(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
04 June 2020 (04.06.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/109584 A1

(51) International Patent Classification:
B62D 63/02 (2006.01) *B62D 21/07* (2006.01)

(21) International Application Number:
PCT/EP2019/083145

(22) International Filing Date:
29 November 2019 (29.11.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1819525.5 30 November 2018 (30.11.2018) GB

(71) Applicant: **JAGUAR LAND ROVER LIMITED** [GB/GB]; Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).

(72) Inventors: **HARRIS, Craig Paul**; Jaguar Land Rover, Patents W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB). **GREEN, Piers**; Jaguar Land Rover, Patents W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).

(74) Agent: **HOLMES, Matthew**; Jaguar Land Rover, Patents W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH,

WO 2020/109584 A1

(54) Title: VEHICLE CHASSIS SYSTEMS

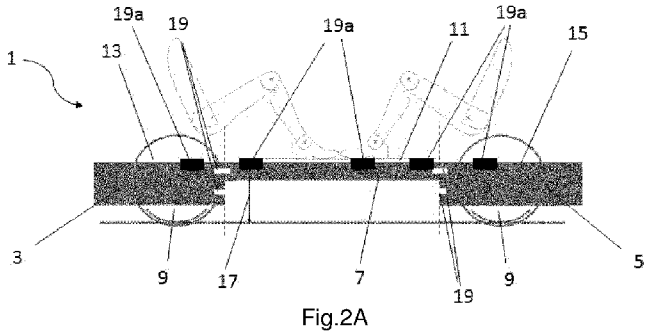


Fig.2A

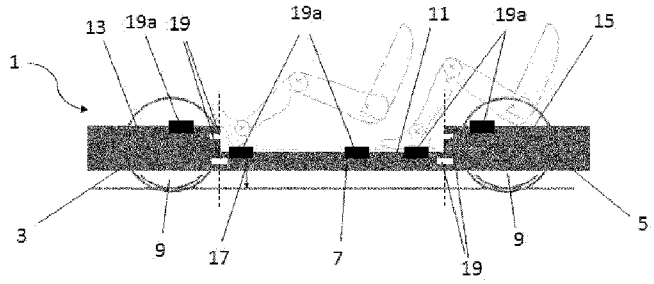


Fig. 2B

(57) Abstract: Embodiments of the present invention provide a vehicle chassis system comprising chassis components that are a front axle box, a rear axle box and a linking central portion. The chassis components are configurable to provide two different configurations of a vehicle chassis, each of the two configurations having the front axle box and the rear axle box joined by the linking central portion. In a first of the two configurations, the floor height is defined relative to the height of a top surface of one or both of the front axle box and the rear axle box. In the second of the two configurations, a top surface of the linking central portion forms a floor that has a different floor height to the floor defined by the top surface of the linking

[Continued on next page]

GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

VEHICLE CHASSIS SYSTEMS

TECHNICAL FIELD

The present disclosure relates to vehicle chassis systems. Aspects of the invention relate to a vehicle chassis system, a vehicle and a method of assembly of a vehicle chassis system.

BACKGROUND

Different categories of vehicle (e.g. shared mobility pods, sedans, SUV and commercial vehicles) may be suited to different floor heights. A well-recognised measure of floor height is occupant heel to ground height. Relatively high occupant heel to ground height may be palatable and/or advantageous for some categories of vehicle, such as SUVs, where for instance ease of entry/egress and/or ground clearance may be prioritised. On the other hand, relatively high occupant heel to ground height may be less desirable where for instance vehicle handling, aerodynamics/vehicle efficiency/range and/or cabin volume for a given vehicle height are prioritised (as is often the case with saloons and some hatch-backs). Providing a relatively low floor height may be particularly advantageous for users/passengers who rely on wheelchairs for their mobility as the low floor will make ingress and egress into and out of the vehicle easier.

Currently, these different categories of vehicle require different vehicle chassis systems suited to their particular designs. Manufacturing numerous vehicle chassis systems of different designs may be considered inefficient and result in increased manufacturing costs and times.

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

Aspects and embodiments of the invention provide a vehicle chassis system, a vehicle and a method of assembly of a vehicle chassis system as claimed in the appended claims.

According to an aspect of the invention there is a vehicle chassis system comprising chassis components that are a front axle box, a rear axle box and a linking central portion, wherein the chassis components are configurable to provide a vehicle chassis in two different configurations, each of the two configurations having the front axle box and the rear axle box joined by the linking central portion.

According to another aspect of the invention there is a vehicle chassis system having chassis components comprising a front axle box, a rear axle box and a linking central portion, wherein the chassis components are configurable to provide a vehicle chassis in two different configurations, each of the two configurations having the front axle box and the rear axle box joined by the linking central portion, wherein in a first of the two configurations, the floor height is defined relative to the height of a top surface of one or both of the front axle box and the rear axle box and in the second of the two configurations, a top surface of the linking central portion forms a floor that has a different floor height to the floor defined by the top surface of the linking central portion. Thus, all else being equal (e.g. tire, wheel, suspension and suspension mounting set-up) this may give rise to a different vehicle occupant heel to ground height in the different configurations. The system may therefore allow vehicles having different floor heights and configurations to be assembled using the same vehicle chassis system. This in turn may improve efficiency in manufacturing (i.e. economies of scale). Further it may mean that it is not necessary to have

a specialised vehicle chassis system to hand in order to assemble the chassis for a vehicle having a particular chassis configuration. Instead it may be that multiple different chassis configurations can be provided using the same chassis components/assembled chassis system.

It may be that in each of the two configurations, the linking central portion separates, in addition to joining, the front axle box and rear axle box. Indeed, it may be considered that in each of the two configurations, the linking central portion couples the front axle box to the rear axle box.

In some embodiments, in the first configuration, the height of the floor of the linking central portion is substantially the same as the height of the top surface of the one or both of the front axle box and rear axle box, so as to form a substantially flat, top chassis surface on top of the respective chassis components. This configuration may be advantageous for vehicles where levelling an overall floor (i.e. the top surfaces of the axle boxes and the linking central portion) with the top surface of the axle boxes is advantageous, e.g. where a substantially flat passenger cabin/load area is desired (e.g. vans) and/or where additional ground clearance is desired (e.g. some SUVs and 4x4s) and/or where volume is desirable beneath the floor created by the linking central portion (e.g. for storage of one or more batteries and/or other vehicle systems).

In some embodiments, in the second configuration, the height of the floor of the linking central portion is lower than the height of the top surface of the one or both of the front axle box and rear axle box. This may allow a lower occupant heel to ground height which may be desirable for particular vehicle configurations (e.g. saloon, hatch-back and sports cars).

In some embodiments, the linking central portion and the one or both of the front axle box and rear axle box are arranged to allow mounting to each other at different respective heights, wherein one such height gives rise to the first configuration and another such height gives rise to the second configuration. Allowing mounting of the components at different respective positions may provide a convenient way to select and implement the desired configuration. Specifically the different configurations may be implemented by selecting the appropriate mounting positions adjusting the relative heights of the components accordingly and securing them at the required mounting positions.

In some embodiments, the linking central portion comprises a selectively removable portion which in the first configuration at least partially covers or fills a void bounded by a remainder of the linking central portion below, the front axle box to one side and the rear axle box to the other side, and in the second configuration is removed to expose the void. The selectively removable portion may provide a convenient way in which to selectively create the desired configuration (i.e. it may be included or omitted). The removable portion may provide additional structural strength in the first configuration by filling the cavity created by the difference in the heights of the floor of the linking central portion and the top surfaces of the axle boxes. In the second configuration, the cavity may facilitate creation of the lowered floor height of the linking central portion.

In some embodiments, the removable portion is a battery arranged to at least contribute to power delivery to one or more systems of a vehicle incorporating the vehicle chassis system. The presence of the battery in the first configuration may be advantageous, because vehicle configurations having a relatively flat overall floor across the axle boxes and linking central portion may tend to be heavier and therefore benefit from additional battery capacity in terms of power delivery and/or range extension.

