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[57]	Abstract:	The present invention provides an electric vehicle comprising a chassis; an electric motor as prime mover; and an electric battery module for powering the electric motor comprising at least one battery and a protective frame structure for positioning the at least one battery and being fixed in a rearmost portion of the chassis wherein; at least one battery is connected to at least said electric motor through a terminal block using a flexible electric connections with the terminal block being located outside a volume defined by the protective frame structure.		

BRIEF DESCRIPTION OF THE DRAWINGS

[024] The electric vehicle of the present invention may be more fully understood from the following description of preferred embodiments thereof, made with reference to the accompanying drawings in which:

[025] Fig. 1 is a partial side view of an electric vehicle according to a first embodiment of the present invention.

[026] Figs. 2 and 2a are orthogonal cutaway views showing the relationships between the electric power module, the chassis and other elements of the electric vehicle with two batteries and three batteries arrangement respectively shown in Fig. 1.

[027] Fig. 3 and 3a are detail views showing the relationship between the electric power module having two batteries and three batteries arrangement respectively and the chassis proximate the rear wheel in Fig. 2 and 2a.

[028] Fig. 4 is a view of one orientation of the electric battery module for the vehicle and its protective frame according to another embodiment of the present invention without batteries installed.

[029] Fig. 5 is the same view as Fig. 4 and with batteries installed.

[030] Fig.6a is a view of one orientation of the protective frame comprising a battery holding guide mounted inside guiding rail of the protective frame according to one of the embodiment of present invention.

[031] Fig.6b is an isometric view of battery holding guide of fig. 6a.

[032] Fig. 7a is a rear isometric view of the protective frame along with a compressor mounting arrangement.

[033] Fig. 7b is a top view of the protective frame along with a compressor mounting arrangement.

[034] Fig 8a is an isometric view of mounting arrangement of components according to Fig. 4 to Fig. 7b.

[035] Fig. 8b is an isometric view of the rear portion of the vehicle illustrating arrangement of components made according to fig. 8a.

[036] Fig. 9 is a detail partial rear section view showing fixing of batteries to the protective frame according to the first embodiment of the invention.

[037] Fig. 10 is a front view of a mounting arrangement for the vehicle control unit (VCU).

[038] Fig. 11 is an orthogonal view of the mounting arrangement for the VCU shown also in Fig. 10

[039] Fig. 12 is a schematic front view of the electric vehicle of embodiments of the present invention showing location of an auxiliary battery.

[040] Figs. 13(a) to 13(c) show further detail of the anti-roll bar of Figs. 2 and 2a and its connection to the trailing arms of the rear suspension system of the electric vehicle shown in Figs 2 and 14(a) and 14(b).

[041] Fig. 14(a) shows a view of the rear of the electric vehicle of embodiments of the present invention with visual indication of acceptable loading for the electric vehicle.

[042] Fig. 14(b) shows view of the rear of the electric vehicle of embodiments of the present invention with visual indication of potentially excessive loading for the electric vehicle.

[043] Fig. 15 is a schematic view of a rear passenger seat base for the vehicle, the seat being provided with an inspection window.

[044] Fig. 16 shows a front schematic view of a dashboard for an electric vehicle according to embodiments of the present invention.

[045] Fig. 17 is a front orthogonal view of a preferred handlebar for use in the electric vehicle according to embodiments of the present invention.

[046] Fig. 18 is a rear orthogonal view of a preferred handlebar for use in the electric vehicle according to embodiments of the present invention.

[047] Fig. 19 is a front orthogonal view of a housing for the handlebar shown in Figs. 14 and 15.

[048] Fig. 20 is an orthogonal view of a plastic cover for the housing shown in Fig. 19.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[049] Referring now to Figs 1 and 2, there is shown an electric vehicle 10 suitable for use as a commuter vehicle. For example, the chassis 11 is essentially the same for both types of vehicle types i.e. vehicle equipped with IC engine and electrically powered vehicle. Differences in the structure of the electric vehicle 10 are essentially dictated by the requirement that the

vehicle be electrically powered. The electric vehicle is a three wheeler including two rear wheels 82 and a front wheel 84.

[050] A driver sits at the front of the electric vehicle 10 on front seat 12 and a rear seat 14 is available for seating of passengers. A target number of passengers is 2 or 3. A further passenger could join the driver on the front seat 12. Both seats 12 and 14 are of bench style though other configurations could be adopted if required. The driver steers electric vehicle 10 through handlebar 15.

[051] Electric vehicle 10 has an electric motor and transmission system 20, as shown in Figs. 3 and 3a, powered by an electric battery module 22 comprising two batteries 24 arranged in two rows separated by a clearance space 24a. Alternatively the electric battery module 22 may comprise three batteries arranged in three rows as shown in Figs. 2a and 3a. Electric battery module 22 is positioned to the rear of the vehicle above the electric motor and transmission system 20, a position which provides a convenient position for routing the wire harness.

[052] Electric motor 20 has a rating of 7kW to 10 kW (though this rating is dictated by application) and is controlled by vehicle control unit (VCU) 100. Batteries 24 are of conventional design each with 48 volt rating connected in parallel so deliverable voltage is 48 volts. Batteries 24 are preferably rechargeable though may be made replaceable by swapping with charged batteries when required. Recharging is possible using charger unit 28 and charging socket 29 which may be connected to a suitable electric power source. Electric battery module 22 may be integrated with security features. Batteries 24 are not required to power components ancillary to the electric motor 20 such as headlights 18. An auxiliary battery 50 is provided for this purpose being located under front seat 12 as shown in Fig. 9

[053] Electric motor 20 includes a rear wheel drive transmission and detail of the relationship between transmission and rear wheels, one rear wheel 82 of which is shown is conveniently shown in Figs. 2 and 3, is provided in the Applicant's co-pending Indian Provisional Application 201721045779, the contents of which are hereby incorporated herein by reference.

[054] Electric battery module 22 is located below a luggage compartment 88, located under the rear roof portion 10B of the electric vehicle 10 which demonstrates compactness as space remains available even with a change from an internal combustion engine prime mover to an electric motor prime mover. Electric battery module 22 includes a protective frame structure 23 made up of a number of structural members 23a formed into a box shape with a handle. Structural members 23a are conveniently lightweight and made of a material such as aluminium or a suitable polymer or composite material. Frame structure 23 is fixed at its bottom to an upper surface of the chassis portion 11a substantially rearward of the axis of rear wheels 82 by vibration isolating elements (not shown) to reduce the vibrations being transmitted to the frame structure from chassis 11. Generally, the frame structure 23 positions and fixes the batteries 24 in such manner as to reduce vibration and noise. Batteries 24 are separated by a space 24a to allow convective air heat transfer away from the module.

[055] Junction box 25 is connected external to and to the rear of frame structure 23 and, in this position, it does not require any further special supporting structure. Junction box 25 is a housing for electrical connections connected to batteries 24 and other components which protects the connections from any external impacts, dust, water, dirt and so on. Junction box 25 therefore acts as a safety barrier. Being located outside the protective frame structure 23 and without opposed sides of its housing being located between heat generating batteries, heat transfer from the

batteries 24 should not affect its operation. The junction box 25 is generally made of lightweight plastic. The junction box 25 includes electric studs which connect the batteries 22 to the operating components of the electric vehicle 10, particularly its electric motor 20. Further, since the junction box 25 is placed on the rear side of the electric vehicle 10, a substantial surface of the junction box 25 is readily accessible from an access door on the rear side of electric vehicle 10 to check the electrical connections in the junction box 25 which is thus easily serviceable. Control over the operation of electric vehicle 10 is exercised by electronic vehicle control unit (VCU) 100.

[056] Access to the frame structure 23 and electric battery module 22 enables removal and swapping of batteries 24 for charging purposes. Battery 24 removal is eased further by provision of guiding rails on either the batteries or frame structure 23 as shown in Fig. 4. Batteries 24 are removed horizontally, possibly to a trolley or other apparatus for added safety in the embodiment shown in Figs. 1, 2 and 5. A vertically disposed arrangement of batteries 24 is also possible and will be described with reference to Figs. 4 to Fig. 8b below.

[057] Batteries 24 may be allowed to slide within the protective frame 23 for installation and removal with guide rails 23c sized to neatly fit the batteries 24 as indicated in Fig. 5 which shows provision for three batteries 24 in an alternative embodiment. A guide rail 23c is provided for each battery 24. Further fixings may be used as required. Batteries 24 may be provided with a handle to further assist installation and removal. Alternatively rear seat 14 or back of seat can be opened to enable access to the batteries 24. The belt 24a may be additionally provided to lock the position of batteries.

[058] During vehicle running condition lot of vibrations are produced, also there are sudden shocks when vehicle is running on a bumpy road. These

vibrations produced may get transferred to the protective frame structure 23 and thereby to the batteries 24 installed inside the frame structure. As a result of these vibrations the batteries 24 may get loosened and starts vibrating inside the frame 23 which creates noise as well damage the batteries. In order to avoid the effect of vibrations the guiding rails 23c of the protective frame 23 may be additionally provided with battery holding guide 23b preferably made of elastic material as illustrated in Fig. 6a.

