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(72) Inventor; and
(71) Applicant : **ANANTHAKRISHNA, Anil** [US/IN]; "Casa Birgitta", No. 10 Brunton Road, MG Road Cross, Bangalore-560025 (IN).

(74) Agent: **RAJAGOPAL, Lakshmi**; Fox Mandal & Associates, FM House 6/12, Primrose Road, Bangalore-560025 (IN).

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(54) **Title**: HYBRID FUEL STORAGE AND PROPULSION SYSTEM FOR AUTOMOBILES

(57) **Abstract**: The present invention provides a hybrid vehicle having fuel storage and electric propulsion system in a trailer car. A hybrid vehicle includes an IC engine vehicle, and a hybrid fuel storage and propulsion unit coupled to the IC engine vehicle for providing electric power to the IC engine vehicle to run in a pure electric mode or a hybrid mode. The fuel storage and propulsion unit can be disposed in a side car for two wheeled IC engine vehicle and a trailer car for three or more wheeled IC engine vehicle. Alternatively, the fuel storage and propulsion unit can be employed within the IC engine vehicle to run the IC engine vehicle in a pure electric mode or hybrid mode. The hybrid fuel storage and propulsion unit includes an energy storage unit, a fuel cell unit, an energy storage management system, and an electronic motor control and event management system.

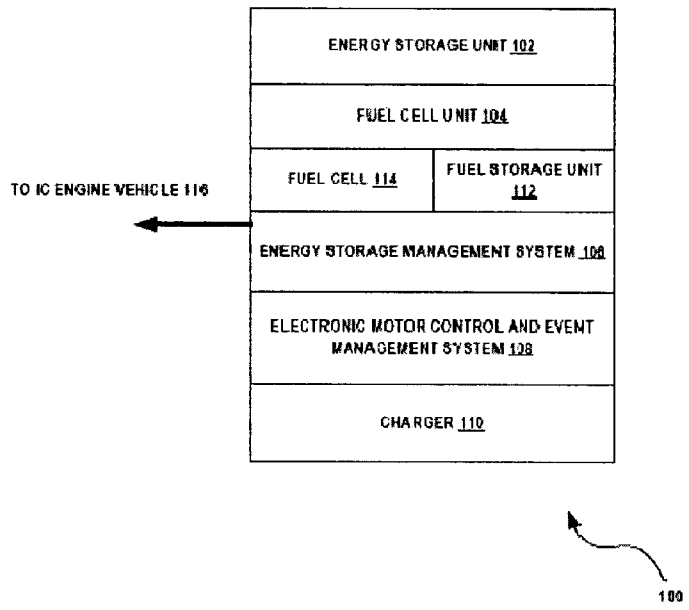


FIGURE 1

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HYBRID FUEL STORAGE AND PROPULSION SYSTEM FOR AUTOMOBILES

RELATED APPLICATION

Benefit is claimed to India Provisional Application No. 683/CHE/2011, entitled "HYBRID FUEL STORAGE AND PROPULSION SYSTEM FOR AUTOMOBILES" by ANIL ANANTHKRISHNA, filed on March 07, 2011, which is herein incorporated in its entirety by reference for all purposes.

FIELD OF THE INVENTION

The present invention generally relates to electric vehicles and more particularly relates to a hybrid vehicle.

BACKGROUND OF THE INVENTION

In automobile vehicle industry, electric vehicles are introduced to control air pollution caused due to IC engine powered vehicles. Currently, the electric vehicles are classified into two groups, namely pure electric and extended electric vehicles (also known as hybrid vehicles). The hybrid vehicles have a primary electric drive with associated batteries and an internal combustion engine coupled to an electric motor/generator.

The hybrid vehicles have distinct advantage of allowing long travel, as atleast one source is always available to drive the vehicle. Hence, there is no risk of running out of fuel as it frequently happens with a traditional internal combustion powered vehicle. The hybrid vehicle can operate as an IC engine vehicle or as an electric vehicle or even as both. For example, driving on terrain or for long distances, IC engine can be used and for shorter distances electric propulsion system can be

used. These advantages come at the costs of approximately one third higher vehicle weight and price.

Further, incorporation of both internal combustion engine and electric motor assembly in the hybrid vehicle makes the system bulky and more complex. The vehicle's suspension, transmission, primary motor all must be designed for the additional weight of a redundant drive train and its fuel. In addition to the above, the need of large battery for fuel storage occupies larger space.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Figure 1 is a block diagram illustrating a hybrid fuel storage and propulsion unit meant for converting an IC engine vehicle to a hybrid vehicle, according to one embodiment.

Figure 2 illustrates a schematic diagram of an IC engine two wheeled vehicle retrofitted with the hybrid fuel storage and propulsion unit, according to one embodiment.

Figure 3 illustrates a schematic diagram of an IC engine two wheeled vehicle retrofitted with the hybrid fuel storage and propulsion unit, according to another embodiment.

Figure 4 illustrates a schematic diagram of a four wheeled hybrid car attached with a trailer car including the fuel storage and propulsion unit, according to yet another embodiment.

Figure 5 illustrates a schematic diagram of a hybrid three wheeler attached with the trailer car including the fuel storage and propulsion unit, according to yet another embodiment.

Figure 6 is a schematic diagram of a two wheeled hybrid vehicle with a side car including the hybrid fuel storage and propulsion unit, according to yet a further embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a hybrid fuel storage and propulsion system for automobiles. The following description is merely exemplary in nature and is not intended to limit the present disclosure, applications, or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

Figure 1 is a block diagram illustrating a hybrid fuel storage and propulsion unit 100 meant for converting a IC engine vehicle to a hybrid vehicle, according to one embodiment. The hybrid fuel storage and propulsion unit 100 includes an energy storage unit 102, a fuel cell unit 104, an energy storage management system 106, an electronic motor control and event management system 108, and a charger 110. These components together enable to convert an IC engine vehicle into a hybrid vehicle to cause an IC engine vehicle (e.g., car, motorbike, auto-rickshaw, cars, trucks and so on) run in a pure electric mode or hybrid mode.

