



(51) International Patent Classification:

B62K 19/30 (2006.01) B62K 21/18 (2006.01)

(21) International Application Number:

PCT/IB2019/050374

(22) International Filing Date:

17 January 2019 (17.01.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

201841001908 17 January 2018 (17.01.2018) IN

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(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, 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).

(54) Title: A MOTOR VEHICLE AND A FRONT STRUCTURE THEREOF

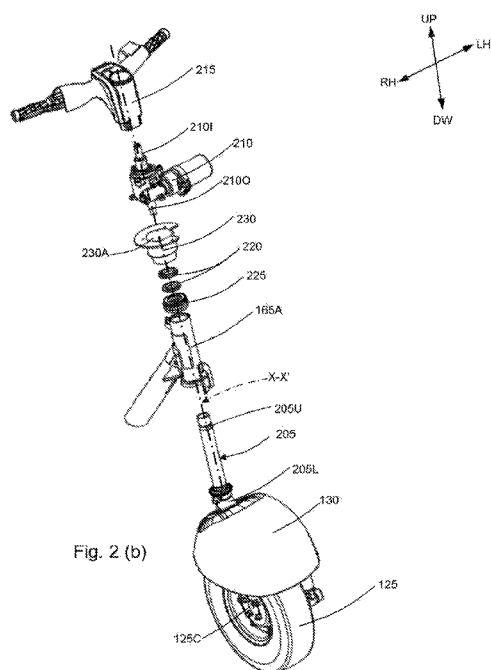


Fig. 2 (b)

(57) Abstract: The present subject matter provides support a front structure (200) for a vehicle (100). Front structure (200) includes support a steering shaft (205) rotatable about a pivot axis (X-X') and is supported by a structural member (165A) of vehicle (100). The steering shaft (205) is having one end (205L) connected to a wheel (125) of the vehicle (100). An electronic support (ES) unit (210) comprising an input shaft (210I) and an output shaft (210O) is disposed along the pivot axis (X-X'). The input shaft (210I) is connected to a steering member (215) and the output shaft (210O) is coupled to the steering shaft (205) with at least a portion of the steering shaft disposed along the pivot axis (X-X'). The steering member (215) is capable of selectively rotating the steering shaft (205) through the electronic support unit (210) and reduces the effort required to be put by the driver.

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

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

A MOTOR VEHICLE AND A FRONT STRUCTURE THEREOF

FIELD OF THE INVENTION

[0001] The present invention relates generally to a motor vehicle and more particularly to a front structure that enables user to maneuver for the motor vehicle.

5

BACKGROUND

[0002] Generally, in a motor vehicle, user operates the vehicle in a seated position. The motor vehicle is provided with a steering system that enables the user to navigate the motor vehicle in a desired direction. In case of a three-wheeled vehicle, colloquially called as auto rickshaw, the vehicle includes a driver compartment in a front portion from where the user/driver will operate the vehicle and a passenger/load compartment in a rear portion of the vehicle is provided that is rearward to the driver compartment. The load of the vehicle is shared by all the wheels of the vehicle. Moreover, in case of another type of three-wheeled vehicle like trikes with two wheels in the front or two-wheeled vehicles with high capacity engines, the weight of the entire vehicle is shared by all the wheels of the vehicle with at least one wheel in the front and at least one wheel in the rear. Therefore, in such vehicle the driver will be maneuvering the vehicle by operating steering system.

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BRIEF DESCRIPTION OF DRAWINGS

[0003] The detailed description of the present subject matter is described with reference to the accompanying figures. Same numbers are used throughout the drawings to reference like features and components.

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[0004] Fig. 1 illustrates a left side view of an exemplary motor vehicle, in accordance with an embodiment of the present subject matter.

[0005] Fig. 2 (a) illustrates a left side perspective view of a front structure mounted to a structural member, in accordance with an embodiment of the subject

25

matter.

[0006] Fig. 2 (b) depicts an exploded view of the front structure depicted in Fig. 2 (a).

[0007] Fig. 2 (c) illustrates an enlarged view of a portion of the front structure,
5 in accordance with the embodiment depicted in Fig. 2 (b).

[0008] Fig. 2 (d) illustrates a cross-sectional view of the front structure taken along axis W-W', in accordance with the embodiment depicted in Fig. 2 (a).

[0009] Fig. 3 (a) depicts a side perspective view of the front portion of the vehicle employed with the front structure, in accordance with an embodiment of
10 the present subject matter.

[00010] Fig. 3 (b) depicts rear view of the front structure, in accordance with the embodiment of Fig. 3 (a).

[00011] Fig. 3 (c) depicts another rear view of the front structure, in accordance with the embodiment of Fig. 3 (a).

[00012] Fig. 3 (d) depicts a side view of the vehicle with the front structure and user representatively shown, in accordance with the present subject matter.

[00013] Fig. 4 depicts various curves depicting effort required for degree of change of rotation in various instances

DETAILED DESCRIPTION

[00014] Generally, two-wheeled or three-wheeled vehicles are popular in
20 many countries because of their ease of operation and/or cost benefit. Exclusively, motor vehicles like the three-wheeled motor vehicles are a significant mode of public transportation. The three-wheeled are used as passenger vehicles or load carrying vehicles. Therefore, the three-wheeled vehicles are having bigger chassis
25 with higher load bearing capacity. Thus, the weight of the motor vehicle is higher and it gets transferred to the wheel so the vehicle.

[00015] In such vehicles, a handle bar is provided that is connected to a

- steering column connecting a front wheel to the handle bar, which is majorly mechanical in nature. The handle bar allows the driver to maneuver the vehicle along a desired path. However, operation of such steering system requires the driver to put in effort to transfer the torque to the maneuvering system. Moreover,
- 5 continuous operation of such steering system for long hours or in traffic conditions when the speed of the vehicle is slow requiring the driver to put higher force. As depicted in Fig. 1, from the first curve C1, the amount of effort required to turn/operate the steering of the vehicle increases progressively and with higher degree of angle of rotation the user has to apply higher force as the torque
- 10 requirements are higher. Moreover, this condition becomes aggravated when the vehicle is operated in high load conditions or during low speed conditions as the steering shaft directly receives load from the wheel. This causes high stress fatigue and shoulder pain to the user that is discomforting and may affect the health of the driver.
- 15 **[00016]** Moreover, there needs to be an optimum specification of the vehicles straight line stability to the ease of maneuverability. Since these are technically contradicting requirements, the change in payload of the vehicle with occupants or dead weight leads to detrimental handling performance & agility of the vehicle during usage.
- 20 **[00017]** For three-wheeled vehicles, there exists an additional challenge of the frequent change in payload of the vehicle owing to inconsistent number of passengers to be carried. For example, in a carriage type three-wheeled vehicle, this change is high owing to significant addition or removal of load. Thus, turning such three-wheeled vehicles with handle bar or steering wheel system after certain
- 25 angle of steering needs excessive and geometrically progressive effort, which is depicted in Fig. 4 as the first curve C1, by the driver as compared to four-wheeled vehicles; as in three-wheeled and two-wheeled vehicles the steering shaft is in

direct connection with the load bearing member of the vehicle like the wheels. As depicted through C1 of Fig. 4, the steering effort required to rotate or steer the handle bar is very high, as the handle bar is in direct connection with the front wheel, which is bearing load of the three-wheeled vehicle. Moreover, the handle bar and front wheel are disposed at 1:1 ratio by virtue of the direct connection. Whereas, in case of a four-wheeler or the like, the steering wheel and the wheels are disposed at certain ratio. For example, rotation of the steering wheel by 8 degrees, the wheels may rotate by 1 degree. This requires lesser steering effort when compared to steering effort required to put in the aforementioned three-wheeler. In Fig. 4, a second curve C2 depicts the steering effort against steering angle in case of a light motor vehicle like a four-wheeler. However, the four-wheeler requires the steering wheel to be rotated at a greater angle in order to attain the steering of the wheels due to the steering ratio being higher. As can be seen from curves C1 and C2, the three-wheeled vehicles or the like are higher loads thereby requiring higher steering effort causing fatigue to the user. Additionally, the three-wheeled or the similar vehicles with the handle bar have limited space in the front portion to have higher steering ratio for rotation to reduce effort. Moreover, the two-wheeled or the three-wheeled vehicle having the steering member directly connected to the wheels getting steered have a compact space in the front portion with a restricted sitting posture because of which the higher steering ratio cannot be attained due to the space limitation and due to the fouling possibilities during larger rotation. Moreover, the conventional two-wheeled or three-wheeled vehicle has the steering ratio as unity and the users are accustomed to such a practice of operation of the vehicle. Therefore, any deviation from the above practice would result in over-steering or under-steering that would result in catastrophic incidents. Thus, as shown in Fig. 4, the first curve C1 depicts the effort or force required to be exerted by the user for steering,

against steering angle in case of a three-wheeled vehicle to be substantially higher even when compared to a four-wheeler with mechanical steering as depicted in second curve C2.

[00018] Generally, bigger four wheelers include an electrically powered system that is capable of supporting the user to maneuver the steering system basing on user input. However, such system when employed in compact vehicles like three-wheelers or two-wheelers makes the steering system bulkier and aesthetically unpleasing. For example, such system is employed outside of the steering system that is making the system bulkier. Additionally, four wheelers have a fundamental difference that the steering system or shaft is offset from the steering wheels of the vehicle. Thus, there always exists substantial packaging space to accommodate independent and offset electrically power system to assist in steering of such vehicles.

[00019] Also, in many four wheelers, the rider and the steering wheel are disposed at a lateral offset from the lateral mid-plane of the vehicle. Therefore, neither they are symmetrically to the front wheel(s) mid-plane, nor they are disposed at the lateral mid plane of the track width. As discussed above, as vehicles with four or more wheels have adequate lateral space as well as longitudinal space, there exists freedom for design for providing steering system for such vehicles with complex mechanism, which is not the same in case of compact two-wheeled or three-wheeled vehicles. These two-wheeled or three-wheeled always need the rider, the handle bar or steering wheel, as well as the front wheel to be disposed symmetrical. Above problem exists, even in case of vehicles with one or more front wheel(s) where the lateral mid plane of the one or more wheel(s) needs to be co-axial disposed with the steering system as well as the rider which is a challenge.