[059] The battery holding guide 23b is provided with snaps (23d, 23e) along its horizontal and lateral sides. The snaps (23d, 23e) are protruded outside battery guiding rail 23c. During installing the batteries 24 inside guiding rails 23c the snaps (23d, 23e) of battery holding guide 23b gets compressed which gives reaction to the batteries 24. The battery holding guide is provided on both top and bottom surface of the battery 24 inside guiding rail 23c. This helps in holding the battery intact in its position from both top and bottom side. The number of snaps and its shape, size or position may vary based on battery size and shape. The battery holding guide 23b is made of elastic material which helps in absorbing vibrations are prevents it from transmitting it to the battery 24 and provides required dampening.

[060] The electric battery module 22 is provided with a battery temperature control system explained with the help of Fig 4 to Fig. 8b. The protective frame structure 23 may be enclosed by suitable means to form a cooling box 425 with one side closed using a door 430 to access the batteries 24 placed inside cooling box 425. The temperature control system may include a cooling box 425 with air circulation means (not shown) so that air circulating inside the cooling box flows over the battery surfaces and helps to maintain desired battery temperature. A suitable temperature control system is described in the Applicant's co-pending Application IN

201721019563, the contents of which are hereby incorporated herein by reference.

[061] The components of said temperature control system such as a compressor (730), condenser (823), evaporator (not shown) and necessary tubing (725) for circulating refrigerant of the system is packaged in the close vicinity around cooling box (425) as illustrated in Fig. 7a,7b and 8a, 8b. The compressor (730) being heavy components is mounted on the chassis of the vehicle using suitable brackets 735 along with its controller such that these components will not interfere with other associated components and the vibrations produced by the compressor 730 is not transferred to the battery 24 and other associated components of the system. The condenser 823 is mounted to the rear part of the chassis preferably to bottom part, either on right or left or central or may be on the sideways (11a) on the bottom part of the chassis with sufficient ground clearance. A mud flap or stone guard (not shown) is provided on the condenser to protect it from mud, water and stone hitting. In order to achieve effective cooling the condenser 825 may be additionally provided with a fan 825. The condenser 823 may alternately positioned near the protective frame 23 above chassis. The evaporator (not shown) is located inside the top portion of the protective frame 23 with a fan or blower (not shown) mounted to circulate air over evaporator and inside the cooling box (425).

[062] Referring to Fig. 8a the batteries 24 provided inside protective frame 23 are connected to the motor transmission through the terminal block 25 using flexible electric connection such as wire or cable (25a, 25b). The terminal block is connected to the batteries 24 using wires 25a on one side and the terminal block is connected to motor-transmission and other associate electric components using flexible wires 25b. The terminal block has plurality of connectors used to connecting the components. The detail

of terminal block 25 used are explained in applicant's another patent application 201821003545 dated 31-Jan-2018 the reference of which is brought herein.

[063] The Fig. 8b represents the rear view of the vehicle mounted with the temperature control system as explained herein above with batteries 24 mounted vertically in the protective frame 23.

[064] Referring now to Fig. 9, the batteries 24 may be fixed to the protective frame structure 23 in an alternative manner. Batteries 24 should be fixed within the protective frame structure 23. Each battery 24 is provided with T shaped mounting brackets 24a with T shaped slots 24aa. Adjacent protective frame members 23a are provided with holes to enable connection of fastening means to protective frame and battery mounting brackets 24a. Bolts 23ab with T shaped heads 23aa are inserted into the holes with the head being fixed in the T shaped slots 24aa. A number of such bolts 23ab are installed to enable secure fixing of the batteries 24.

[065] Referring now to Figs. 10 and 11, the VCU 100 is mounted to vehicle frame members 11B and 11C by suitable mounting brackets 101 and bolts 111A. VCU 100 is therefore securely fixed to the frame offset from the centre axis of the electric vehicle 10. VCU 100 is also positioned away from the batteries 24 or other heat generating components as it performance may deteriorate if it is mounted near the electric battery module 22. Further the magnetic flux around the battery may also affect the functioning of VCU 100 (commonly known as electromagnetic interference (EMI).

[066] As described above, the weight of a single battery 24 which is currently available comes close to 14 kg. Since the electric battery module 22 includes three batteries 24 the total weight of the electric battery module 22 approaches 50 kgs which is on higher side. Therefore, the centre of

gravity (CG) of electric vehicle 10 is mostly governed by the weight of the electric battery module 22 and is raised upward from the ground surface compared to hydrocarbon fuelled internal combustion engine versions of the same vehicle type. As this increases the chances of rolling or overturning of the electric vehicle 10 at higher speeds, and leads to unsafe conditions especially when the vehicle is driven at slightly higher speed on curvy roads. Further, in order to achieve riding comfort, electric vehicle 10 is provided with a softer suspension than required for a comparable internal combustion (IC) engine equipped vehicle. For example, spring rate in vehicles equipped with IC engines is around 6.3 Kg/mm, which is reduced to 4.07Kg/mm in the comparable electric vehicle. The softer suspension provides riding comfort but has a high risk of vehicle overturning. Hence there is need to provide a suspension system which can give riding comfort but the same time reduces the risk of overturning of electric vehicle 10.

[067] In order to overcome the problem of rolling of electric vehicle 10, the chassis 11 includes anti-roll bar 90 as shown in Figs. 2 and 13(a) to (c). The anti-roll bar 90 is relatively long with a small diameter member made from a rod, bar or tubes which connects the trailing arms 92 of the trailing arm suspension for both the rear wheels 82 of the electric vehicle 10 as shown in Figs. 13(a) to (c). The anti-roll bar 90 is fixed onto the trailing arms 92 using suitable connecting structure. The shape of the anti-roll bar 90 is such that it does not interfere with the positioning of other components and requires minimum space hence can be arranged very compactly. Suspension, including trailing arms 92 and shock absorber 93 is provided on the trailing arms 92 of both the rear wheels 82. One of each of these components is shown in the figures.

[068] The softer suspension provides riding comfort and can also provide a visual indication of the overloading of the electric vehicle 10 which the skilled reader will observe has basic structure very similar to current petrol

and CNG fuelled commuter vehicles used in India. The trailing arm suspension limits the transfer of shocks and vibrations to the passenger compartment 80 of the vehicle and its side walls 17a. The passenger compartment 80 is connected as a sprung mass with the chassis 11 of the electric vehicle. As the passengers sits on the rear seat 14 the load in the passenger compartment 80 increases, the suspension gets compressed and the distance between the compartment 80 and the chassis 11 visibly reduces – as shown by a comparison between Figs. 14(a) and 14(b) where both portions 86 and 87 are visible at acceptable loading but not at potentially excessive loading as shown in Fig. 14(b) where portion 86 is not visible. These portions could be coloured for clearer viewing – since softer suspension is provided. Therefore, when the passenger compartment 80 is loaded by more than a predetermined amount, the rear part 81 of electric vehicle, including the passenger compartment 80 comes closer to chassis 11 which is easily visible from either side of the electric vehicle 10. This gives an indication to the driver that the vehicle is overloaded and need to reduce the load on the vehicle. The vehicle can be provided with a scale which can give the indication of load against the vertical downward movement of the passenger compartment thereby giving easy representation of load on the vehicle. Therefore the softer suspension can fulfil two objectives, one is providing comfortable riding to passengers and other is providing visual indication of load acting on the electric vehicle 10.

[069] The electric vehicle 10 can be provided with various sizes of wheels 82, 84 for example 12 inch diameter or 8 inch diameter radial tyres. A better Rolling Resistance (RR) is required on electric vehicles to get good efficiency. A lower RR value is better for efficiency. However, as wheel size increases, RR value also increases. Therefore in vehicles provided with bigger 12inch wheels, the rolling resistance is more. In order to get lower rolling resistance with bigger 12 inch tyres the conventional Bias belt tyres

are replaced by radial tyre which has lower RR value and thus using radial tyres improves the vehicle efficiency.

[070] Referring further to Figs. 2 and 2a, the VCU 100, DC-DC convertor 26, charger unit 28 and charging socket 29, the function of charger unit 28 is to charge the electric batteries on board using an external power supply. Charger socket 29 is connected to one side of the charger unit 28 with the electric battery module 22 being connected to the other side of the charger unit 28. Charger unit 28 must be positioned in a secure and safe position within electric vehicle 10 for avoidance of external impacts and theft. VCU 100 is an electronic component comprising battery monitoring unit, charge monitoring unit and transmission and load control unit. VCU 100 includes related monitoring, sensing and control circuitry of the vehicle. VCU 100 is small in size and is a low weight component. It is fitted near the charger unit 28 directly on the cross members of the rear chassis frame 11a using a very simple plate like bracket. Therefore no specialised mounting brackets need to be provided for fitting the same. The mounting of VCU 100 is shown with reference to Figs. 10 and 11. DC-DC convertor 26 is also mounted on the rear part of chassis 11a.

