, sized or otherwise configured modular chassis sections to thereby form chassis structures for different vehicle types. Furthermore, such a modular chassis system may allow for interchangeability during a vehicle's lifetime, for example to overcome wear and tear or to modify an already existing vehicle. Beneficially, vehicles may thereby be relatively easily and readily repurposed and/or repaired, with attendant cost and time savings with respect to producing a new vehicle from scratch. Furthermore, structurally coupling the chassis sections together provides a chassis structure suitable for use in a vehicle, for example for supporting the top hat or body of a vehicle (*e.g.* in use). Advantageously, a vehicle may thereby be relatively rapidly and readily assembled using such a so-formed chassis structure.

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The wheel attachment means or point may comprise one or more connectors or connections, *e.g.* for connecting to a wheel. The wheel attachment means or point may comprise one or more apertures, *e.g.* for receipt of an axle. The wheel attachment means or point of at least one of the first and second modular chassis sections may comprise steering means or a steering mechanism, for example one or more steering rods, tie rods, kingpins, *etc.* In embodiments, the wheel attachment means or point may comprise suspension means, for example a suspension attachment, connection or mounting point and/or a suspension apparatus.

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Each of the modular chassis sections each comprise a portion of a first and second longitudinal beams or frame rails (which, for the sake of convenience, will hereinafter be referred to as a first longitudinal beams), for example of the chassis structure for the vehicle. The first and second longitudinal beam portions are configured to engage, meet or correspond to one another to form the first and second longitudinal beams, for example when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle. The first and second longitudinal beam portions are substantially straight in at least two planes, for example when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle.

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Provision of straight first and/or second longitudinal beams portions provides a substantially straight load path through a chassis structure for a vehicle. Such a straight load path facilitates dissipation of forces, for example in the event of an impact, whilst reducing the likelihood of buckling or bending of the first and/or second longitudinal beam portions. The effect of such a feature is a more robust chassis system in the event of a vehicle impact and with efficient use of materials so avoiding excessive component weight.

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The first and or second longitudinal beam portions may extend in a direction which is substantially parallel with a principal or longitudinal axis of the modular chassis system or chassis structure, for example when the modular chassis sections are structurally coupled to form the chassis structure.

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The first longitudinal beam portions may be configured to be co-linear in at least one plane and/or the second longitudinal beam portions may be configured to be co-linear in at least one plane, for example when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle.

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Provision of co-linear first and/or second longitudinal beams portions, when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle, provides a substantially straight load path through a chassis structure for a vehicle. Such a straight load path facilitates enhanced resistance and/or dissipation of forces, for example in the event of an impact (*e.g.* a front or rear impact), whilst reducing the likelihood of buckling or bending of the first and/or second longitudinal beam portions. The effect of such a feature is a more robust chassis system in the event of a vehicle impact. We have found that provision of a straight (*e.g.* substantially) first and/or second longitudinal beam (such as may be provided by co-linear longitudinal beam portions) is beneficial when the first and/or second longitudinal beam comprise plural portions configured to engage, meet or correspond to one another to form the first and/or second longitudinal beam. Without wishing to be bound by any theory it is believed that the point of engagement between the plural portions of longitudinal beams may correspond to points of relative weakness, for example stress concentration points. By ensuring that the longitudinal beam is substantially straight, loads (for example from impacts) may be transferred through the longitudinal beams and through the engagement points between the plural portions of the longitudinal beams with a relatively reduced likelihood of distorting or detaching the engagement between the plural portions of the longitudinal beams.

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The first longitudinal beam or portions thereof and second longitudinal beam or portions thereof may be substantially parallel with one another, for example may extend in substantially parallel directions.

The first longitudinal beam and/or second longitudinal beam may extend between a front end of the chassis structure and a rear end of the chassis structure, for example along the length (*e.g.* the majority of the length, substantially the entire length or the entire length) of the chassis structure, *e.g.* when the modular chassis sections are structurally coupled to form the chassis structure. The first longitudinal beam and/or the second longitudinal beam may provide or define a load path (for example a substantially straight load path), *e.g.* between a front end of the chassis structure and a rear end of the chassis structure.

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Provision of the first and/or second longitudinal beams portions extending between a front end of the chassis structure and a rear end of the chassis structure provides a straight load path throughout the chassis structure which beneficially reduces the likelihood of breaking or buckling of the first and/or second longitudinal beams when the chassis structure is subjected to a front or rear impact.

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The first longitudinal beam or portions thereof and/or the second longitudinal beam or portions thereof may comprise elongate profiles, *e.g.* beam sections. The first longitudinal beam or one or more portions thereof and/or the second longitudinal beam or one or more portions thereof may comprise one or more of a U, C, W, Z, T, I or box section. The first longitudinal beam or one or more portions thereof and/or the second longitudinal beam or one or more portions thereof may comprise a rectangular, trapezoidal, rhombohedral or triangular cross-section.

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The energy storage means may be located between the portions of the first and second longitudinal beams within the at least one intermediate modular chassis section.

Providing the energy storage means and/or receptacle between portions of the first and second longitudinal beams provides a degree of protection from both longitudinal and lateral impact forces, reducing the likelihood of damage to the energy storage means and/or components received within the receptacle. Furthermore, providing the energy storage means and/or receptacle in the chassis structure provides a saving of space in the region above the chassis in a finally assembled vehicle. Accordingly, relatively increased volume of space may be available within the top hat (*e.g.* upper part or body) of a finally assembled vehicle. Such increased volume of space may provide relatively enhanced comfort for occupants of a vehicle formed in such a manner and/or may provide greater flexibility with regard to positioning of components such as occupant supports and the like within the top hat.

The modular chassis system may comprise a receptacle. The receptacle may be arranged to receive or retain the or an energy storage means. The receptacle may be located between, for example at least partially bounded by, portions of the first and second longitudinal beams. The receptacle may be further defined between a pair of spaced cross-members, for example extending between the first and second longitudinal beam portions of the intermediate modular chassis section. The cross-members, in combination with portions of the first and second longitudinal beam may provide relatively enhanced protection to the receptacle.

The energy storage means may comprise a power supply or source. The energy storage means may comprise at least one battery module, hydrogen fuel cell, capacitor, supercapacitor and/or fuel container or the like. The at least one battery module (where provided) may be configured to supply power to at least one drive unit of the or a vehicle (for example comprising the modular chassis section when in assembled form, *e.g.* a chassis structure). The at least one battery module may be arranged or configured or arrangeable or configurable to power or at least contribute to powering, in use, the movement of a vehicle incorporating the modular chassis system (*e.g.* when in assembled form).

A component bay may be provided laterally outboard of a central zone, for example defined between the first and second longitudinal beams, and between the wheel attachment means or point of the first and second modular chassis sections, when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle.

Advantageously, provision of a component bay increases the storage capacity of the modular chassis system.

In embodiments, the energy storage means is located between the portions of the first and second longitudinal beams within the intermediate modular chassis section. The energy storage means may comprises at least one battery module configured to supply power to at least one drive unit of the vehicle.

The component bay may be provided in or comprised of the intermediate modular chassis section. The component bay may be described or defined between one of the first and second longitudinal beams of the intermediate modular chassis section and an outer bay member. The outer bay member may be connected or attached to the first or second longitudinal beam portion of the intermediate modular chassis section, *e.g.* at or adjacent each of its ends. In embodiments, the outer bay member may comprise a portion of a sill or sill member.

Advantageously, the outer bay member may provide protection to components stored, received or housed within the component bay, for example from forces from side impacts.

A first component bay may comprise or retain or be configured to receive high voltage electrical components. The first component bay may be provided laterally outboard on a first side of the central zone. A second component bay may comprise or retain or be configured to receive low voltage electrical components. The second component bay may be provided laterally outboard on a second side of the central zone. The first and second component bays may be configured or arranged to separate or isolate (e.g. at least partially) their contents, e.g. high voltage electrical components and low voltage electrical components. The first component bay and second component bay may be separated by the central zone.