[00020] Additionally, the steered unsprung mass in four wheelers, which

typically constitute the wheel assembly and levers or McPherson struts are dynamically isolated from the physics experienced on the steering wheel. For four wheeled track width vehicle with steering wheels, it is not feasible to have a co-axial steering system for the steering wheels' axis to be concentric to the steered axis of the wheels. Such disjoint arrangement in four wheelers provides ample space and flexibility to design link, leverage & electrical system to perform steering assist function. Also the track width of four wheelers is so high that it mandates a differential performance between the castor & camber parameters of the vehicle to compensate the effect of track width. The center of gravity (CG) of the steering axis in four wheelers is substantially offset from the CG of the steered mass giving a higher freedom in designing the two systems (steering system & steered system) independently. As compared to four wheelers, two wheelers and three wheelers have a completely different geometry and physics of the systems. The steering system axis is always co-axial & concentric with the steered system (unsprung mass of the vehicle) except in case of trikes with two front wheels.

[00021] Even in case of trike type vehicles, they suffer from the fundamental challenge of having to steer both the two front wheels in a conjoint manner to achieve comfortable & satisfactory handling performance of the vehicle. Therefore, implementing a steering assist system suitable for offset type four wheeled vehicles is not feasible for two-wheeled or three-wheeled vehicles. Such arrangement by very nature of construction will account for huge lateral space thereby increasing the width of the vehicle which is not desirable. Thus there is need to have a compact steering assist system for two-wheeled or three-wheeled vehicles which have their CG substantially close to the steering axis of the vehicle. Moreover, the conventional system is not having a fail-safe mode of operation when the electrical/electronic system fails. For example, in conventionally suggested electrical steering assist system, the system is having an electrical

motor that is connected to shaft by a gear train that is in constant contact with the steering shaft. Therefore, when such a system fails due to failure of the control unit, battery drain, or failure of any other electrical/electronic system, the steering system is locked at a certain position. This would stall the vehicle as the steering
5 system is not operable. Additionally, conventional steering assist systems are continuously in engaged position. This is detrimental in case of two or three-wheeled vehicle as this would drain valuable energy from the battery or power source during time when payload of the vehicle is substantially low and when there is no need of power assist e.g. low traffic conditions. Draining of the
10 battery or the power source would affect other system of the vehicle that is operational taking power from the battery.

[00022] Thus, there is a need for a steering system that is capable of providing a steering assist to user selectively and the steering system should be fail-safe. The steering system should enable the user to operate the vehicle even during failure
15 of the electrical/electronic system that is providing the assist. Also, the system should enable compact packaging in small compact vehicles like the two-wheeled or three-wheeled vehicles.

[00023] Hence, the present subject matter provides a front structure for a motor vehicle (two-wheeled or three-wheeled vehicle) that reduces the effort to be
20 put by the user for maneuvering the vehicle. The front structure is compact and can be employed in compact vehicles like three-wheelers or two-wheelers. Moreover, the front structure is packaged aesthetically. Further, the front structure provides steering assist to the user and at the same time provides fail-safe operation upon failure of electrical system.

25 **[00024]** It is a feature that the present subject matter provides improved dynamic performance for steering the two-wheeled or three-wheeled vehicles, as the CG of a steering assist system is disposed within an annular locus formed by

rotation of an axis passing through the wheel center, which is parallel to the steering axis, about the steering axis.

[00025] The present subject matter provides a front structure including an electronic support (ES) unit mounted to a structural member of the vehicle. The electronic support unit comprises an input shaft disposed along said pivot axis and
5 connected to a steering member operated by the user. The electronic support unit includes an output shaft disposed along the pivot axis functionally coupled to a steering shaft. One end portion of the steering shaft that is connected to the output shaft is disposed concentrically about the pivot axis. Other end portion of the
10 steering shaft is connected to a wheel, preferably disposed in a front portion of the vehicle, having a center disposed substantially in line with the pivot axis in a longitudinal direction of the vehicle. The steering member is capable of selectively rotating the steering shaft through the electronic support unit.

[00026] It is a feature of the present subject matter that the steering shaft that
15 is rotatably disposed about a structural member of the vehicle, like the head tube, is connected to a steering wheel of the vehicle that directly receives loads. At the same time, the direct load bearing member like the steering shaft is directly steered by the electronic support unit disposed coaxially to the steering shaft. Especially, the one end portion functionally coupled to the output shaft of the
20 electronic support unit is coaxial.

[00027] It is a feature that the front structure rotates the unsprung mass like the wheel and at least a portion of the unsprung mass including the steering shaft.

[00028] Further, the front structure provides optimum power usage as the electronic support unit is actuated only upon detection of a steering requirement
25 from the user. Also, the front structure can be adapted to assist when the steering angle is beyond a pre-determined angle.

[00029] Further, the front structure is capable of being employed in a compact

motor vehicle. The front structure includes a steering shaft rotatably supported by a structural member of the motor vehicle. The steering shaft is having one end connected to a wheel of the motor vehicle. An electronic support (ES) unit comprising an input shaft and an output shaft is disposed along a pivot axis of the front structure. The input shaft is functionally connected to a steering member that is operated by the user. The output shaft is functionally coupled to the steering shaft with at least a portion of the steering shaft disposed along the pivot axis. The steering member is capable of selectively rotating the steering shaft through the ES unit and the ES unit is capable of providing steering assist by rotating the steering shaft when the steering member is rotated beyond a certain angle. The ES unit can support steering of the steering shaft based on velocity of the vehicle or based on the torque exerted by the user.

[00030] It is an aspect of the present subject matter that the ES unit is mounted to an attachment member thereof that is mounted to the head pipe. Thus, the ES unit is secured to a rigid structure without adding any additional weight on the front structure. The attachment member includes a holder aperture extending along/coaxial to the pivot axis and the attachment member is mounted to the structural member through the holder aperture whereby at least a portion the attachment member is coaxially disposed about the structural member. Therefore, it is an advantage that the attachment member is compactly disposed about the structural member like the head pipe thereby providing a compact front structure.

[00031] It is an aspect of the present subject matter that the front structure is capable of providing a one to one drive feel when the ES unit is operational or when the ES unit in non-operational as the steering member, the shafts of the ES unit, the steering connected to the wheel are substantially coaxial and along the pivot axis. Also, the wheel being steered is substantially in line with the pivot axis in a longitudinal direction. It is an advantage that the user will feel comfortable

operating the front structure with or without electronic support as the system provides the same degree of rotation of the steering shaft with the corresponding change in steering shaft. Thus, it is an additional feature that the user will not require any training for operating the front structure and so the front structure can be retrofittable and operable with ease without affecting the ergonomics

[00032] It is a feature that the front structure enables the user to steer the vehicle without any assist from the ES unit during high speed or less traffic conditions as the wheel that is being steered is in line with the pivot axis of the steering shaft in a longitudinal direction and the user can operate the front structure similar to a conventional with ease without any additional load or weight acting thereon.

[00033] It is a feature that the attachment member includes an abutting base for securing the attachment member to the structural member. Also, the attachment member includes a support wall extending in a direction at a first angle with respect to the base. The ES unit is mounted to the support wall. It is another advantage that the attachment member enables the ES unit to be mounted coaxially about the pivot axis of the front structure. It is an advantage that the ES unit secured to the structural member is isolated from any direct impacts acting on the ES unit as the ES unit is not resting on the steering that is direct load/impact receiving member.

[00034] The support wall extends along a circumference of the base and the ES unit includes a casing for securing the ES unit to the support wall through the casing. Therefore, the casing supports the electrical motor of the ES unit and the rotating member thereof. Further, the attachment member is made of a rigid non-conducting material or a metallic material with electrical insulation.

[00035] It is another aspect that the output shaft of the ES unit includes a first cross-section at output shaft-engaging portion. The steering shaft includes a

second cross-section provided at steering shaft-engaging portion thereof. The second cross-section is conforming & complementing the first cross-section thereby creating a locking between the shafts. It is an advantage that the steering shaft and the output shaft are lockingly engaged without the need for additional
5 fasteners.

[00036] The output shaft-engaging portion and the steering shaft-engaging portion are not transferring any axial loads to each other as the steering shaft locking receives the output shaft of the ES unit and there is no direct contact in axial direction to transfer forces. Therefore, it is another additional advantage that
10 the output shaft-engaging portion and the steering shaft-engaging portion annularly abut the other of the output shaft-engaging portion and the steering shaft engaging portion, whereby there is an annular engagement that enables angular rotation of the steering shaft when the output shaft of the ES unit is operated by the control unit.

15 [00037] It is another feature that the wheel that is being steered by the front structure including the ES unit is substantially disposed at the center of the vehicle thereby providing stability to the vehicle.

[00038] Further feature being, the ES unit is capable of assisting the user to rotate the steering shaft irrespective of change in load in case of either carriage
20 type or passenger type of vehicles that are subjected to loads variations.

[00039] The ES unit includes an electric motor that is functionally connected to the output shaft and a motor shaft is disposed along a shaft axis substantially disposed in a horizontal direction. Therefore, the shaft axis is non-parallel to the pivot axis.

25 [00040] It is another feature that the electric motor is having the shaft axis extending in a lateral direction of the vehicle. Therefore, the electric motor does not interfere with the components disposed longitudinally adjacent to the front

structure, which includes the front cowl or the rider foot space region. Therefore, it is an advantage that the motor vehicle retains the layout and user space.

[00041] Further, the electric motor is disposed rearward to a front cowl of the vehicle, downward to an instrument panel, forward to a driver seat, and upward to
5 a driver foot space of the vehicle. Therefore, the ES unit disposed about the front structure comprises the electric motor optimally disposed without affecting other ancillary components of the vehicle.

[00042] It is an additional aspect that the instrument panel covers the electric motor in a top direction and a rearward direction thereby the motor vehicle
10 appears to be a conventional motor vehicle without steering assist. Moreover, it is an advantage that the electric motor is securely placed below the instrument panel.

[00043] It is a feature that the attachment member is provided with a cut portion that is capable of accommodating the electric motor as the electric motor is larger in size and has a curved outer profile that is to be supported by the wall
15 of the attachment member.

[00044] It is additional feature that the input shaft, the output shaft, and an upper portion of the steering shaft are disposed along the pivot axis, and the pivot axis is the axis of rotation of the steering member. It is an advantage that the steering assembly is compactly packaged about the pivot axis and only the electric
20 motor of the ES unit extends outward.