The energy storage unit 102 includes one or more batteries which stores electric energy required for driving an IC engine vehicle 116 in pure electric mode or hybrid mode. Each of the one or more batteries is formed using electro-chemical storage cells. The one or more batteries may be a single chemistry or hybrid chemistry batteries with a single pole terminal or multi-pole terminals on each cell. The batteries may also include super-capacitors to enhance reduced equivalent series resistance (ESR) and increase efficiency of regenerative braking.

The fuel cell unit 104 converts fuel energy into electrical energy and replenishes charge of the energy storage unit 102. The fuel cell unit 104 includes a fuel storage tank 112 for storing fuel such as methanol or hydrogen. The fuel cell unit 104 includes a fuel cell 114 for generating electrical energy using the fuel stored in the storage tank 112. The fuel cell unit 104 replenishes charge of the energy storage unit 102 upon opportunity (e.g., traffic stop, parking stop, during IC engine mode operation, etc.)

The energy storage management system 106 manages electric energy stored in the energy storage unit 102. For example, the energy storage management system 106 controls rate of charge, rate of discharge, monitors temperature, and keeps track of input/output energy count. Additionally, the management system 106 maintains storage cells within the energy storage unit 102 in balance with one another.

The electronic motor control and event management system 108 includes one or more microcontrollers for monitoring various parameters associated with the operation of a hybrid vehicle. For example, the management system 108 checks for fuel levels in the fuel storage tank 112, checks for energy density within the batteries by communicating with the energy storage management system 106. The management system 108 also checks motor temperature and revolutions/minute, checks for engine temperature, transmission ratio, fuel consumption, checks window for opportunity changing, check for regenerative braking, controls engine functions and energy levels, controls functions of electric motors, commutates motor poles for rotation, governs speed and torque of the IC engine 116 and the electric motor for optimum performance and efficiency. The management system 108 has mechanism that performs regenerative braking through the electric motors and also performs constant recharging of batteries.

The charger 110 may include a grid based high frequency switch mode fast battery charger and an onboard fuel cell based battery charger for replenishing the charge of the energy storage unit 102. The grid based charger performs required power conversion to charge batteries using energy from the grid using a high frequency switch mode power converter. The grid based charger is an intelligent high frequency switch mode fats charger that is either portable or integrated into vehicle chassis. The onboard fuel cell based battery charger controls and manages power conversion from the fuel cell to the batteries.

Figure 2 illustrates a schematic diagram of an IC engine two wheeled vehicle 200 retrofitted with the hybrid fuel storage and propulsion unit 100, according to one embodiment. The IC engine two wheeled vehicle 200 is a two wheeled vehicle running on power from the IC engine 116. As can be seen, the IC engine two wheeled vehicle 200 is converted into a hybrid two wheeled vehicle by retrofitting the hybrid fuel storage and propulsion unit 100 onto the IC engine two wheeled vehicle 200.

In **Figure 2**, the hybrid fuel storage and propulsion unit 100 includes the energy storage unit 102, the energy storage management system 106, the electronic motor control and event management system 108, the charger 110, the fuel storage unit 112, the fuel cell 114, and a fossil fuel/bio-fuel storage unit 202. The fuel storage unit 112, the fuel cell 114, and the fossil fuel/bio-fuel storage unit 202 are housed in an enclosure 204 of the two wheeled vehicle 200. Further, the energy storage unit 102, the energy storage management system 106, the electronic motor control and event management system 108, the charger 110 are housed in a compartment beneath the enclosure 204, where the said compartment can be separate or a part of the enclosure 204.

The IC engine two wheeled vehicle 200 consists of a front wheel 206 and a rear wheel 208 constructed such that the wheel rim is detachable completely or partially

from the vehicle such that it provides for ease of removing the same for rectifying a flat tyre or changing the same as when required. The wheels 206 and 208 of the two wheeled vehicle 200 are drivingly coupled to electric motors 210. The electric motors 210 can be a hub motor integrated in each of the front wheel 206 and the rear wheel 208 or separate electric motors drivingly coupled the front wheel 206 and the rear wheel 208 via mechanical transmission. These electric motors 210 can be either a single motor or multiple stators with a single housed rotor or inter-coupled rotor mechanisms with independent commutation and control systems. The electric motors 210 are configured to drive the wheels 206 and 208, pure electric mode or hybrid mode and are configured as generators driven by the wheels 206 and 208 in an IC engine mode and regenerative mode.

In an IC engine mode, the two wheeled vehicle 200 runs on IC engine power received from the IC engine 116. It is appreciated that, the IC engine 116 is run on fossil fuel such as gasoline, and diesel, or bio-fuels supplied from the fossil fuel/bio-fuel storage unit 202. During the pure electric mode or hybrid mode, the hybrid fuel storage and propulsion unit 100 provides electric power to the electric motors 210 to run the two wheeled vehicle 200 in a pure electric mode or a hybrid mode. In other words, the electric motors 210 drives the two wheeled vehicle 200 using the electric power received from the hybrid fuel storage and propulsion unit 100 during the pure electric mode or hybrid mode of operation. Specifically, during the pure electric mode, the fuel storage and propulsion unit 100 drives the motors 210 through electric power which in turn drive the wheels 206 and 208. During the hybrid mode, the IC engine 116 is drivingly coupled to the electric motors 210 via mechanical transmission unit such that the wheels 206 and 210 are driven by power from the IC engine 116 as well as the electric motors 210 that are driven by the fuel storage and propulsion unit 100.

