



(51) International Patent Classification:
F02M 25/08 (2006.01)

(21) International Application Number:
PCT/IB2017/055992

(22) International Filing Date:
29 September 2017 (29.09.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201641033875 04 October 2016 (04.10.2016) IN

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

(54) Title: AN EVAPORATIVE EMISSION CONTROL ASSEMBLY FOR A VEHICLE

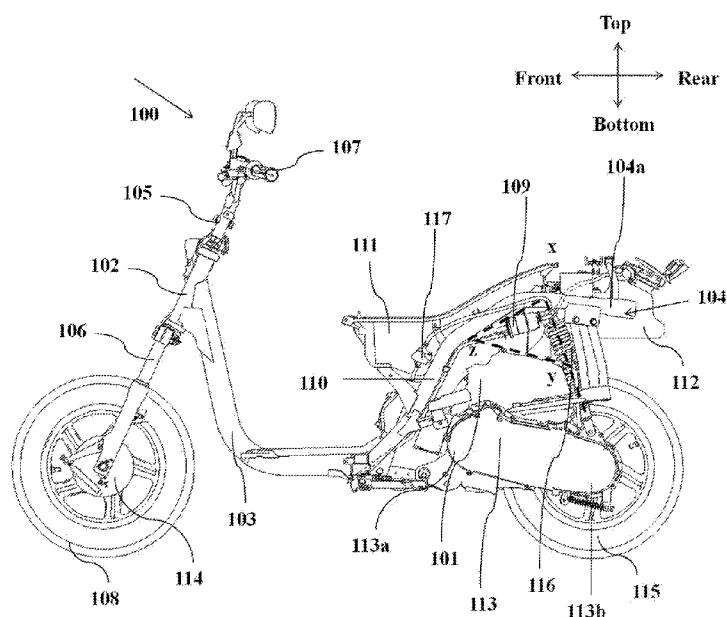


Fig. 1

(57) Abstract: The present invention relates to an evaporative emission control assembly for a two-wheeled vehicle. The evaporative emission control assembly (109) includes a container (109c) disposed at a close proximity to a fuel tank assembly (112) disposed at the rear end of the vehicle (100). The evaporative emission control assembly (109) is disposed at a proximity to the fuel tank assembly (112), in front of at least one rear suspension (116) and above an air filter assembly (101) disposed above a front portion (113a) of an engine assembly (113). The location of the container (109c) facilitates improved adsorption of the fuel vapour in a fuel hose (209) of the fuel tank assembly (112).

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

Declarations under Rule 4.17:

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

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

AN EVAPORATIVE EMISSION CONTROL ASSEMBLY FOR A VEHICLE

TECHNICAL FIELD

[0001] The present invention relates generally to a two-wheeled vehicle. More particularly, the present invention relates to an evaporative emission control assembly for the two-wheeled vehicle.

BACKGROUND

[0002] Generally, in a two-wheeled vehicle, an air intake apparatus supplies filtered air and fuel mixture to an internal combustion engine for operation. The fuel, which is stored in a fuel tank and fuel supply lines of the two-wheeled vehicle will slowly evaporate over time, releasing volatile fuel vapour into the air, which escapes into the atmosphere. Hence, an evaporative emission control system is used to prevent fuel vapours present in the fuel tank and the fuel supply lines from escaping into the air. Additionally, these fuel vapours are used for combustion in the internal combustion engine. These systems are designed to store and utilize fuel vapours before they can escape into the atmosphere. The main unit of the evaporative emission control system is an evaporative fuel storage container such as a canister unit, which is used to store the fuel vapours by adsorbing it. The stored fuel vapours are then supplied to the internal combustion engine during the engine operation through a purge control valve controlled mechanically or electronically.

BRIEF DESCRIPTION OF THE DRAWINGS

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

[0004] **Fig. 1** illustrates a left side view of a two-wheeled vehicle employing an embodiment of the present invention.

[0005] **Fig. 2** illustrates a top perspective view of a two-wheeled vehicle in assembled condition and employing the present invention.

[0006] Fig. 3 illustrates a left side view of a vehicle frame assembly supporting a fuel tank at the rear end.

[0007] Fig. 4 illustrates a side perspective view of the vehicle frame assembly employing an evaporative emission control assembly coupled to the fuel tank.

[0008] Fig. 5 illustrates a detailed top perspective view of the evaporative emission control assembly coupled to the fuel tank.

[0009] Fig. 6 illustrates an exploded view of a fuel tank assembly.

DETAILED DESCRIPTION

[00010] Various features and embodiments of the present invention here will be discernible from the following further description thereof, set out hereunder. In the ensuing exemplary embodiments, the vehicle is a two-wheeled vehicle. However, it is contemplated that the disclosure in the present invention may be applied to any vehicle capable of accommodating the present subject matter without defeating the spirit of the present invention. The detailed explanation of the constitution of parts other than the present invention, which constitutes an essential part, has been omitted at suitable places.

[00011] Fuel evaporation in a fuel tank and fuel supply lines is a normal phenomenon in the two-wheeled vehicle. The packaging and layout design of an evaporative emission control system is a very important aspect in the design of the two-wheeled vehicle, because it plays a crucial role in reducing evaporative emission of fuel for better fuel utilization, increased thermal efficiency, and mileage. The location of the evaporative fuel storage evaporative emission control assembly is a very important factor in the working, design and functioning of the evaporative emission control system. Various customer needs makes the vehicle layout complex with lot of systems. Hence, it becomes very challenging to package the various components of the evaporative emission control system in the two-wheeled vehicle

[00012] The fuel evaporation in the fuel tank and the fuel supply lines occur due to increased temperatures resulting from various factors such as, outside temperatures which can cause heating of the fuel tank and fuel supply systems, the hot engine and exhaust system which can cause heating of the fuel tank and fuel supply systems, heat from an internal combustion

engine for a period of time even after engine is turned off, and exposed tank during refueling which forces the fuel vapors out by the incoming liquid fuel.

