(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 050 842 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
03.08.2016 Bulletin 2016/31

(21) Application number: **14848743.2**

(22) Date of filing: **29.09.2014**

(51) Int Cl.:
B67D 7/04 *(2010.01)* ***B67D 7/84*** *(2010.01)*
B67D 7/22 *(2010.01)*

(86) International application number:
PCT/CN2014/087837

(87) International publication number:
WO 2015/043539 (02.04.2015 Gazette 2015/13)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **29.09.2013 CN 201310456699**

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(54) ADDITIVE INJECTION DEVICE AND METHOD FOR FUELING FACILITY

(57) An additive injection device for a fueling facility and a method for injecting an additive into fuel. The additive injection device comprises: a storage tank for storing an additive; a pump connected to the storage tank; and a controller connected to the pump, the controller starting additive injection in response to fueling start at a fueling facility, and terminating additive injection in response to fueling termination at the fueling facility, and further controlling the amount of the filled additive injected into the fuel in the fueling facility. The additive injection device and the method for injecting an additive into fuel can improve comfortableness and ssfety during additive adding.

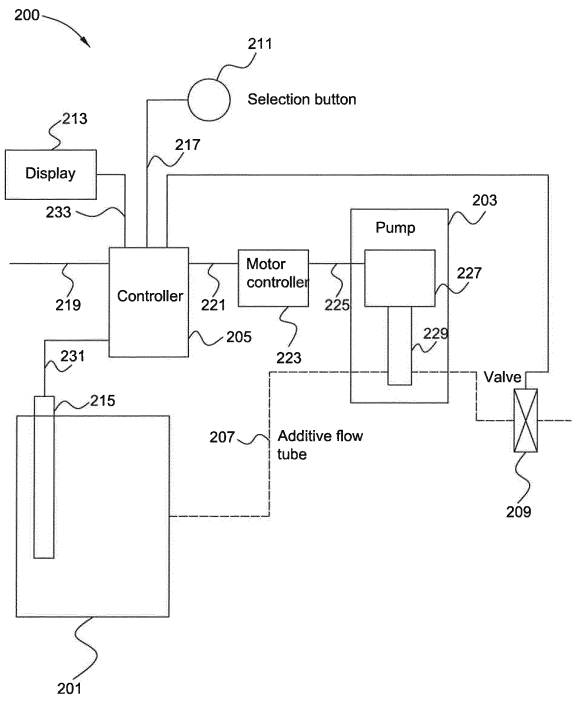


FIG. 2

EP 3 050 842 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an additive injecting apparatus, particularly to an additive injecting apparatus used with a fuel dispenser.

BACKGROUND

[0002] Fuel fluids of various kinds are known in the art. Many fuels can provide better performance when used in combination with fuel additives. Examples of the benefits of such additives include improving fuel quality and reducing emissions. Given the benefits of blending additives with fuel, bottled additives are popular in the market. However, blending bottled additives with fuel is often inconvenient and messy. For example, when a customer refuels a vehicle with additive blended fuel at a fuel dispenser, bottled additives need to be purchased prior to the refueling and poured into a vehicle fuel tank manually. The additives are smelly and may spill as being poured into the vehicle fuel tank. The customer also needs to determine the quantity of required additives based on the volume of fuel dispensed at the fuel dispenser. Furthermore, as the gasoline station is an inflammable and explosive dangerous location, the injection of additives should avoid any hidden dangers.

BRIEF DESCRIPTION

[0003] In view of the above-mentioned technical problem, in some embodiments, the invention provides an additive injecting apparatus configured to couple used with a fuel dispenser, the additive injecting apparatus comprising: a tank configured to store an additive; a pump coupled with said tank; and a controller coupled with said pump, said controller configured to initiate injection of the additive in response to initiation of fuel dispensing at said fuel dispenser and terminate the additive injection in response to termination of said fuel dispensing at said fuel dispenser, and operable to control a volume of the additive injected to said fuel and dispensed therewith at said fuel dispenser.