[071] As shown in Fig. 15, a service window 88 is provided near the leg space of the passenger proximate rear seat support 85 which can be used for servicing purposes. This gives direct access to the components which are placed under the rear passenger seat 14 and its support 85 such as VCU 100, charger 28 and charging socket 29. This location provides a high level of protection for these components. The location and number of service windows may change in this space based on the component placing and servicing requirement.

[072] Referring to dashboard 19 as shown in Fig 16. , this includes an indicator 19a which serves as both a speedometer and a battery state of

charge SOC indicator. SOC of the battery module 24 can be displayed using speed segments or ODO segments of the indicator 19a when the state of charge icon is turned ON. This is straightforward during charging since vehicle speed is known to be zero. Hence the speed segment of indicator 19a can be utilized to display battery SOC. This gives advantages of lesser space requirement, less number of LCD segments and compact packaging of the speedometer.

[073] Referring now to Figs. 17 to 20, there is shown more detail of a preferred design for handlebar 15 of electric vehicle 10. The handlebar 15 is provided with controls 15A such as switches for lights, indicators, horn and so on, controls 15A preferably being provided on the left hand side of handlebar 15. Handlebar 15 also includes an accelerator grip 15B on the right side of the handlebar 15 to accelerate/decelerate the electric vehicle 10. A brake arm could also be provided on left or right side of handlebar 15. The handlebar 15 includes a hollow housing 15G to accommodate part of the wiring harness 15F which connects the previously described electrical components to auxiliary battery 50 to receive the power. The accelerator, brake and clutch wires 15F are also routed through the housing 15G. Conventionally, handlebars are made of metal which increases its manufacturing cost as well as weight. Appropriate arrangements for mounting the control wires also require extra machining of a handlebar increasing cost.

[074] In order to overcome the above mentioned disadvantages handlebar 15 is partly made of metal casting while some parts are made by plastic molding, for example the top cover 15H of the handle bar 15. Fig. 19 conveniently shows the metal casting for the handlebar housing 15G and its control tube mountings 15CA and 15DA. Any low cost and light weight material can be used for handlebar top cover 15H. Housing 15G and control tube mountings 15CA and 15DA are integrally cast using a pressure

die casting method. Control wires (15F) are riveted directly to the housing 15CA and 15DA avoiding an arrangement for mounting the cables or machining for casting. One control tube could be permanently riveted and other control tube provided as a part of die casting with final hand grips 15C and 15D being mounted directly. A TPS sensor which is used to monitor the throttle position can be integrated into the handlebar 15. The cast housing 15G, with its control tube mountings 15CA and 15DA enables direct mounting of control tubes and grips 15C and 15D.

[075] Handlebar top cover 15H covers the housing 15G and portions of the control tubes through cover portions 15Ha and 15Hb. Accordingly, top cover 15H need not be manufactured from costly and heavy metal, rather being made from plastic which is light in weight and has lower cost. Plastic also helps in improving the aesthetic look of the handlebar 15 being mouldable into various shapes. Top cover 15H can be removable such that the space 15G below can be used as a storage space; or to enable direct access to wire harness 15F for replacement or maintenance. In another embodiment the cover 15H can comprise an indicator for speed and charger as explained above.

[076] In an alternative embodiment wherein a foot operated accelerator is provided both the control tubes are formed in die casting and hand grips 15C and 15D can be placed directly on handlebar 15 along with the drive selection and other controls.

[077] Modifications and variations to the electric vehicle described in the present specification may be apparent to skilled readers of this disclosure. Such modifications and variations are deemed within the scope of the present invention.

"AN ELECTRIC VEHICLE"

FIELD OF THE INVENTION

[001] This invention relates to electric vehicles.

BACKGROUND TO THE INVENTION

[002] A strong trend to electric vehicle manufacture and use is now becoming evident as concerns with climate change and availability of fossil fuels become evident. Electric vehicles include a number of batteries including a large number of electric cells. The number of batteries required for an application is driven largely by the required vehicle range. At the present time, readily available batteries remain bulky and this may limit their use particularly where desired vehicle range conflicts with small vehicle size.

[003] For example, small vehicles which currently operate using liquid and gaseous hydrocarbon fuels could advantageously be shifted to electric motor prime movers to reduce emissions. An initial trend to reduced emission prime movers has involved transition from petrol operated engines to gaseous fuelled engines, for example of the LPG or CNG type. This has reduced emissions. However, proposed changes in regulations, is driving a shift to electrically powered vehicles. The timeline for such shift is short and there are obvious difficulties in reconfiguring a vehicle fleet to operate with electric motors. Vehicle re-design and re-configuration of manufacturing plants for electric vehicle manufacture is a potentially time consuming and costly exercise. Yet it is desirable to meet directives/focus set by the Government Of various countries

[004] A key issue in vehicle re-design is the challenge of maintaining a basic vehicle structure the same as, or at least similar to, current vehicle structure to aid the manufacturing transition and maintain customer acceptance whilst packaging the batteries. This is a particular issue for smaller vehicles and does not need to be addressed, at least to the same extent, as for bespoke four wheeler electric cars as produced.

[005] In addition, design considerations must take account of heat generation by the batteries and the need for a convenient design that enables heat transfer away from sensitive components. Failure to allow for this may lead to damage to the most sensitive and costly electrical and electronic components of an electric vehicle.

[006] It is an object of the present invention to provide an electric vehicle design which enables convenient packaging of the required batteries and other components which also supports for a compact layout.

SUMMARY OF THE INVENTION

[007] With this object in view, the present invention provides an electric vehicle comprising:

a chassis;

an electric motor as prime mover;

an electric battery module for powering the electric motor comprising at least one battery and a protective frame structure for positioning the at least one battery and being fixed to the rear part of the chassis of the vehicle wherein a terminal block connects the at least one battery to at least said electric motor using flexible electric connections.

[008] The terminal block is located outside a volume defined by the protective frame structure and may include a plurality of connections

between electric battery module and at least the electric motor. Flexible connections rather than direct connections between terminal block, battery and electric motor are much preferred, using wired connectors. Such connections improve durability through better compensation for vibration than direct connectors. The terminal block may be mounted on any side of the protective frame including rear, top or side surfaces.

[009] Where a junction box is the terminal block for making connections between the at least one battery and at least the electric motor, the junction box is located outside a volume defined by the protective frame structure. As a result, it is less susceptible to damage or faults in operation due to heat generation from the batteries, especially where the junction box or terminal block has at least one substantial surface located outside the protective frame structure and away from direct contact with battery surfaces. Inclusion of a cooling system as described below is also advantageous in this respect. Moreover, this configuration allows access to the junction box or terminal block even when the at least one battery is at installed position.

[010] Typical voltages to be employed are above the common 12v batteries, often being 48 volts or higher. Preferred voltage range for present purposes is in the range 32 volts up to 60 volts with a preferably parallel connection delivering the required voltage (say 48 volts). Given these voltage ranges, the electric battery module and motor, as well as high voltage wiring are desirably located behind a rear firewall.

[011] Preferably, given battery sizes currently available, the at least one battery, typically a plurality of batteries are disposed horizontally or vertically inside the frame and access to the frame structure for swapping or removal of batteries for charging is preferably from the rear side of the vehicle or from its passenger compartment. This is the easiest current

economic option. A number of rows of batteries may be provided, typically a pair of rows, the rows of batteries being separated by a clearance. However vertical positioning is also possible. Access to the electric power module from the back of the vehicle is also possible.

[012] Conveniently, the frame structure provides an access area for removing or inserting the batteries from the frame structure. The frame structure and batteries may be provided with guides such as guide rails to facilitate the removal/ insertion of batteries. The guide rails may be optionally provided with battery holding guide which may be a separate or integral part of guiding rail. The battery holding guide comprises plurality of snaps which exerts pressure on battery surface and helps in keeping the battery position intact. The holding structure is preferably made of elastic material which also helps in absorbing the vibration. Therefore, the holding guide helps in reducing impact of vibrations on the battery. The batteries may be horizontally or vertically disposed which helps to achieve easy removal and insertion by shifting the Center of Gravity of batteries downward on the rear side so assisting with insertion of the batteries.

[013] Conveniently, at least a portion of a luggage compartment for the vehicle may be arranged above the battery frame structure. This shows the compactness of the vehicle since the electric battery module can be fitted within the electric vehicle while leaving enough space for a luggage compartment.

[014] Desirably, the battery frame structure is fixed to the chassis by vibration isolating elements to reduce the vibrations being transmitted to the battery from chassis or vice versa. Generally, the protective frame structure positions the batteries in such manner as to reduce vibration and noise.

[015] The centre of gravity (CG) of electric vehicle (10) is mostly governed by the weight of the electric battery module and is expected to be higher from the ground than for a comparable vehicle equipped with an internal combustion engine. In order to achieve riding comfort a vehicle is provided with a softer suspension. The softer suspension provides riding comfort but creates a high risk of the vehicle overturning. Hence there was need to provide a suspension system which can give riding comfort but the same time reduces the risk of overturning of vehicle. The vehicle advantageously includes an anti-roll bar to improve vehicle stability and rider comfort. The anti-roll bar is conveniently a small diameter member made from a rod, bar or tube which can be connected to the suspension system of the vehicle, for example to the trailing arms of a trailing arm suspension.