[00013] A major problem in the two-wheeled vehicle is space constraints, which force the fuel tank and supply lines to be arranged to be close to areas of the vehicle having high temperatures. Such arrangements include the utility box to be used by the rider to place helmet and any other luggage to meet the requirements of the rider. The conventional two wheeled vehicle having utility box below the seat assembly are subject to space restrictions due to the fuel tank situated adjacently in close proximity to areas around the internal combustion engine causing increased temperatures in that area. Additionally, in another two-wheeled vehicle the fuel tank assembly can be located towards the front of the vehicle and hence is exposed directly to the atmosphere heating the fuel inside. Typically for optimum functioning and durability of the evaporative emission control assembly, it is desirable to have shorter lengths of the hoses connecting to and from the container. Longer hoses lead to condensation of the vapors and loss of effective adsorption by the canister. For stable functioning, it is desirable to have minimum physical vibration and vibrations and oscillations from the rear suspension transferred on to the canister as well as its corresponding mountings. Further, the volume and size of the canister is governed by a size of the fuel tank assembly as well as other factors like thermal loads in vicinity, permissible emission levels, space available for canister in the vehicle. Therefore, packaging and mounting of the canister becomes a critical requirement in a vehicle and more particularly in a two-wheeled vehicle.

[00014] In a know prior art, a canister arrangement structure for saddle-ride type vehicle, includes a canister arranged around a seat rail, a shock absorber is mounted between the seat rail and a swing arm, a grip portion is attached behind the shock absorber and below the seat rail. The canister is arranged above the grip portion such that the canister lies within a foot placement portion bulging outwardly in a vehicle width direction from the grip portion. However, this prior art has a drawback of not being able to adequately protect the canister from external impacts and environmental factors. For example, the canister is only covered by a cover member, which is not a rigid structure and cannot withstand any external impacts and environmental factors. Further, since the canister is placed adjacently to the seat rail, an exclusive space for the canister has to be provided in the vehicle. Further, the canister is mounted away from the engine

assembly and the fuel tank assembly, which will make the hoses connected between the canister and the fuel tank assembly and the engine assembly to be undesirably lengthier. Further, the canister is located very close to the seat assembly, this location closer to the seat assembly is not easier to service whenever any of the hoses routed there within have to be replaced or requires servicing. Furthermore, the canister here is mounted behind the shock absorber and closer to the rear wheel, this will occupy the wheel-well space in the saddle ride type vehicle. Furthermore, since the canister is mounted behind and closer to the shock absorber, the oscillations received by the shock absorber are easily amplified and transferred to the canister, which further affects the stability of mounting, durability of the attachment portions, and stable functioning of the canister.

[00015] Therefore, there is a need to provide a canister in the vehicle in a location such that the canister is adequately disposed and being able to be protected from any external impacts and environmental factors as well as save space in the vehicle, which is, not accounting to increased space in the vehicle by saving the wheel-well space as well as minimize the vibrations and oscillations received from the rear suspension, minimize thermal loads and lengths of the hoses connecting to and from the container.

[00016] Generally, the evaporative emission control assembly consists of an evaporative fuel storage container such as a small canister unit full of charcoal to adsorb the fuel vapours on its surface. Other components include valves, hoses, and ports. When fuel evaporates inside the fuel tank, the excess fuel vapours are transferred to the canister unit. The fuel vapours are adsorbed by the charcoal and stored there until they can safely be transferred back to the internal combustion engine to be burned with the normal air-fuel mixture.

[00017] One end of the evaporative fuel storage container is connected to the internal combustion engine intake while the other end is exposed to atmospheric air. When the internal combustion engine is in operation, it creates suction in its intake, which results in pressure difference on either side of the evaporative fuel storage container creating a vacuum that draws fresh air which mixes with the fuel vapours adsorbed on the surface of the charcoal present and flows inside into the internal combustion engine. These systems can be controlled mechanically or can also be automated.

[00018] The location of the evaporative fuel storage container is a very important aspect of the design of the evaporative emission control system for the two-wheeled vehicle. The two-wheeled vehicle is always subjected to space constraints and lack of storage space to accommodate additional features and systems inside. Additionally, the canister unit durability maybe reduced if it is kept exposed to outside environmental factors. Hence, one of the most crucial design factors in consideration of the design of the two-wheeled vehicle is the location of the evaporative fuel storage container of the evaporative emission control system.

[00019] Conventionally, in the two-wheeled vehicle, the evaporative fuel storage container is disposed at various locations under the seat of the two-wheeled vehicle. Such locations include disposed in proximity to the fuel tank assembly, disposed in close proximity to the utility box, disposed in close proximity to a main tube of the vehicle, and disposed in close proximity to the rear frames of the vehicle. However, such locations primarily have the drawback of occupying space in the two-wheeled vehicle thus causing space constraints. In addition, the evaporative fuel storage container maybe exposed to harsh outside environmental factors, which may reduce the durability due to mud, dust and water entry. Further, disposing the container under a seat assembly, in proximity to a utility box leads to compromise in a utility storage space available for the user. The container present in close proximity to the fuel tank assembly can lead to tradeoff in volume of fuel tank assembly in a straddle-type vehicle and in addition, to difficulty in accessibility in scooter type vehicle. In motorcycles, the container closer to the engine assembly is more pertinent to exposure to engine thermal loads as well as external environmental factors like mud, dust and the like. In scooters. Furthermore, in motorcycles mounting a container on a main tube to have the container closer to the fuel tank leads to additional lengths of the hoses, which is detrimental to the performance of the evaporative emission control assembly.

[00020] Hence, it is an object of the present invention to have the evaporative fuel storage container located optimally in a substantially rearward and a central portion of the and enclosed by the surrounding vehicular parts vehicle in order to address all of the above cited prior art problems. Such a location would optimize packaging and storage space inside the two-wheeled vehicle, and protect it from external factors as well as harsh environmental factors.

[00021] With the proposed design changes, the following advantages can be obtained such as optimizing packaging for the evaporative fuel storage container and provide a good storage space for it, protect the evaporative fuel storage container from harsh environmental factors (such as, dust, mud and water entry), reducing servicing time, providing easy access to the evaporative fuel storage container and all the hoses and valves, optimize hose length, minimize transfer of vibrations and oscillation from the rear suspension to the container of the evaporative emission control assembly and its mountings, minimized thermal loads, prevent loss of utility space in the vehicle and also account to increased volume in the fuel tank assembly and can operate by using purge valve or without using purge valve. Such an assembly is also applicable to all applications, which use the internal combustion engine including a straddle type motorcycle, the scooter type motorcycle and a three-wheeled vehicle.