[00045] It is another aspect of the present subject matter that the motor vehicle includes the wheel connected to other end portion of steering shaft and the wheel is disposed substantially along lateral center of the vehicle. However, in another implementation, for a vehicle with wheels disposed in the front being in greater
25 number than the wheels disposed in the rear, the wheels disposed in the front are having a center (in lateral direction) aligning with a center of the motor vehicle.

[00046] Moreover, it is yet an additional aspect that the electric motor along

with the ES unit is at least partially disposed above the instrument panel and rearward of the front cowl of the vehicle. The ES unit is compactly disposed in the front portion of the motor vehicle. Further, the ES unit disposed above the instrument panel also provides a compact front structure without interfering with the user posture and user ergonomics.

[00047] The structural member in one implementation is a head pipe of a frame assembly of the vehicle and the head pipe is extending along the pivot axis and a main frame of the frame assembly is extending rearwardly downward from the head pipe. However, in another implementation, the structural member is a monocoque body structure that rotatably supports the front structure.

[00048] It is an aspect that the input shaft is mechanically connected to the steering member and the output shaft, and the electrical motor is connected to the output shaft through a rotation conversion mechanism. The rotation conversion mechanism enables the rotational motion of the motor shaft of the electric motor in shaft axis into the rotation motion of the output shaft that is disposed in the pivot axis.

[00049] The aforesaid and other advantages of the present subject matter would be described in greater detail in conjunction with the figures in the following description.

[00050] Fig. 1 illustrates a left side view of an exemplary motor vehicle 100, in accordance with an embodiment of the present subject matter. The vehicle 100 has a frame assembly (not shown) including a head tube, a main tube assembly extending rearward from the head tube. The frame assembly acts as the structural member of the vehicle 100. Hereinafter, the frame assembly or the sub-parts of the frame assembly are referred to as the structural member. The vehicle 100 has a front cowl 105 disposed in a front portion of the vehicle 100. A windshield 110 is mounted on the front cowl 105. A floorboard 115 is extending rearward from a

bottom portion of the front cowl 105 and the floorboard 115 is supported by the structural member. A front structure 200 is rotatably supported by the structural member of the vehicle 100. In the present implementation, the structural member, which is the frame assembly, includes a head pipe 165A (shown in Fig. 2 (a))
5 disposed behind the front cowl 105. The front structure 200 includes a front wheel 125 connected to a steering member that is operated by the user. A front fender 130 is disposed above the front wheel 125 and is covering at least a portion of the front wheel 125. A rear panel 135 is disposed in a rear portion of the vehicle 100 and is connecting a posterior portion of the floorboard 115. Two rear wheels 140
10 are connected to a swing arm 145 through one or more suspension(s) 150, and the swing arm 145 is in turn connected to the structural member. A hood 155 connects a top portion of the front cowl 105 and a top portion of the rear panel 135.

[00051] The vehicle 100 is longitudinally divided into two portions along a partition line P-P' forming a driver compartment DC and a passenger compartment PC. The driver compartment DC has a driver's seat assembly 120
15 and the passenger compartment PC has a long passenger seat 160 with a seating capacity of minimum three passengers. The vehicle can be used as a passenger carrier vehicle or a load carrier vehicle. In case of a load carrier vehicle, instead of the passenger compartment, a load carriage is provided.

20 **[00052]** The vehicle includes a power unit (not shown) mounted to the frame assembly in rear portion of the vehicle 100. The power unit comprises of an internal combustion (IC) engine (not shown) or a traction motor (not shown), a transmission system (not shown) is functionally connected to the rear wheels for transmitting power from the power unit.

25 **[00053]** Fig. 2 (a) depicts a side view of the front structure mounted to the structural member of the vehicle 100, in accordance with the embodiment of Fig. 1. The structural member 165 in the present embodiment is a frame assembly. The

frame assembly includes a head pipe 165A and a main frame 165B, wherein the head pipe 165A is disposed in a front portion of the vehicle 100 and rearward to the front cowl 105 and forward to the driver seat assembly 120. The main frame 165B extends rearward from the head pipe 165A. The main frame 165B in one
5 implementation includes one or more tubular members 165BA extending rearward from the rear portion of the head pipe 165A. The main frame 165B extends from the head pipe 165A and below the floorboard towards a rear portion of the vehicle 100.

[00054] In the present implementation, the structural member 165 is a metallic
10 frame made of tubular members. However, the structural member is not limited to the metallic tubular frame assembly, as the structural member may include a frame made of fiber reinforced polymers or casted frame. Also, in some applications, the structural member is a monocoque structure that has a body functioning as structural member. The front structure 200 is rotatably supported by the structural
15 member 165 that is the head pipe 165A. The front structure 200 includes the front wheel 125 that is connected to a steering shaft 205. The steering shaft 205 includes one end portion connected to the front wheel 125 through a front suspension system 170 and the other end portion is journaled about the head tube 165A. The head pipe 165A supports an upper bearing assembly and a lower
20 bearing assembly (not shown), which enable rotation of the steering shaft 205. Further, the front structure 200 includes an electronic support (ES) unit 210 that is mounted to the head pipe 165A and is supported by the structural member 165/frame assembly. In the present implementation, the frame assembly supports the front structure 200 that includes the substantially bulkier and heavy ES unit.
25 The terms 'head pipe' and 'structural member' are interchangeably used. Furthermore, the ES unit is functionally connected to the steering shaft 205 and a steering member 215. In the present implementation, as depicted, the steering

member 215 is a handle bar that includes throttle control, lever, and control switches. However, the steering member 215 can be a steering wheel or any other known steering device, wherein the function of the steering member 215 is provided to enable user/driver to maneuver the vehicle 100.

5 [00055] Fig. 2 (b) depicts an exploded view of the front structure 200 in accordance with the embodiment of Fig. 2 (a). The steering shaft 205 is a tubular member made of rigid material including any known metal is having one end portion 205U that is disposed about the head pipe 165A and the other end portion 205L is extending outward from the head pipe 165A and is connected to the front
10 suspension system 170. The one end portion 205U is disposed concentrically about the pivot axis X-X'. In the present implementation, the steering shaft 205 is having a solid or hollow profile. The steering shaft 205 includes one end portion 205U, which is upper end portion, disposed about the head pipe 165A and the other end portion 205L, which is lower end portion thereof, is having a slightly
15 forwardly bent portion to connect to the front wheel 125 that is disposed ahead of the front cowl 105. The other end portion 205L is connected to the wheel 125 that is being steered at a center 125C of the wheel 125. In the depicted embodiment, the front cowl 105 disposed in the front portion necessitates the front wheel 125 to be disposed forwardly of the front cowl 105 whereby the axle of the front wheel
20 125 is disposed ahead of the axis X-X' and the other end portion 205L is having a curved shape. Preferably, the steering shaft 205 is having the other end portion 205L curved formed by the connection between the steering shaft 205 and the wheel 125 at a point ahead of the pivot axis X-X' providing effectively a positive caster angle to enable stable riding. Further, other end portion 205L is connected
25 to the wheel 125 at a wheel center 125C disposed substantially in line with the pivot axis X-X' in a longitudinal direction F-R of the vehicle 100. In other words, when viewed in longitudinal direction F-R, the center 125C of the wheel 125, the

pivot axis X-X' with the input shaft 210I and the output shaft 210O of the front structure 200 are in line.

[00056] Further, the front structure 200 is provided with bearing assembly 225 at upper and lower portion of the head pipe 165A. Races of the bearing assembly
5 are mounted to the steering shaft 205 or to the head pipe 165A depending on the position they are disposed. Further, one or more lock nuts 220 are secured to a top end of the steering shaft 205 whereby the braces provided on the steering shaft 205 at the lower portion and the lock nut provided on the steering shaft top end hold the steering shaft 205 about the head pipe 165A at a desired position.

10 [00057] Furthermore, the front structure 200 includes an attachment member 230, which is capable of supporting the ES unit 210, is mounted to the head pipe 165A. In the present implementation, the attachment member 230 is having an inner circular cross-section. The inner circular cross-section is defined by a holder aperture 230A that extends along the pivot axis X-X' in an assembled condition of
15 the attachment member 230. The attachment member 230 can be fastened to the head tube 165A or welded to the outer surface of the head tube 165A. The attachment member 230 in an assembled condition encloses at least a portion of the head tube 165A and encloses the bearing assembly 225. In the present implementation, the ES unit 210 is secured to the attachment member 230. The ES
20 unit 210 includes an input shaft 210I and an output shaft 210O and the output shaft 210O passes through the holder aperture 230A and is functionally connected to the steering shaft 205. The input shaft 210I is disposed upward and is connected to the steering member 215.

[00058] Fig. 2 (c) depicts an enlarged view of the ES unit 210 being mounted
25 to the attachment member, in accordance with the embodiment of Fig. 2 (d). The attachment member 230 is having a cylindrical abutting base 230B that is having a circular cross-section at the inner portion. However, the attachment member 230

may have a cross-section that complements the outer profile of the head pipe 165A. The attachment member 230 is provided with a stepped profile, wherein the lower portion that is secured to the head pipe 165A is having inner diameter to substantially matching the outer diameter of the head pipe 165A. Therefore, the attachment member 230 may be a clearance/transition fit thereof. The portion of the abutting base 230B that is other than the portion gets connected to the head tube 165A is having a higher diameter so as to accommodate the protrusion formed by the races of the bearing assembly 225 of the head tube 165A. The attachment member 230 further includes a wall portion 230W that is having a cross-sectional area greater than the abutting base 230B to support the ES unit 210. The ES unit 210 is a heavy component as it includes an electric motor 235, and rotation conversion mechanism (not shown) enclosed by a casing 240 of the ES unit 210. The casing 240 includes mechanical and electrical/electronic components that enable the functioning of the ES unit 210. For example, the casing 240 includes electronic sensors to sense the angle of rotation of the steering member 215 and also mechanical systems like rotational conversion mechanism.

[00059] The wall 230W is extending in a first direction with respect to the abutting base 230B that is extending substantially in a direction along pivot axis X-X'. The wall 230W is disposed at a first angle with respect to the abutting base 230B, wherein in the present implementation the first angle is at an orthogonal angle (90 degrees). The wall 230W extending in first direction at an angle orthogonal to the abutting base 230B is disposed substantially about the circumference of the abutting base 230B whereby the wall 230W forms a plate like structure that supports the ES unit 230 on the top.