Figure 3 illustrates a schematic diagram of an IC engine two wheeled vehicle 300 retrofitted with the hybrid fuel storage and propulsion unit 100, according to another

embodiment. In the IC engine two wheeled vehicle 300, the energy storage unit 102, the energy storage management system 106, the electronic motor control and event management system 108, the charger 110 are housed in a crash guard 302. The crash guard 302 is specially designed to accommodate the above components of the fuel storage and propulsion unit 100. This makes the fuel storage and propulsion unit 100 easily retrofitted to the IC engine two wheeled vehicle 300.

Also, the crash guard 302 carrying the above components helps save storage space in the two wheeled vehicle 200. More importantly, the crash guard 302 can be fitted to vehicles that cannot accommodate these components due to space constraint. One skilled in the art can realize that the hybrid fuel storage and propulsion unit 100 can be retrofitted to any type of IC engine vehicles, including three or more wheels, moped or scooters and not limited to two wheeled motorbikes, for running the IC engine vehicle on electric power and/or IC engine power.

Although the foregoing description illustrates the fuel storage and propulsion unit 100 retrofitted into the IC engine vehicle, one skilled in the art will understand that the fuel storage and propulsion unit 100 can be externally attached to the IC engine vehicle to convert the IC engine vehicle to a hybrid vehicle as illustrated in **Figures 4** through **6**.

Figure 4 illustrates a schematic diagram of a four wheeled hybrid car 400 attached with a trailer car 404 including the fuel storage and propulsion unit 100, according to yet another embodiment. The hybrid vehicle 400 consists of an IC engine vehicle 402 (e.g., a four wheeled automobile) and a trailer car 404 attached to the IC engine vehicle 402. The trailer car 404 includes a trailer frame 406 configured to be coupled to the IC engine vehicle 402. The trailer car 404 is attached to the rear end of the IC engine vehicle 402 by means of a hitch mechanism or any other joint

mechanism 408. The trailer car 404 contains the hybrid fuel storage and propulsion unit 100 disposed on the trailer frame 406.

As illustrated, the IC engine vehicle 402 consists of front wheels 410 and rear wheels 412. The wheels 410 and 412 are constructed such that the wheel rim is detachable completely or partially from the vehicle 402 such that it provides for ease of removing the same for rectifying a flat tyre or changing the same as when required. The wheels 410 and 412 can be either integrated with a hub motor or drivingly coupled to a separate electric motor. In **Figure 4**, the wheels 410 and 412 are shown as drivingly coupled to the separate electric motor 416. The separate electric motor 416 can be either a single motor or multiple stators with a single housed rotor or inter-coupled rotor mechanisms with independent commutation and control systems. The electric motor 416 is configured to drive the wheels 410 and 412 in a pure electric mode or hybrid mode. During the IC engine mode and regenerative braking mode, the electric motor 416 is configured as a generator driven by the wheels 410 and 412.

In an IC engine mode, the IC engine vehicle 402 runs on IC engine drive received from the IC engine 116. It is appreciated that, the IC engine 116 is run on fossil fuel such as gasoline, diesel or bio-fuels. The IC engine vehicle 402 includes a fuel tank 414 for storing and supplying the fossil fuel and/or bio-fuels to the IC engine 116. In case the IC engine vehicle 402 runs on the IC engine mode, the trailer car 404 may be electrically or mechanically decoupled from the IC engine vehicle 402.

During the pure electric mode or hybrid mode, the hybrid fuel storage and propulsion unit 100 provides electric power to the electric motor 416 to run the IC engine vehicle 402 in a pure electric mode or a hybrid mode. In other words, the electric motor 416 drives the IC engine vehicle 402 using the electric power received from the hybrid fuel storage and propulsion unit 100 during the pure electric mode or hybrid mode of operation. Specifically, during the pure electric

mode, the fuel storage and propulsion unit 100 drives the electric motor 416 through electric power which in turn drives the wheels 410 and 412 of the IC engine vehicle 402. During the hybrid mode, the IC engine 116 is drivingly coupled to the electric motor 416 via mechanical transmission unit such that the wheels 410 and 412 are driven by power from the IC engine 116 as well as the electric motor 416 that are driven by the fuel storage and propulsion unit 100.

The fuel storage and propulsion unit 100 is also configured to provide motive power a trailer car 404 while the IC engine vehicle 402 is moving so that the trailer car 404 moves without applying a substantial load to the normal IC engine vehicle 402. The wheels 418 of the trailer car 404 may optionally be drivingly coupled to a motor/generator 420 through appropriate mechanical transmissions for driving the wheels 418 using electric power as shown in **Figure 4**.

Alternatively, each of the wheels 418 can be integrated with the hub motor 420 for directly driving the wheels 418 of the trailer car 404 using the electric power. The motor/generator 420 can be either a single motor or multiple stators with a single housed rotor or inter-coupled rotor mechanisms with independent commutation and control systems. The motor/generator 420 may also be configured to generate and store electrical energy due to regenerative braking during the regenerative braking mode and IC engine mode. The wheels 418 may have mechanical braking mechanism and are constructed such that the wheel rim is detachable completely or partially from the trailer car 404 such that it provides for ease of removing the same for rectifying a flat tyre or changing the same as when required.

Although, the above description is made with reference to usage of the trailer car 404 to propel four wheeled hybrid vehicle 400, one can envision that the trailer car 404 with the hybrid fuel storage and propulsion unit 100 can be used to propel IC engine vehicle with three wheels such as auto-rickshaw or with more than four wheels such as trucks and buses. An example of a three wheeled hybrid auto-

rickshaw 500 attached with the trailer car 404 including the hybrid fuel storage and propulsion unit 100 is shown in **Figure 5**, according to further another embodiment.