In some embodiments, the battery is arranged to supply electrical power to an electric traction motor arranged to act as a prime mover for the vehicle.

In some embodiments, the linking central portion and the one or both of the front axle box and rear axle box are arranged to allow mounting to each other both where the linking central portion is inverted with respect to the one or both of the front axle box and rear axle box and where it is non-inverted with respect to the one or both of the front axle box and rear axle box and where mounting with the linking central portion one of inverted and non-inverted gives rise to the first configuration and mounting with the linking central portion the other of inverted and non-inverted gives rise to the second configuration. Thus, mounting formations on the front axle box and rear axle box for attachment to the linking central portion may be configured to be compatible with corresponding mounting formations of the linking central portion when the linking central portion is inverted and non-inverted. Flipping only one or some of the components (which as will be understood may be asymmetric about the relevant mount point) may provide a convenient way to select and implement the desired configuration.

In some embodiments, the linking central portion and the one or both of the front axle box and rear axle box are arranged to allow mounting to each other both where the linking central portion and the one or both of the front axle box and rear axle box are inverted and where they are non-inverted, and where mounting the respective chassis components one of inverted and non-inverted gives rise to the first configuration, and mounting the respective chassis components the other of inverted and non-inverted gives rise to the second configuration. By allowing mounting two or more of the components where they are all inverted and where they are all non-inverted, it may not be necessary to flip the chassis once assembled in order to alter the configuration.

In some embodiments, the chassis system with the front axle box and rear axle box joined by the linking central portion is invertible, and when one of inverted and non-inverted the chassis system gives rise to the first configuration, and when the other of inverted and non-inverted gives rise to the second configuration. Thus, it may be that the configuration can be determined (and if desired subsequently reversed) by flipping the entire chassis system.

In some embodiments, vehicle upper body attachment points are provided on one or more of the chassis components in a manner so as to permit a vehicle upper body to be selectively attached to the respective chassis components with the vehicle upper body extending upwards regardless of whether or not the relevant chassis components are inverted. This may facilitate mounting of a vehicle body to the chassis system regardless of the configuration selected.

In some embodiments, one or more vehicle seat attachment points are provided on one or more of the chassis components in a manner so as to permit vehicle seats to be selectively attached to the respective chassis components with the vehicle seats extending upwards regardless of whether or not the relevant chassis components are inverted. This may facilitate mounting of one or more vehicle seats to the chassis system regardless of the configuration selected.

In some embodiments, one or more vehicle wheel attachment points are provided on one or more of the chassis components in a manner so as to permit vehicle wheels to be selectively attached to the respective chassis components with the vehicle wheels extending downwards regardless of whether or not the respective chassis components are inverted. This may facilitate mounting of one or more vehicle wheels to the chassis system regardless of the configuration selected.

In some embodiments, the linking central portion comprises a battery box arranged to house a battery arranged to at least contribute to power delivery to one or more systems of a vehicle incorporating the vehicle chassis system. The linking central portion may be a convenient location to provide such a battery box.

In some embodiments, the battery is arranged to supply electrical power to an electric traction motor arranged to act as a prime mover for the vehicle.

In some embodiments, the linking central portion comprises a vehicle floor pan.

In some embodiments, the linking central portion substantially carries the load of joining the front axle box and the rear axle box. It may additionally or alternatively be considered that the linking central portion is a structural component of the vehicle chassis system. Where the linking central portion is structural, there may be no need or reduced need for additional structural components to connect the front and rear axle boxes.

In some embodiments, the front axle box and/or the rear axle box form a structural component of the vehicle chassis system. Where the front and/or rear axle boxes are structural, there may be no need or reduced need for additional structural components to the front and rear of the linking central portion.

In some embodiments, the front axle box and/or the rear axle box comprise at least one vehicle powertrain component.

In some embodiments, the chassis components are joined to one another such that the vehicle chassis system is assembled.

In some embodiments, the vehicle chassis system is assembled in the first configuration.

In some embodiments, the vehicle chassis system is assembled in the second configuration.

According to yet another aspect there is provided a vehicle comprising the vehicle chassis system in accordance with the previous aspect.

According to a further aspect there is provided a method of assembly of a vehicle chassis system comprising chassis components which are a front axle box, a rear axle box and a linking central portion, the method comprising:

i) selecting between first and second configurations, in which the front axle box and rear axle box are joined by the linking central portion, where in the first configuration an upper surface of the linking central portion defines a floor that is substantially the same floor height as a height of a top surface of one or both of the front axle box and rear axle box; in the second of the two configurations, the top surface of the linking central portion forms a floor whose height is different to the height of a top surface of one or both of the front axle box and rear axle box; and

ii) configuring the chassis components according to the selected configuration.

It may be that in each of the two configurations, the linking central portion separates, in addition to joining, the front axle box and rear axle box. Indeed, it may be considered that in each of the two configurations, the linking central portion couples the front axle box to the rear axle box.

In some embodiments, configuring the chassis components according to the selected configuration comprises selecting between different respective positions for the linking central portion and one or both of the front axle box and rear axle box, wherein one such position gives rise to the first configuration and another such position gives rise to the second configuration and mounting the front axle box and rear axle box to the linking central portion accordingly.

In some embodiments, configuring the chassis components according to the selected configuration comprises selecting between incorporation or non-incorporation of a selectively removable portion of the linking central portion, which in the first configuration at least partially covers or fills a void bounded by a remainder of the linking central portion below, the front axle box to one side and the rear axle box to the other side and in the second configuration is removed to expose the void, and incorporating or not incorporating the selectively removable portion accordingly.

In some embodiments configuring the chassis components according to the selected configuration comprises selecting between mounting the linking central portion and one or both of the front axle box and rear axle box where the linking central portion is inverted with respect to the one or both of the front axle box and rear axle box and where it is non-inverted with respect to the one or both of the front axle box and rear axle box, where mounting with the linking central portion one of inverted and non-inverted gives rise to the first configuration and mounting with the linking central portion the other of inverted and non-inverted gives rise to the second configuration, and mounting the linking central portion to the front axle box and rear axle box accordingly.

In some embodiments configuring the chassis components according to the selected configuration comprises selecting between mounting the linking central portion and one or both of the front axle box and rear axle box where the linking central portion and the one or both of the front axle box and rear axle box are inverted and where they are non-inverted, where mounting the respective chassis components one of inverted and non-inverted gives rise to the first configuration and mounting the respective chassis components the other of inverted and non-inverted gives rise to the second configuration, and mounting the linking central portion to the front axle box and rear axle box accordingly.

In some embodiments configuring the chassis components according to the selected configuration comprises selecting between inverting or not inverting the vehicle chassis system with the front axle box and rear axle box joined by the linking central portion, where when one of inverting and not inverting the chassis system gives rise to the first configuration and the other of inverting and not inverting gives rise to the second configuration and inverting or not inverting accordingly.

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

One or more 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 vehicle in accordance with embodiments of the invention;

Figure 2a is a simplified view of a vehicle chassis system in a first configuration in accordance with an embodiment of the invention;

Figure 2b is a simplified view of a vehicle chassis system in a second configuration in accordance with an embodiment of the invention;

Figure 3a is a simplified view of a vehicle chassis system in a first configuration in accordance with an embodiment of the invention;

Figure 3b is a simplified view of a vehicle chassis system in a second configuration in accordance with an embodiment of the invention;

Figure 4a is a simplified view of a vehicle chassis system in a first configuration in accordance with an embodiment of the invention, a removable portion is shown fitted to the vehicle chassis system;

Figure 4b is a simplified view of a vehicle chassis system in a second configuration in accordance with an embodiment of the invention;

Figure 4c is a simplified view of a vehicle chassis system in a first configuration in accordance with an embodiment of the invention, a removable portion is shown being fitted to the vehicle chassis system;

Figure 5a is a perspective view of a central linking portion in a first configuration in accordance with an embodiment of the invention;

Figure 5b is a perspective view of a central linking portion in a second configuration in accordance with an embodiment of the invention;

Figure 6a is a simplified view of a vehicle chassis system in a first configuration in accordance with an embodiment of the invention;

Figure 6b is a simplified view of a vehicle chassis system in a second configuration in accordance with an embodiment of the invention;

Figure 7a is a perspective view of a central linking portion in a first configuration in accordance with an embodiment of the invention; and

Figure 7b is a perspective view of a central linking portion in a second configuration in accordance with an embodiment of the invention.