In embodiments, the component bay is provided laterally outboard of a central zone defined between the first and second longitudinal beams, and between the wheel attachment means of the first and second modular chassis sections, when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle. The first component bay comprising high voltage electrical components is provided laterally outboard on a first side of the central zone and a second component bay comprising low voltage electrical components is provided laterally outboard on a second side of the central zone.

Providing a pair of component bays increases the storage capacity of the modular chassis system. Additionally, provision of plural component bays allows for the separation of components. Such separation may reduce the risk of damaging a large number of components during an impact to a respective one of the component bays. Additionally or alternatively, such separation may allow components of different types to be received and/or retained in different component bays. For example, one or more component in a first component bay can be at least partially isolated or protected from one or more component in a second component bay.

The modular chassis system may comprise a first end module. The first end module may comprise a first longitudinal beam extension section and/or a second longitudinal beam extension section. The first end module and the first modular chassis section may be provided with coupling or connection means or features for structurally coupling or structurally connecting the first and/or second longitudinal beam extension sections of the first end module to the first and/or second longitudinal beam portions of the first modular chassis section. The first end module may be configured to form a front portion of the chassis structure for the vehicle and may be configured to be sacrificially deformable under crash loads. In particular, the front portion of the chassis structure may be configured to be sacrificially deformable under crash loads from a frontal impact.

The modular chassis system may comprise a second end module. The second end module may comprise a first longitudinal beam extension section and/or a second longitudinal beam extension section. The second end module and the second modular chassis section may be provided with coupling or connection means or features for structurally coupling or structurally connecting the first and/or second longitudinal beam extension sections of the second end module to the first and/or second longitudinal beam portions of the second modular chassis section. The second end module may be configured to form a rear portion of the chassis structure for the vehicle and may be configured to be sacrificially deformable under crash loads. In particular, the rear portion of the chassis structure may be configured to be sacrificially deformable under crash loads from a rear impact.

The first longitudinal beam extension section and/or the second longitudinal beam extension section and/or the first end module and/or second end module may be configured or arranged to preferentially deform during impact (e.g. front or rear impact) of a vehicle comprising the modular chassis system. In embodiments, the first longitudinal beam extension section and/or the second longitudinal beam extension section or the first end module and/or second end module may be formed of a relatively less strong material than are the first and/or second modular

chassis sections and/or the portions of the first and/or second longitudinal beams comprised thereon. In embodiments, the first and second longitudinal beam extension sections or the first and second end modules may be formed with predetermined zones of localised weakness, defining a predetermined zone for energy absorption through controlled deformation in the event of an impact.

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In embodiments, the first longitudinal beam extension section and/or the second longitudinal beam extension section may be sized and/or shaped to preferentially deform during impact (*e.g.* front or rear impact) of a vehicle comprising the modular chassis system. In embodiments, the first longitudinal beam extension section and/or the second longitudinal beam extension section may be formed from a relatively thinner material than are the first and/or second modular chassis sections and/or the portions of the first and/or second longitudinal beams comprised thereon.

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Advantageously, provision of sacrificially deformable first and/or second end modules protects the first, second and/or the at least one intermediate modular chassis sections from damage during impact of a vehicle comprising the modular chassis system. Energy from an impact may be at least partially absorbed and/or dissipated by deformation (*e.g.* at least partial crumpling or collapse) of the sacrificially deformable first and/or second end modules. Accordingly, such first and/or second end modules may provide a relatively less expansive and readily replaceable component than the modular chassis sections. In the event of an impact the cost and/or time of repair or replacement may, therefore, be relatively reduced through provision of such sacrificially deformable first and/or second end modules.

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The at least one intermediate modular chassis section may comprise one or more sub-modules. The or each sub-module may be provided with modular chassis connection features, for example for structurally connecting the sub-modules.

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Having an intermediate modular chassis section comprising one or more sub-modules provides the ability to alter the dimensions, shape and/or other characteristics of the intermediate modular chassis section (and of a chassis structure comprising the same). In this way, vehicles of different types may be manufactured on the same production line regardless of their size, shape or other characteristics.

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One or each of the one or more sub-modules may comprise a receptacle, for example for receiving one or more energy storage means.

One, some or each of the modular chassis coupling or connection means or features may be provided at interfaces or joins between the longitudinal beam portions. One, some or each of the modular chassis coupling or connection means or features may be configured to transfer longitudinal crash or impact loads between adjacent chassis modules, *e.g.* along the longitudinal beam portions.

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Advantageously, transferring longitudinal crash or impact loads between adjacent chassis modules enhances the ability of a chassis structure formed from the modular chassis system to resist impact loading. Without wishing to be bound by any particular theory, it is believed that allowing an impact load to be transferred along the length of a chassis structure helps to prevent concentration of stresses at particular points within the chassis structure, which might otherwise result in excessive deformation of the chassis structure.

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One or more of the modular chassis coupling or connection means or features may be arranged or configured or adapted to allow or provide for selective decoupling following coupling, for example to allow separation of the relevant modular chassis sections.

- 5 Advantageously, providing modular chassis coupling or connection means or features arranged to allow selective decoupling increases the adaptability and flexibility of the modular chassis. For example, it allows for simple replacement of chassis components in the event of a required or desired vehicle alteration or for replacement or repair in the event of chassis structure damage (e.g. due to an impact).
- 10 The modular chassis coupling or connection means or features of one of the modular chassis sections may comprise one or more features or connectors arranged to correspond, cooperate and/or mate with the coupling or connection means or features of another one of the modular chassis sections (for example releasably or non-releasably). The modular chassis system may comprise a first modular chassis coupling, e.g. for structurally coupling the first modular chassis section to the or one of the at least one intermediate modular chassis sections.
- 15 The first modular chassis coupling may comprise the modular chassis coupling or connection means or features of the first modular chassis section, e.g. and a first portion of the modular chassis coupling or connection means or features of the or one of the at least one intermediate modular chassis sections. The modular chassis system may comprise a second modular chassis coupling, e.g. for structurally coupling the second modular chassis section to the or one of the at least one intermediate modular chassis sections. The second modular chassis coupling may
- 20 comprise the modular chassis coupling or connection means or features of the second modular chassis section, e.g. and a second portion of the modular chassis coupling or connection means or features of the or one of the at least one intermediate modular chassis sections. The modular chassis coupling or connection means or features may comprise any suitable means or feature or connector, for example allowing for selective decoupling following coupling. The modular chassis coupling or connection means or features may comprise one or more rigid, inflexible
- 25 joints, for example to couple the sections/modules/sub-modules to form a single conjoined structure. The modular chassis coupling or connection means or features may comprise or define one or more of a bolted joint, a sleeved joint and a slotted joint (e.g. at least part thereof).

- Such coupling or connection means or features provide for a strong and reliable coupling when coupled, but also
- 30 allow for relatively quick and simple decoupling (where such decoupling is provided). Advantageously, assembly of the modular sections into a chassis structure may be achieved relatively rapidly and readily. Moreover, where the coupling or connection means or features are decouplable, decoupling of one or more of the modular sections may be achieved relatively rapidly and readily.

- 35 At least one of the first and second modular chassis sections may comprise at least one drive unit. At least one of the first and second modular chassis sections may comprise drive-by-wire drive unit control and/or steering control and/or brake control.

- The first modular chassis section, second modular chassis section and at least one intermediate modular chassis
- 40 section may describe or define a three-box or three-volume-form, for example when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle.

The modular chassis system may be assembled to form a vehicle chassis structure, for example a vehicle skateboard. The modular chassis system may be assembled to form a rolling chassis.