Figure 6 is a schematic diagram of a two wheeled hybrid vehicle 600 with a side car 602 including the hybrid fuel storage and propulsion unit 100, according to yet a further embodiment. In **Figure 6**, the hybrid vehicle 600 is an IC engine based two wheeled vehicle 604 with a side car 602 including the hybrid fuel storage and propulsion unit 100. The side car 602 includes the fuel storage and propulsion unit 100 and is similar to the trailer car 404 of the **Figures 4 and 5**, except the side car 602 is coupled to the side of the two wheeled vehicle 604 such as motor-cycle using a connecting rod 606. Also, it can be seen in **Figure 6** that, the two wheeled hybrid vehicle 600 may also house the hybrid fuel storage and propulsion unit 100 which can be used by the IC engine vehicle 604 in absence of the side car 602.

It will be recognized that the above described invention may be embodied in other specific forms without departing from the spirit or essential characteristics of the disclosure. Thus, it is understood that, the invention is not to be limited by the foregoing illustrative details, but it is rather to be defined by the appended claims.

We Claim:

1. A hybrid vehicle comprising:
an IC engine vehicle; and
a hybrid fuel storage and propulsion unit configured to be retrofitted in the IC engine vehicle for providing electric power to the IC engine vehicle to run the IC engine vehicle in at least one of a pure electric mode and a hybrid mode.

2. The vehicle of claim 1, wherein the IC engine vehicle comprises at least one front wheel and at least one rear wheel.

3. The vehicle of claim 2, wherein the hybrid fuel storage and propulsion unit comprises one or more electric motors drivingly coupled to each of the at least one front wheel and at least one rear wheel.

4. The vehicle of claim 3, wherein the one or more electric motors coupled to each of the at least one front wheel and the at least one rear wheel are configured to receive electric power from the hybrid fuel storage and propulsion unit to drive the respective at least one front wheel and the at least one rear wheel.

5. The vehicle of claim 4, wherein the IC engine vehicle comprises an IC engine drivingly coupled to the one or more electric motors via a mechanical transmission unit during the hybrid mode of the IC engine vehicle.

6. The vehicle of claim 5, wherein the electric motors are selected from the group consisting of hub motors and external motors.

7. The vehicle of claim 1, wherein the hybrid fuel storage and propulsion unit comprises:

an energy storage unit for storing electric energy required for driving the IC engine vehicle in a pure electric mode or a hybrid mode;

a fuel cell unit for converting fuel energy into electrical energy and replenishing charge of the energy storage unit;

an energy storage management system for managing the electric energy stored in the energy storage unit; and

an electronic motor control and event management system for managing parameters associated with the operation of the hybrid vehicle.

8. The vehicle of claim 7, wherein the energy storage unit comprises one or more batteries, each of the batteries includes electro-chemical storage cells and super-capacitors.

9. The vehicle of claim 8, wherein the hybrid fuel storage and propulsion unit further comprises a high frequency switch mode fast charger for replenishing charge of at least one of the fuel cell unit and the one or more batteries using an external charging point.

10. The vehicle of claim 9, wherein the fuel cell unit comprises:

at least one fuel storage tank for storing fuel to generate electrical energy; and

at least one fuel cell for generating electrical energy using the fuel stored in the at least one fuel storage tank.

11. The vehicle of claim 10, wherein the hybrid fuel storage and propulsion unit comprises a fuel storage tank for storing and supplying fossil fuel/bio-fuel to the IC engine of the IC engine vehicle.

12. The vehicle of claim 10, wherein the fuel tank houses the fuel cell unit.

13. The vehicle of claim 11, wherein the IC engine vehicle comprises a crash guard housing the energy storage unit, the energy storage management system and the electronic motor control and event management system, and the high frequency switch mode fast charger.

14. A hybrid fuel storage and propulsion unit comprising:

an energy storage unit for storing electric energy in a chemical form;

a fuel cell unit for converting fuel energy into electrical energy and replenishing charge of the energy storage unit;

an energy storage management system for managing the electric energy stored in the energy storage unit; and

an electronic motor control and event management system for managing parameters associated with the operation of the hybrid vehicle, wherein the hybrid fuel storage and propulsion unit is configured to be retrofitted in an IC engine vehicle for providing electric power from the energy storage unit to the IC engine vehicle to cause the IC engine vehicle run in at least one of a pure electric mode and a hybrid mode.

15. The hybrid fuel storage and propulsion unit of claim 14, wherein the energy storage unit comprises one or more batteries, each of the batteries includes electro-chemical storage cells and super-capacitors.

16. The hybrid fuel storage and propulsion unit of claim 14, further comprising a high frequency switch mode fast charger for replenishing charge of at least one of the fuel cell unit and the one or more batteries using an external charging point.

17. The hybrid fuel storage and propulsion unit of claim 14, wherein the fuel cell unit comprises:

at least one fuel storage tank for storing fuel to generate electrical energy; and

at least one fuel cell for generating electrical energy using the fuel stored in the at least one fuel storage tank.

18. The hybrid fuel storage and propulsion unit of claim 14 further comprises a fuel storage tank for storing and supplying fossil fuel or bio-fuel to the IC engine of the IC engine vehicle.

19. The hybrid fuel storage and propulsion unit of claim 18, wherein the energy storage unit, the energy storage management system and the electronic motor control and event management system, and the high frequency switch mode fast charger are housed in a crash guard of the IC engine vehicle, wherein the IC engine vehicle is a two wheeled IC engine vehicle.