DETAILED DESCRIPTION

Referring first to Figures 2a and 2b a vehicle chassis system is generally shown at 1. The vehicle chassis system 1 has a front axle box 3, a rear axle box 5 and a linking central portion 7 which are each components of the vehicle chassis system. The linking central portion 7 is disposed between the front axle box 3 and the rear axle box 5. In an assembled vehicle incorporating the vehicle chassis system 1, the linking central portion 7 is the main structural component joining the front axle box 3 and rear axle box 5. In this embodiment the linking central portion 7 comprises a main central region of a vehicle chassis located between front and rear wheel mounting areas. In this embodiment the linking central portion 7 also comprises a vehicle floor pan (though it will be appreciated that this need not be the case in other embodiments). In this embodiment the linking central portion 7 also comprises a battery box arranged to accommodate a battery which is itself arranged to deliver power for motion of a vehicle of which the vehicle chassis system 1 forms a part. The first axle box 3 and second axle box 5 are both also structural components of the vehicle chassis system, having, in an assembled vehicle incorporating the vehicle chassis system 1, main suspension components for respective wheels 9 mounted thereto and at least one of them having vehicle drivetrain components mounted thereto.

The vehicle chassis system 1 is in complete form, having been assembled from the components, which in this case are modular. In Figure 2a the vehicle chassis system 1 is shown in a first configuration in which a top surface 11 of the linking central portion 7 forms a floor which is at the same height as a top surface 13 of the front axle box 3 and a top surface 15 of the rear axle box 5. In Figure 2b the vehicle chassis system 1 is shown in a second configuration in which the top surface 11 of the linking central portion 7 forms a floor which is at a different height (in this case a lower height) by comparison with the top surface 13 of the front axle box 3 and the top surface 15 of the rear axle box 5. The two configurations give different heal to ground heights as indicated by arrow 17. The different heal to ground heights may mean that the first and second configurations are respectively suited to different vehicle types. For instance, the vehicle chassis system 1 in the first configuration may be particularly suited to vehicles where a substantially continuous, flat, top chassis surface is desirable (e.g. where it is desired to create a large, flat interior floor area such as in a van or in a shared mobility vehicle) or in vehicles where a higher ride height is desired. In shared mobility vehicles, passengers may travel in the vehicle in a sitting or a standing position. By contrast, the vehicle chassis system 1 in the second configuration may be particularly suited to vehicles where a lower roofline and handling are prioritised (e.g. saloon cars). Alternatively, a low floor height may be advantageous for a shared mobility vehicle, where some passengers may rely on wheelchairs for their mobility and as such, a low floor height will be desirable as it will make ingress and egress into and out of the vehicle easier.

Assembly of the different configurations is achievable using the same components of the vehicle chassis system 1. In this case the variation is achieved by means of respective mounting formations 19 provided at one/or more mounting locations on each of the components. The mounting formations 19 are arranged to allow connection of the front axle box 3 to the linking central portion 7 and for connection of the rear axle box 5 to the linking central portion 7. The mounting formations 19 are configured to allow height indexing of the respective joined components. It may be for instance that multiple mounting formations are provided on one or both of the components at different heights in each mounting location, only one of those mounting formations in each mounting location on each component being used. Then the mounting formations being used would depend on the configuration selected. Alternatively a single mounting formation may be provided at each mounting location of each component, with at least one of those mounting formations being height adjustable with respect to the remainder of the respective component on which it is provided. Cooperating pairs of mounting formations (one on each component) might for instance be configured to provide a bolted joint, a sleeved joint or a slotted joint.

In the example shown, each of the front axle box 3, rear axle box 5 and linking central portion 7 are provided with seat attachment points 19a. In the particular embodiment of Figures 2a and 2b, some seat attachment points 19a are arranged to suit intended seat locations associated with the first configuration and some to suit intended seat locations of the second configuration. Thus, some seat attachment points 19a are redundant and remain unused regardless of the configuration. In an alternative embodiment, some or all of the attachment points take the form of cargo tie-down anchorages or cargo support points arranged to secure cargo during transport. Additional mounting formations 19 or attachment points 19a may be provided on the axle boxes and/or the linking central portion 7 arranged to facilitate the attachment, during vehicle assembly, of a vehicle upper body which may provide any or all of: an occupant compartment; a luggage compartment; or a cargo area.

Referring now to Figures 3a and 3b, a vehicle chassis system is generally shown at 20. The vehicle chassis system 20 is similar to vehicle chassis system 1, and similar features are labelled with the same reference numbers. The vehicle chassis system 20 differs from the vehicle chassis system 1 in its mounting formations arranged to allow connection of the front axle box 3 to the linking central portion 7 and for connection of the rear axle box 5 to the linking central portion 7. It also differs in terms of the manner of the relative adjustment between the components in order that assembly into one or other of the first and second configurations is made.

As with vehicle chassis system 1, assembly of the different configurations is achievable using the same components of the vehicle chassis system 20. As before, the variation is achieved by means of respective mounting formations 19 provided at one/or more mounting locations on each of the components. The mounting formations 19 are configured to allow mounting to each other both where the linking central portion 7 is inverted with respect to the one or both of the front axle box 3 and rear axle box 5 and where it is non-inverted with respect to the one or both of the front axle box 3 and rear axle box 5. It will be appreciated that, regardless of the orientation of the linking central portion 7, the components located within it need not necessarily be adapted to suit being inverted from a design orientation, rather these components may be assembled into the linking central portion 7 only once intended final orientation of the linking central portion 7 has been determined. Alternatively, rather than inverting the linking central portion 7, it may instead be configured so as to be mountable to the front and rear axle boxes in a plurality of positions so as to provide a vehicle with a lower or higher floor height as may be appropriate for the given vehicle application. It may be for instance that the mounting formations 19 are non-orientation specific (e.g. tubular sleeves configured so that one slides into the other and having a circular cross-section) and/or are symmetric about a horizontal axis (e.g. tubular sleeves configured so that one slides into the other and having a square or rectangular cross-section or cooperating plates which can be aligned for bolting even when one plate is flipped). Additionally, the mounting formation(s) 19 provided on the front axle box 3 and rear axle box 5 are positioned asymmetrically on their respective axle boxes with respect to the vertical direction. In this way, inversion of the respective axle box 3, 5 with respect to the linking central portion 7 can give rise to different heights of the top surface 11 of the linking central portion 7 (e.g. alternatively a sunken floor with respect to the top surface of the respective axle box 3, 5 and a substantially continuous top chassis surface on top of the chassis components).

Referring now to Figures 4a, 4b and 4c, a vehicle chassis system is generally shown at 30. The vehicle chassis system 30 is similar to vehicle chassis system 1, and similar features are labelled with the same reference numbers. The vehicle chassis system 30 differs from the vehicle chassis system 1 in that adjustment between the first and second configurations is achieved by selective removal of a selectively removable portion 31 of the linking central portion 7 rather than any adjustment between the linking central portion 7 and one or both of the front axle box 3 and rear axle box 5. When inserted, the selectively removable portion 31 fills a void 33, such that the top surface

11 of the linking central portion 7, (or in the case of the vehicle chassis system 30 being in the first configuration, the lower surface 11u), is at substantially the same height as the top surfaces 13, 15 of the front axle box 3 and rear axle box 5 respectively, (or in the case of the vehicle chassis system 30 being in the first configuration, the respective lower- or under-surfaces of the axle boxes) . Where however the selectively removable portion 31 is removed, it exposes the void 33 and consequently the top surface 11 of the linking central portion 7 is below the level of the top surfaces 13, 15 of the front axle box 3 and rear axle box 5 respectively (i.e. the second configuration). The mounting formations 19 may be purely structural in nature, that is to say, arranged to secure the linking central portion to the axle boxes, or may be for securing seating components, vehicle body structures or cargo restraints (tie-downs or lashing points) to the linking central portion and/or to the axle boxes.