According to another aspect of the invention, there is provided a modular chassis system for a vehicle comprising a first modular chassis section comprising wheel attachment means or point and modular chassis coupling or connection means or features for structurally coupling the first modular chassis section to an intermediate modular chassis section; a second modular chassis section comprising wheel attachment means or point and modular chassis coupling or connection means or features for structurally coupling the second modular chassis section to a or the intermediate modular chassis section; and at least one intermediate modular chassis section comprising modular chassis coupling or connection means or features for structurally coupling the at least one intermediate modular chassis between two other modular chassis sections, wherein: the modular chassis sections are configured to be structurally coupled in series to form a chassis structure for the vehicle such that the at least one intermediate modular chassis section is disposed between the first and second modular chassis sections within the chassis structure.

According to another aspect of the invention, there is provided a modular chassis system for a vehicle comprising a first modular chassis section comprising wheel attachment means or point and modular chassis coupling or connection means or features for structurally coupling the first modular chassis section to an intermediate modular chassis section; a second modular chassis section comprising wheel attachment means or point and modular chassis coupling or connection means or features for structurally coupling the second modular chassis section to a or the intermediate modular chassis section; and at least one intermediate modular chassis section comprising energy storage means and modular chassis coupling or connection means or features for structurally coupling the at least one intermediate modular chassis between two other modular chassis sections, wherein: the modular chassis sections are configured to be structurally coupled in series to form a chassis structure for the vehicle such that the at least one intermediate modular chassis section is disposed between the first and second modular chassis sections within the chassis structure.

According to another aspect of the invention, there is provided a first modular chassis section as described herein.

According to yet another aspect of the invention, there is provided a second modular chassis section as described herein.

According to a further aspect of the invention, there is provided an intermediate modular chassis section as described herein.

According to another aspect of the invention, there is provided a vehicle comprising a modular vehicle chassis system as described herein. The vehicle may comprise a top hat or upper body portion, for example mounted to the chassis structure formed from the modular vehicle chassis system.

According to yet another aspect of the invention, there is provided a kit of parts comprising a first modular chassis section, a second modular chassis section and at least one intermediate modular chassis section as described herein.

According to still another aspect of the invention, there is provided a method of assembly of a modular chassis system for a vehicle, the method comprising: structurally coupling a first modular chassis section comprising wheel attachment means or point to an intermediate modular chassis section; structurally coupling a second modular chassis section comprising wheel attachment means or point to the or an intermediate modular chassis section; where the, or at least one of the, intermediate modular chassis section comprise energy storage means; wherein

the modular chassis sections are structurally coupled in series to form a chassis structure for a vehicle such that the or each intermediate modular chassis section is disposed between the first modular chassis section and the second modular chassis sections within the chassis structure.

5 According to a further aspect of the invention, there is provided a method of assembly of a modular chassis system for a vehicle, the method comprising: structurally coupling a first modular chassis section comprising wheel attachment means, a pair of laterally spaced longitudinal beams and modular chassis coupling means, to an intermediate modular chassis section also comprising a pair of laterally spaced longitudinal beams; structurally  
10 coupling a second modular chassis section comprising wheel attachment means to the or an intermediate modular chassis section; where the, or at least one of the, intermediate modular chassis section comprise energy storage means located between the pair of laterally spaced longitudinal beams and intermediate modular chassis coupling means configured to structurally couple the intermediate modular chassis section between the first and second modular chassis sections; wherein the modular chassis sections are structurally coupled in series to form a chassis structure terminated at each end by a modular chassis section when each pair of laterally spaced longitudinal  
15 beams are connected together via correspondingly spaced apart longitudinal structures formed in the intermediate modular chassis section when the intermediate modular chassis section is disposed between the first and a second modular chassis sections so as to form a pair of co-linear, longitudinal beams that extend substantially the length of the vehicle and, wherein the first modular chassis section, the intermediate modular chassis section and the second modular chassis section are assembled together when the spaced longitudinal beams are structurally  
20 connected together, such that the longitudinal beams when so assembled, each having a centreline of constant height along the length of the vehicle and a constant lateral separation from a longitudinal centreline of the vehicle.

Advantageously, the method of assembly of a modular chassis system according to the invention provides for the handling of relatively smaller components which are relatively more manageable than is the case with manipulation  
25 of an entire vehicle chassis. Furthermore, the modular chassis system allows the manufacture of the vehicle to be carried out by first associating or mounting vehicle components with or on each modular chassis section and, at least initially, assembling the vehicle on a modular basis. Then, each modular chassis section can be structurally coupled together to form a chassis structure for a vehicle. In this way, a rolling chassis may be produced prior to installing upper body components (*e.g.* the top hat) of a vehicle.

30 The method may comprise locating or installing high voltage electrical components within a first component bay comprised in or on the, one or each of the intermediate modular chassis sections.

35 The method may comprise locating or installing low voltage electrical components within a second component bay comprised in or on the, one or each of the intermediate modular chassis sections.

The method may comprise structurally coupling a first end module (*e.g.* comprising a first longitudinal beam extension section and a second longitudinal beam extension section) to the first modular chassis section, for example such that the first end module forms or describes a front portion of the chassis structure.

40 The method may comprise structurally coupling a second end module (*e.g.* comprising a first longitudinal beam extension section and a second longitudinal beam extension section) to the second modular chassis section, for example such that the second end module forms or describes a rear portion of the chassis structure.

The method may comprise structurally coupling one or more sub-modules to one another to form the or an intermediate modular chassis section.

In embodiments, structurally coupling any of the first modular chassis section, the second modular chassis section, the or each intermediate modular chassis section, the first end module, the second end module and/or one or more sub-modules may comprise providing one or more rigid, inflexible joints to couple the sections/modules/sub-modules to form a single conjoined structure.

In embodiments, structurally coupling any of the first modular chassis section, the second modular chassis section, the or each intermediate modular chassis section, the first end module, the second end module and/or one or more sub-modules may comprise releasably coupling (*e.g.* to allow selective decoupling) of the sections and/or modules, for example to allow separation of the relevant modular chassis sections.

The method may comprise locating or installing at least one drive unit in at least one of the first and second modular chassis sections.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination that falls within the scope of the appended claims. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination that falls within the scope of the appended claims, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a vehicle chassis structure assembled from a modular chassis system according to an embodiment of the invention;

Figure 2 shows an exploded and simplified schematic plan view of the modular chassis system shown in Figure 1;

Figure 3 shows an exploded schematic plan view of a modular chassis system according to a further embodiment of the invention;

Figure 4 shows a schematic plan view of the modular chassis system of Figure 3 assembled into a chassis structure;

Figure 5 shows a schematic exploded plan view of a modular chassis system according to a further embodiment of the invention; and

Figure 6 shows a side view of a vehicle according to an embodiment of the invention.

#### DETAILED DESCRIPTION

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Referring now to Figures 1 and 2, there is shown a modular chassis system 1 (which has been assembled into a chassis structure as part of a rolling chassis R in Figure 1) according to an embodiment of the invention.

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The modular chassis system 1 comprises a first modular chassis section 2, a second modular chassis section 3, an intermediate modular chassis section 4, a first end module 5 and a second end module 6. In assembled form (as shown in Figure 1) the modular chassis system 1 comprises a first longitudinal beam 7 and a second longitudinal beam 8.

15

The first modular chassis section 2 comprises a pair of wheel attachment points 20 for connecting wheels W thereto. The pair of wheel attachment points 20 are located either side of a longitudinal axis L of the modular chassis system 1 in assembled form. The first modular chassis section 2 comprises a first portion 71 of the first longitudinal beam 7 and a first portion 81 of the second longitudinal beam 8. One of the wheel attachment points 20 of the first modular chassis section 2 is formed on a respective one of the first portion 71, 81 of the first and second longitudinal beams 7, 8 and the other of the wheel attachment points 20 is formed on the other of the first portion 71, 81 of the first and second longitudinal beam 7, 8.