[00060] The ES unit 210 further includes the electric motor 235 a shaft (not shown) disposed along a motor shaft axis Y-Y'. The motor shaft axis Y-Y' is substantially in a horizontal line. The motor shaft of the electric motor 235 is

extending into the casing 240 that includes the rotation conversion mechanism. In one implementation, the rotation conversion mechanism includes a worm gear that is mounted to the motor shaft of the electric motor 235 and the worm gear is functionally coupled to a gear that is concentrically disposed and connected to the steering shaft 205. Thus, the rotation conversion mechanism disposed in the casing converts the rotational motion of the motor shaft of the electric motor 235 about pivot axis X-X' into the direction about the motor shaft axis Y-Y'.

[00061] In the depicted implementation, the casing 240 includes mounting boss 240M that are provided at select position annularly about the bottom portion of the casing 240. Also, the wall 230W is provided with attachment member 230 with mounting holes provided to match the mounting boss 240M, whereby the ES unit 210 is secured to the wall 230W by fastening the casing 240 to the wall portion 230W. Further, the output shaft 210O, in assembled condition of the ES unit 210, extends inside the attachment member 230.

[00062] Fig. 2 (d) depicts a cross-sectional view of the front structure taken along axis W-W', taken in accordance with the embodiment as depicted in Fig. 2 (a). Further, Fig. 2 (d) depicts an enlarged view of a portion of the front structure and a cross-sectional view taken along axis C-C'. The cross-sectional view depicts, the input shaft 210I connected to the steering member 215, wherein the input shaft is engagingly connected to the steering member 215 through a groove provided in the bottom portion of the steering member 215. For example, the input shaft 210I can have a circular cross-section that is secured to the steering member 215 by a fastener or the input shaft 210I can have a non-circular cross-section that engages with the steering member 215. The output shaft 210O that is extending into the attachment member 230 when assembled on the head pipe 165A engages with the end portion 205U that extends till a top portion of the head pipe 165A. At least a portion of the abutting base 230B of the attachment member 230 is abutting the

outer peripheral surface 165AS of the head pipe 165A. Therefore, the attachment member 230 is rigidly secured to the head pipe 165A so as to withstand the weight of the ES Unit 210, the steering member 215, and the force exerted by the user.

[00063] Further, the output shaft 210O is secured to the end portion 205U of the steering shaft 205. In a preferred embodiment, the portion of the output shaft 210O that engages with the steering shaft 205 is provided with a non-circular cross-section. Consequently, the end portion 205U of the steering shaft 205 is provided with a cross-section complementing the cross-section of the output shaft 210O. This enables locking of the output shaft 210O with the steering shaft 205 in the angular direction whereby rotation of the output shaft 210O results in the rotation of the steering shaft 205. It is an advantage that any impact received by the steering shaft 205, due to road condition from the front wheel 125 is not directly transferred to the ES unit 210 or the steering member 215. Thus, the ES unit 210 is secured from the impacts from the road condition as the output shaft 210O and the steering shaft 205 are having an annular connection without any direct vertical connection/contact. The output shaft 210O of the ES unit 210 is locking with a locking member 206 provided in the steering shaft 205, wherein rotational force from the output shaft 210O is transferred to the steering shaft 205 through the locking member 206. The locking member 206 is either press-fitted or encasted with the steering shaft 205 that is preferably a hollow member. Thus, output shaft-engaging portion 210E of the output shaft 210O and the steering shaft-engaging portion 205E of the steering shaft 205 do not have a direct contact as the output shaft 210O locks with the locking member 206 whereby the ES unit is supported on the head pipe 165A and the steering shaft 205 is also supported by the head pipe 165A and there is not contact along the axes or in axial direction thereof. This reduces any impacts/vibrations from the steering shaft 205 from reaching the ES unit 210, especially to sensors like torsion bar that is sensitive to

vibrations and impacts providing false readings to the control unit. In other words, as depicted in Fig. 2 (d), the cross-sectional view taken in a horizontal plane along axis C-C' depicts that the output shaft 210O includes a first cross-section CS1 at output shaft-engaging portion 210E and the steering shaft 205 includes a second cross-section CS2 provided at a steering shaft-engaging portion 205E thereof, wherein the second cross-section CS2 is complementing said first cross-section CS1. The output shaft-engaging portion 210E and the steering shaft-engaging portion 205E being provided with annular connection without vertical/axial contact along the pivot axis X-X', and wherein one of the output shaft-engaging portion 210E and the steering shaft-engaging portion 205E annularly abuts the other of the output shaft-engaging portion 210E and the steering shaft-engaging portion 205E.

[00064] Moreover, in one implementation, the steering shaft 205 is having a top portion secured about the head pipe 165A through steering lock nut(s) 166. Below the steering lock nut(s) 166 an upper race is provided that enables rotation of the steering shaft 205 about the head pipe 165A. Further, a vertical contact between the ES unit 210 and the steering shaft 205 in axial direction is avoided. To elaborate, the steering shaft 205 is provided with a locking member 206 disposed therein having a bore with a first length and the output shaft 210O includes an engaging portion having a second length that is engaging with the bore of the steering shaft 205, wherein the second length is lesser than first length. Therefore, the engaging portion of the output shaft 210O engages with the steering shaft 205 but does not provide axial contact that lead to transfer of forces/impact from the wheel 125. Also, the steering shaft 205 being hollow enables the output shaft 210O to have not vertical/axial contact between them.

[00065] For example, in the present embodiment, the steering shaft 205 is having a hollow profile/portion HP and the locking member 206 is disposed

therein with the locking member 206 having a first cross-section CS1. The output shaft 210O is provided with the second cross-section CS2 at the output shaft-engaging portion 210E and the output shaft with the second cross-section is slidably into the first cross-section CS1, preferably by interference fit. Because of the conforming and the complementing profile of the cross-section CS1, CS2 the shafts 210O, 205 are lockingly engaged. However, because of the hollow profile HP the output shaft 210O is not in axial contact with the steering shaft 205 and only has annular contact. This is limiting/eliminates any transfer of the loads onto the ES unit 210 thereby protecting ES unit and other sensitive components of the ES unit 210.

[00066] Furthermore, the front structure 200 enables selective steering assist. The input shaft 210I rotates about the ES unit 210 when the user rotates the steering member 215. The input shaft 210I is electrically connected to a sensing unit that provides the degree of rotation/angle of rotation of the steering member 215 at the same time the input shaft 210I that is functionally connected to the output shaft 210O transfers the rotational force from the steering member 215 thereof mechanically. However, when the ES unit 210 detects the degree of rotation of the input shaft 210I, which is the rotation of the steering member 215, beyond a certain degree, the ES unit 210 provides electrical support by enabling the electric motor 235 to rotate the output shaft 210O that is functionally connected to the steering shaft 205. This provides the torque assist to the user for rotation when the user tries to rotate the steering member 215 beyond a certain degree that requires higher torques thereby reducing the force required to be put by the user. Moreover, the front structure 200 can operate basing on velocity of the vehicle or basing on torque applied on the steering system by user, the relevant sensors provide the velocity and/or torque related data to a control unit that actuates the electronic support (ES) unit 210.

[00067] Additionally, the front structure 200 being provided with the steering shaft 205, the shafts 210I, 210O of the ES unit 210, and the steering member 215 disposed about the same pivot axis X-X' enables the front structure 200 to be operated mechanically and also to provide the electrical support through the ES unit 210 when the user tries to rotate the steering member 215 beyond certain angle. Moreover, during any failure of the ES unit 210 that includes failure of the electrical motor 235, the control unit, or the auxiliary power source that drives the electrical motor, even in such condition, the input shaft 210I and the output shaft 210O shall have mechanical connection, thereby enabling fail safe & hassle free-operation by the user. Thus in case of any failure of the ES unit during driving, the impact on the vehicle is minimized & safety of the occupants is achieved.

[00068] Also, the front structure 200 enables compact packaging in the vehicle 100. Fig. 3 (a) depicts a side perspective view of the front portion of the vehicle 100 employed with the front structure 200, in accordance with an embodiment of the present subject matter. Fig. 3 (b) depicts rear view of the front structure, in accordance with the embodiment of Fig. 3 (a). The front structure 200 is compactly disposed ahead of the driver seat 120. The head pipe 165A is disposed rearward to the front cowl 105 and the steering shaft 205 journaled about the head pipe 165A. The steering shaft 205 passes through the front cowl 105 and gets connected to the front wheel 125. The ES unit 210 is mounted above end portion 205U (as depicted in Fig. 2 (d)) of the steering shaft 205 and the head pipe 165A and is disposed rearward to the front cowl 105. Further, the steering member 215 is disposed above said ES unit 210. Further, the length of the ES unit 210 along the pivot axis X-X' is adapted to match with the desired height of the steering member 215 for the driver/user to operate the vehicle. Thus, the ES unit 210 is compact does not affect the riding posture of the user as well as enable

compact layout packaging of the vehicle.

[00069] The electric motor 235 disposed about the motor shaft axis Y-Y', which is the shaft axis, is in a later direction RH-LH (shown in Fig. 3 (d)) and substantially in a horizontal direction. The electric motor 235 does not interfere
5 with the rider foot space FS that extends from the rear portion of the front cowl 105 to the driver seat assembly 120. Also, the electric motor 235 extending in the lateral direction RH-LH is substantially enclosed by an instrument panel 245 (shown in Fig. 3 (c)).

[00070] Fig. 3 (c) depicts another rear view of the front structure 200,
10 employed on the vehicle 100 in accordance with the embodiment of Fig. 3 (a). The instrument panel 245 is disposed below the steering member 215 and above the head pipe 165A. The instrument panel 245 includes a through hole for the front structure 200 to be disposed therethrough. The instrument panel 245 covers the electric motor 235 which is the major portion of the front structure 200
15 extending outward, in top and rear direction. Thus, the electric motor 235 of the front structure 200 is securely located in the vehicle 100. Also, at least a portion of the front structure 200 is covered by the instrument panel 245. Thus, the vehicle 100 is aesthetically appealing as the bulkier ES unit 210 is substantially not visible to the rider or other passersby.