In the embodiment of Figures 4a, 4b and 4c, the selectively removable portion 31 is a battery arranged to deliver electrical power to an electric traction motor arranged to provide some if not all of the torque necessary for vehicle motion of a vehicle incorporating the vehicle chassis system 30 provided in the first configuration. When the vehicle chassis system 30 is in the second configuration, the battery power delivered by the selectively removable portion 31 may complement battery power for motion of the vehicle delivered by additional batteries provided elsewhere (e.g. in the remainder of the linking central portion 7). Additionally or alternatively, one or more mounting formations 19b may be provided in the linking central portion 7 and/or the selectively removable portion 31. These mounting formations 19b may comprise electrical connectors and or fluid couplings arranged to connect the operation of components accommodated in the selectively removable portion 31 to those in the linking central and/or to transmit electrical power, cooling fluid and/or data communications between the selectively removable portion 31 and the linking central portion 7 and thus throughout the chassis system 30.

In an example shown in Figure 4c, the removable portion 31 is located beneath the linking central portion, which is arranged in the first configuration to provide a flat floor for the vehicle. In this configuration, the removable portion 31 is arranged as a rapidly swappable transient battery or range extender, which may be particularly useful if the vehicle is required to occasionally travel long distances in a single journey that would otherwise exceed the range provided by the traction battery contained within the linking central portion. Swapping the removable portion 31 with a fully charged battery may be performed more quickly than the charging process itself and would result in shorter journey times as a result. As shown in the Figure, the range extending battery in the removable portion 31 is fitted up into the void 33 of the linking central portion 7 and secured thereto. To replace this range extending battery, the mounting formations 19b are released once the removable portion 31 is adequately supported and then lowered and removed from beneath the vehicle, a replacement battery is then brought into place beneath the vehicle and fitted up into place and the mounting formations 19b secured to lock the removable portion 31 to the linking central portion 7.

Referring now to Figures 5a and 5b, an alternative representation of the linking central portion 7 of the vehicle chassis system 30 is shown. The linking central portion 7 in Figure 5a is shown in the orientation it would have when the associated vehicle chassis system is in the first configuration, and in Figure 5b the second configuration. It may be seen from the Figures and particularly Figures 2 through 7, that regardless of the configuration chosen for the chassis system 30, the resulting vehicle always has a straight and continuous longitudinal loadpath from the front to the rear of the vehicle. Regardless of the configuration, the longitudinal loadpath from the front axle box 3 to the rear axle box 5 through the central linking portion 7 is along a straight and substantially horizontal line passing through the central linking portion 7. By avoiding unnecessary vertical or lateral offsets along the longitudinal loadpath from the front to the rear of the vehicle, material usage may be optimised and excess weight

of chassis components kept to a minimum, optimising crash safety performance which providing good range and dynamic behaviour.

Referring now to Figures 6a and 6b, a vehicle chassis system is generally shown at 40. The vehicle chassis system 40 is similar to vehicle chassis system 1, and similar features are labelled with the same reference numbers. The vehicle chassis system 40 differs from the vehicle chassis system 1 in that adjustment between the first and second configurations is achieved by inverting/flipping all components (i.e. the front axle box 3, rear axle box 5 and linking central portion 7) of the vehicle chassis system 40 rather than any relative adjustment between the linking central portion 7 and one or both of the front axle box 3 and rear axle box 5. The inversion may be performed prior to or during assembly of the components (e.g. they may be joined when all non-inverted or when all inverted), or the inversion may occur post assembly (e.g. the whole vehicle chassis system is inverted with all components already joined). In the embodiment of Figures 6a and 6b, the components are provided with cooperating mounting formations 19 provided at one/or more mounting locations on each of the components. The components are modular and intended to be assembled via the mounting locations. In other embodiments however it will be appreciated that the vehicle chassis system 40 may be formed from non-modular components which may (for instance) have been manufactured as or into a single unit. In this case configuring from among the first and second configurations is achieved by inverting the entire vehicle chassis system 40 as one complete piece.

Referring now to Figures 7a and 7b, an alternative representation of the linking central portion 7 of the vehicle chassis system 40 is shown. The linking central portion 7 in Figure 7a is shown in the orientation it would have when the associated vehicle chassis system is in the first configuration, and in Figure 7b the second configuration. As can be seen, pairs of first configuration upper frame rails 41 and second configuration upper frame rails 43 form part of the linking central portion 7. Each first configuration upper frame rail 41 is substantially aligned in x and y directions but spaced apart in the z direction with respect to a corresponding second configuration upper frame rail 43. The first configuration upper frame rails 41 and second configuration upper frame rails 43 may therefore be considered stacked. The first configuration upper frame rails 41 are straight (i.e. are without any significant offset). The second configuration upper frame rails 43 each have a central deflected or offset region 45 in a downwards direction (e.g. towards the first configuration upper frame rails 41). The central offset regions 45 accommodate a floor-pan 47 which is sunken with respect to end regions 49 of the second configuration upper frame rails 43, which are beyond the central offset regions 45 to either side. By having at least one pair of frame rails being formed substantially straight and arranged to lie substantially horizontally when assembled in the vehicle, there are always at least one pair of frame rails optimally arranged to transmit longitudinal loading and provide an ideal loadpath in the event of a frontal or rear impact. In this way, energy absorption and thus crash safety performance can be optimised without adding significant weight.

Referring to Figure 1 a vehicle 50 is shown which may comprise the vehicle chassis system of any of the discussed embodiments. In the example shown, the vehicle 50 is a shared mobility vehicle which may be converted by selective configuration of the chassis system 30 into a delivery vehicle, a personal transport vehicle or a public shuttle vehicle.

It will be appreciated that various changes and modifications can be made to the present invention without departing from the scope of the present application. 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 (which fall within the scope of the claims), 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 vehicle chassis system, the chassis system having chassis components comprising:
   a front axle box;
   a rear axle box; and
   a linking central portion,
   the chassis components are configurable to provide two different configurations of a vehicle chassis, each of the two configurations having the front axle box and the rear axle box joined by the linking central portion,
   wherein in a first of the two configurations, the floor height is defined relative to the height of a top surface of one or both of the front axle box and the rear axle box and in the second of the two configurations, a top surface of the linking central portion forms a floor that has a different floor height to the floor defined by the top surface of the linking central portion.

2. A vehicle chassis system according to claim 1 where in the first configuration, the height of the floor of the linking central portion is substantially the same as the height of the top surface of the front axle box and rear axle box, so as to form a substantially flat, top chassis surface on top of the respective chassis components.

3. A vehicle chassis system according to claim 1 or claim 2 where in the second configuration, the height of the floor of the linking central portion is lower than the height of the top surface of the one or both of the front axle box and rear axle box.

4. A vehicle chassis system according to any of claims 1 to 3, where the linking central portion and the one or both of the front axle box and rear axle box are arranged to allow mounting to each other at different respective heights, wherein one such height gives rise to the first configuration and another such height gives rise to the second configuration.

5. A vehicle chassis system according to any of claims 1 to 3, where the linking central portion comprises a selectively removable portion which in the first configuration at least partially covers or fills a void bounded by a remainder of the linking central portion below, the front axle box to one side and the rear axle box to the other side, and in the second configuration is removed to expose the void.

6. A vehicle chassis system according to claim 5, wherein the removable portion is a battery arranged to at least contribute to power delivery to one or more systems of a vehicle incorporating the vehicle chassis system.

7. A vehicle chassis system according to any of claims 1 to 3 where the linking central portion and the one or both of the front axle box and rear axle box are arranged to allow mounting to each other both where the linking central portion is inverted with respect to the one or both of the front axle box and rear axle box and where it is non-inverted with respect to the one or both of the front axle box and rear axle box, and where mounting with the linking central portion one of inverted and non-inverted gives rise to the first configuration, and mounting with the linking central portion the other of inverted and non-inverted gives rise to the second configuration.