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The first modular chassis section 2 comprises coupling means 21 for structurally coupling the first modular chassis section 2 to the intermediate modular chassis section 4 and the first end module 5. The coupling means 21 comprise part of bolted joints in this embodiment. More specifically, the part of the bolted joints comprise one or more nuts and bolts and plates provided with one or more bolt holes (not shown) extending through the thickness thereof. The coupling means 21 are provided at each end of each respective first portion 71, 81 of the first and second longitudinal beam 7, 8. The coupling means 21 allow for selective coupling and decoupling of the first modular chassis section 2 and intermediate modular chassis section 4 and the first modular chassis section 2 and the first end module 7.

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The second modular chassis section 3 comprises a pair of wheel attachment points 30 for connecting wheels W thereto. The pair of wheel attachment points 30 are located either side of the longitudinal axis L of the modular chassis system 1 in assembled form. The second modular chassis section 3 comprises a second portion 72 of the first longitudinal beam 7 and a second portion 82 of the second longitudinal beam 8. One of the wheel attachment points 30 of the second modular chassis section 3 is formed on a respective one of the second portion 72, 82 of the first and second longitudinal beams 7, 8 and the other of the wheel attachment points 30 is formed on the other of the second portion 72, 82 of the first and second longitudinal beam 7, 8.

35

In the present embodiment, the wheel attachment points 20, 30 comprise a steering mechanism, for example having steering rods, tie rods, and/or kingpins and the like. Additionally, a suspension link S is disposed adjacent each wheel W, in this embodiment.

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The second modular chassis section 3 comprises coupling means 31 for structurally coupling the first modular chassis section 3 to the intermediate modular chassis section 4 and the first end module 5. The coupling means 31 comprise part of bolted joints in this embodiment. More specifically, the part of the bolted joints comprise one

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or more nuts and bolts and plates provided with one or more bolt holes (not shown) extending through the thickness thereof. The coupling means 31 are provided at each end of each respective second portion 72, 82 of the first and second longitudinal beam 7, 8. The coupling means 31 allow for selective coupling and decoupling of the second modular chassis section 3 and intermediate modular chassis section 4 and the second modular chassis section 3 and the second end module 6.

The intermediate modular chassis section 4 comprises a further portion 73 of the first longitudinal beam 7 and a further portion 83 of the second longitudinal beam 8. The intermediate modular chassis section 4 comprises an energy storage means which comprises a battery module B, in this embodiment. The battery module B is located inboard of the further portions 73, 83 of the first and second longitudinal beams 7, 8.

The intermediate modular chassis section 4 comprises coupling means 40 for structurally coupling the intermediate modular chassis section 4 to the first modular chassis section 2 and to the second modular chassis section 3. The coupling means 40 comprises part of bolted joints in this embodiment. More specifically, the part of the bolted joints comprises plates provided with one or more bolt holes (not shown) extending through the thickness thereof. The coupling means 40 are provided at each end of each respective further portion 73, 83 of the first and second longitudinal beam 7, 8. The coupling means 40 allow for selective coupling and decoupling of the intermediate modular chassis section 4 and first modular chassis section 2 and the intermediate modular chassis section 4 and the second modular chassis section 3.

A first cross-member 41a extends from adjacent a first end of the further portion 73 of the first longitudinal beam 7 to adjacent a first end of the further portion 83 of the second longitudinal beam 8. A second cross-member 41b extends from adjacent the second end of the further portion 73 of the first longitudinal beam 7 to adjacent the second end of the further portion 83 of the second longitudinal beam 8.

The intermediate modular chassis section 4 comprises a receptacle 42 at least partially bound by further portions 73, 83 of the first and second longitudinal beam 7, 8 and by cross-members 41a, 41b. The battery module B is located in the receptacle 42.

A first component bay 43 is provided laterally outboard of the receptacle 42. The first component bay 43 is located between wheel attachment points 20, 30, when the modular chassis system 1 is in assembled form. The first component bay 43 is defined between further portion 73 of the first longitudinal beam 7 and a first outer bay member 44.

A second component bay 45 is provided laterally outboard of the receptacle 42, to the obverse side of the longitudinal axis L than is the first component bay 43. The second component bay 46 is located between wheel attachment points 20, 30, when the modular chassis system 1 is in assembled form. The second component bay 45 is defined between further portion 83 of the second longitudinal beam 8 and a second outer bay member 46.

The first end module 5 comprises a first longitudinal beam extension 74 of the first longitudinal beam 7 and a second longitudinal beam extension 84 of the second longitudinal beam 8. Coupling means 50 (configured to structurally couple the first end module 5 to the first modular chassis section 2) are provided at or adjacent an end of each of the first and second longitudinal beam extensions 74, 84. The coupling means 50, which comprise part of bolted joints in this embodiment, are arranged to cooperate with and couple to the coupling means 21 of the first

modular chassis section 2. The coupling means 50 allow for selective coupling and decoupling of the first end module 5 and first modular chassis section 2.

The first end module 7 comprises a cross-member 51 which extends between the first and second longitudinal beam extensions 74, 84, at or adjacent ends thereof opposite to the ends comprising the coupling means 50. The cross-member 51 provides or defines a front portion of the modular chassis system 1 when it has been assembled, in this embodiment. The cross-member 51 may take the form of a front bumper beam and the first and second longitudinal beam extensions 74, 84 may take the form of crush cans arranged together to provide readily replaceable sacrificial energy absorbers that mitigate against otherwise potentially costly vehicle damage in the event of a low speed frontal impact.

The second end module 6 comprises a first longitudinal beam extension 75 of the first longitudinal beam 7 and a second longitudinal beam extension 85 of the second longitudinal beam 8. Coupling means 60 (configured to structurally couple the second end module 6 to the second modular chassis section 3) are provided at or adjacent an end of each of the first and second longitudinal beam extensions 75, 85. The coupling means 60, which comprise part of bolted joints in this embodiment, are arranged to cooperate with and couple to the coupling means 31 of the second modular chassis section 3. The coupling means 60 allow for selective coupling and decoupling of the second end module 6 and second modular chassis section 3.

The second end module 6 comprises a cross-member 61 which extends between the first and second longitudinal beam extensions 75, 85, at or adjacent ends thereof opposite to the ends comprising the coupling means 60. The cross-member 61 provides or defines a rear portion of the modular chassis system 1 when it has been assembled, in this embodiment. The cross-member 61 may take the form of a rear bumper beam and the first and second longitudinal beam extensions 75, 85 may take the form of crush cans arranged together to provide readily replaceable sacrificial energy absorbers that mitigate against otherwise potentially costly vehicle damage in the event of a low speed rear impact.

The portions 71, 72, 73 and first longitudinal beam extensions 74, 75 of the first longitudinal beam 7 and the portions 81, 82, 83 and the second longitudinal beam extensions 84, 85 of the second longitudinal beam 8 are formed as C-sections, in this embodiment. In embodiments, however, one, some or each may be formed with any suitable cross-sectional shape, for example having U, W, Z, T, I or box section or the like.

The first longitudinal beam extensions 74, 75 and second longitudinal beam extensions 84, 85 are configured to be relatively more deformable or breakable under crash loads (e.g. impact loads) than are the portions 71, 72, 73, 81, 82, 83 of the first and second longitudinal beams 7, 8. In this embodiment, the first and second longitudinal beam extensions 74, 75, 84, 85 are formed of relatively thinner gauge material than are the portions 71, 72, 73, 81, 82, 83 of the first and second longitudinal beams 7, 8. In embodiments, however, the first and second longitudinal beam extensions 74, 75, 84, 85 may, additionally or alternatively, be formed with pre-defined weak-points or frangible portions or one or more fused portion.