20. The hybrid fuel storage and propulsion unit of claim 18, wherein the fuel cell unit is housed in the fuel tank.

21. A hybrid vehicle comprising:

an IC engine vehicle; and

a hybrid fuel storage and propulsion car coupled to the IC engine vehicle comprising:

a frame configured to be coupled to the IC engine vehicle; and

a hybrid fuel storage and propulsion unit disposed on the frame for providing electric power to the IC engine vehicle to run the IC engine vehicle in at least one of a pure electric mode and a hybrid mode.

22. The vehicle of claim 21, wherein the IC engine vehicle comprises at least one front wheel and at least one rear wheel

23. The vehicle of claim 22, wherein the IC engine vehicle comprises one or more electric motors drivingly coupled to the at least one front wheel and at least one rear wheel.

24. The vehicle of claim 23, wherein the one or more electric motors drivingly coupled to each of the at least one front wheel and the at least one rear wheel are configured to receive electric power from the hybrid fuel storage and propulsion unit to drive the respective at least one front wheel and the at least one rear wheel.

25. The vehicle of claim 24, wherein the IC engine vehicle comprises an IC engine drivingly coupled to the one or more electric motors via a mechanical transmission unit during the hybrid mode of the IC engine vehicle.

26. The vehicle of claim 25, wherein the one or more electric motors are selected from the group consisting of hub motors and external electric motors.

27. The vehicle of claim 21, wherein the hybrid fuel storage and propulsion unit comprises:

an energy storage unit for storing electric energy required for driving the IC engine vehicle;

a fuel cell unit for converting fuel energy into electrical energy and replenishing charge of the energy storage unit;

an energy storage management system for managing the electric energy stored in the energy storage unit; and

an electronic motor control and event management system for managing parameters associated with the operation of the hybrid vehicle.

28. The vehicle of claim 27, wherein the energy storage unit comprises one or more batteries, each of the batteries includes electro-chemical storage cells and super-capacitors.

29. The vehicle of claim 28, wherein the hybrid fuel storage and propulsion unit further comprises a high frequency switch mode fast charger for replenishing

charge of at least one of the fuel cell unit and the one or more batteries using an external charging point.

30. The vehicle of claim 29, wherein the high frequency switch mode fast charger is selected from the group consisting of a grid based high frequency switch mode fast battery charger and a fuel cell based charger.

31. The vehicle of claim 30, wherein the fuel cell unit comprises:

at least one fuel storage tank for storing fuel to generate electrical energy; and

at least one fuel cell for generating electrical energy using the fuel stored in the at least one fuel storage tank.

32. The vehicle of claim 21, wherein the IC engine vehicle comprises a fuel storage tank for storing and supplying fossil fuel or bio-fuel to the IC engine of the IC engine vehicle.

33. The vehicle of claim 21, wherein the hybrid fuel storage and propulsion car comprises electric motors drivingly coupled to wheels of the hybrid fuel storage and propulsion car, and wherein the electric motors are selected from the group consisting of hub motors and external motors.

34. The vehicle of claim 33, wherein the electric motors are configured to receive electric power from the hybrid fuel storage and propulsion unit to provide motive power to the hybrid fuel storage and propulsion car.

35. The vehicle of claim 34, wherein the electric motors is configured to generate electric during IC engine mode and regenerative braking mode.

36. The vehicle of claim 21, wherein the hybrid fuel storage and propulsion car is selected from the group consisting of a trailer car and a side car.

37. A trailer car comprising:

a trailer frame configured to be coupled to an IC engine vehicle; and

a hybrid fuel storage and propulsion unit disposed on the trailer frame for providing electric power to the IC engine vehicle to run the IC engine vehicle in at least one of a pure electric mode and a hybrid mode.

38. The trailer car of claim 37, wherein the hybrid fuel storage and propulsion unit comprises:

energy storage unit for storing electric energy required for driving the IC engine vehicle in the at least one of a pure electric mode or a hybrid mode;

a fuel cell unit for converting fuel energy into electrical energy and charging the energy storage unit;

an energy storage management system for managing the electric energy stored in the energy storage unit; and

an electronic motor control and event management system for managing parameters associated with the operation of the hybrid vehicle.

39. The trailer car of claim 38, wherein the energy storage unit comprises one or more batteries, each of the batteries includes electro-chemical storage cells and super-capacitors.

40. The trailer car of claim 37, wherein the hybrid fuel storage and propulsion unit further comprises a charger for replenishing at least one of the fuel cell unit and the one or more batteries using an external charging point.

41. The trailer car of claim 40, wherein the charger is selected from the group consisting of a grid based high frequency switch mode fast battery charger and a fuel cell based charger.

42. The trailer car of claim 38, wherein the fuel cell unit comprises:

at least one fuel storage tank for storing fuel to generate electrical energy; and

at least one fuel cell for generating electrical energy using the fuel stored in the at least one fuel storage tank.

43. The trailer car of claim 37, further comprising an electric motor drivingly coupled to each of wheels of the trailer car.

44. The trailer car of claim 37, wherein the electric motor is selected from the group consisting of hub motor and external electric motor.

45. The trailer car of claim 44, wherein the electric motor is configured to receive electric power from the hybrid fuel storage and propulsion unit to provide motive power to the trailer car.

46. The trailer car of claim 46, wherein the electric motor is configured to generate electric energy due to regenerative braking during an IC engine mode and regenerative braking mode.

47. A side car comprising:

a side car frame configured to be coupled to an IC engine vehicle, wherein the IC engine vehicle comprises at least two wheels; and

a hybrid fuel storage and propulsion unit disposed on the side car frame for providing electric power to the IC engine vehicle to run the IC engine vehicle in at least one of a pure electric mode and a hybrid mode.