20 [00071] Also, Fig. 3 (d) analyzed along with Fig. 2 (d), the ES unit 210 mounted to the head pipe 165A having the input shaft 210I and the output shaft 210O disposed along the pivot axis X-X' and being functionally connected to the steering member 215 provide an ergonomic posture to the rider. As the rider can have an elbow bend angle α is less as the ES unit 210 mounted to the head pipe is
25 compactly disposed without affecting the height of the front structure 200. The low elbow bend angle α enables the rider to operate the front structure 200 with ease. Further, the ES unit 210 capable of selectively rotating the steering shaft 205

that is connected to the front wheel 125 having a center 125C in line with the pivot X-X' along a longitudinal direction F-R of the vehicle 100, whereby the user can optimally steer the vehicle 100 without feeling the effort of steering the load receiving structure, which is the steering shaft 205, of the vehicle 100.

5 [00072] Fig. 4 depicts various curves depicting effort required for degree of rotation in various instances. The graph is representative of rotation in one direction from the center or from normal condition of the handle bar 215. As discussed, the first curve C1 shows the steering effort versus steering angle in case of the conventional three-wheeled vehicle without the power assist and as shown,
10 the amount of effort progressively is increasing with the degree of rotation and is substantially higher. The present graph also depicts the second curve C2 that is depicting the steering effort required to be put by user in case of a four-wheeler, especially considering a light motor vehicle type four-wheeler with mechanical steering, which is having a steering ratio greater than unity. As can be seen the
15 effort is substantially less compared to a three-wheeled vehicle. The effort/steering effort can be force in Newton or torque in Newton-meter and the steering angle is in degrees.

[00073] Further, a third curve C3 depicts the effort versus steering angle in case of the present subject matter. Firstly, the present subject matter retains the
20 steering ratio to be unity thereby retaining the operational feel similar to the conventional system, with reduced effort. For example, the present front structure 200 requires the user to rotate with the handle bar 215 similar to the conventional handle bar but with substantially reduced effort as can be understood from curves C1, and C3. As the ES unit 210 assists the user to steer upon detection of a change
25 in angle or detecting the torque exerted by the user. Thus, the overall effort to be put by the user is reduced. Moreover, the ES unit is provided with electric motor capacity required to steer the front structure depending on the vehicle

configuration and load carrying capacity. Thus, depending on the application or the steering requirements the user can choose a specific capacity electric motor that is compactly disposed within the front portion of the vehicle 100 as aforementioned.

- 5 [00074] It is to be understood that the aspects of the embodiments are not necessarily limited to the features described herein. Many modifications and variations of the present subject matter are possible in the light of above disclosure. Therefore, within the scope of claims of the present subject matter, the present disclosure may be practiced other than as specifically described.

List of reference signs:

	100	vehicle		210E	output shaft-engaging
	105	front cowl			portion
	110	windshield	30	210I	input shaft
5	115	floorboard		210O	output shaft
	120	seat assembly		215	steering member
	125	front wheel		220	lock nuts
	125C	wheel center		225	bearing assembly
	130	front fender	35	230	attachment member
10	135	rear panel		230A	holder aperture
	145	swing arm		230B	abutting base
	150	suspension		230W	wall portion
	155	hood		235	electric motor
	160	passenger seat	40	240	casing
15	165	structural member		240M	mounting boss
	165A	head pipe		245	instrument panel
	165B	main frame		C1	first curve
	166	steering lock nut		C2	second curve
	200	front structure	45	C3	third curve
20	205	steering shaft		CS1	first cross section
	205E	steering shaft-engaging		CS2	second cross section
		portion		F-R	longitudinal direction
	205U	one end portion		FS	foot space
	205L	other end portion	50	HP	hollow portion
25	206	locking member		P-P'	partition line
	210	electronic support (ES)		X-X'	pivot axis
	unit			Y-Y'	motor shaft axis

We claim:

1. A front structure (200) for a two-wheeled or three-wheeled vehicle (100), said front structure (200) comprising:

a steering shaft (205) rotatably supported by a structural member (165) of said two-wheeled or three-wheeled vehicle (100), and said steering shaft (205) pivotable about a pivot axis (X-X') of two-wheeled or three-wheeled vehicle (100); and

an electronic support unit (210) mounted to said structural member (165), said electronic support unit (210) comprising an input shaft (210I) and an output shaft (210O) disposed along said pivot axis (X-X'), said input shaft (210I) functionally connected to a steering member (215) and said output shaft (210O) functionally coupled to said steering shaft (205) through one end portion (205U) of the steering shaft (205) disposed concentrically about said pivot axis (X-X'), said steering shaft (205) includes other end portion (205L) connected to a wheel (125) having a center (125C) disposed substantially in line with said pivot axis (X-X') in a longitudinal direction (F-R) of said vehicle (100), and said steering member (215) capable of selectively rotating said steering shaft (205) through said electronic support unit (210).

2. The front structure (200) for a two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said electronic support unit (210) is mounted to an attachment member (230), said attachment member (230) includes a holder aperture (230A) extending along said pivot axis (X-X') and said attachment member (230) is mounted to a head pipe (165A) of said structural member (165) through said holder aperture (230A) whereby at least a portion said attachment member (230) is coaxially disposed about said head pipe (165A).

3. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 2, wherein said attachment member (230) includes an abutting base (230B) for securing said attachment member (230) to said structural member (165), and said attachment member (230) includes a support wall (230W) extending in a direction at a first angle with respect to direction of extension of the base (230B), and said electronic support unit (210) is mounted to said support wall (230W).

4. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 3, wherein said support wall (230W) extends along a circumference of said base (230B) and said electronic support unit (210) includes a casing (240) for securing said electronic support unit (210) to said support wall (230W) through said casing (240).

5. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said output shaft (210O) includes a first cross-section (CS1) at output shaft-engaging portion (210E) and said steering shaft (205) includes a second cross-section (CS2) provided at steering shaft-engaging portion (205E) thereof, wherein said second cross-section (CS2) is conforming and complementing said first cross-section (CS1).

6. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 2 or 5, wherein said electronic support unit (210) is mounted to said head pipe (165A) and the steering shaft (205) is also rotatably secured to the head pipe (165A), wherein the output shaft-engaging portion (210E) of the electronic support unit (210) is locking with locking member (206) of the steering shaft (205) provided therein whereby annular contact is provided between the steering shaft-engaging portion (205E) and the output shaft-engaging portion (210E) without any contact in axial direction about the pivot axis (X-X'), and wherein one of the output shaft-engaging portion (210E) and said steering

shaft-engaging portion (205E) annularly abuts the other of the output shaft-engaging portion (210E) and said steering shaft engaging portion (205E).

7. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said electronic support unit (210) includes an
5 electric motor (235) functionally connected to said output shaft (210O), said electric motor (235) having a motor shaft disposed along a motor shaft axis (Y-Y') disposed in a substantially horizontal direction.

8. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said electronic support unit (210) includes an
10 electric motor (235) functionally connected to said output shaft (210O), and said electric motor (235) is having a motor shaft axis (Y-Y') extending in a substantially lateral direction (RH-LH) of said vehicle (100).

9. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1 or 7, wherein said vehicle (100) includes a front cowl (105)
15 disposed in a front portion thereof, and said electric motor (235) is disposed rearward to a front cowl (105) of said vehicle (100), downward to an instrument panel (245) disposed rearward to the front cowl (105), forward to a driver seat assembly (120), and upward to a foot space (FS) of said vehicle (100).

10. The front structure (200) for the two-wheeled or three-wheeled vehicle (100)
20 as claimed in claim 1 or claim 9, wherein said vehicle (100) includes said instrument panel (245) at least partially covering said electric motor (235) in a top direction and a rearward direction.

11. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 2 or 9, wherein said attachment member (230) is provided
25 with a cut portion (230P) that is capable of accommodating the electric motor (235) along with a casing (240) of the electronic support unit (210).

12. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said input shaft (210I), said out shaft (210O), and an upper portion (205U) of said steering shaft (205) are disposed along said pivot axis (X-X'), and said pivot axis (X-X') is the axis of rotation of said steering member (215).
5

13. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said two-wheeled or three-wheeled vehicle (100) includes said wheel (125) connected to other end portion (205L) of steering shaft (205) and said wheel (125) is disposed substantially along lateral center of said vehicle (100).
10

14. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said structural member (165) includes a head pipe (165A), and said head pipe (165A) is extending along the pivot axis (X-X') and a main frame (165B) of said structural member (165) is extending rearwardly downward from said head pipe (165A).
15

15. The front structure (200) for the two-wheeled or three-wheeled vehicle (100) as claimed in claim 1, wherein said input shaft (210I) is mechanically connected to said steering member (215) and said output shaft (210O), and said electrical motor (235) is connected to said output shaft (210O) through a rotation conversion mechanism.
20

16. A front structure (200) for a two-wheeled or three-wheeled vehicle (100), said front structure (200) comprising:

a steering shaft (205) rotatably supported by a structural member (165) of said vehicle (100), and said steering shaft (205) pivotable about a pivot axis (X-X');
25

an electronic support unit (210) mounted to said structural member (165), said electronic support unit (210) comprising an input shaft (210I)

and an output shaft (210O) disposed along said pivot axis (X-X'), said input shaft (210I) functionally connected to a steering member (215) and said output shaft (210O) functionally coupled to said steering shaft (205) through one end portion (205U) of the steering shaft (205) disposed concentrically about said pivot axis (X-X'), said steering shaft (205) includes other end portion (205L) connected to a wheel (125) having a center (125C) disposed substantially in line with said pivot axis (X-X') in a longitudinal direction of said vehicle (100), and said steering member (215) capable of selectively rotating said steering shaft (205) through said electronic support unit (210) and said electronic support unit (210) includes an output shaft (210O), and

one shaft of said steering shaft (205) and said output shaft (210O) is having at least a hollow portion (HP) and other shaft of the steering shaft (205) and the output shaft (210O) is engagingly connected to the one shaft through the hollow portion (HP) thereby limiting axial contact and load transfer therebetween.