The modular chassis system 1 is assembled (as shown in Figure 1) by structurally coupling:

- the first modular chassis section 2 to the intermediate modular chassis section;
- the second modular chassis section 3 to the intermediate modular chassis section 4;
- the first end module 5 to the first modular chassis section 2; and
- the second end module 6 to the second modular chassis section 3.

The modular chassis sections 2, 3, 4 are structurally coupled in series to form the chassis structure such that the intermediate modular chassis section 4 is disposed between the first and second modular chassis sections 2, 3.

- 5 Structural coupling in the present embodiment comprises forming the bolted joints between each modular chassis section 2, 3, 4 and between the first end module 5 and the first modular chassis section 2 and between the second end module 6 and the second modular chassis section 3.

10 When the modular chassis system 1 is assembled, each of the portions 71, 72, 73 and first longitudinal beam extensions 74, 75 of the first longitudinal beam 7 are colinear and are engaged together to thereby define the first longitudinal beam 7. When the modular chassis system 1 is assembled, each of the portions 81, 82, 83 and the second longitudinal beam extensions 84, 85 of the second longitudinal beam 8 are colinear and are engaged together to define the second longitudinal beam 8. The first and second longitudinal beams 7, 8 are parallel with one another and with the longitudinal axis L of the modular chassis 1. One of the first and second longitudinal beams 7, 8 is disposed to one side of the longitudinal axis L and the other of the first and second longitudinal beams 7, 8 is disposed to the other side of the longitudinal axis L.

Figure 2 is provided with arrows representing a load path through the modular chassis system 1 (when in assembled form), for example during an impact to the front portion thereof. The first and second longitudinal beams 7, 8 provide a linear load path through the modular chassis system 1, parallel with the longitudinal axis L from the front portion to the rear portion of the modular chassis system 1. Advantageously, the linear load path provided by the first and second longitudinal beams 7, 8 allows the modular chassis system 1 in assembled form to absorb and transmit impact forces along its length instead of concentrating loading at particular positions along the length of the modular chassis system 1. In this way, the likelihood of breaking and/or bucking of the chassis structure formed from the modular chassis system when it is assembled is relatively reduced.

Advantageously, configuration of the first and second longitudinal beam extensions 74, 75, 84, 85 to be relatively more deformable and/or frangible under crash load than are the portions 71, 72, 73, 81, 82, 83 of the first and second longitudinal beams 7, 8 provides protection of the first, second and intermediate modular chassis sections 2, 3, 4 from crash loads. The energy imparted by a crash will be at least partially absorbed in the first and/or second end module 5, 6 by the deformation and/or breakage and, therefore, the total energy transmitted to the first, second and intermediate modular chassis sections 2, 3, 4.

35 When the modular chassis system 1 is in assembled form, the first modular chassis section 2 has a receptacle 22 defined therein. The receptacle 22 is partially bounded by the first portions 71, 81 of the first and second longitudinal beams 7, 8 and by the cross-member 41a of the intermediate modular chassis section 4. A drive unit E which comprises an electric motor E, in this embodiment, is located in the receptacle 22 of the first modular chassis section 2. The electric motor E is operatively connected to the wheels W attached to wheel attachment points 20.

40 When the modular chassis system 1 is in assembled form, the second modular chassis section 3 has a receptacle 32 defined therein. The receptacle 32 is partially bounded by the second portions 72, 82 of the first and second longitudinal beams 7, 8 and by the cross-member 41b of the intermediate modular chassis section 4. A drive unit E which comprises an electric motor E, in this embodiment, is located in the receptacle 32 of the second modular chassis section 3. The electric motor E is operatively connected to the wheels W attached to wheel attachment points 30. The battery module B is configured to supply power to at least one of the electric motors E.

In some embodiments, a drive-by-wire drive unit control, a steering control and/or a brake control may be disposed in either or both of the receptacles 22, 32 of the first and second modular chassis sections 2, 3.

5 Referring now to Figures 3 and 4, there is shown a modular chassis system 11 according to a further embodiment of the invention in which like features to those described in respect of the modular chassis system 1 shown in Figures 1 and 2 are denoted by like references preceded by a '1' and will not be described further herein. The modular chassis system 11 (in both assembled and disassembled form) differs from the modular chassis system 1 shown in Figures 1 and 2 in that it is absent first and second end modules 5, 6. Accordingly, the first and second  
10 modular chassis sections 12, 13 may be provided without coupling means 21, 31 at their free ends for coupling to first and second end modules 5, 6. Additionally or alternatively, the first and second modular chassis sections 12, 13 may be provided with coupling means for structurally coupling to one or more further components, sections or modules.

15 As shown in Figure 4, low voltage electrical components LV can be received in the first component bay 143, whilst high voltage electrical components HV can be received in the second component bay 145. Advantageously, such an arrangement ensures that the high voltage electrical components HV are spaced and separated from the low voltage electrical components LV and that both are spaced and separated from the battery modules B by the further portions 173, 183 of the first and second longitudinal beams 17, 18. Furthermore, the first component bay  
20 143 provides protection to the low voltage electrical components LV by virtue of the outer bay member 144 whilst the second component bay 145 provides protection to the high voltage electrical components HV by virtue of the outer bay member 146.

Referring now to Figure 5 there is shown a modular chassis system 21 according to a further embodiment of the invention in which like features to those described in respect of the modular chassis system 1 shown in Figures 1  
25 and 2 are denoted by like references preceded by a '2' and will not be described further herein. The modular chassis system 21 (in both assembled and disassembled form) differs from the modular chassis system 1 shown in Figures 1 and 2 in that it is absent first and second end modules 5, 6 and in that the intermediate modular chassis section 24 is formed from two sub-modules 24a and 24b arranged to be structurally coupled together to form  
30 intermediate modular chassis section 24.

Each respective sub-module 24a, 24b comprises a further portion 273a, 273b of the first longitudinal beam 27 and a further portion 283a, 283b of the second longitudinal beam 28. Each respective sub-module 24a, 24b comprises first and second outer bay member portions 244a, 244b, 246a, 246b. Sub-module 24a comprises cross-member  
35 247a which extends transversely to the further portions 273a, 283a and from the first outer bay member portion 244a to the second outer bay member portion 246a. Sub-module 24b comprises cross-member 247b which extends transversely to the further portions 273b, 283b and from the first outer bay member portion 244b to the second outer bay member portion 246b.

40 Each of the cross-members 247a, 247b comprise holes (not shown) extending therethrough and arranged to cooperate with one another such that a respective threaded fastener such as a bolt can be received therethrough to form a bolted joint, in this embodiment. In this way, the cross-members 247a, 247b comprise coupling means for structurally coupling the sub-modules 24a, 24b of the intermediate modular chassis section 24 together.

When the sub-modules 24a, 24b are structurally coupled together, the further portions 273a, 273b of the first longitudinal beam 27 and the further portions 283a, 283b of the second longitudinal beam 28 are each co-linear. An intermediate modular chassis segment 24 is thereby formed by structural coupling of the sub-modules 24a, 24b to one another. The intermediate modular chassis segment 24 is similar to the intermediate modular chassis segment 4 shown in Figures 1 and 2 except that two receptacles 242a, 243b, two first component bays 243a, 243b and two second component bays 245a, 245b are provided.

Referring now to Figure 6, there is shown a vehicle V according to an embodiment of the invention. The vehicle V comprises a modular chassis system 1 in assembled form (as a chassis structure).

Although the coupling means in the above-described embodiments are described as being bolted joints, this need not be the case. Some or all of the coupling means may be any combination of a bolted joint, a sleeved joint, a slotted joint or any other suitable coupling mechanism.

Additionally or alternatively, although the coupling means are described as allowing selective decoupling, this need not be the case and, instead, one, some or each of the coupling means may be a permanent or semi-permanent coupling or connection. Where a permanent or semi-permanent coupling or connection is provided this may comprise welding, adhesive or any other suitable means of coupling or connection.