48. The side car of claim 47, wherein the hybrid fuel storage and propulsion unit comprises:

energy storage unit for storing electric energy required for driving the IC engine vehicle in the at least one of a pure electric mode or a hybrid mode;

a fuel cell unit for converting fuel energy into electrical energy and charging the energy storage unit;

an energy storage management system for managing the electric energy stored in the energy storage unit; and

an electronic motor control and event management system for managing parameters associated with the operation of the hybrid vehicle.

49. The side car of claim 48, wherein the energy storage unit comprises one or more batteries, each of the batteries includes electro-chemical storage cells and super-capacitors.

50. The side car of claim 49, wherein the hybrid fuel storage and propulsion unit further comprises a charger for replenishing charge of at least one of the fuel cell unit and the one or more batteries using an external charging point.

51. The side car of claim 50, wherein the charger is selected from the group consisting of a grid based high frequency switch mode fast battery charger and a fuel cell based charger.

52. The side car of claim 48, wherein the fuel cell unit comprises:

at least one fuel storage tank for storing fuel to generate electrical energy; and

at least one fuel cell for generating electrical energy using the fuel stored in the at least one fuel storage tank.

53. The side car of claim 47, further comprising an electric motor drivingly coupled to each of wheels of the side car.

54. The side car of claim 53, wherein the electric motor is selected from the group consisting of hub motor and external electric motor.

55. The side car of claim 54, wherein the electric motor is configured to receive electric power from the hybrid fuel storage and propulsion unit to provide motive power to the side car.

56. The side car of claim 55, wherein the electric motor is configured to generate electric energy due to regenerative braking during an IC engine mode and regenerative braking mode.

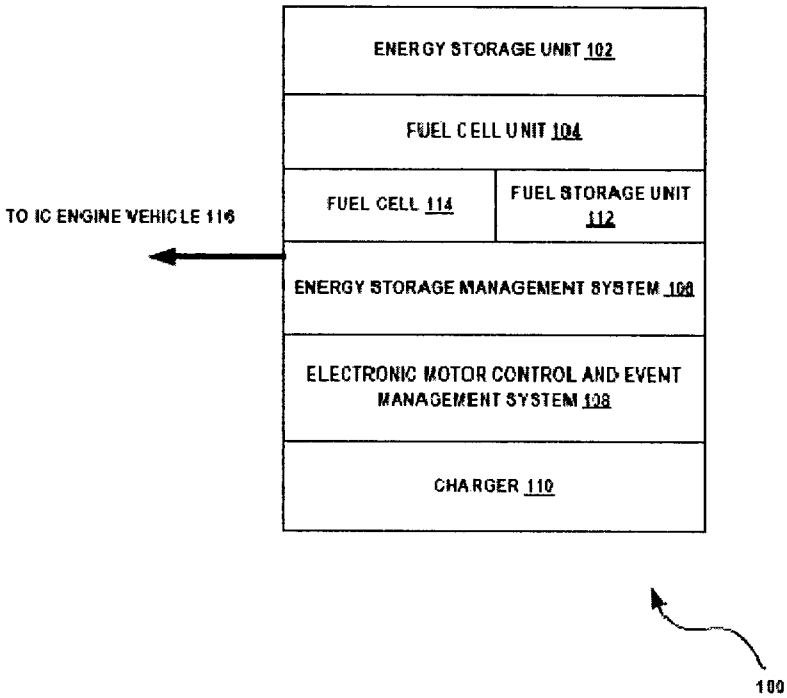

ENERGY STORAGE UNIT 102
FUEL CELL UNIT 104
FUEL CELL 114
FUEL STORAGE UNIT 112
TO IC ENGINE VEHICLE 116
ENERGY STORAGE MANAGEMENT SYSTEM 106
ELECTRONIC MOTOR CONTROL AND EVENT MANAGEMENT SYSTEM 108
CHARGER 110
100