8. A vehicle chassis system according to any of claims 1 to 3 where the linking central portion and the one or both of the front axle box and rear axle box are arranged to allow mounting to each other both where the linking central portion and the one or both of the front axle box and rear axle box are inverted and where they are non-inverted, and where mounting the respective chassis components one of inverted and non-inverted gives rise to the first configuration, and mounting the respective chassis components the other of inverted and non-inverted gives rise to the second configuration.

9. A vehicle chassis system according to any of claims 1 to 3 and 8 where the chassis system with the front axle box and rear axle box joined by the linking central portion is invertible and when one of inverted and non-inverted the chassis system gives rise to the first configuration and when the other of inverted and non-inverted gives rise to the second configuration.

10. A vehicle chassis system according to any of claims 1 to 3 and 7 to 9 where vehicle upper body attachment points are provided on one or more of the chassis components in a manner so as to permit a vehicle upper body to be selectively attached to the respective chassis components with the vehicle upper body extending upwards regardless of whether or not the relevant chassis components are inverted.

11. A vehicle chassis system according to any of claims 1 to 3 and 7 to 10 where one or more vehicle seat attachment points are provided on one or more of the chassis components in a manner so as to permit vehicle seats to be selectively attached to the respective chassis components with the vehicle seats extending upwards regardless of whether or not the relevant chassis components are inverted.

12. A vehicle chassis system according to any of claims 1 to 3 and 7 to 11 where one or more vehicle wheel attachment points are provided on one or more of the chassis components in a manner so as to permit vehicle wheels to be selectively attached to the respective chassis components with the vehicle wheels extending downwards regardless of whether or not the respective chassis components are inverted.

13. A vehicle chassis system according to any preceding claim, where the linking central portion comprises a battery box arranged to house a battery arranged to at least contribute to power delivery to one or more systems of a vehicle incorporating the vehicle chassis system.

14. A vehicle chassis system according to any preceding claim, where the linking central portion substantially carries the load of joining the front axle box and the rear axle box.

15. A vehicle chassis system according to any preceding claim, where the front axle box and/or the rear axle box form a structural component of the vehicle chassis system.

16. A vehicle chassis system according to any preceding claim, where the vehicle chassis system is assembled in the first configuration.

17. A vehicle chassis system according to any of claims 1 to 15, where the vehicle chassis system is assembled in the second configuration.

18. A vehicle comprising the vehicle chassis system according to any of claims 1 to 17.

19. A method of assembly of a vehicle chassis system comprising chassis components which are a front axle box, a rear axle box and a linking central portion, the method comprising:
    i) selecting between first and second configurations in which the front axle box and rear axle box are joined by the linking central portion, where in the first configuration, an upper surface of the central portion defines a floor height that is substantially the same as height of a top surface of one or both of the front axle box and the rear axle box, and in the second of the two configurations, a top surface of the linking central portion forms a floor that has a different floor height to the floor defined by the top surface of the linking central portion;
    ii) configuring the chassis components according to the selected configuration.

20. A method according to claim 19 where configuring the chassis components according to the selected configuration comprises selecting between different respective positions for the linking central portion and one or both of the front axle box and rear axle box, wherein one such position gives rise to the first configuration and another such position gives rise to the second configuration, and mounting the front axle box and rear axle box to the linking central portion accordingly.

21. A method according to claim 19 where configuring the chassis components according to the selected configuration comprises selecting between incorporation or non-incorporation of a selectively removable portion of the linking central portion, which in the first configuration at least partially covers or fills a void bounded by a remainder of the linking central portion below, the front axle box to one side and the rear axle box to the other side and in the second configuration is removed to expose the void, and incorporating or not incorporating the selectively removable portion accordingly.

22. A method according to claim 19 where configuring the chassis components according to the selected configuration comprises selecting between mounting the linking central portion and one or both of the front axle box and rear axle box where the linking central portion is inverted with respect to the one or both of the front axle box and rear axle box and where it is non-inverted with respect to the one or both of the front axle box and rear axle box, where mounting with the linking central portion one of inverted and non-inverted gives rise to the first configuration and mounting with the linking central portion the other of inverted and non-inverted gives rise to the second configuration, and mounting the linking central portion to the front axle box and rear axle box accordingly.

23. A method according to claim 19 where configuring the chassis components according to the selected configuration comprises selecting between mounting the linking central portion and one or both of the front axle box and rear axle box where the linking central portion and the one or both of the front axle box and rear axle box are inverted and where they are non-inverted, where mounting the respective chassis components one of inverted and non-inverted gives rise to the first configuration and mounting the respective chassis components the other of inverted and non-inverted gives rise to the second configuration, and mounting the linking central portion to the front axle box and rear axle box accordingly.

24. A method according to claim 19 or claim 23 where configuring the chassis components according to the selected configuration comprises selecting between inverting or not inverting the vehicle chassis system with the front axle box and rear axle box joined by the linking central portion, where when one of inverting and not inverting the chassis system gives rise to the first configuration and the other of inverting and not inverting gives rise to the second configuration, and inverting or not inverting accordingly.