Additionally or alternatively, although only one intermediate modular chassis section 4, 14 is shown in the modular chassis systems 1, 11 shown in Figures 1 to 4 this need not be the case and, instead, any number of intermediate modular chassis sections may be provided. Additionally or alternatively, the, one, some or each intermediate modular chassis section 4, 14 may be formed from sub-modules of any suitable number, shape, size or configuration.

Additionally or alternatively, the first and/or second component bays may not be provided.

It will also be appreciated by those skilled in the art that any number of combinations of the aforementioned features and/or those shown in the appended drawings provide clear advantages over the prior art and are therefore within the scope of the invention described herein.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed. The claims should not be construed to cover merely the foregoing embodiments, but also any embodiments which fall within the scope of the claims.

## CLAIMS

1. A modular chassis system for a vehicle comprising:
  - a first and a second modular chassis sections, each comprising wheel attachment means, a pair of
  - 5 laterally spaced longitudinal beams and modular chassis coupling means;
  - and
  - an intermediate modular chassis section comprising energy storage means and intermediate modular chassis coupling means configured to structurally couple the intermediate modular chassis section between the first and second modular chassis sections, wherein:
  - 10 each pair of laterally spaced longitudinal beams connect via correspondingly spaced apart longitudinal structures formed in the intermediate modular chassis section when the intermediate modular chassis section is disposed between the first and a second modular chassis sections so as to form a pair of co-linear, longitudinal beams that extend substantially the length of the vehicle, wherein the longitudinal beams each have a centreline of constant height along the length of the vehicle and a constant lateral separation
  - 15 from a longitudinal centreline of the vehicle.
2. A modular chassis system according to claim 1, wherein the energy storage means is located between the portions of the first and second longitudinal beams within the intermediate modular chassis section.
- 20 3. A modular chassis system according to claim 1 or claim 2, wherein the energy storage means comprises at least one battery module configured to supply power to at least one drive unit of the vehicle.
4. A modular chassis system according to any of any preceding claim, wherein a component bay is provided laterally outboard of a central zone defined between the first and second longitudinal beams, and between
- 25 the wheel attachment means of the first and second modular chassis sections, when the modular chassis sections are structurally coupled to form the chassis structure for the vehicle.
5. A modular chassis system according to claim 4, wherein a first component bay comprising high voltage electrical components is provided laterally outboard on a first side of the central zone and a second
- 30 component bay comprising low voltage electrical components is provided laterally outboard on a second side of the central zone.
6. A modular chassis system according to any preceding claim, the modular chassis system comprising a first end module, wherein the first end module comprises a first longitudinal beam extension section and a
- 35 second longitudinal beam extension section and wherein the first end module and the first modular chassis section are provided with coupling means for structurally coupling the first and second longitudinal beam extension sections of the first end module to the first and second longitudinal beam portions of the first modular chassis section, wherein the first end module is configured to form a front portion of the chassis structure for the vehicle and is configured to be sacrificially deformable under frontal crash loads.
- 40 7. A modular chassis system according to any preceding claim, the modular chassis system comprising a second end module, wherein the second end module comprises a first longitudinal beam extension section and a second longitudinal beam extension section and wherein the second end module and the second modular chassis section are provided with coupling means for structurally coupling the first and second
- 45 longitudinal beam extension sections of the second end module to the first and second longitudinal beam

portions of the second modular chassis section, wherein the second end module is configured to form a rear portion of the chassis structure for the vehicle and is configured to be sacrificially deformable under rear crash loads.

- 5 8. A modular chassis system according to any preceding claim, where the at least one intermediate modular chassis section comprises one or more sub-modules provided with modular chassis coupling means for structurally coupling the sub-modules.
9. A modular chassis system according to any preceding claim, wherein the modular chassis coupling means are provided at interfaces between the longitudinal beam portions, and are configured to transfer longitudinal crash loads between adjacent chassis modules along the longitudinal beam portions.
- 10 10. A modular chassis system according to any preceding claim, where one or more of the modular chassis coupling means are arranged to allow selective decoupling following coupling to allow separation of the relevant modular chassis sections.
- 15 11. A modular chassis system according to any preceding claim, wherein the modular chassis coupling means define one or more of a bolted joint, a sleeved joint and a slotted joint.
- 20 12. A modular chassis system according to any preceding claim, wherein at least one of the first and second modular chassis sections comprises at least one drive unit.
13. A modular chassis system according to any preceding claim, wherein the wheel attachment means of at least one of the first and second modular chassis sections comprises steering means.
- 25 14. A modular chassis system according to claim 12 or claim 13, wherein at least one of the first and second modular chassis sections comprises drive-by-wire drive unit control and/or steering control and/or brake control.
- 30 15. A modular chassis system according to any preceding claim, where the modular vehicle chassis system is assembled to form a vehicle chassis structure.
16. A first modular chassis section according to any of claims 1 to 14.
- 35 17. A second modular chassis section according to any of claims 1 to 14.
18. An intermediate modular chassis section according to any of claims 1 to 14.
19. A vehicle comprising a modular chassis system according to any of claims 1 to 14.
- 40 20. A kit of parts comprising a first modular chassis section, a second modular chassis section and at least one intermediate modular chassis section according to any of claims 1 to 14.
21. A method of assembly of a modular chassis system for a vehicle, the method comprising:

structurally coupling a first modular chassis section comprising wheel attachment means, a pair of laterally spaced longitudinal beams and modular chassis coupling means,

to an intermediate modular chassis section also comprising a pair of laterally spaced longitudinal beams;

5 structurally coupling a second modular chassis section comprising wheel attachment means to the or an intermediate modular chassis section;

where the, or at least one of the, intermediate modular chassis section comprise energy storage means located between the pair of laterally spaced longitudinal beams and intermediate modular chassis coupling means configured to structurally couple the intermediate modular chassis section between the first  
10 and second modular chassis sections;

wherein the modular chassis sections are structurally coupled in series to form a chassis structure terminated at each end by a modular chassis section when each pair of laterally spaced longitudinal beams are connected together via correspondingly spaced apart longitudinal structures formed in the intermediate modular chassis section when the intermediate modular chassis section is disposed between the first and  
15 a second modular chassis sections so as to form a pair of co-linear, longitudinal beams that extend substantially the length of the vehicle and, wherein

the first modular chassis section, the intermediate modular chassis section and the second modular chassis section are assembled together when the spaced longitudinal beams are structurally connected together, such that

20 the longitudinal beams when so assembled, each having a centreline of constant height along the length of the vehicle and a constant lateral separation from a longitudinal centreline of the vehicle.