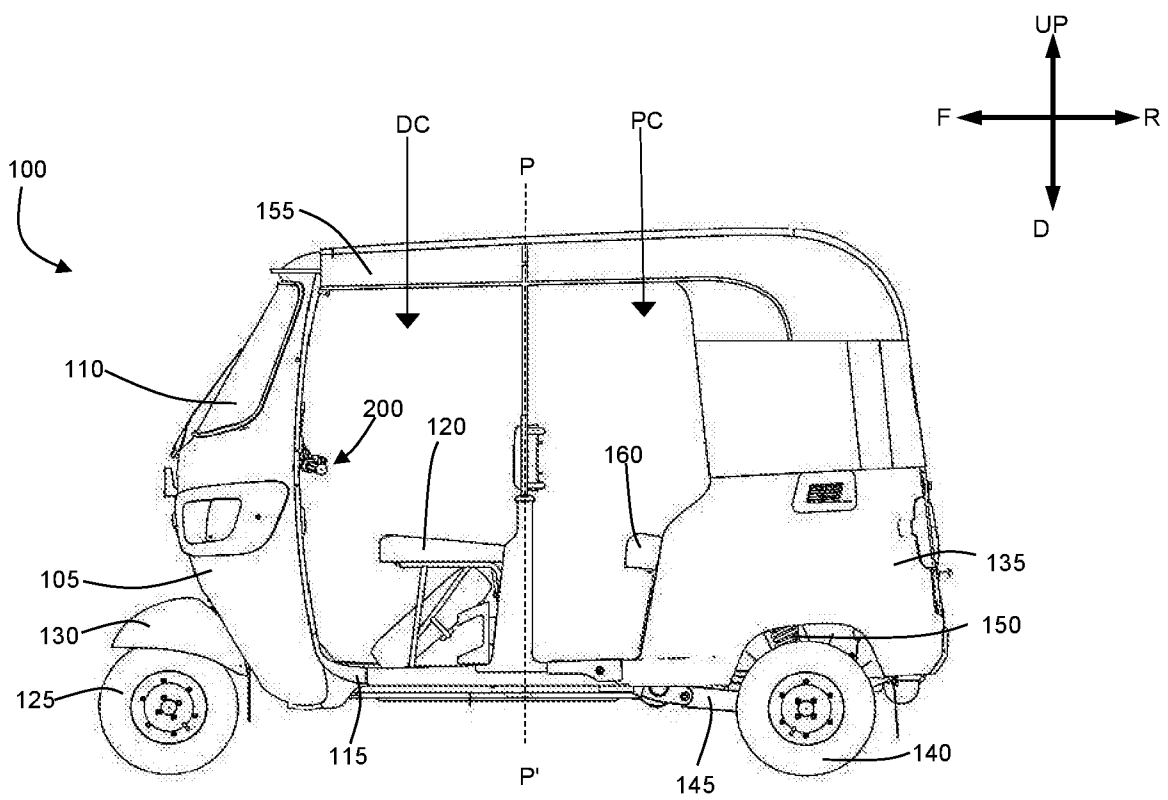
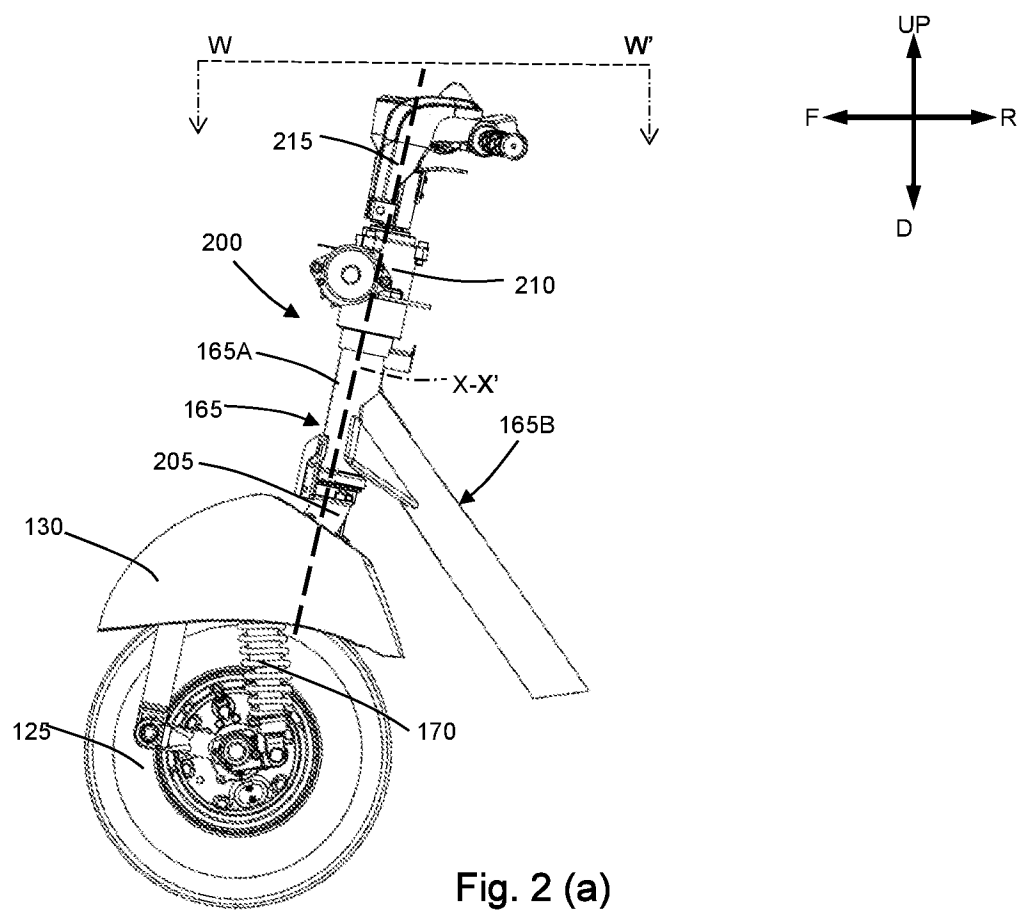
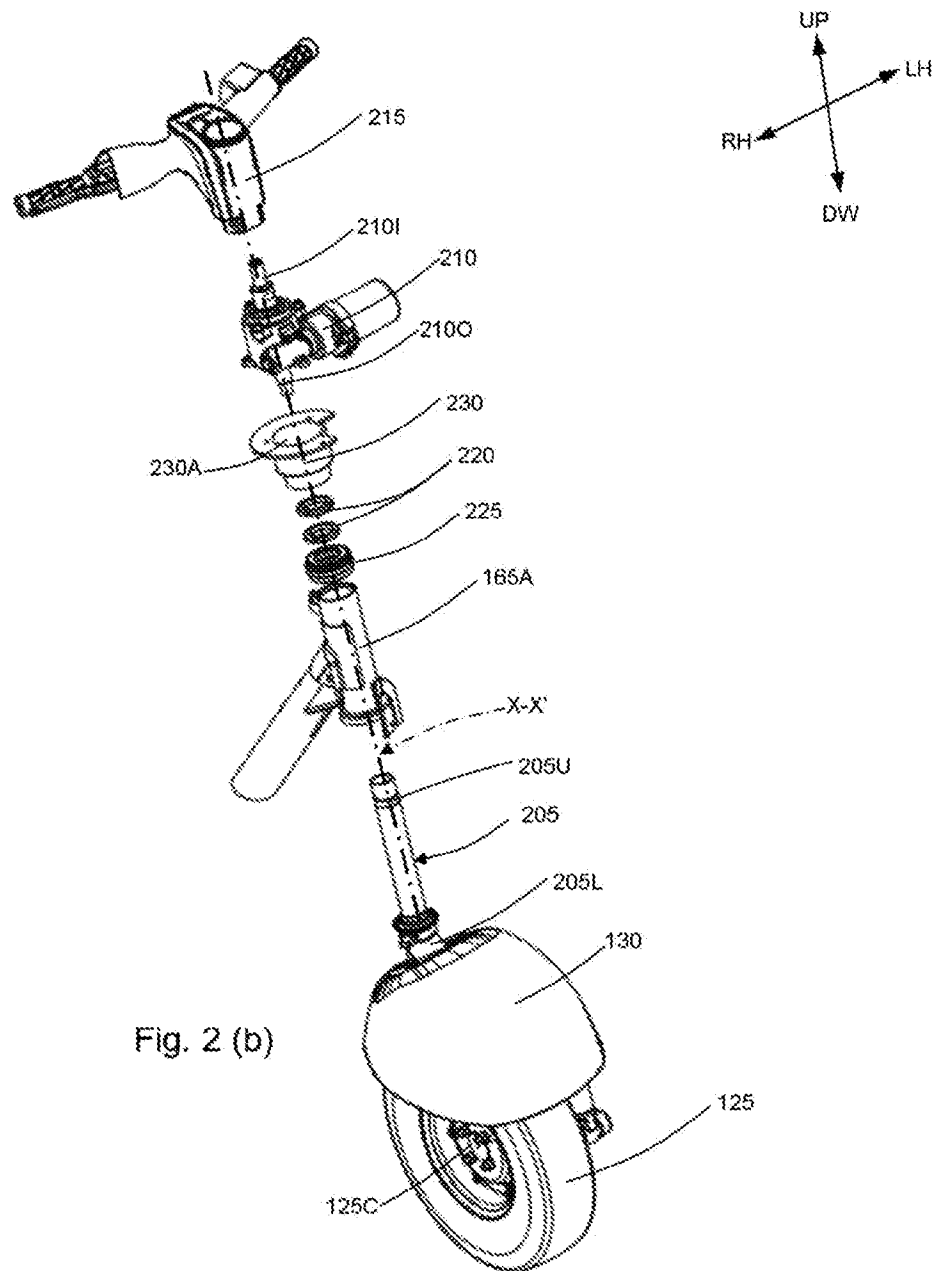