[016] The softer suspension can also provide a visual indication of the overloading of the electric vehicle where a rear passenger compartment of the vehicle is connected as a sprung mass with the chassis. As the load in the passenger compartment increases, the suspension compresses and the distance between the passenger compartment and the chassis may visibly reduce since softer suspension is provided. Therefore, when the passenger compartment is loaded by more than predetermined amount, a rear part of electric vehicle, including the passenger compartment, comes closer to chassis which is easily visible from either side of the electric vehicle. This gives a visual indication to the driver that the vehicle is overloaded and that there is a need to reduce the load on the vehicle. The vehicle can be provided with a scale which can give the indication of load against the vertical downward movement of the passenger compartment thereby giving easy representation of load on the vehicle. Therefore the softer suspension can fulfil two objectives, one is providing comfortable riding to passengers and other is providing visual indication of load acting on the electric vehicle so as to calibrate the loading capacity of the electric battery module to the maximum vehicle loading.

[017] Further, the electric vehicle may be provided with various sizes of wheels for example 12 inch diameter or 8 inch diameter, preferably with an appropriate type of tyre such as radial tyres to provide the better Rolling Resistance (RR) typically required on electric vehicles to get good efficiency.

[018] The electric battery module advantageously comprises a battery temperature control system with a view to optimising battery efficiency and battery life given that in some countries like India temperatures often exceed 25°C. The protective frame structure may be enclosed by suitable means to form a cooling box with one side closed with a door to access the batteries placed inside cooling box. The temperature control system may include a cooling box with air circulation means so that air circulating inside the cooling box flows over the battery surfaces and helps to maintain desired battery temperature. A suitable temperature control system is described in the Applicant's co-pending Application IN 201721019563, the contents of which are hereby incorporated herein by reference. The components of said temperature control system such as a compressor, condenser and necessary tubing for circulating refrigerant of the system is packaged in the close vicinity around cooling box. The compressor along with its controller, condenser being heavy components are mounted on the chassis of the vehicle such that these components will not interfere with other associated components.

[019] The battery is in connection with a charger unit located below passenger seat and fixed to the chassis of the vehicle and used for charging the battery using external power supply. An electric vehicle is provided with a vehicle control unit (VCU) comprising battery monitoring unit, charge monitoring unit, transmission and load control unit mounted on

the chassis below passenger seat. The charger, VCU are accessible through a service window provided inside a passenger compartment.

[020] An electric vehicle is provided with an indicator which serves as both a speedometer and a battery state of charge (SOC) indicator. During charging the indicator shows the SOC of the battery while during running condition the same indicator is used as speedometer.

[021] An electric vehicle is provided with a handlebar partly made of metal casting and partly made of plastic material such that a hollow housing is formed there between to accommodate at least a part of wiring harness wherein; the metal casting is provided with metal tube mounting used for riveting at least a control wire.

[022] The vehicle may include an auxiliary battery to provide electric power to vehicle control unit headlights, tail lights, dashboard and control system. This reduces demand on the electric power module, improves electric motor performance and improves safety. Such auxiliary battery conveniently has a 12 volt rating. The electric vehicle may be provided with a telematics unit mounted below driver's seat which used to tracking vehicle data, location etc. and is in connection with remote server to transmit the data to server.

[023] The vehicle is intended to be a compact vehicle which can be used for commuter applications, such vehicle at least including three and four wheel vehicles. Such compact vehicles would have similar manufacturing costs and design to hydrocarbon fuelled vehicles currently available to the marketplace.

We Claim:

1. An electric vehicle comprising:
a chassis;
an electric motor as prime mover; and
an electric battery module for powering the electric motor comprising at least one battery and a protective frame structure for positioning the at least one battery and being fixed in a rearmost portion of the chassis of the vehiclewherein; the battery is connected to said electric motor through a terminal block using flexible electric connections.

2. An electric vehicle as claimed in claim 1 wherein;the terminal block is located outside a volume defined by the protective frame structure.

3. An electric vehicle as claimed in claim 1 wherein; the protective frame is provided with guides preferably, guide rails to facilitate the insertion and removal of batteries inside protective frame.

4. An electric vehicle as claimed in claim 3 wherein; the guiding rails are provided with battery holding guide comprising plurality of snaps made of elastic material to hold the battery intact in its position.

5. An electric vehicle as claimed in claim 1 wherein; the protective frame is mounted on the chassis by vibration isolating elements to reduce the vibrations being transmitted to the battery from chassis or vice versa.

6. An electric vehicle as claimed in claim 1 wherein; the battery module is provided with a temperature control system comprising an air circulation means to circulate air over the battery surfaces and to maintain the temperature of batteries during operation.

7. An electric vehicle as claimed in claim 6 wherein; the temperature control system comprises at least a compressor, a condenser and an evaporator wherein;

the compressor and condenser is mounted to the rear part of chassis of the vehicle using suitable mounting bracket.

8. An electric vehicle as claimed in claim 7 wherein; the condenser is mounted on right, left, central or sideways on the bottom part of the chassis.

9. An electric vehicle as claimed in claim 1 wherein; the battery module comprising at least two batteries connected in parallel to deliver the required voltage.

10. An electric vehicle as claimed in claim 1 wherein; at least one battery is disposed substantially horizontally inside the protective frame such that the Centre of Gravity (CG) of battery is downward on the rear side so as to assist insertion of the batteries inside protective frame.

11. An electric vehicle as claimed in claim 1 wherein; the battery is disposed substantially in vertical position inside the protective frame such that the Centre of Gravity (CG) of battery is downward on the rear side so as to assist insertion of the batteries inside protective frame.

12. An electric vehicle as claimed in claim 1 wherein; the protective frame structure is having access either from rear side of the vehicle or from passenger compartment for swapping or removal/insertion of batteries.

13. An electric vehicle as claimed in claim 1 wherein; the protective frame is mounted on the rear portion of chassis such that at least a portion of a luggage compartment for the vehicle may be arranged above the protectiveframe structure.

14. An electric vehicle as claimed in claim 1 wherein; the chassis of the vehicle is connected to wheels of the vehicle using a softer suspension system comprising an anti-roll bar.

15. An electric vehicle as claimed in claim 14 wherein; the suspension is provided with a visual indication means for indicating a loading of the electric vehicle preferably in the form of a scale.

16. An electric vehicle as claimed in claim 1 is provided with wheels having radial tyres.

17. An electric vehicle as claimed in claim 1 wherein; the battery is in connection with a charger unit located below passenger seat and fixed to the chassis of the vehicle and used for charging the battery using external power supply.

18. An electric vehicle as claimed in claim 1 is provided with a vehicle control unit (VCU) comprising battery monitoring unit, charge monitoring unit, transmission and load control unit mounted on the chassis below passenger seat.

19. An electric vehicle as claimed in claim 17 or 18 wherein; the charger, VCU are accessible through a service window provided inside a passenger compartment.

20. An electric vehicle as claimed in claim 1 is provided with an indicator which serves as both a speedometer and a battery state of charge (SOC) indicator.

21. An electric vehicle as claimed in claim 1 is provided with a handlebar partly made of metal casting and partly made of plastic material such that a hollow housing is formed there between to accommodate at least a part of wiring harness wherein; the metal casting is provided with metal tube mounting used for riveting at least a control wire.

22. An electric vehicle as claimed in claim 1 comprises an auxiliary battery provided below driver's seat to provide electric power to auxiliary components of the vehicle including vehicle control unit, headlights, tail lights, dashboard and control system.

23. An electric vehicle as claimed in claim 1 is a three wheeled vehicle.

24. An electric vehicle as claimed in claim 1 is a four wheeled vehicle.

Dated 7th day of December, 2018

For Bajaj Auto Limited

Milind Joshi

Sr. Manager (R&D)