[0004] In some embodiments, in the above mentioned apparatus, the additive injecting apparatus further comprising: a housing enclosing said tank, said pump and said controller; and a first substrate dividing the space within said housing into a non-hazardous zone and a hazardous zone, wherein said non-hazardous zone is configured to preferentially accommodate electrical components of said fuel injecting apparatus, and said hazardous zone is configured to preferentially accommodate non-electrical components of said fuel injecting apparatus, wherein at least one of said electrical components is positioned in said hazardous zone and said electrical component in said hazardous zone is anti-explosive.

[0005] In some embodiments, in the above mentioned apparatus, said pump comprises a metering pump including a motor and a pump head, and wherein said motor is placed in said non-hazardous zone and said pump head is placed in said hazardous zone.

[0006] In some embodiments, in the above mentioned apparatus, the additive injecting apparatus further comprising: a second substrate dividing said hazardous zone into a hydraulic zone and an air-gap zone, wherein said non-hazardous zone is positioned above said hazardous zone, wherein said air-gap zone is positioned between said non-hazardous zone and said hydraulic zone.

[0007] In some embodiments, in the above mentioned apparatus, each of the first and second substrates is dust-protected against ingress of solid foreign objects and splash-protected against ingression of liquid with harmful effects.

[0008] In some embodiments, in the above mentioned apparatus, said housing proximate said air-gap zone and said housing proximate said hydraulic zone each has a ventilation hole.

[0009] In some embodiments, in the above mentioned apparatus, the additive injecting apparatus further comprising: a tank gauge coupled with said controller and operable to generate a detection signal indicative of an volume of the additive in said tank, wherein an alarm is generated if said volume of the additive in said tank is determined to be outside a predetermined range according to said detection signal, and wherein said additive is stopped from being injected to said fuel if said volume of the additive in said tank is determined to be less than a predetermined threshold below a lower limit value of said predetermined range.

[0010] In some embodiments, in the above mentioned apparatus, said volume of the additive dispensed for said fuel dispensing is selected from one of: 1) a predetermined volume; 2) a predetermined ratio of the volume of additive to the fuel dispensed for said fuel dispensing.

[0011] In some embodiments, the invention provides a method for injecting an additive to a fuel, comprising: initiating injection of said additive to said fuel by an additive injecting apparatus in response to reception of a signal received from a fuel dispenser indicative of initiation of a fuel dispensing; controlling a volume of said additive injected to said fuel and dispensed with said fuel dispensing by said additive injecting apparatus; and terminating said injection of said additive to said fuel by an additive injecting apparatus in response to reception of a signal received from said fuel dispenser indicative of termination of said fuel dispensing.

[0012] In some embodiments, in the above mentioned method, the method further comprising: receiving by a controller a detection signal from a tank gauge indicative of a volume of the additive in a tank; generating by said controller an alarm if said volume of the additive in said tank is determined to be outside a predetermined range according to said detection signal; and stopping by said controller said injection of said additive to said fuel if said volume of the additive in said tank is determined to be

less than a predetermined threshold below a lower limit value of said predetermined range.

[0013] In some embodiments, the invention provides an additive injecting apparatus, comprising: a tank configured to store an additive; a metering pump coupled with said tank and configured to inject said additive from said tank to a fuel in a fuel dispenser and operable to meter a volume of the additive injected to said fuel, wherein said metering pump includes a motor and a pump head; a controller coupled with said metering pump and configured to control the additive injection and operable to control said volume of the additive injected to said fuel; a housing configured to enclose said tank, said metering pump and said controller; and a first substrate configured to divide the space in said housing into a non-hazardous zone and a hazardous zone, wherein said controller and said motor are placed in said non-hazardous zone, and said pump head and said tank are placed in said hazardous zone.