Fig. 1





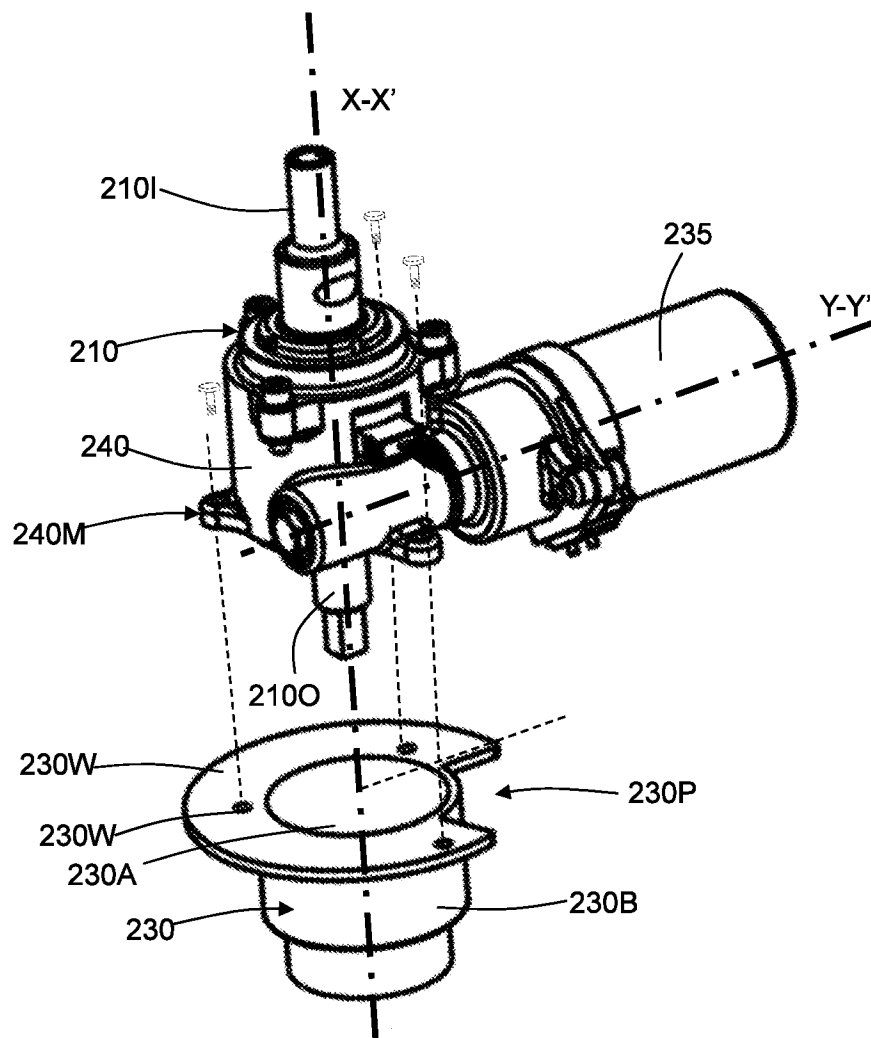
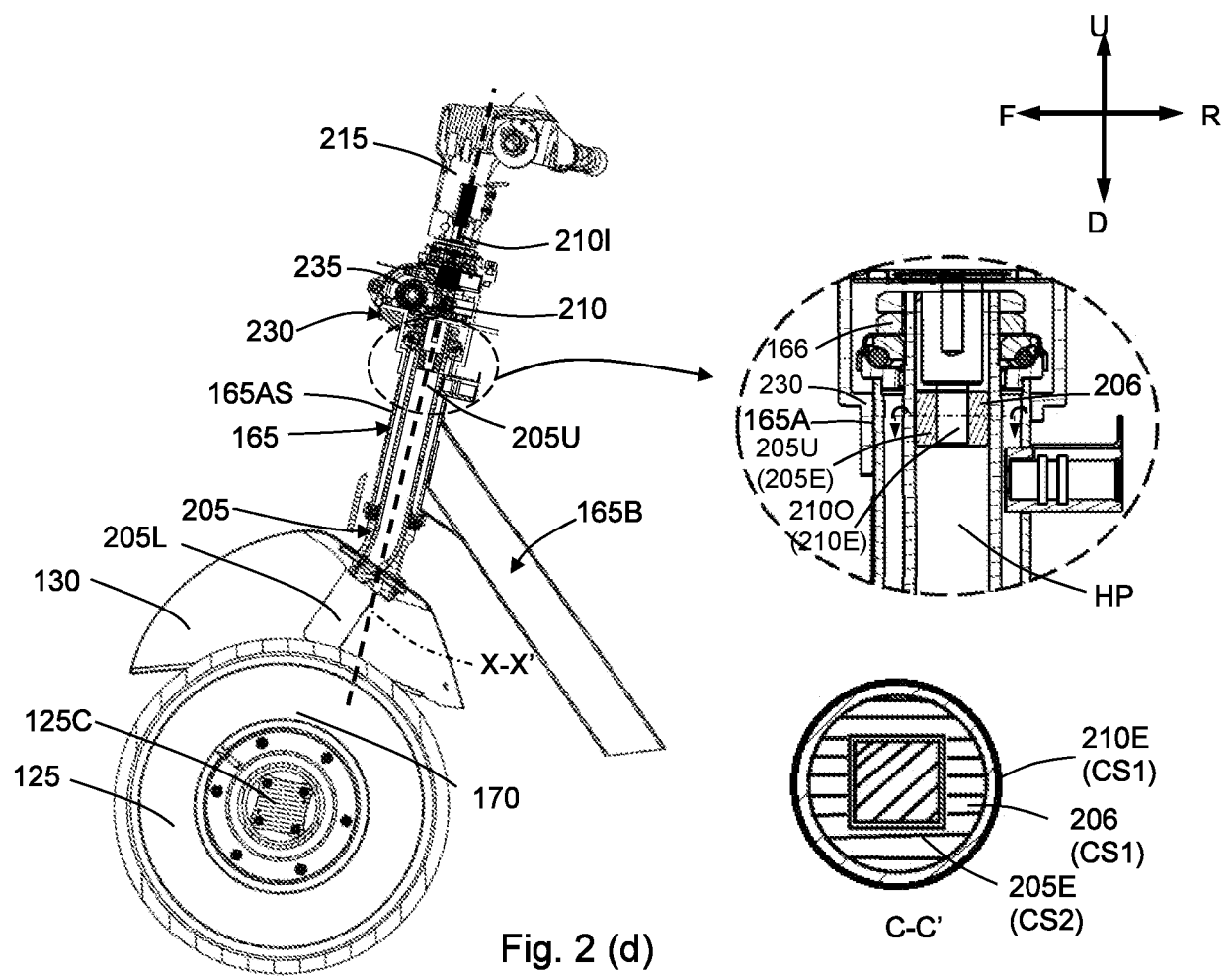


Fig. 2 (c)



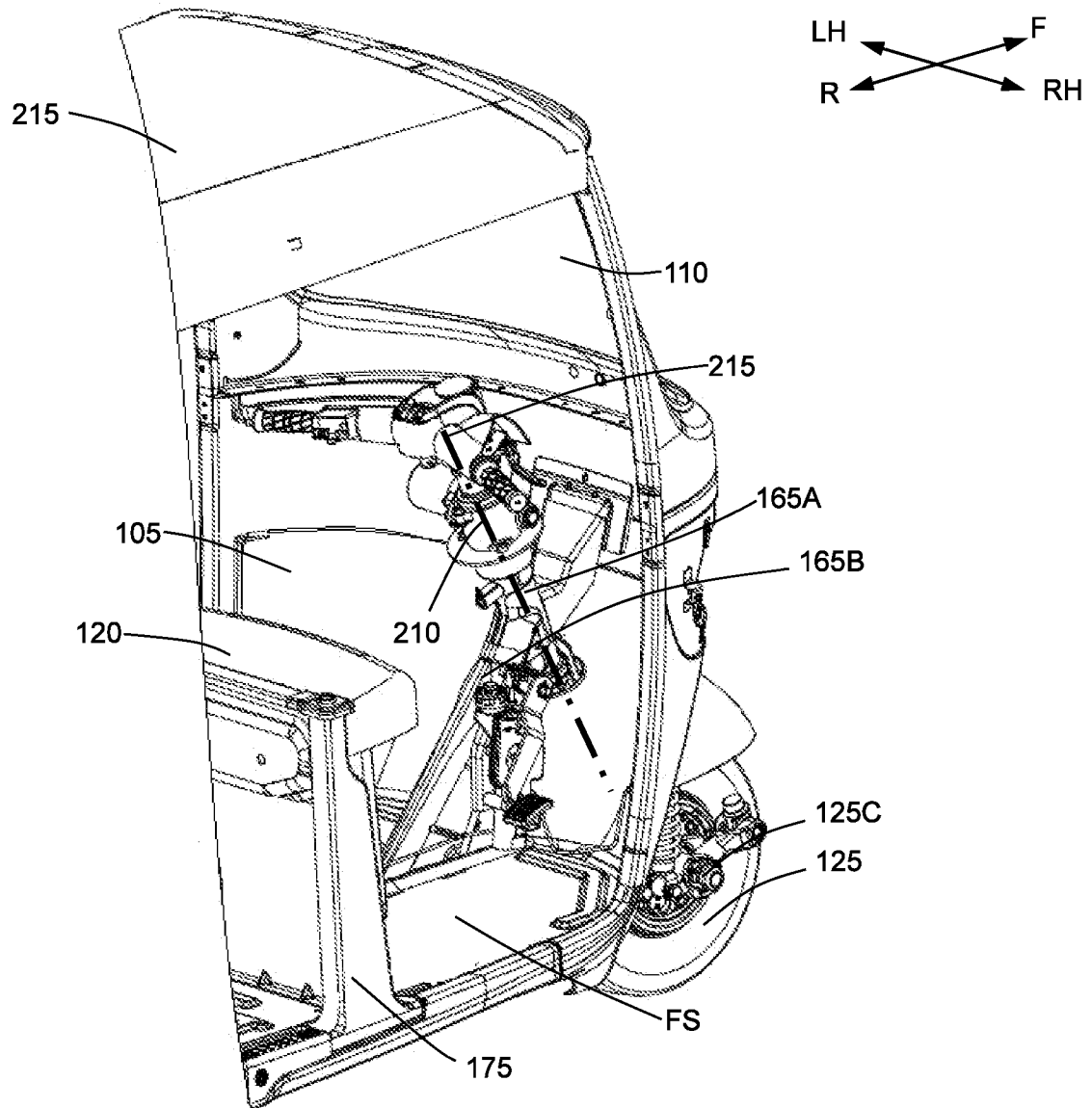


Fig. 3 (a)