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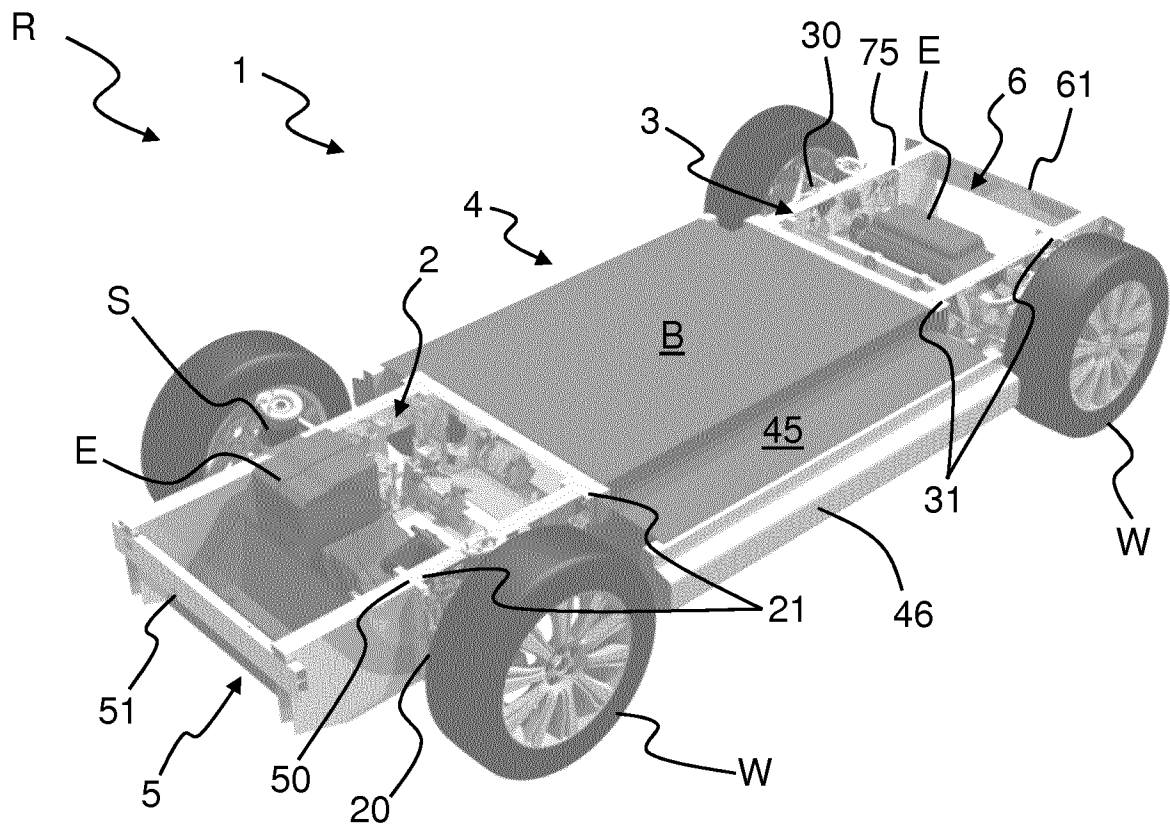


FIGURE 1

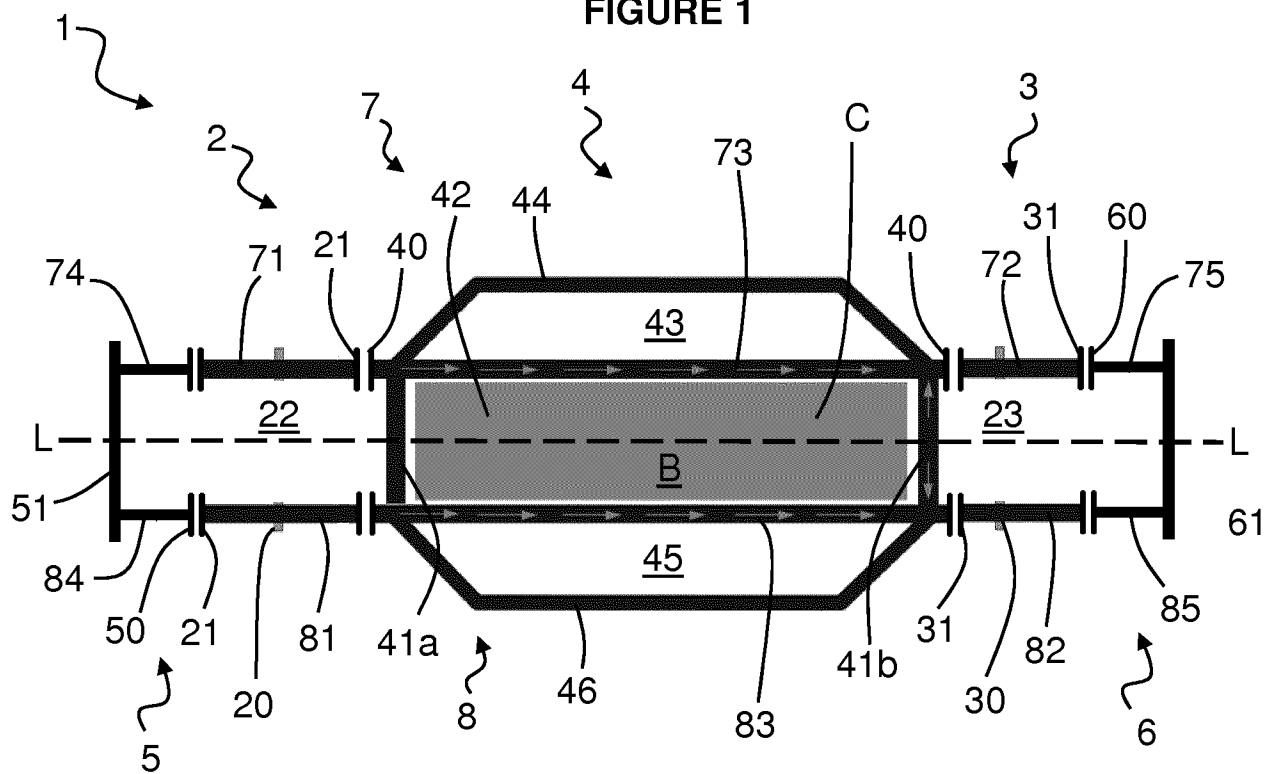


FIGURE 2

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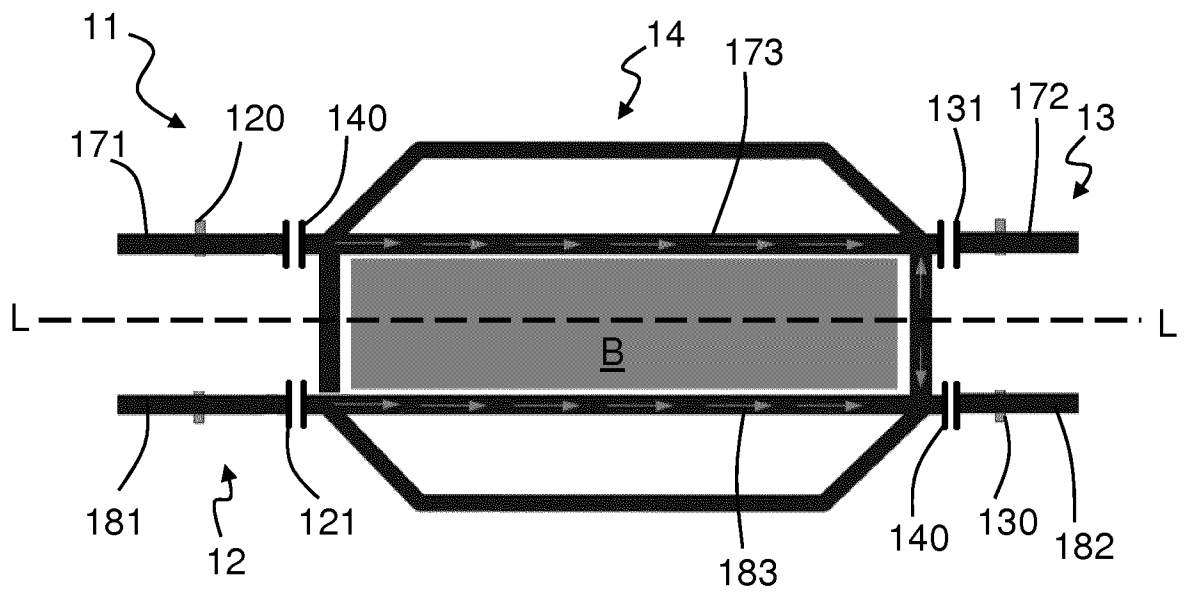