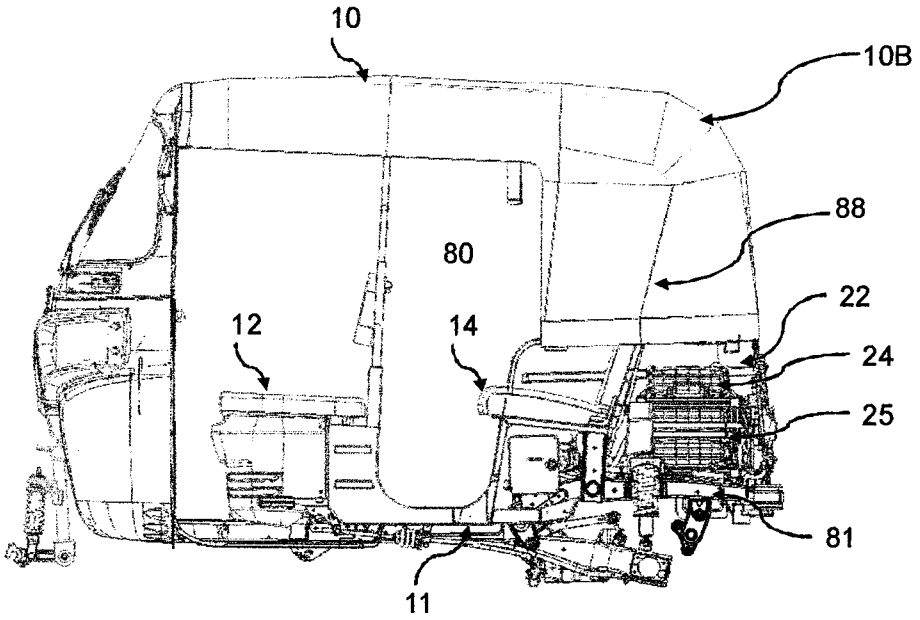

FIG.1

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Applicant

By:
MARI-LEN P. MONTOYA
Resident Agent

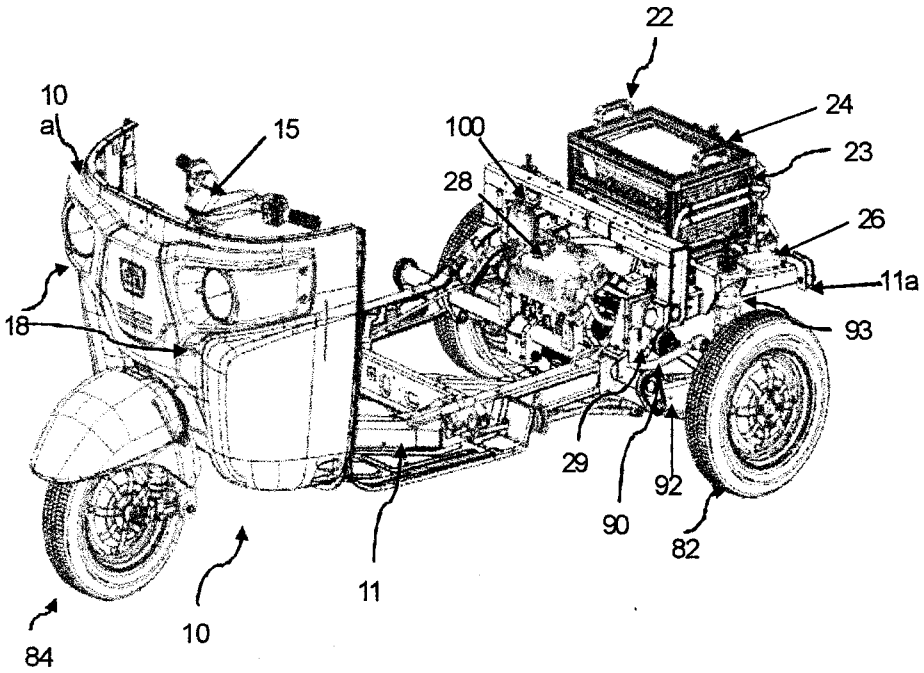

FIG.2

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Resident Agent

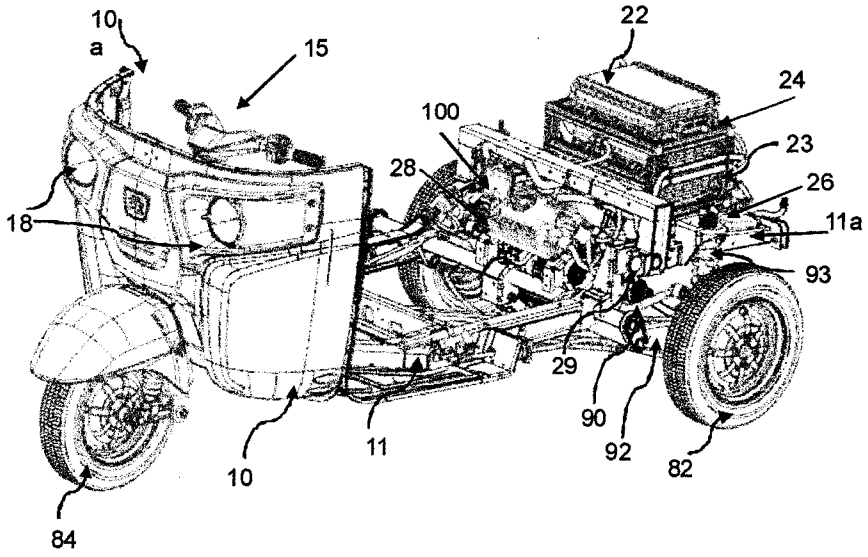

FIG.2a

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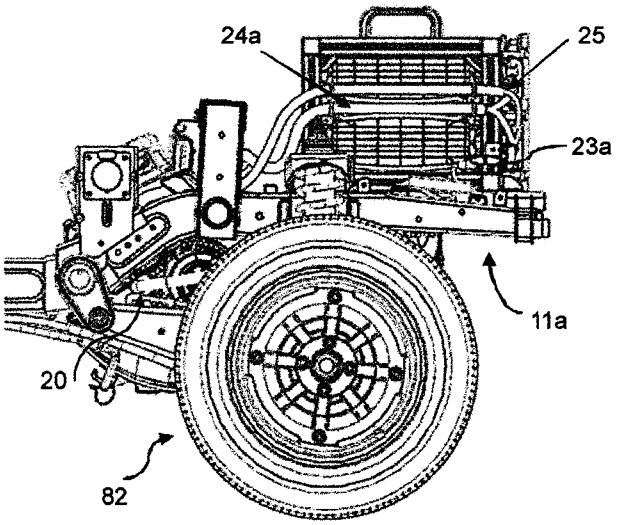

FIG.3

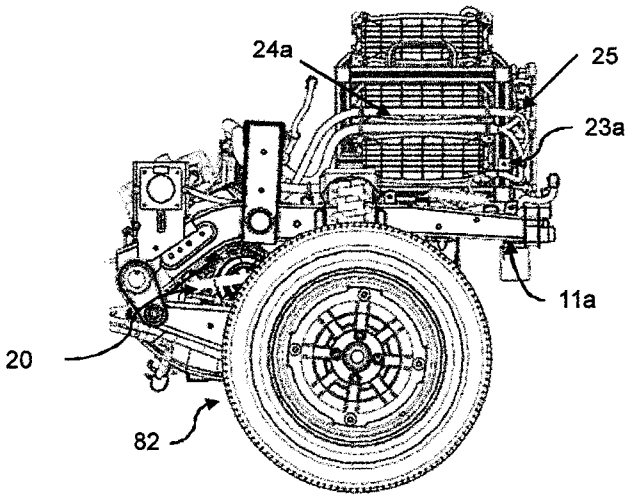

FIG.3a

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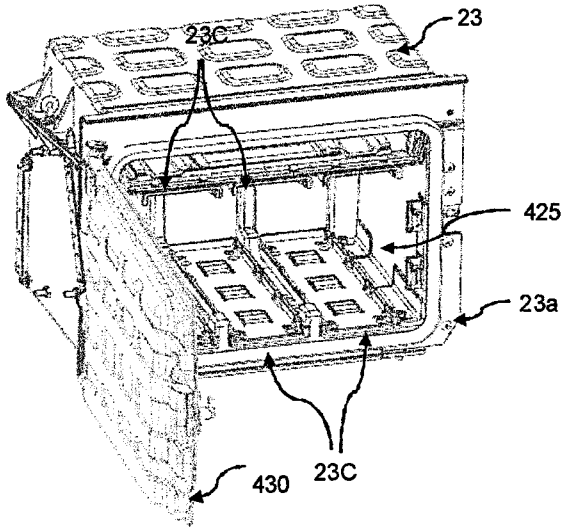

FIG.4

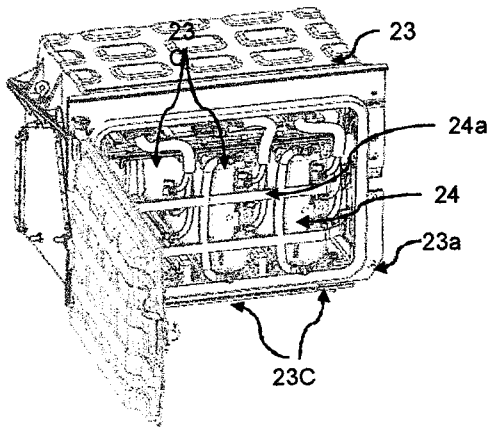

FIG.5

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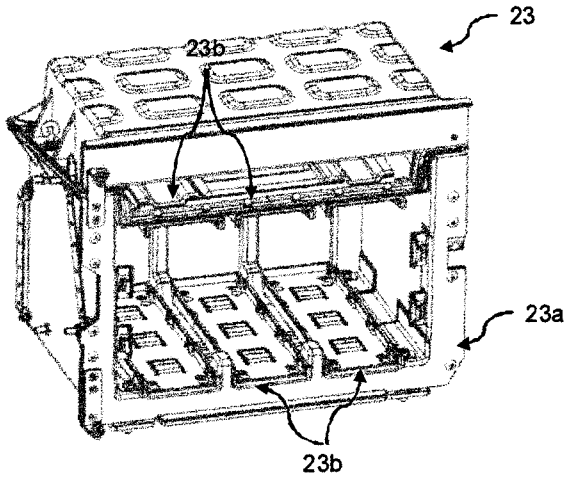