[00022] According to an embodiment of the present invention, the evaporative emission control container is located at the rear end of the vehicle. The evaporative emission control container is so packaged such that all four hoses connected to the canister are easy to assemble and disassemble. The evaporative emission control container (hereinafter referred to as container) and the roll over valve are disposed close to a fuel tank to maintain minimum length of the hoses connecting to the roll over valve to the fuel tank and the roll over valve to the container. Further, the arrangement of the container and arrangement of hose according to an embodiment prevents the condensation of fuel in the hoses.

[00023] According to an embodiment of the present invention, the container is disposed underneath and along at least one of the frame of the pair of the rear frames including a RH rear frame and a LH rear frame, and substantially in a central portion of the vehicle. The container is placed in a safe and secure location surrounded by the at least one frames of the pair of rear frames, the air filter assembly disposed above a front portion of the engine assembly and the rear suspension assembly. This will protect the container from any external impacts and the surrounding parts will protect the container from environmental factors.

[00024] Further, according to an embodiment of the present invention, the container is located substantially close to the fuel tank disposed at the centrally rear end of the vehicle. The location of the container facilitates improved adsorption of the fuel vapour.

[00025] Furthermore, the roll over valve is disposed on a top surface of the fuel tank disposed behind a seat lock. Furthermore, the container is packaged such that easy servicing is carried out without dismantling the utility box and fuel tank assembly. Further, since the container is placed in front of the rear suspension assembly, the wheel-well space between the seat assembly and the rear wheel is not compromised.

[00026] According to an embodiment, the location of the container protects the container from any external impacts occurring during accidents and prevents entry of any foreign particles into the container.

[00027] Furthermore, according to an embodiment of the present invention, the container is disposed in front of a rear suspension assembly and above an air filter assembly disposed above a front portion of the engine assembly. The container as mentioned in the present invention is a canister. The oscillations received by the rear suspension assembly are not easily transmitted to the container of the evaporative emission control assembly, since the container in the present invention is substantially forward of the rear suspension. Therefore, a more stable mounting and stable and reliable working of the evaporative emission control assembly is achieved.

[00028] According to an embodiment of the present invention, the container is disposed in the vehicle such that, an optimal distance between the fuel tank and container, and container and carburettor is obtained. The optimal hose length ratio from the fuel tank assembly to the container and from the container to the carburettor is approximately in the range of 1 to 2. The preferred hose length ratio from the fuel tank assembly to the container and from the container to the carburettor is 1.6. This enables reducing possibility of condensation of the fuel vapours going into an intake port of an engine assembly and thereby minimizing emissions from the combustion process of the engine assembly.

[00029] The present invention along with all the accompanying embodiments and their other advantages would be described in detail in conjunction with the figures in the following paragraphs.

[00030] **Fig. 1** illustrates a two-wheeled vehicle in accordance with one embodiment of the present invention. The vehicle **100** comprises of a vehicle frame assembly **200**, which

conventionally provides a generally open central area to permit "step-through" mounting by a rider. Typically, the vehicle frame assembly **200** comprises of a head tube **102**, a main tube **103**, a pair of rear frames **104** (only one shown), and a means to connect the head tube **102** and the pair of rear frames **104**. One end of the main tube **103** extends downwardly and rearwardly and connected with the pair of rear frames **104** while at the other end there is the head tube **102**, which is configured to rotatably support a steering shaft **105**, and further connected to the front suspension assembly **106** at the lower end. A handlebar support member (not shown) is connected to an upper end of the steering shaft **105** and supports a handlebar assembly **107**. The front suspension assembly **106** (only one is shown) is attached to a bracket (not shown) on the lower part of the steering shaft **105** on which is supported a front wheel **108**. A front fender (not shown) mounted to the lower portion of the steering shaft **105** covers an upper portion of the front wheel **108**. The pair of rear frames **104** includes a down frame section **110** inclined downwards, connected to the main tube **103** at one end, and extending rearward in a substantially horizontal direction at the other end. A plurality of cross pipes (not shown) is secured in between the pair of rear frames **104** to support vehicular attachments including a utility box **111**, a seat assembly (not shown) and a fuel tank assembly **112**.

[00031] The seat assembly being a load bearing member is supported on the pair of rear frames **104**. Generally, a utility box **111** is supported between the front portions of the left and right end of the pair of rear frames **104** to be disposed below the seat assembly (not shown). The fuel tank assembly **112** is disposed on the frame assembly **200** between the rear portions of the left and right end of the pair of rear frames **104** and above an air filter assembly **101** and an engine assembly **113**. There is a front brake **114** and a rear brake (not shown) arranged on the front wheel **108** and a rear wheel **115** respectively.

[00032] The rear wheel **115** is supported towards a rear side of the frame by the engine assembly **113**, which is horizontally coupled swing ably to the rear of the frame assembly **200** of the vehicle **100** through a rear suspension **116**. Conventionally, the engine assembly **113** comprises a cylinder head assembly, a cylinder block and a crankcase. The air filter assembly **101** is located in close proximity and above the cylinder head assembly of the engine assembly **113**. An evaporative emission control assembly **109** is disposed at a proximity to the fuel tank assembly **112**.

[00033] According to an embodiment of the present invention, the evaporative emission control assembly **109** is disposed in front of the rear suspension **116** and below the pair of rear frames **104** including an RH rear frame **104b** and a LH rear frame **104a** (not shown) and substantially towards the central portion of the vehicle **100**. According to an embodiment, the evaporative emission control assembly **109** is disposed on a left hand side of the vehicle **100**, in front of the rear suspension **116** and below the LH rear frame **104a**. The evaporative emission control assembly **109** is protected from the rear side by the rear suspension **116** disposed on the LH side of the vehicle **100**. The fuel tank assembly **112** protects one side of the evaporative emission control assembly **109** and the other side of the evaporative emission control assembly **109** is completely protected by the side panel (not shown) that covers the sides of the vehicle below the seat assembly.

[00034] According to an embodiment of the present invention, the evaporative emission control assembly **109** is disposed above the air filter assembly **101** assembled above a substantially front portion **113a** of the engine assembly **113**.