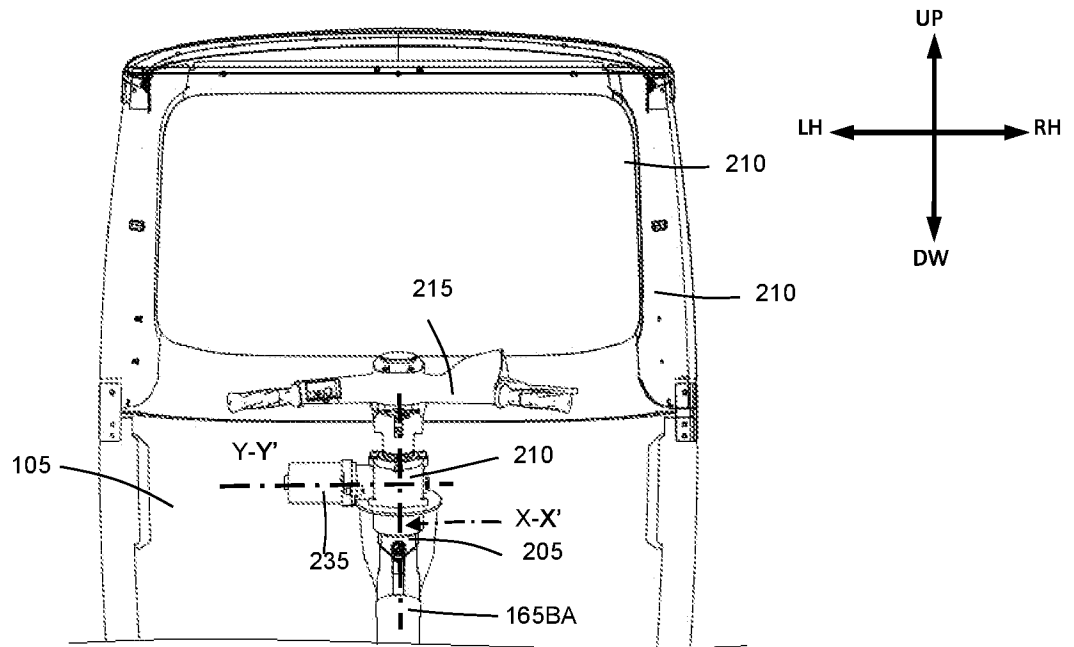


Fig. 3 (b)

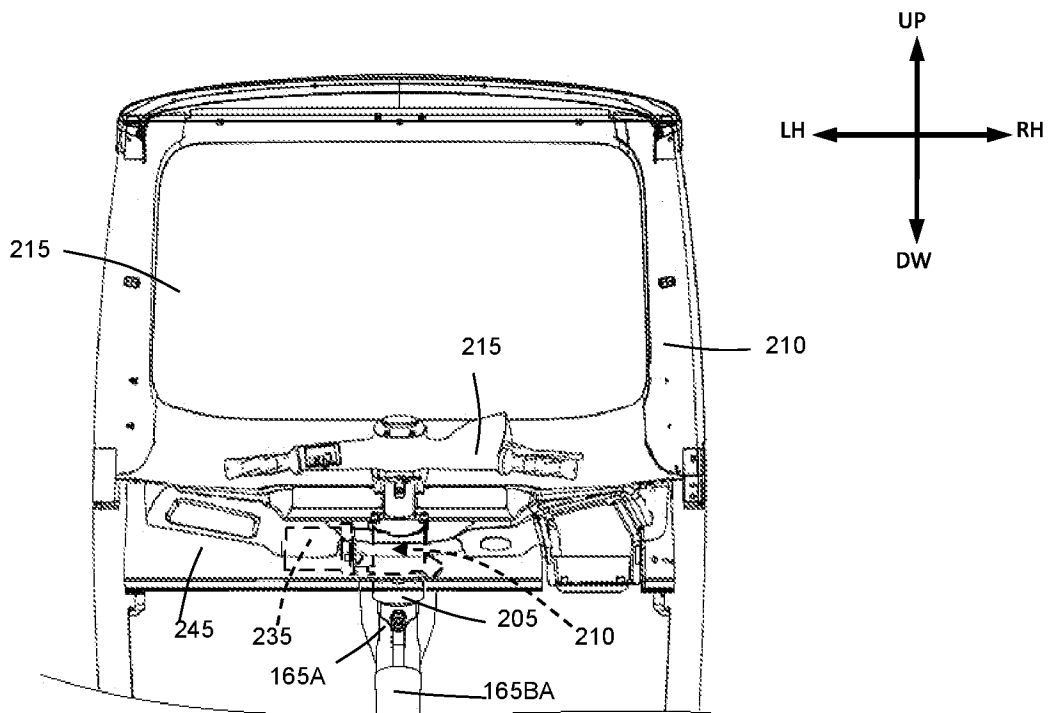


Fig. 3 (c)

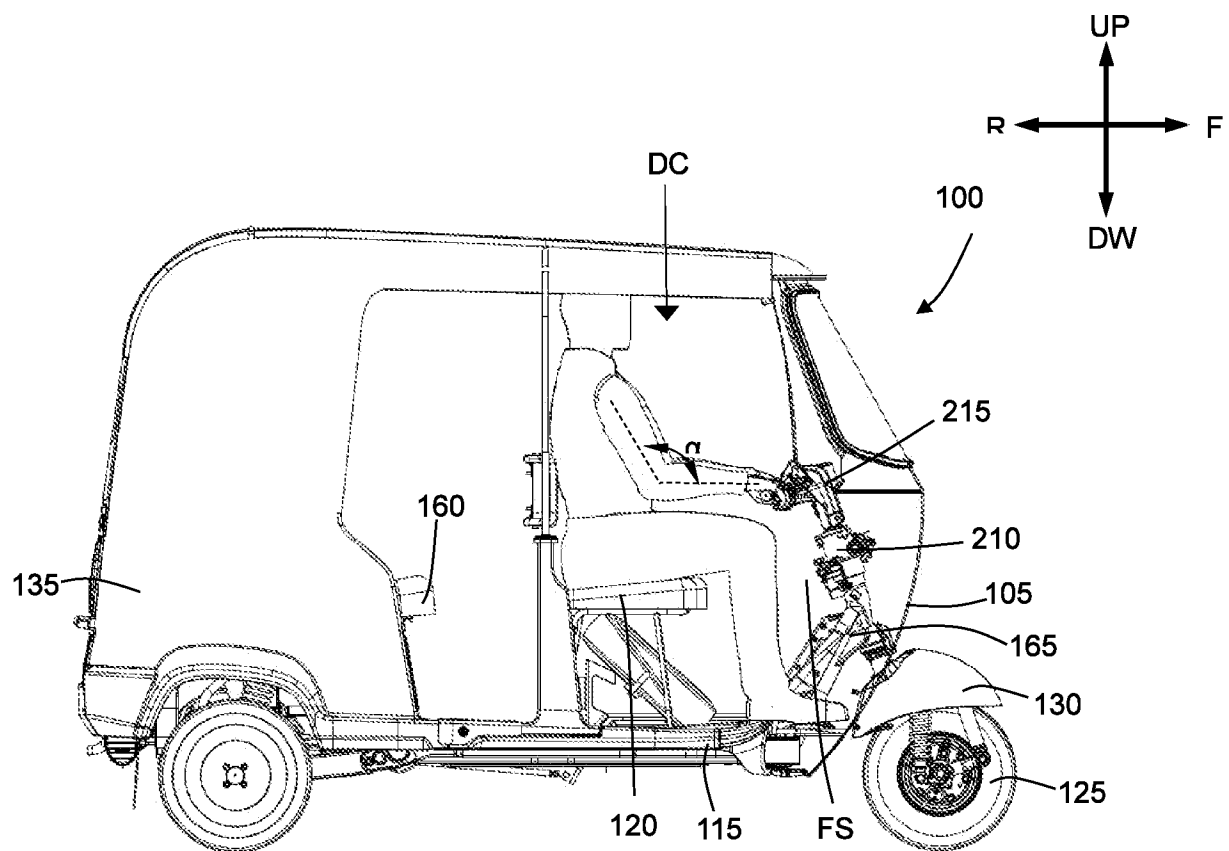


Fig. 3 (d)

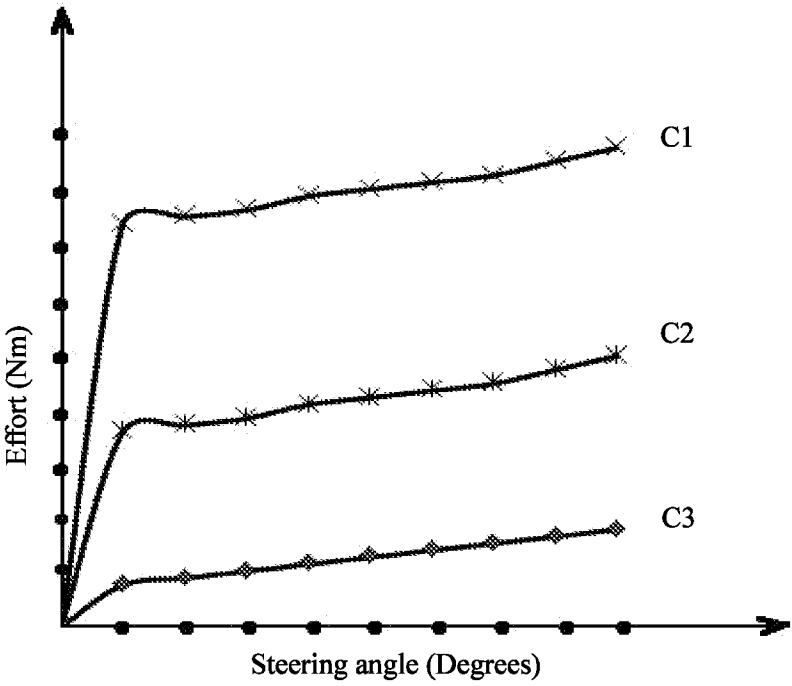


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2019/050374

A. CLASSIFICATION OF SUBJECT MATTER
B62K19/30, B62K21/18 Version=2019.01

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)

B62K19/30, B62K21/18

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)

TotalPatent One, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US7878292B2 (HONDA MOTOR CO LTD [JP]) 01 Feb 2011; column 3, line 35-50 & 57; fig 1-3;	1, 2, 7, 9, 10, 12-14 and 15
A	US7878292B2 (HONDA MOTOR CO LTD [JP]) 01 Feb 2011; column 3, line 35-50 & 57; fig 1-3;	3-6, 8, 11 and 16
Y	US8606464B2 (HONDA MOTOR CO LTD [JP] et al.) 10 Dec 2013; column 3, line 27; fig 1;	1, 2, 7, 9, 10, 12-14 and 15
A	US8606464B2 (HONDA MOTOR CO LTD [JP] et al.) 10 Dec 2013; column 3, line 27; fig 1;	3-6, 8, 11 and 16
A	US5095770B1 (RADAR HOMER J [US]) 25 Jan 2000; column 2, line 59-66;	1-16;

☐ 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

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Date of the actual completion of the international search

09-05-2019

Date of mailing of the international search report

09-05-2019

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2019/050374

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