FIG.6a

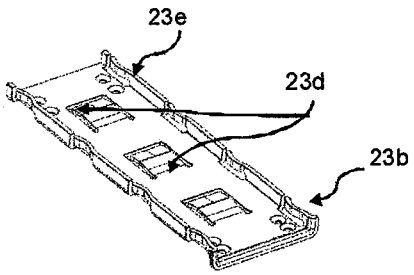

FIG.6b

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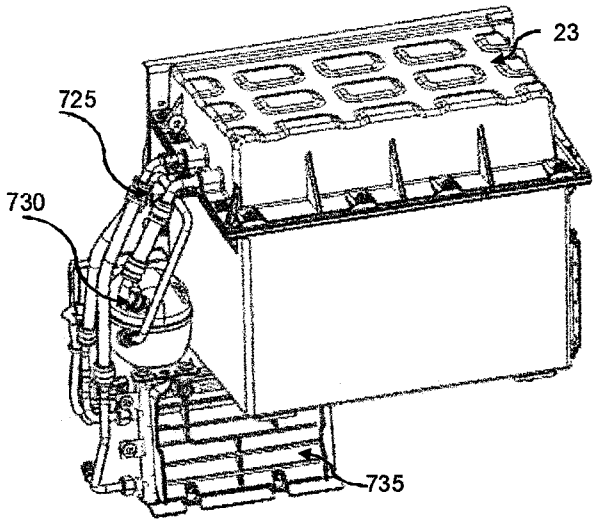

FIG.7a

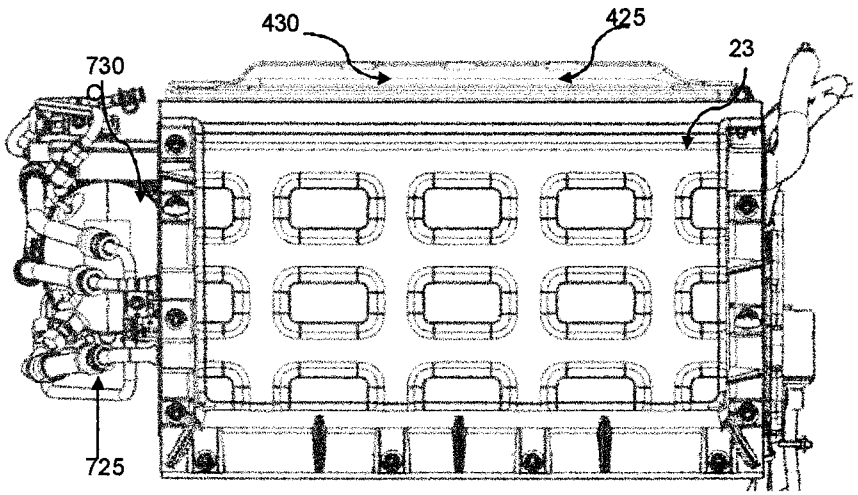

FIG.7b

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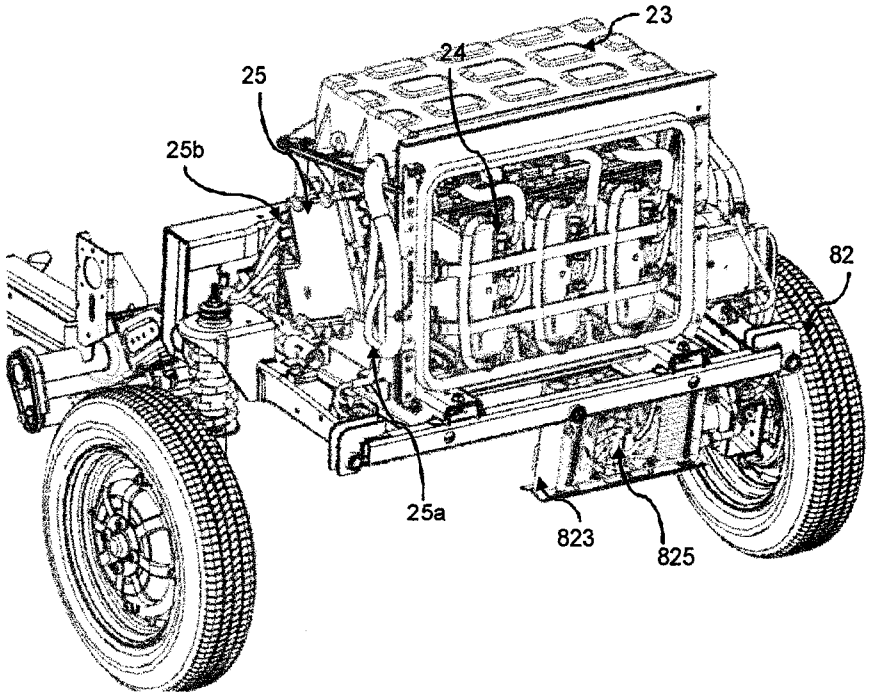

FIG.8a

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Resident Agent

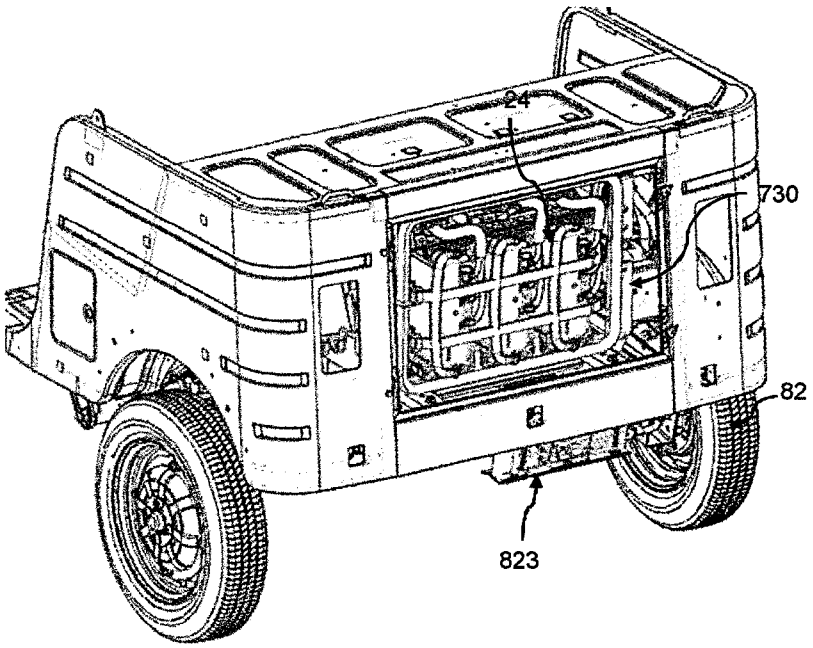

FIG.8b

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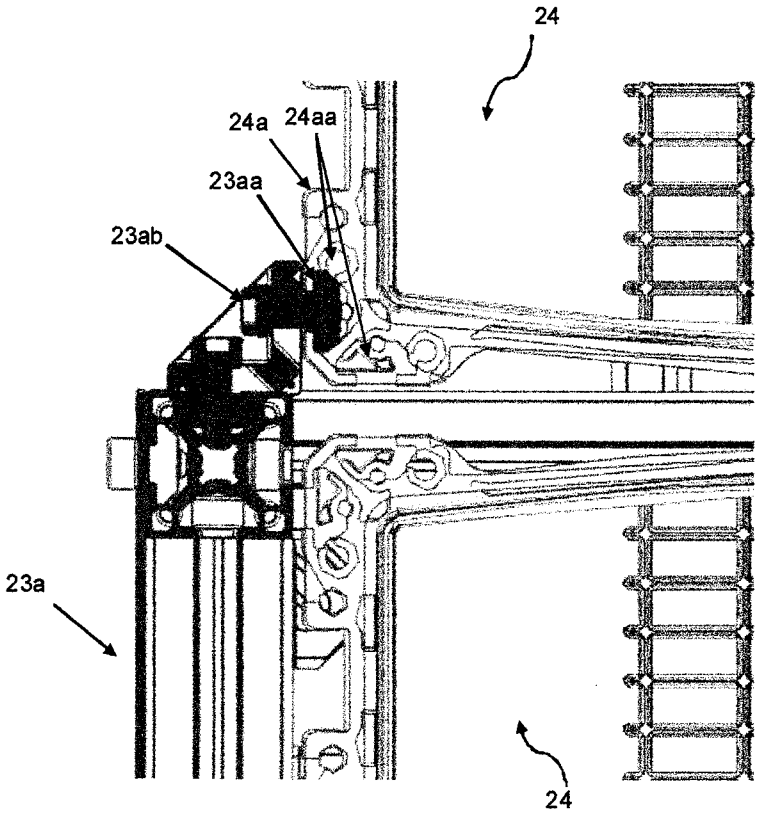