[00035] According to an embodiment of the present invention, the evaporative emission control assembly **109** is disposed in a triangular space **xyz** formed in between a plane **xz** passing through a bottom surface of said at least one rear frame **104a**, **104b** of the pair of rear frames **104**, a rear suspension axis **xy**, and a top surface **zy** of the air filter assembly **101**. The evaporative emission control assembly **109** is protected by the surrounding parts from any external impacts and from entry of mud, dust, water and any other foreign particles.

[00036] **Fig. 2** illustrates a top perspective view of a frame assembly employing the evaporative emission control assembly at the rear end of the vehicle **100**. The evaporative emission control assembly **109** including a canister unit is disposed at a proximity to the fuel tank assembly **112**. Since, the fuel tank assembly **112** in the vehicle **100** is situated at the rear end of the vehicle **100**; the evaporative emission control assembly **109** including a container **109c** is also disposed at the rear end so that it is placed closer to the fuel tank assembly **112**. The proposed location of the evaporative emission control assembly **109** facilitates easy collection of vapors from the fuel tank assembly **112** by the container **109c** present in the evaporative emission control assembly **109**. Therefore, a hose connecting the fuel tank assembly **112** to the evaporative emission control assembly **109** becomes less lengthwise. Furthermore, another hose

from the evaporative emission control assembly **109** is connected to a carburetor **202**. An optimal hose length ratio between the fuel tank assembly and the container and between the container and the carburetor is approximately in the range of 1 to 2. The preferred ratio between the fuel tank assembly and the container and between the container and the carburetor is 1.6.

[00037] **Fig. 3** illustrates a side view of a vehicle frame assembly and an evaporative emission control assembly attached to the frame assembly. According to an embodiment of the present invention, the evaporative emission control assembly **109** is disposed along a container plane **ab** comprising the container **109c** present at an angle to a vehicle longitudinal plane **LP**. For example, in an embodiment, the container plane **ab** is parallel to the vehicle longitudinal plane **LP**. A hose **201** connecting to the evaporative emission control assembly **109** and a purge valve **206** is routed along the LH rear frame **104a**. The hose **201** lies above the LH rear frame **104a** and is guided by the LH rear frame **104a**. According to the proposed invention, the serviceability of the evaporative emission control assembly **109** is comparatively easy. The evaporative emission control assembly **109** is easily accessible and can be removed by accessing the mountings used to attach the evaporative emission control assembly **109** at the desired location. Further, there is no need to remove or dismantle any other vehicular parts to access the evaporative emission control assembly **109**.

[00038] **Fig. 4** illustrates a perspective side view of a frame assembly employing the present invention. According to an embodiment of the present invention, the purge valve **206** is disposed above any one rear frame of the pair of rear frames including the RH rear frame **104b** and the LH rear frame **104a**, and above engine assembly (not shown). The particular arrangement of the purge valve **206** as disclosed in the present invention renders the serviceability of the purge valve **206** to be comparatively easier. Further, the hose **201** is packaged in such a way that the RH rear frame **104b** and the LH rear frame **104a** support the hose **201**. Thereby, preventing free hanging of the hose **201** and preventing interfering of the hose **201** with surrounding vehicular parts. Therefore, a more secure packaging of the evaporative emission control assembly **109** is provided according to an embodiment of the present invention. Furthermore, the hose length from evaporative emission control assembly **109** to the purge valve **206** is shorter comparatively.

[00039] Fig. 5 illustrates a perspective view of arrangement of the evaporative emission control assembly with respect to the fuel tank assembly. A roll over valve **207** is disposed on a fuel tank top surface **112tp** of the fuel tank assembly **112**. The fuel vapours are easily transmitted from a higher gradient of the top surface of a lower gradient wherein the evaporative emission control assembly **109** is situated. Therefore, a more efficient functioning of the evaporative emission control is achieved through the proposed invention.

[00040] Fig. 6 illustrates an exploded view of a fuel tank assembly. The evaporative emission control assembly **109** is mounted to the at least one rear frame (**104a**, **104b**- now shown) of the pair of rear frames **104** (not shown) through a connecting member **109b**. The evaporative emission control assembly **109** including the container **109c** is held by a sleeve member **109a** capable of enabling mounting of the container **109c** in the evaporative emission control assembly **109** to the connecting member **109b**. A first hose **208** communicates between the fuel tank assembly **112** and the evaporative emission control assembly **109** through the roll over valve **207**. A fuel hose **209** communicates between the fuel tank assembly **112** and the engine assembly (not shown). Further, the hose **201** is connected from the evaporative emission control assembly **109** to the purge valve **206** held by a boot member **206a** and mounted to a bracket **206b**.

[00041] The evaporative emission control assembly **109** according to the proposed invention is mounted in a safe and secure location surrounded by various vehicular parts. The location also facilitates optimization of various hose lengths connecting to the various ports of the container and other vehicular parts.

[00042] According to an embodiment of the present invention, evaporative emission control assembly **109** includes a container comprising a canister unit capable of adsorbing the fuel vapors.

[00043] Although the subject matter has been described in considerable detail with reference to certain embodiments thereof, other embodiments are possible. It is to be understood that the aspects of the embodiments are not necessarily limited to the features described herein.

We claim:

1. A vehicle (100) comprising:
 - a vehicle frame assembly (200) including a pair of rear frames (104) extending rearwardly upward from a main tube (103), said main tube (103) extending rearwardly downward from a head tube (102) disposed in a front portion of said vehicle (100); and
 - an evaporative emission control assembly (109) including a container (109c), a purge valve (206) and a roll over valve (207), said evaporative emission control assembly (109) is coupled to a fuel tank assembly (112) disposed substantially between said pair of rear frames (104), said evaporative emission control assembly (109) is disposed in a container plane (ab) at an angle to a vehicle longitudinal plane (LP), at least a portion of said evaporative emission control assembly (109) is disposed below and along the at least one rear frame (104a, 104b) of said pair of rear frames (104).
2. The vehicle (100) as claimed in claim 1, wherein said evaporative emission control assembly (109) is disposed at a proximity to said fuel tank assembly (112), in front of at least one rear suspension (116) and above an air filter assembly (101) disposed above a front portion (113a) of an engine assembly (113).
3. The vehicle (100) as claimed in claim 1, wherein said vehicle (100) includes at least one rear suspension (116) including one end mounted to at least one rear frame (104a, 104b) of said pair of rear frames (104) and other end of said at least one rear suspension (116) is coupled to a rear wheel (115), an engine assembly (113) to drive said vehicle (100) and an air filter assembly (101) coupled to said engine assembly (113), wherein said container (109c) is disposed in a triangular space (xyz) formed in between a plane (xz) passing through a bottom surface of said at least one rear frame (104a, 104b) of said pair of rear frames (104), a rear suspension axis (xy), and a top surface (zy) of said air filter assembly (101).
4. The vehicle (100) as claimed in claim 1, wherein said roll over valve (207) is disposed on a fuel tank top surface (112tp) of said fuel tank assembly (112) and said purge valve (206) is disposed above said at least one rear frame (104a, 104b) of said pair of rear frames (104).