FIGURE 3

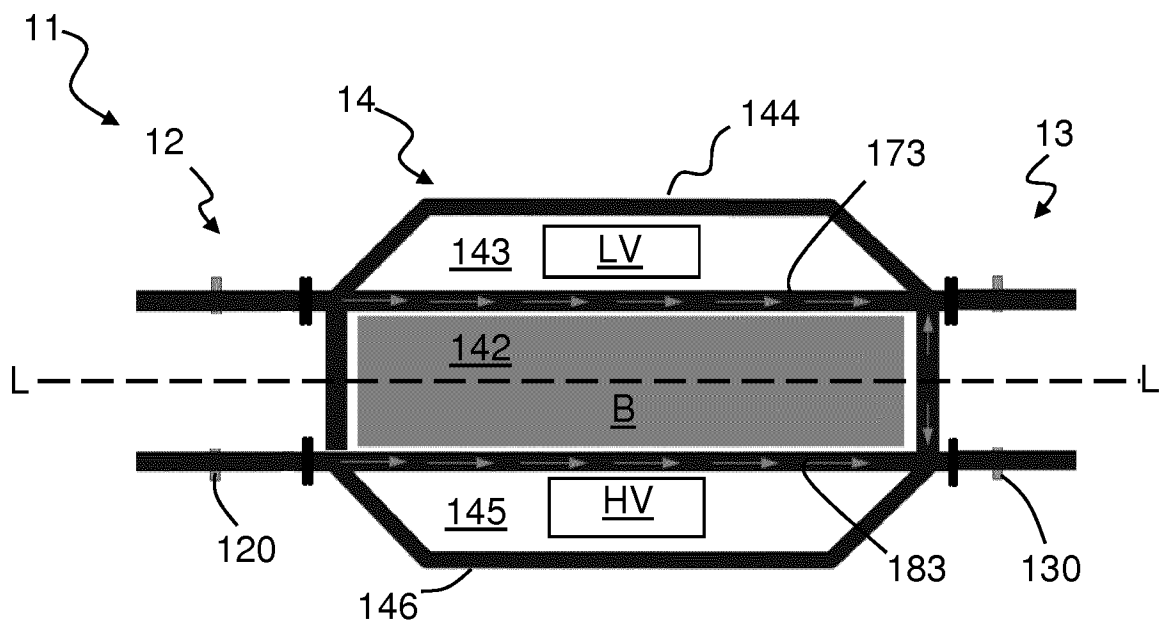


FIGURE 4

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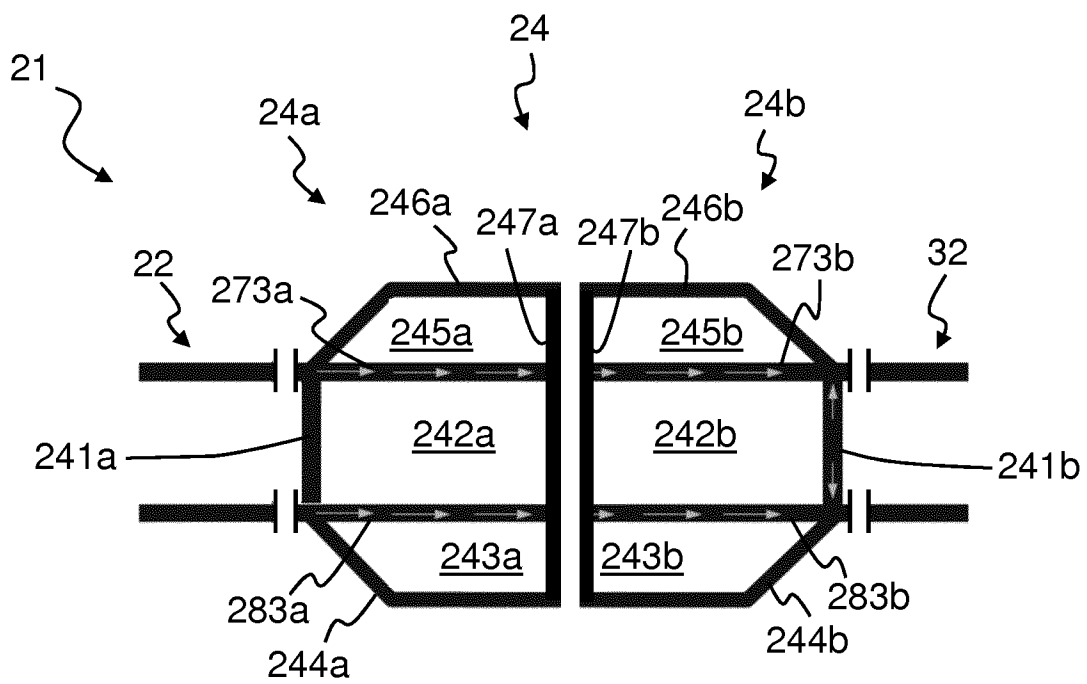


FIGURE 5

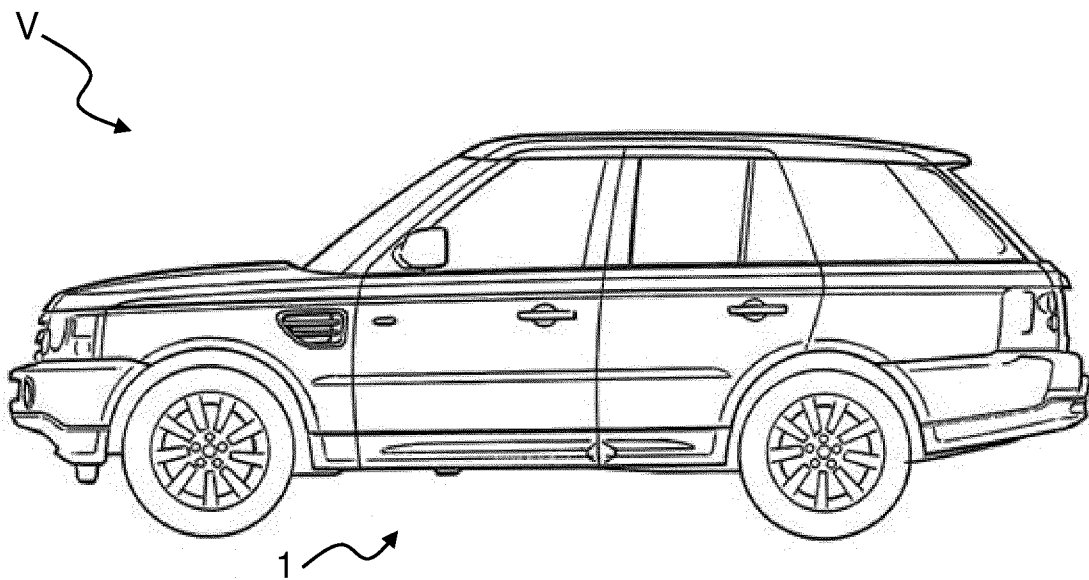


FIGURE 6

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/082959

## A. CLASSIFICATION OF SUBJECT MATTER

INV. B62D21/07 B62D21/12 B62D63/02  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                  | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------------|-----------------------|
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| Y         | abstract; figures 1-6                                                                                               | 4-7                   |
| A         | claim 1                                                                                                             | 8,9                   |
|           | claim 8                                                                                                             |                       |
|           | -----                                                                                                               |                       |
| Y         | EP 1 048 551 A2 (VOLKSWAGEN AG [DE]) 2 November 2000 (2000-11-02)                                                   | 4-6                   |
| A         | figure 1                                                                                                            | 1                     |
|           | paragraph [0012]                                                                                                    |                       |
|           | -----                                                                                                               |                       |
| Y         | DE 297 22 344 U1 (BALL WILFRIED [DE]) 15 April 1999 (1999-04-15)                                                    | 7                     |
| A         | claim 1; figures 1-3                                                                                                | 1                     |
|           | -----                                                                                                               |                       |



Further documents are listed in the continuation of Box C.



See patent family annex.

## \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 March 2020

Date of mailing of the international search report

25/03/2020

Name and mailing address of the ISA/

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Authorized officer

Huyge, Kevin

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/082959

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date         |
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