FIGURE 1

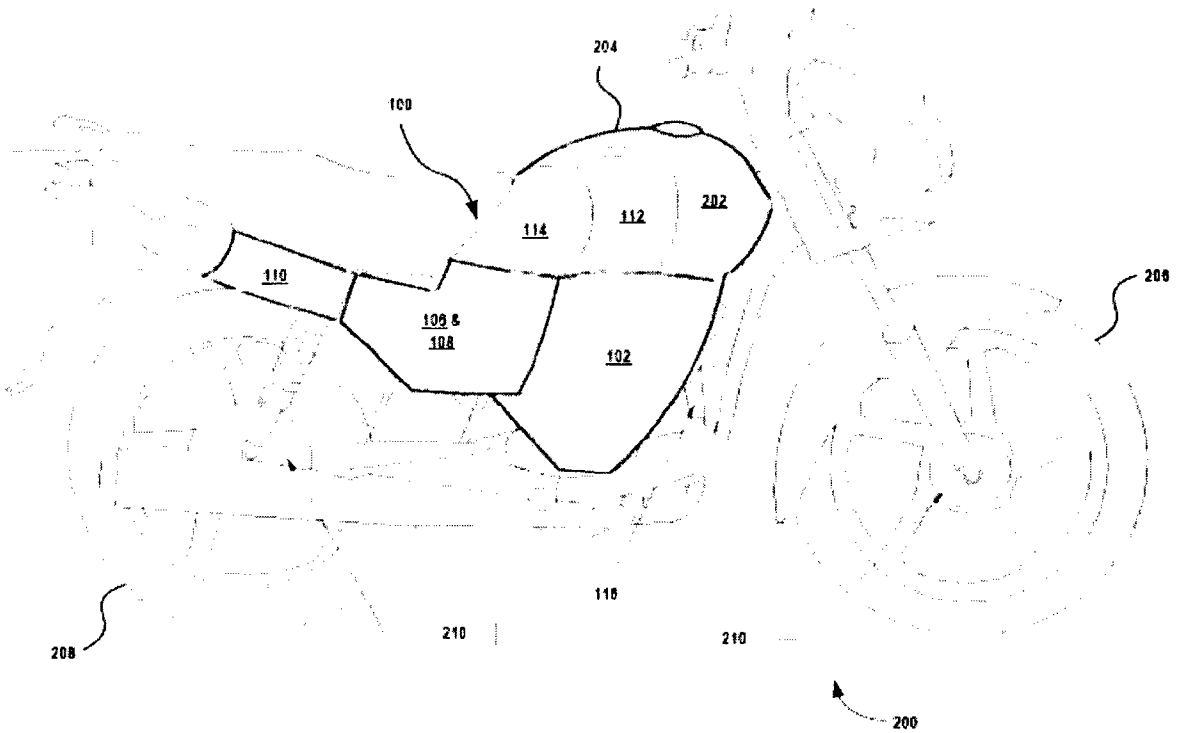


FIGURE 2

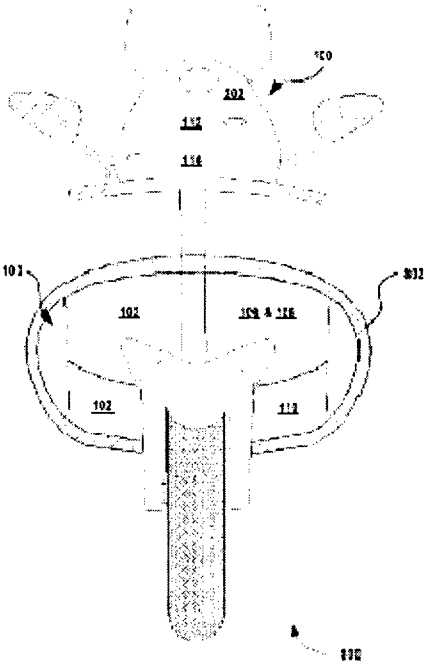


FIGURE 3

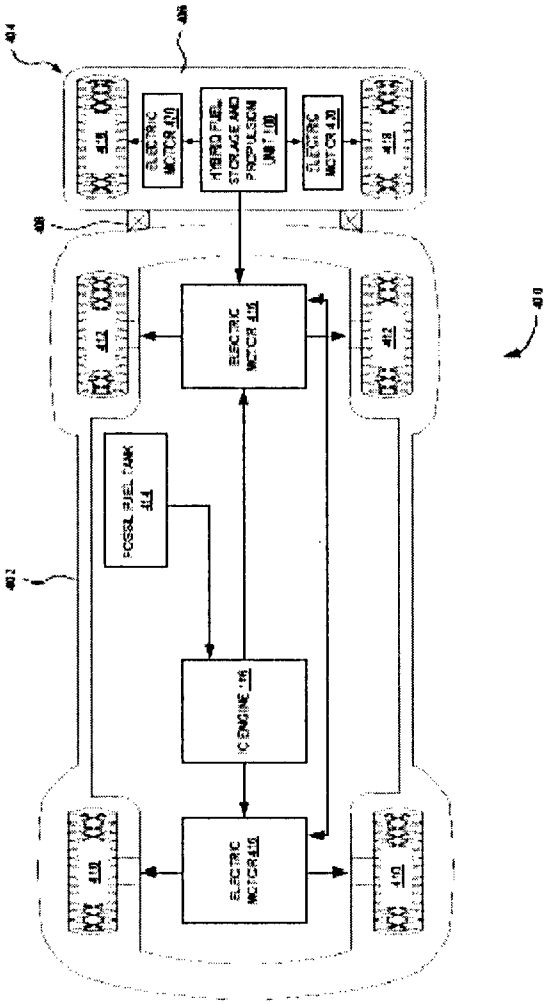

ELECTRIC MOTOR 420
HYBRID FUEL STORAGE AND PROPULSION UNIT 100
ELECTRIC MOTOR 420
ELECTRIC MOTOR 415
FOSSIL FUEL TANK 414
IC ENGINE 416
ELECTRIC MOTOR 415