5. The vehicle **(100)** as claimed in claim 1, wherein said evaporative emission control assembly **(109)** and the purge valve **(206)** are connected through a hose **(201)** routed along the any one of the LH rear frame **(104a)** and the RH rear frame **(104b)** of the pair of rear frames **(104)**.
6. The vehicle **(100)** as claimed in claim 1, wherein said evaporative emission control assembly **(109)** includes a first hose **(208)** capable of communicating between the fuel tank assembly **(112)** and the container **(109c)** through the roll over valve **(207)**.
7. The vehicle **(100)** as claimed in claim 1, wherein said container **(109a)** is disposed along a container plane **(ab)** parallel to the vehicle longitudinal plane **(LP)**.
8. The vehicle **(100)** as claimed in claim 1, wherein said container **(109c)** is held by a sleeve member **(109a)** capable of enabling mounting of said container **(109c)** to the connecting member **(109b)**, said connecting member **(109b)** is mounted to the at least one rear frame **(104a, 104b)** of the pair of rear frames **(104)**.
9. The vehicle **(100)** as claimed in claim 1, wherein said purge valve **(206)** is held by a boot member **(206a)** mounted to a bracket **(206b)**.
10. The vehicle **(100)** as claimed in claim 6, wherein said hose **(201)** lies above any one of the LH rear frame **(104a)** and the RH rear frame **(104b)** of the pair of rear frames **(104)**.
11. The vehicle **(100)** as claimed in claim 5 or claim 6, wherein said first hose **(208)** and said hose **(201)** have a ratio of lengths approximately in the range of 1 to 2.