FIG.9

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Resident Agent

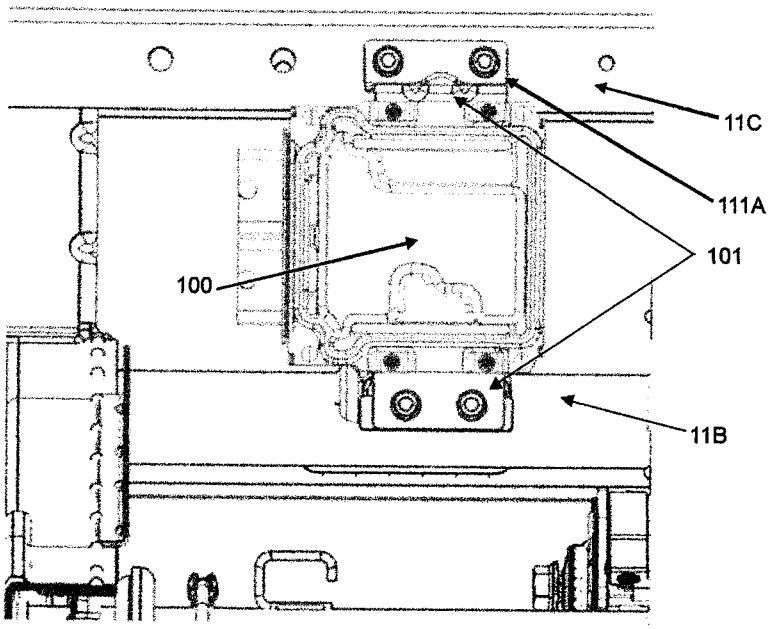

FIG.10

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Resident Agent

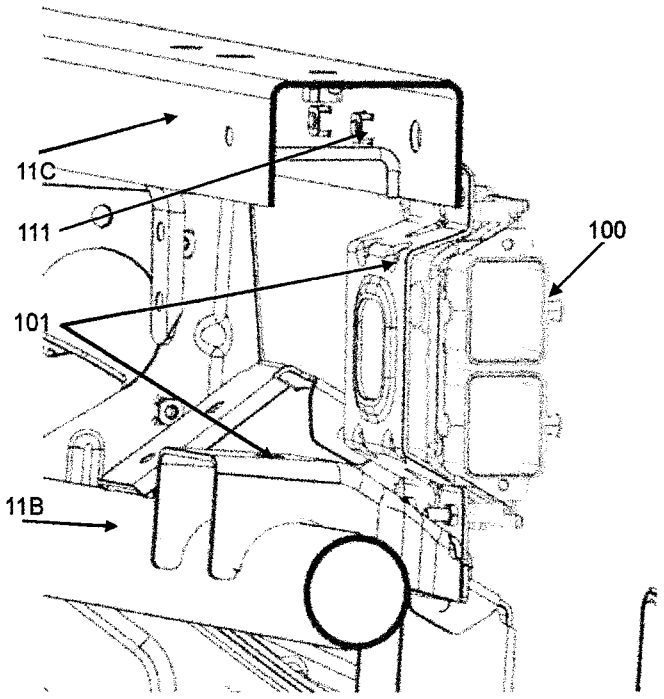

FIG.11

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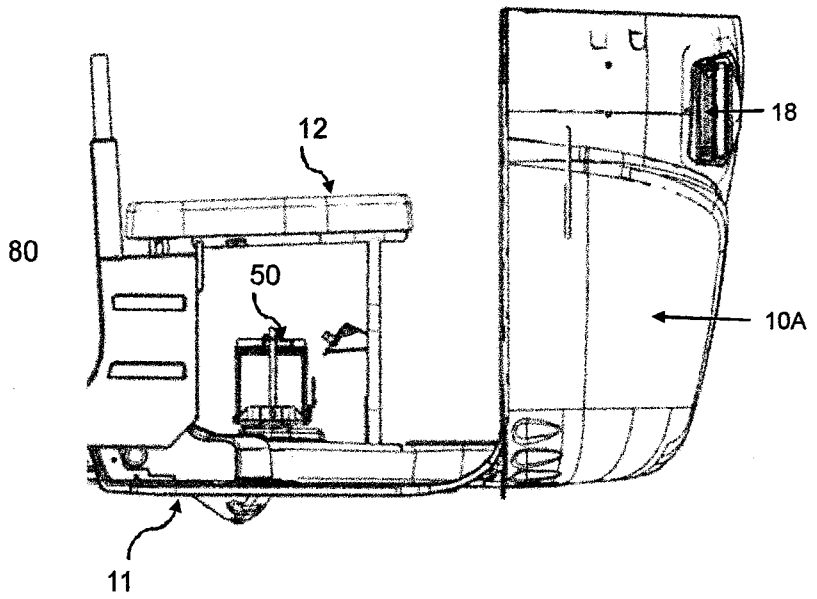

FIG.12

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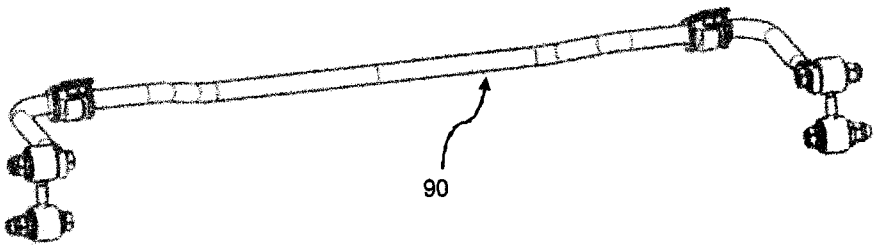

FIG.13a

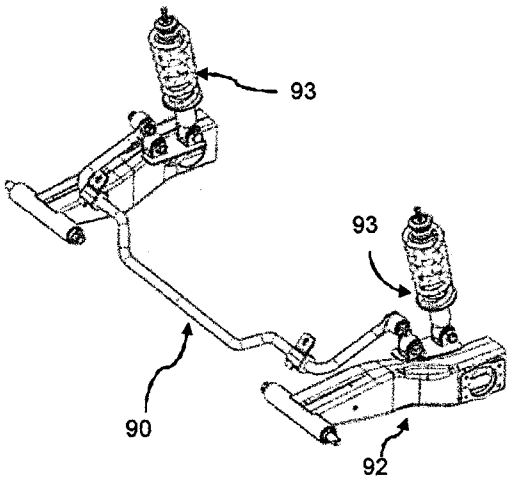

FIG.13b

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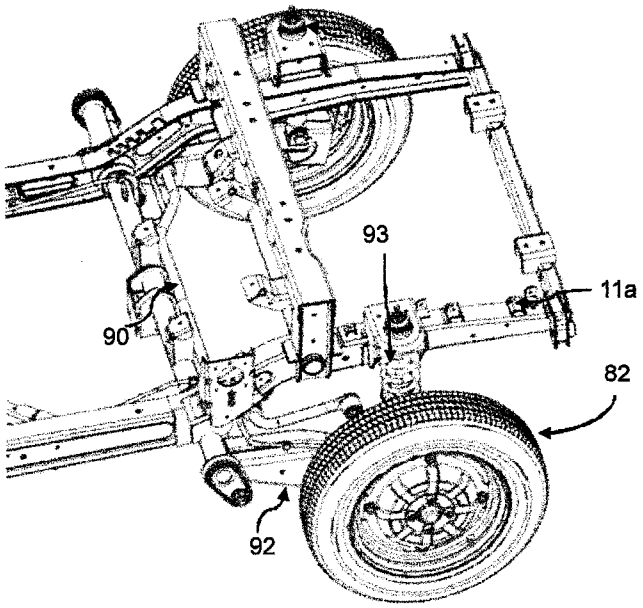

FIG.13c

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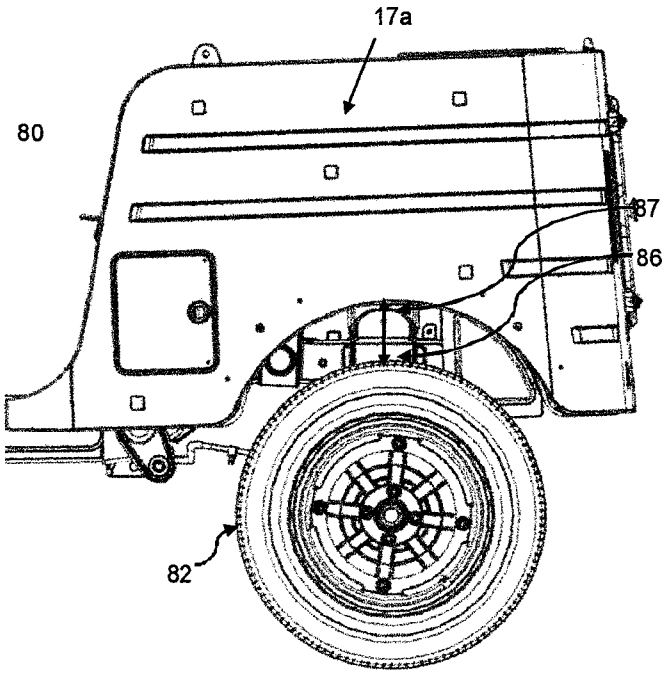