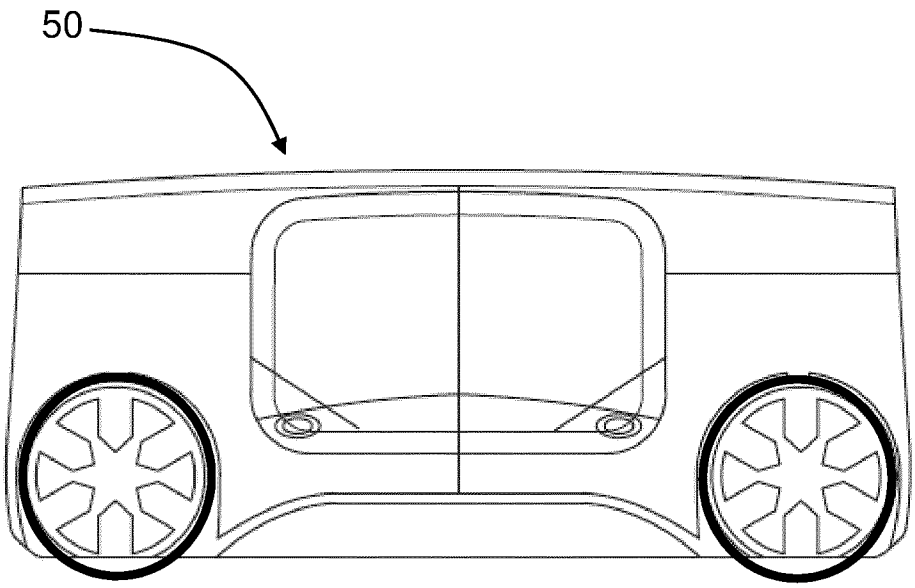


Fig.1

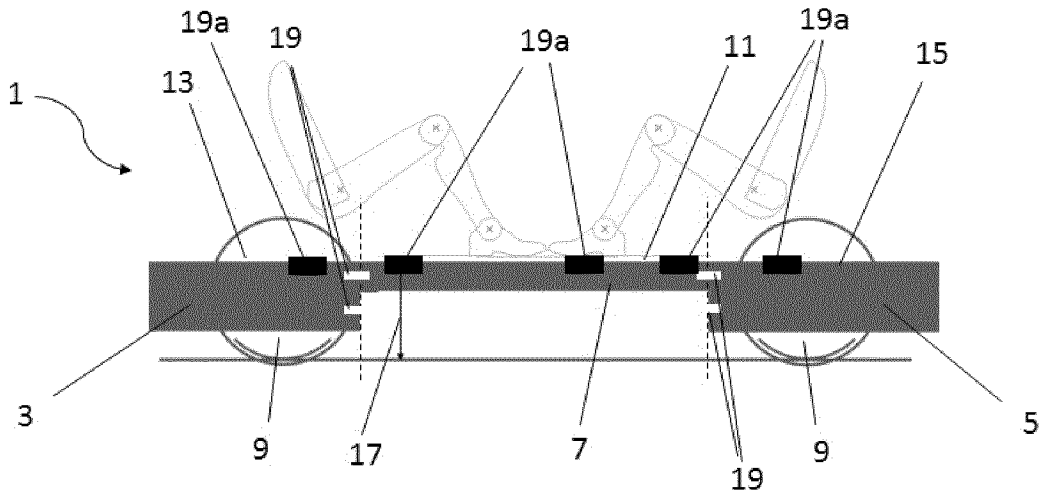


Fig.2A

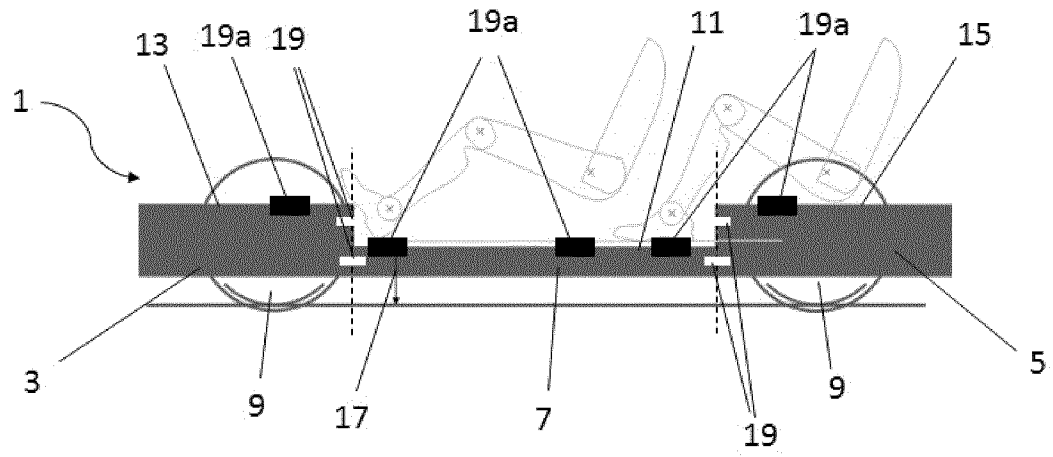


Fig. 2B

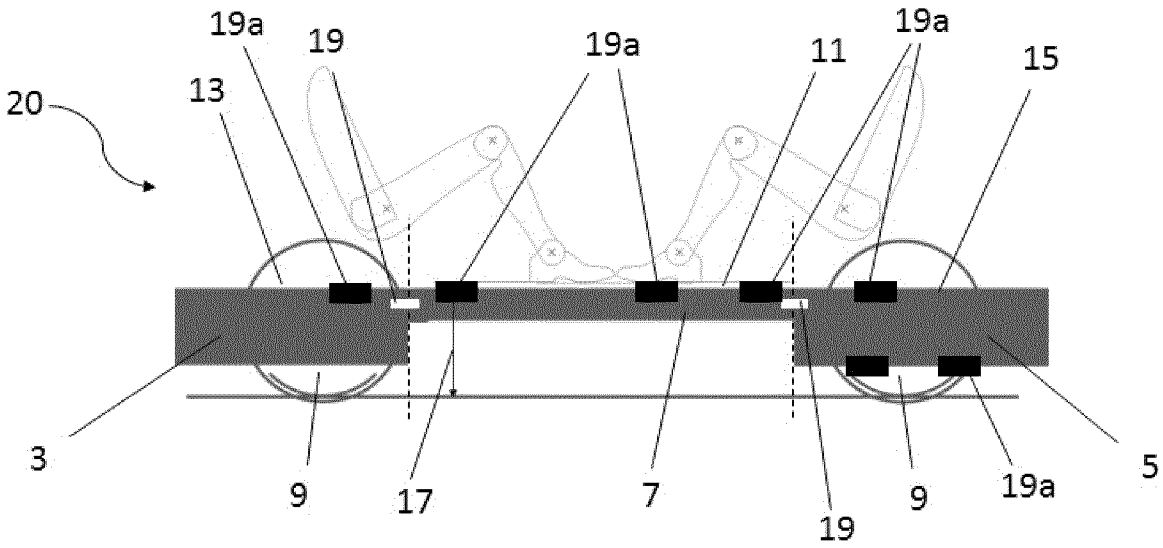

19a
19
19a
11
19a
15
20
13
3
9
17
7
19
9
19a
5

Fig. 3A

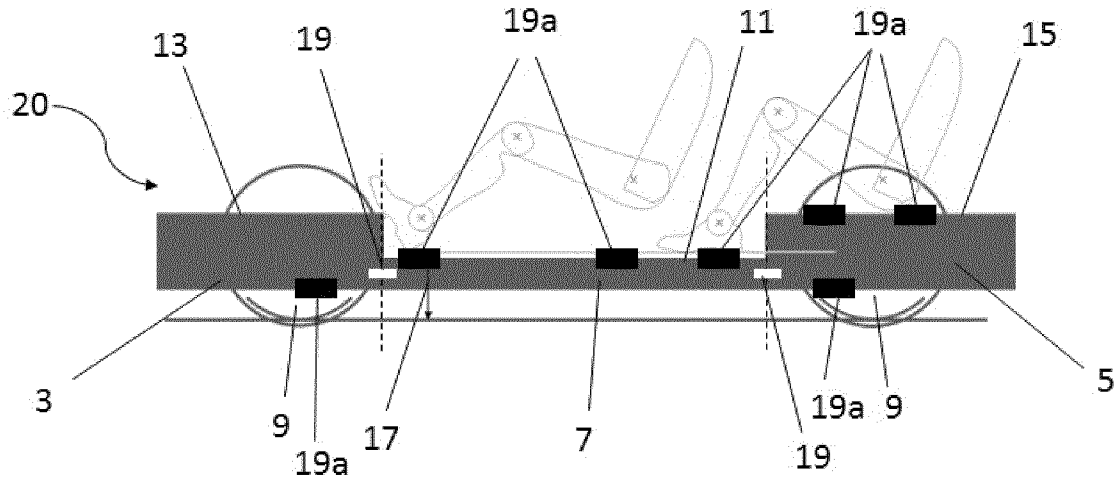

13
19
19a
11
19a
15
20
3
9
19a
17
7
19
19a
9
5

Fig. 3B

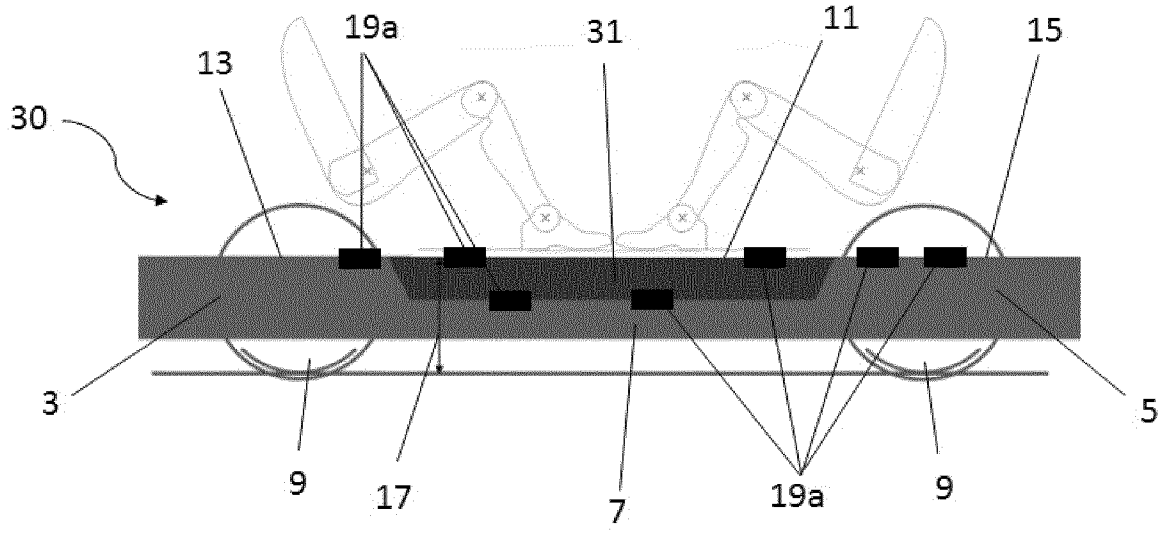


Fig. 4A

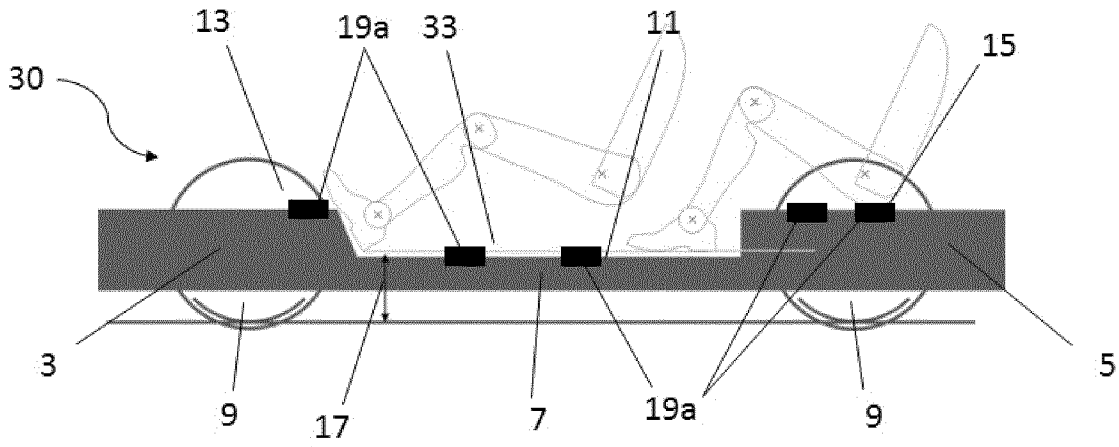


Fig. 4B

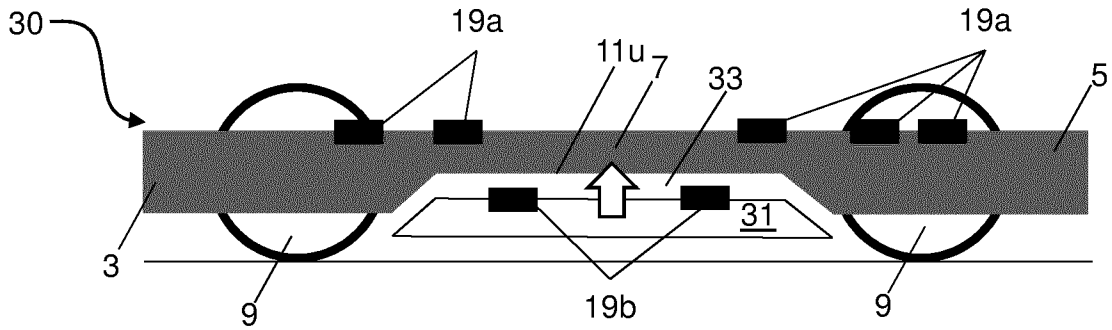


Fig. 4C

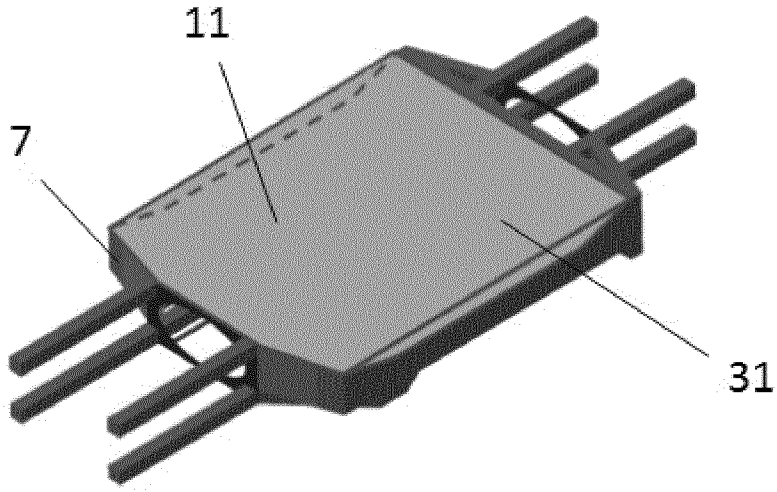


Fig. 5A

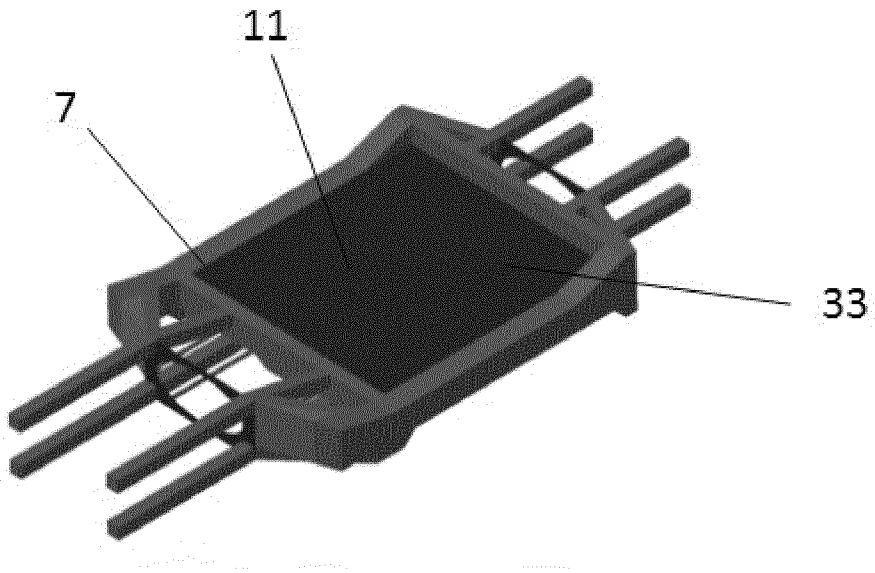


Fig. 5B

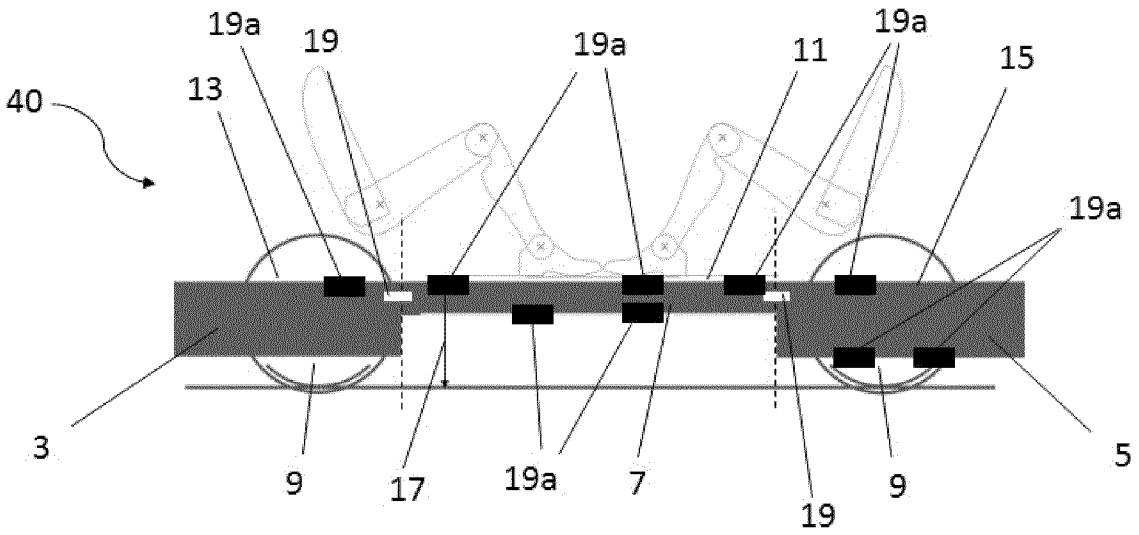

19a
19
19a
11
19a
15
40
13
19a
3
9
17
19a
7
19
9
5

Fig.6A

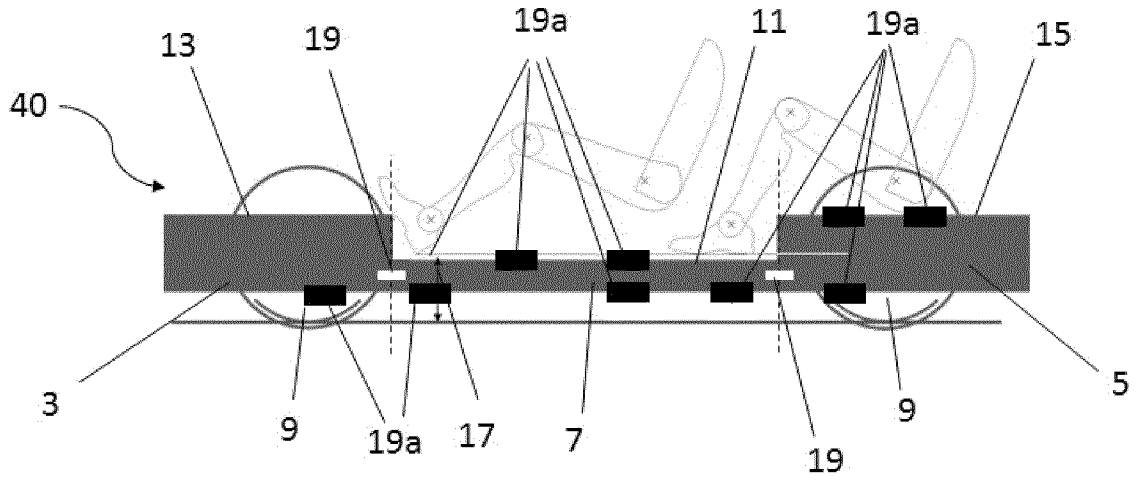

13
19