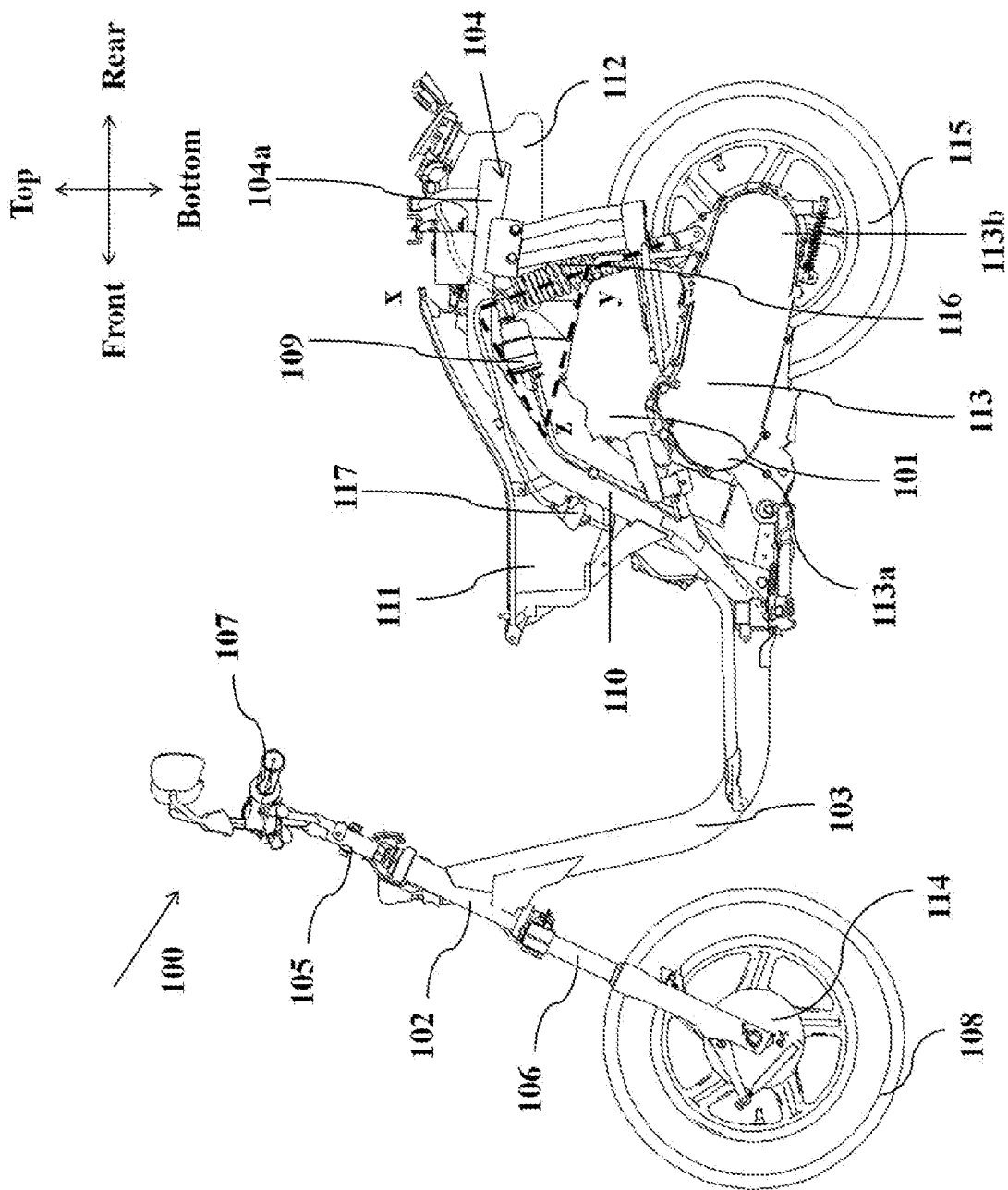


Fig. 1

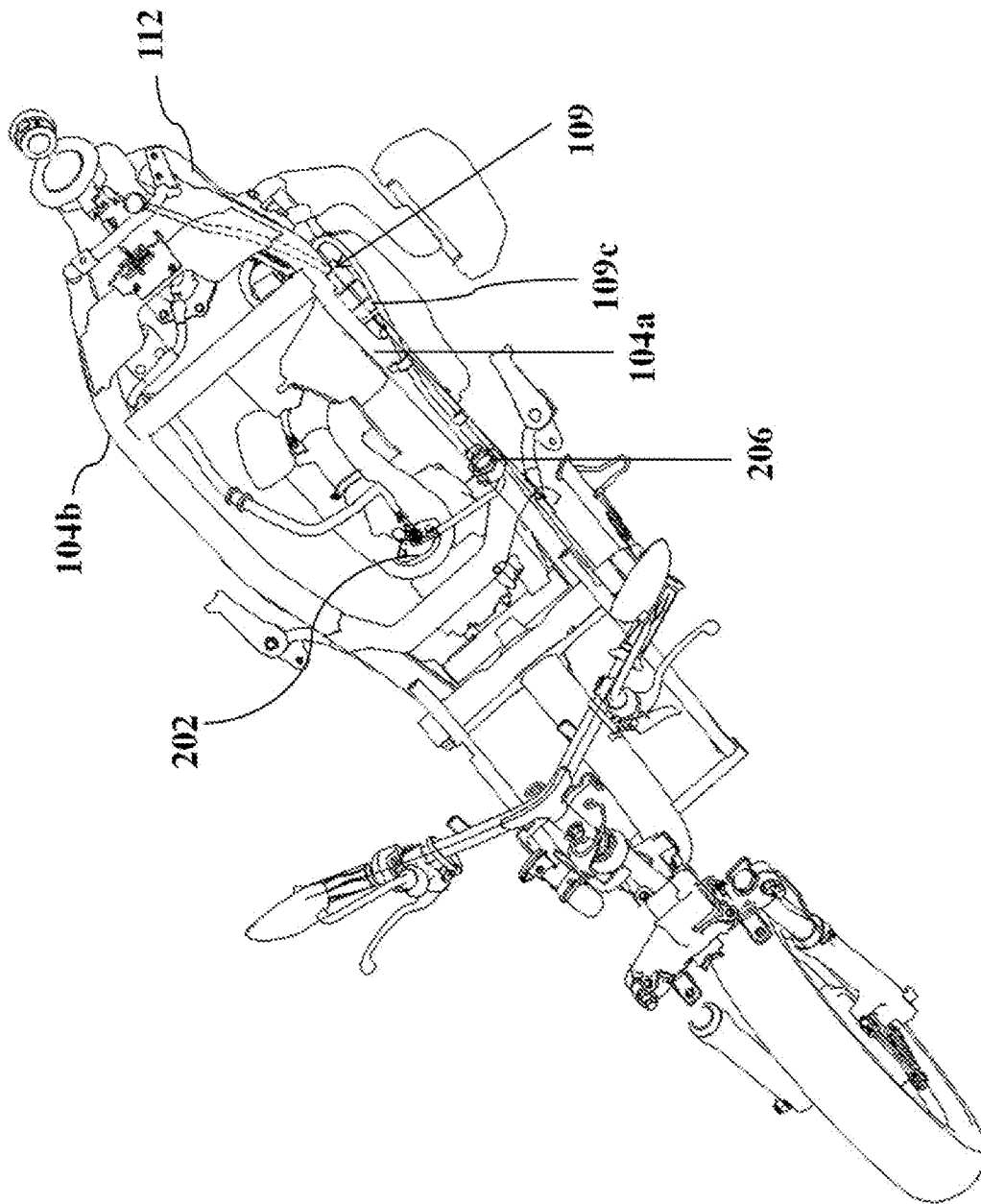


Fig. 2

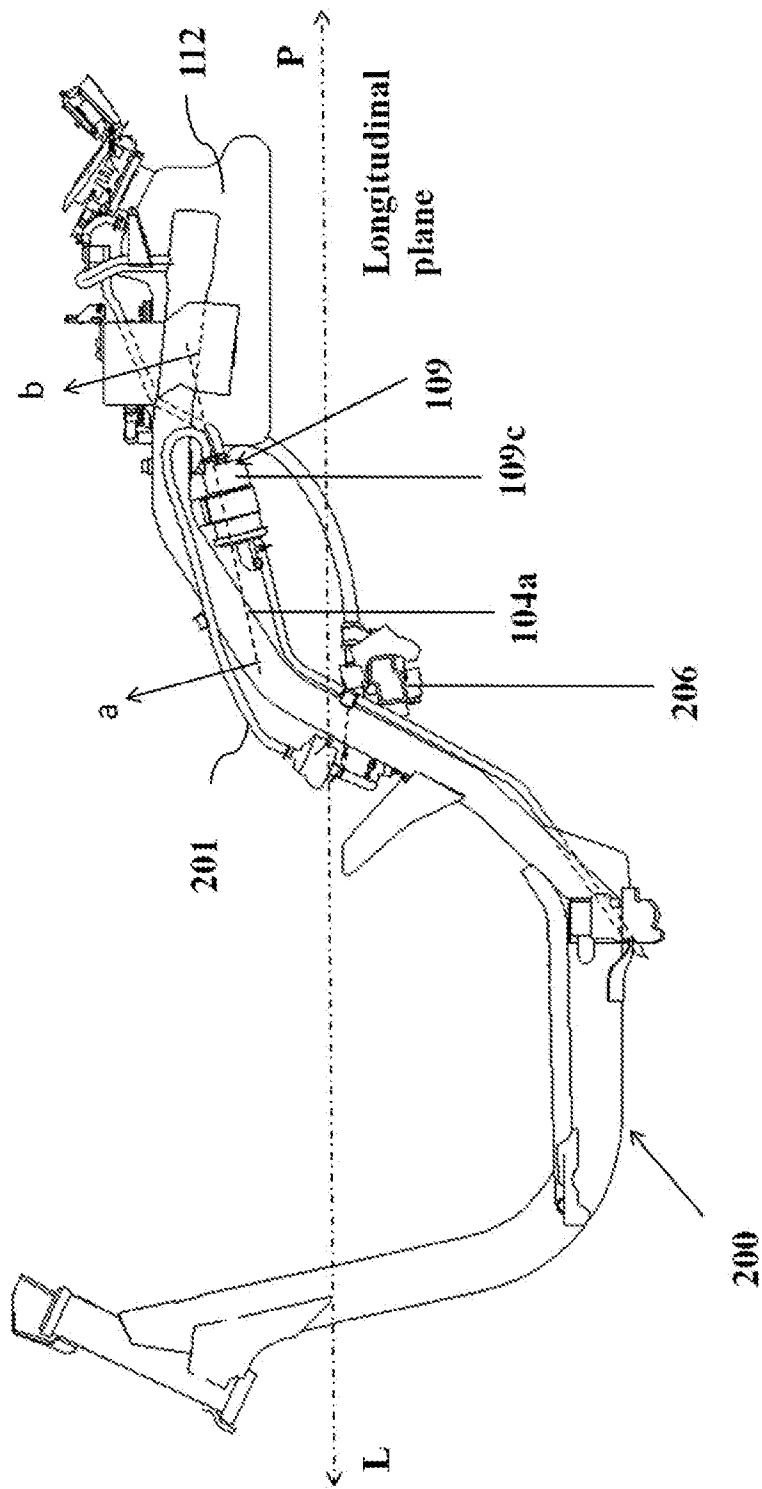


Fig. 3

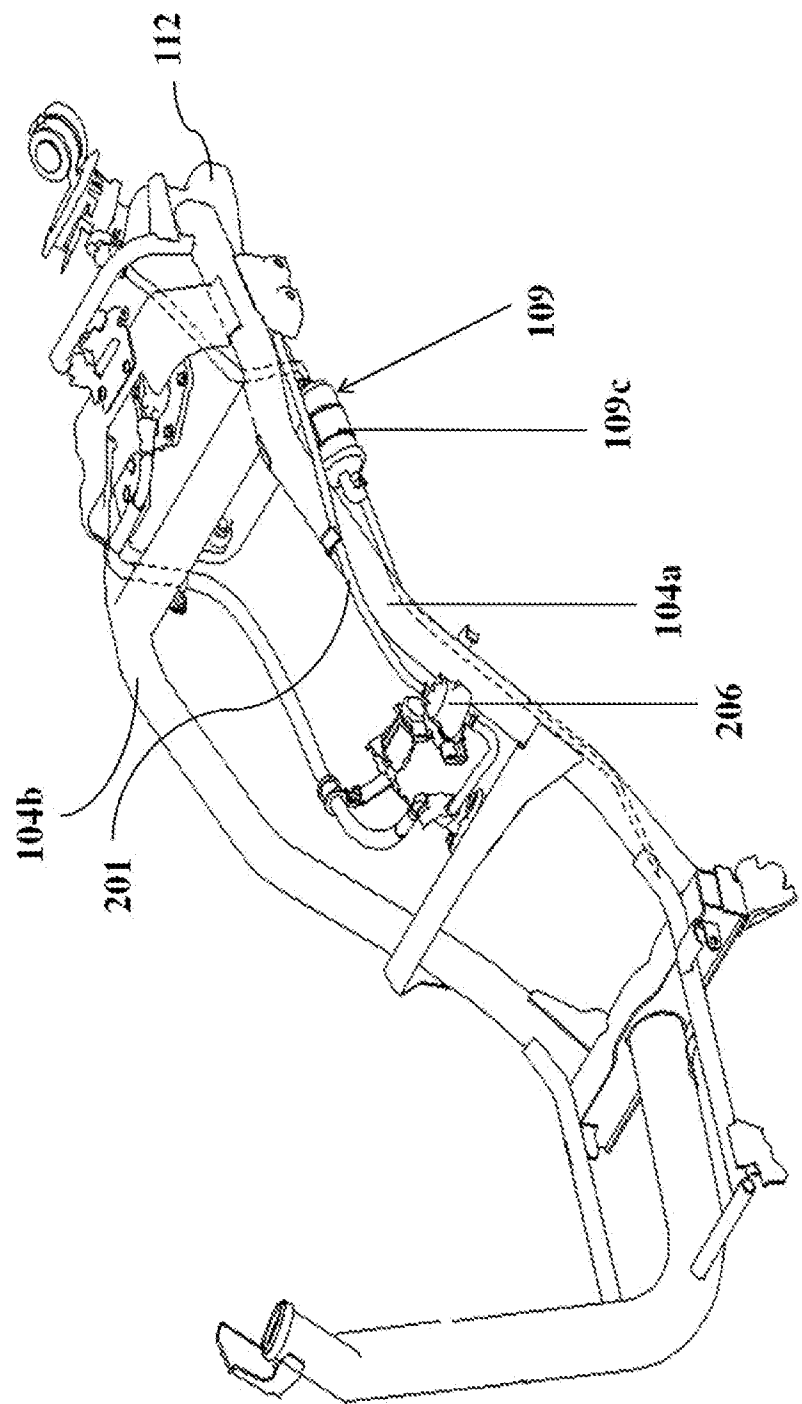


Fig. 4

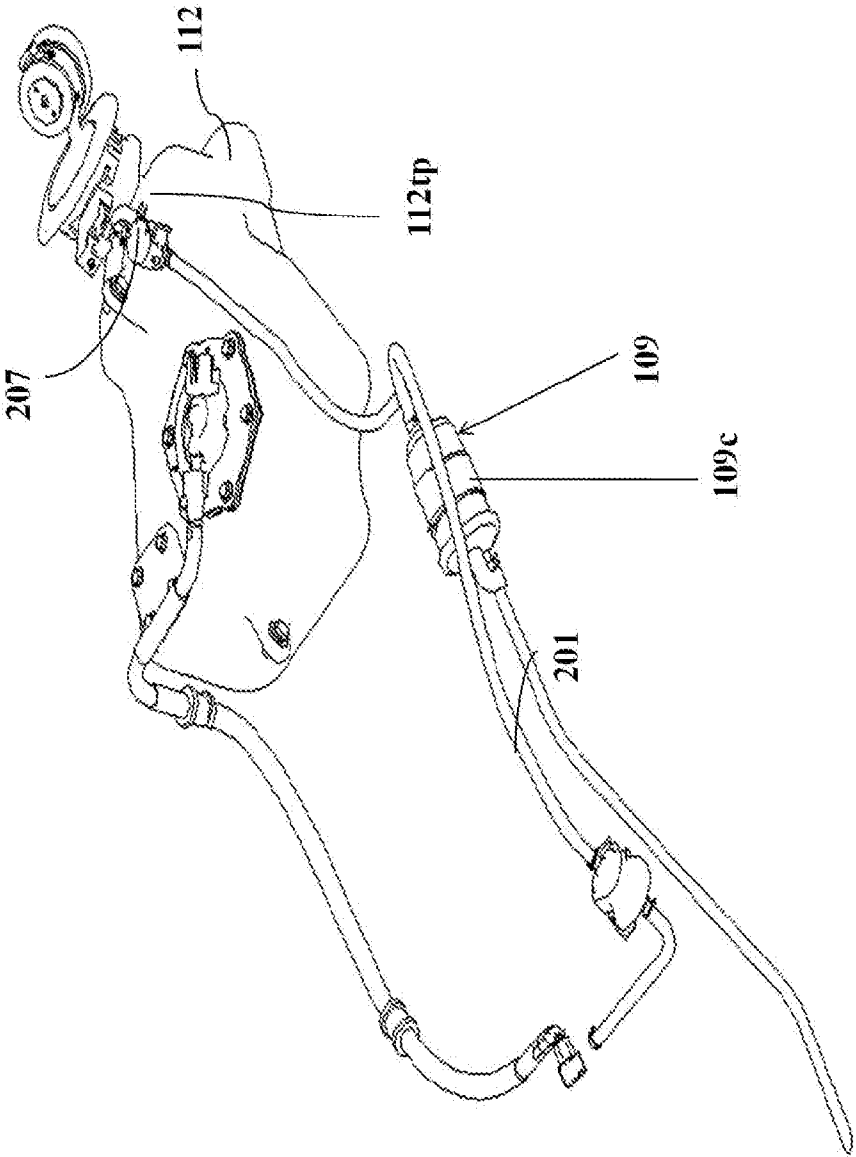


Fig. 5

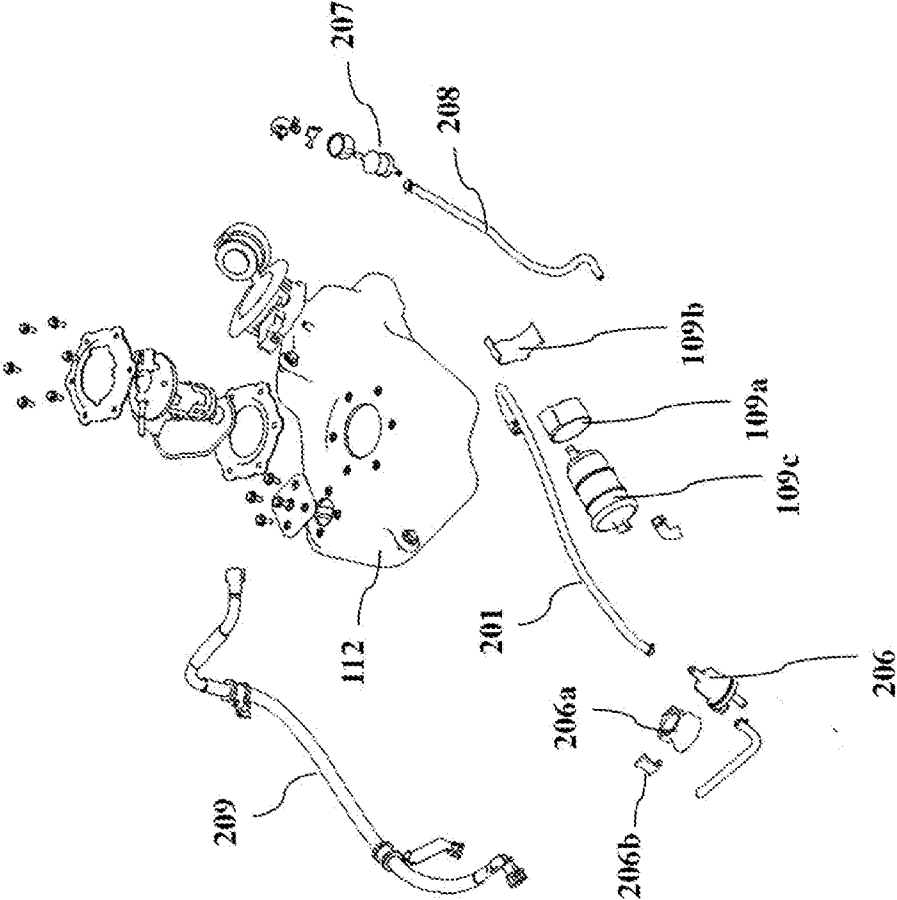


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/055992

A. CLASSIFICATION OF SUBJECT MATTER
F02M25/08 Version=2018.01

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F02M

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

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

Patseer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US2010243360 A1 (HONDA MOTOR CO LTD) 30 September 2010 (30.09.2010) Para [0021], [0031]-[0033], Figure 1-4	1-2, 5, 7-9
Y	Para [0021], [0031]-[0033], Figure 1-4	3-4, 6, 10-11
Y	JP2015174455 A (HONDA MOTOR CO LTD) 05 October 2015 (05.10.2015) Figure 9	3
Y	IN 3899/DEL/2012 A (SUZUKI MOTOR CORPORATION) 01 August 2014 (01.08.2014) Page 11, 12, Figure 2	4, 6, 10-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

01-02-2018

Date of mailing of the international search report

01-02-2018

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2017/055992

Citation	Pub.Date	Family	Pub.Date
US 2010243360 A1	30-09-2010	CN 101844600 A	29-09-2010
		JP 2010229840 A	14-10-2010
JP 2015174455 A	05-10-2015	IN 1141/CHE/2015 A	01-07-2016
IN 4184/CHE/2013 A	06-02-2015	JP 2014061852 A	10-04-2014