FIG.14a

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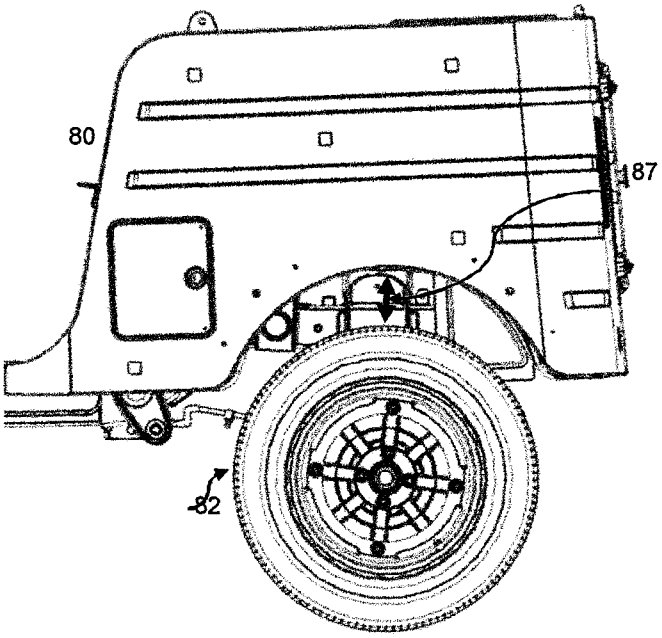

FIG.14b

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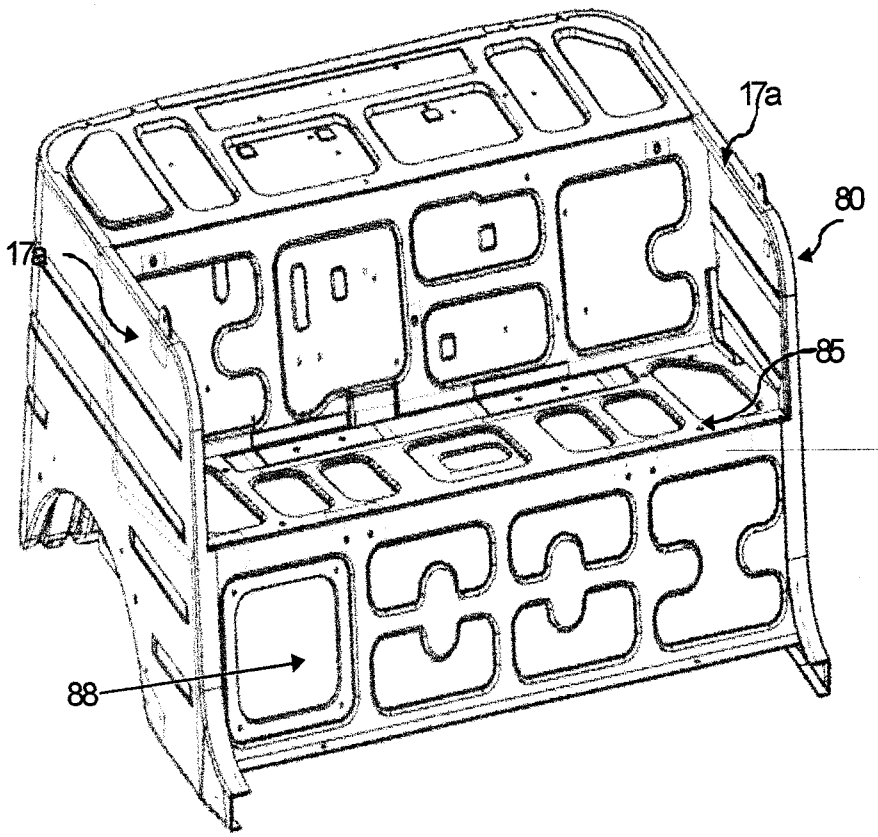

FIG.15

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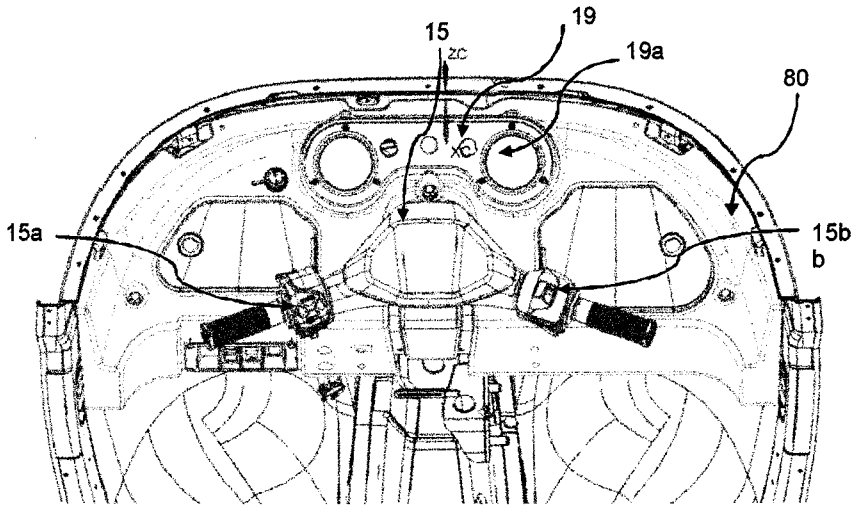

FIG.16

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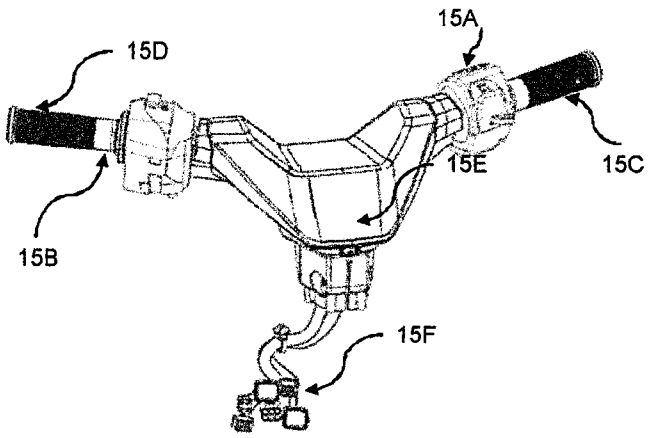

FIG.17

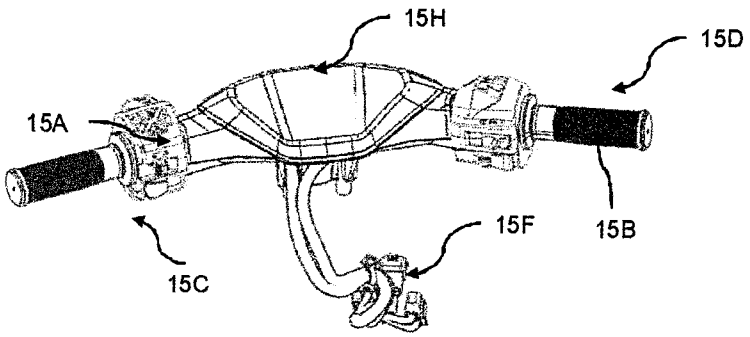

FIG.18

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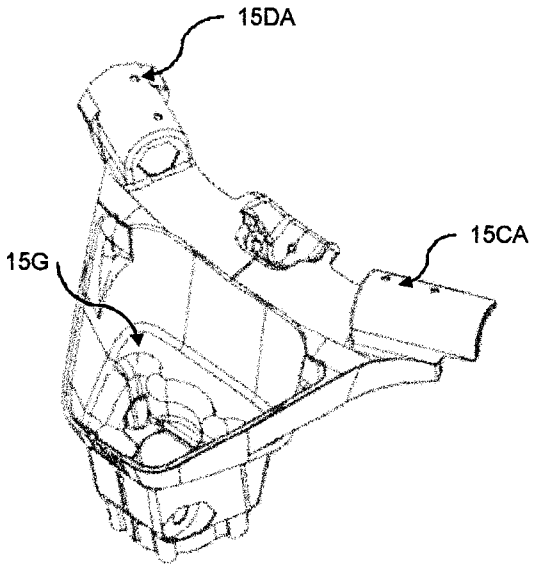

FIG.19

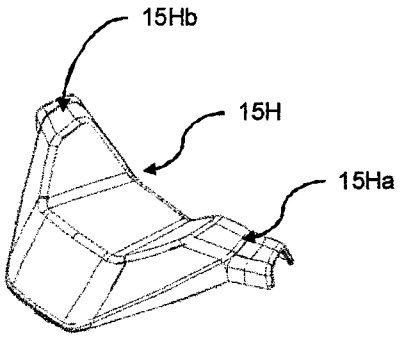

FIG.20

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