19a
11
19a
15
40
3
9
19a
17
7
19
9
5

Fig. 6B

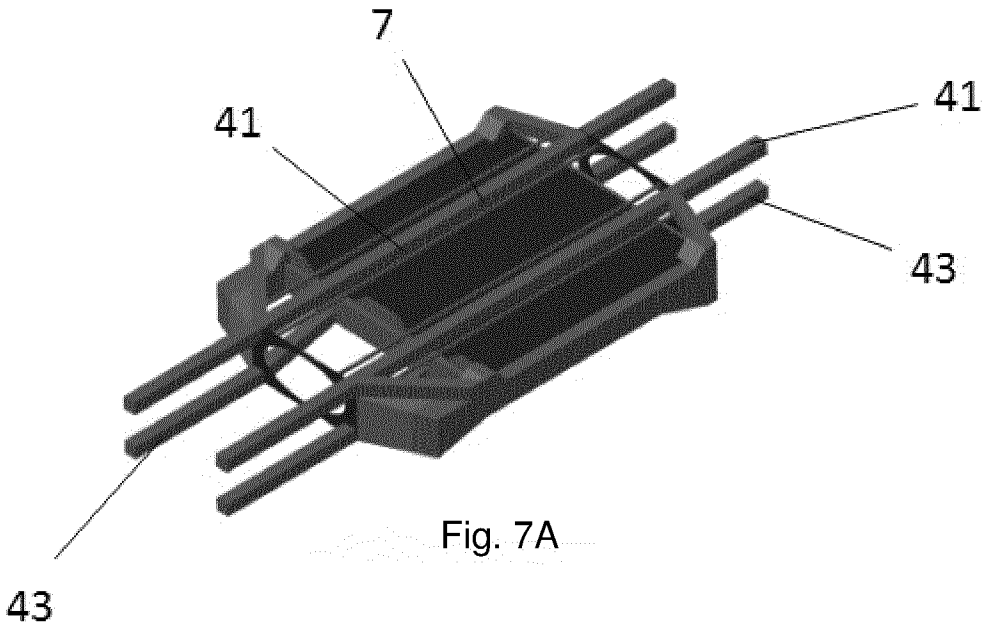


Fig. 7A

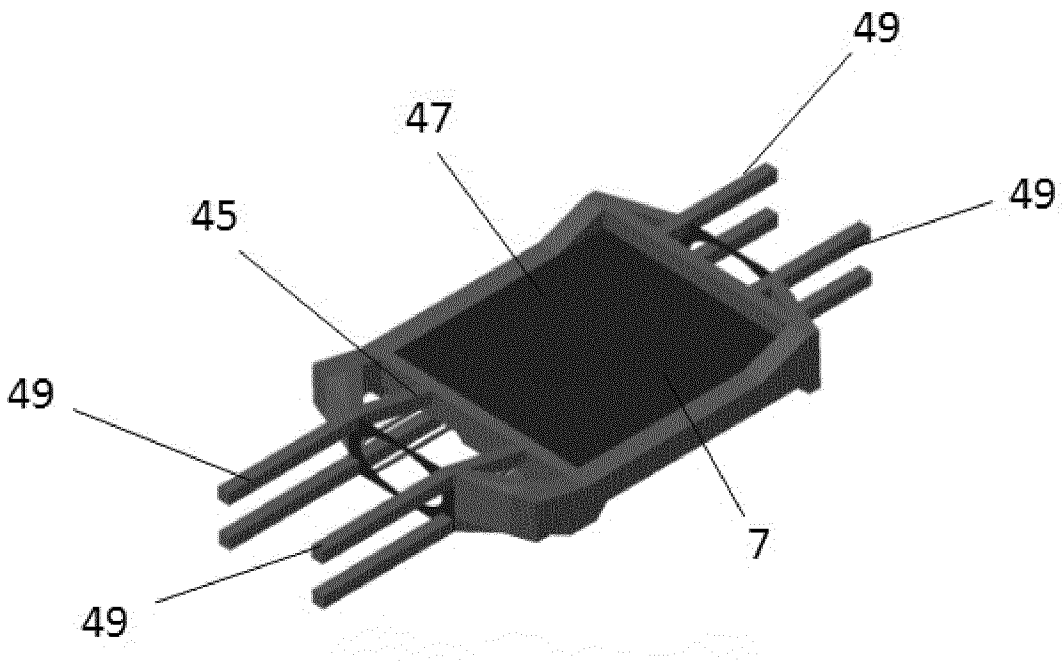


Fig. 7B

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/083145

A. CLASSIFICATION OF SUBJECT MATTER
INV. B62D63/02 B62D21/07
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.
A	US 2017/253271 A1 (BERTEZZOLO MATTEO [IT]) 7 September 2017 (2017-09-07) paragraph [0030] - paragraph [0049]; figures 1-9	1-24
A	CN 2 394 824 Y (WU JINQING [CN]) 6 September 2000 (2000-09-06) page 3, line 5 - page 4, line 8; figures 1-4	1-24
A	WO 2013/156639 A1 (BRUGOS ESPINA ROBERTO [ES]) 24 October 2013 (2013-10-24) the whole document	1-24

☐ 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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

"P" document published prior to the international filing date but later than the priority date claimed

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
30 January 2020	11/02/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Signorini, Luca

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2019/083145

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2017253271 A1	07-09-2017	CN 107074283 A	18-08-2017
		EP 3201069 A1	09-08-2017
		JP 2017530901 A	19-10-2017
		KR 20170063594 A	08-06-2017
		RU 2017114535 A	06-11-2018
		SG 11201702455X A	27-04-2017
		US 2017253271 A1	07-09-2017
		WO 2016051311 A1	07-04-2016
CN 2394824 Y	06-09-2000	NONE	
WO 2013156639 A1	24-10-2013	ES 1076926 U	14-05-2012
		WO 2013156639 A1	24-10-2013