FIGURE 4

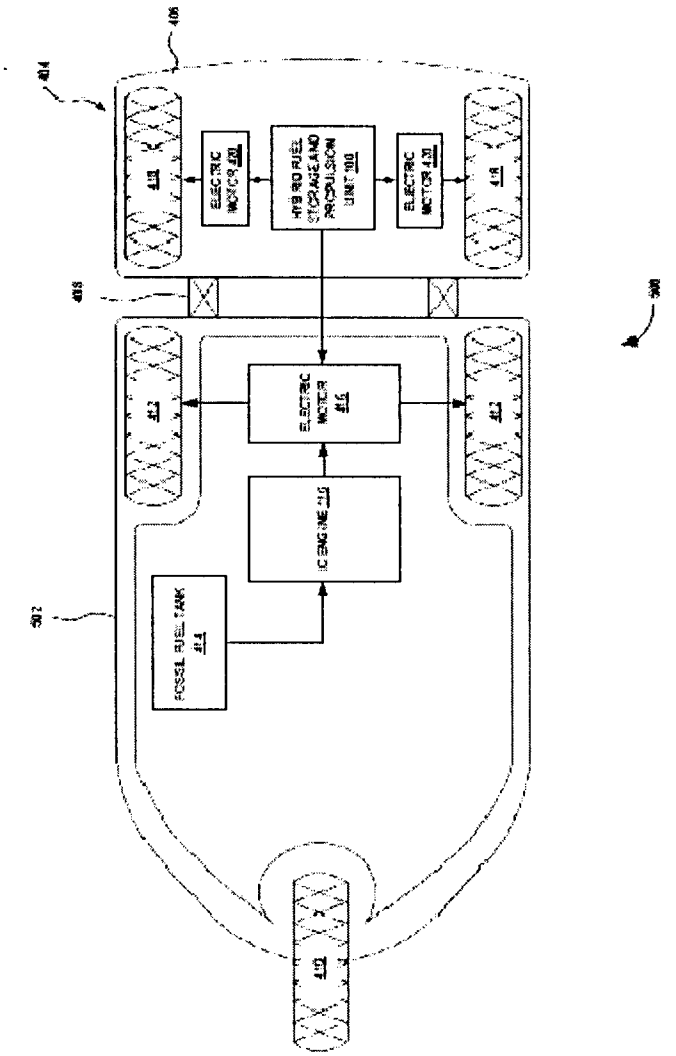

406
404
ELECTRIC MOTOR 420
HYBRID FUEL STORAGE AND PROPULSION UNIT 100
ELECTRIC MOTOR 420
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ELECTRIC MOTOR 415
IC ENGINE 410
FOSSIL FUEL TANK 414
402
300

FIGURE 5

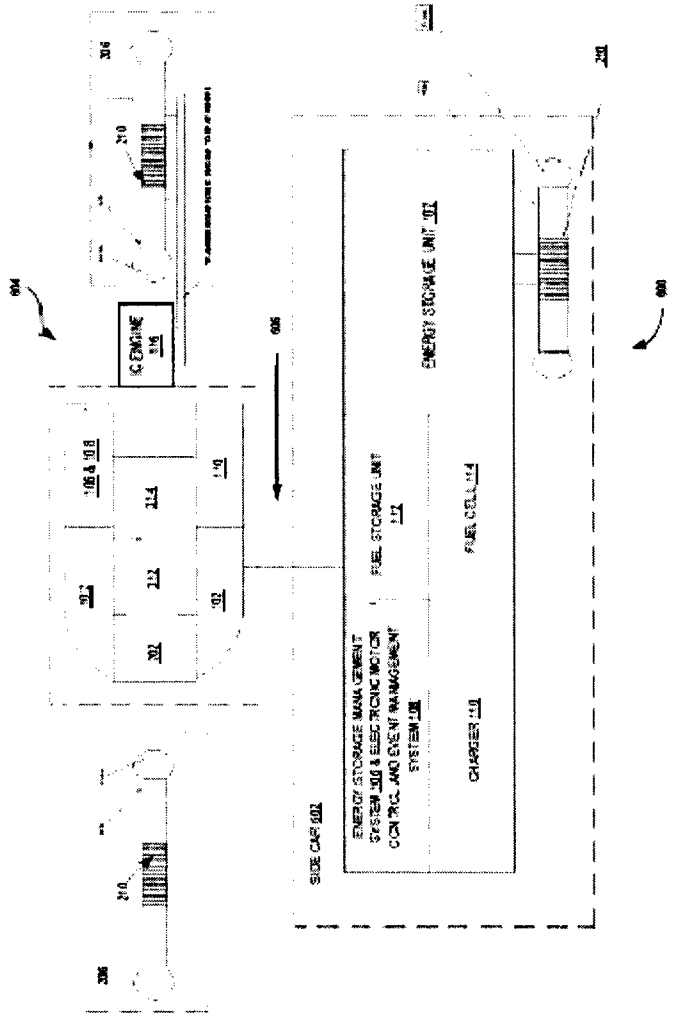


FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN 11/00357

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B60K 6/20 (2011.01)
USPC - 180/65.29
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)
IPC(8): B60K 6/20 (2011.01)
USPC: 180/65.29

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 180/65.21, 65.22, 65.23, 65.25, 65.26, 65.275, 65.29, 65.31, 65.8; 477/3; 701/22 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(PGPB,USPT,USOC,EPAB,JPAB); Google Patents, Google
Search terms used: internal, combustion, retrofit, regenerative, braking, electric, hybrid, mode, energy storage, fuel, cell, side car, trailer, IC, ICE, pure electric, electric energy, chemical, storing, battery, converting, kit, tank, replenish, high, frequency, switch, fast, charger

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/0223725 A1 (RODRIGUEZ et al.)10 September 2009 (10.09.2009), entire document, especially Fig 2, 3; para [0030]-[0035], [0037], [0042], [0044], [0046], [0053], [0055], [0056], [0060]-[0062]	1-56
Y	US 2011/0046831 A1 (ANANTHAKRISHNA) 24 February 2011 (24.02.2011), Fig 1; para [0020], [0028], [0029], [0040]	1-56
Y	US 2005/0230168 A1 (FILLMAN et al.) 20 October 2005 (20.10.2005), Fig 12; para [0060], [0061]	21-56
Y	US 2010/0106351 A1 (HANSSEN et al) 29 April 2010 (29.04.2010), para [0004]	21-46
Y	US 2010/0155161 A1 (CORRADINI) 24 June 2010 (24.06.2010), para [0011], [0014], [0015], [0024]	47-56
Y	US 7,681,676 B2 (KYDD) 23 March 2010 (23.03.2010), Fig 1, 2: col 3, ln 13-14; col 4, ln 17-21, ln 53-67; col 5, ln 51-60; col 8, ln 1-12	1
Y	US 2007/0199746 A1 (REID et al.) 30 August 2007 (30.08.2007), para [0051]-[0055]	7, 14

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 November 2011 (15.11.2011)	01 DEC 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)