[0014] The additive injecting apparatus and method provided by the present invention, relieve persons who refuel vehicles from unpleasant experiences with bottled additives, by automatically performing the additive injecting and blending process, and controlling and determining a volume of additives dispensed with the fuel dispensing. Furthermore, the additive injecting apparatus achieves a safer configuration without extra cost and thus improve the reliability of the additive injection, by dividing the internal space of the additive injecting apparatus into different zones according to each zone's hazardous level and placing each component into an appropriate zone.

DRAWINGS

[0015] The present disclosure will become better understood when the following detailed embodiments are described with reference to the accompanying drawings, wherein:

FIG. 1 is a block diagram of a gas station according to one embodiment of the present invention;

FIG. 2 is a block diagram of the additive injecting apparatus in FIG. 1 according to one embodiment of the present invention;

FIG. 3 is a perspective view of the additive injecting apparatus in FIG. 1 according to one embodiment of the present invention.

FIG. 4 is a flow chart of a method for injecting additives to fuel according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0016] One or more specific embodiments of the present disclosure will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0017] Unless defined otherwise, technical and scientific terms used herein have the same meaning as is commonly understood by one of ordinary skill in the art to which this disclosure belongs. The terms "first", "second", and the like, as used herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. Also, the terms "a" and "an" do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced items. The use of "including", "comprising", or "having" and variations thereof herein are meant to encompass the items listed thereafter and equivalents thereof as well as additional items. The terms "connected" and "coupled" are not restricted to physical or mechanical connections or couplings, and can include electrical connections or couplings, whether direct or indirect. Furthermore, "electric circuit" or "electric circuit system" and "controller" or the like may comprise a single component or an assembly of a number of active elements or passive elements that are directly or indirectly connected, for example one or more integrated chips, so as to achieve corresponding functions.

[0018] FIG. 1 is a block diagram of a gas station 100 in accordance with one embodiment. Detailed descriptions of well-known functions, configurations or constructions are omitted for brevity and clarity so as not to obscure the description of the present disclosure with unnecessary detail. Thus, the present disclosure is not limited to the exemplary embodiments which will be described below, but may be implemented in other forms. The gas station 100 includes an additive injecting apparatus 101 and a fuel dispenser 103. In one embodiment, the additive injecting apparatus 101 is a stand alone device placed close to the fuel dispenser 103. One or more additive flow tubes 115 from the additive injecting apparatus 101 are connected to fuel flow hoses 107 of the fuel dispenser 103 at interconnection points 113 respectively. With the additive injecting apparatus 101, additives can be injected automatically to the fuel at an interconnections point 113 to formulate additive blended fuel. The additive blended fuel is injected to a vehicle fuel tank through nozzles 105 after flowing through a fuel flow hose 107 downstream of the interconnection point 113.

[0019] In the example of FIG. 1, the additive injecting

apparatus 101 is designed to be a stand alone device placed close to the fuel dispenser 103. In alternative embodiments, the additive injecting apparatus 101 can have various configurations adapted to various application needs, e.g., being integrated into, attached to or enclosed in the fuel dispenser 103. Furthermore, before the additives are injected into the fuel at the interconnection point 113, check valves (not shown) are used to prevent reverse flow of fuels into the additive injecting apparatus 101.

[0020] Advantageously, if it is desired to refuel a vehicle with additive blended fuel, the additive injecting and blending process is performed automatically by the additive injecting apparatus 101. In one embodiment, the additive injecting apparatus 101 can further determine and control a volume of additives dispensed for the fuel dispensing, which will be discussed in more detail in the following description, particularly with respect to FIG. 2. As such, persons who refuel vehicles are relieved from unpleasant experiences with bottled additives.

[0021] FIG. 2 is a block diagram of the additive injecting apparatus 101 in FIG. 1 in accordance with one embodiment. In the example of FIG. 2, the additive injecting apparatus 101 includes a tank 201 configured to store an additive, a pump 203 coupled with the tank 201, and a controller 205 coupled with the pump 203. With respect to the combination of FIG.1 and FIG.2, the controller 205 is configured to initiate injection of the additive in response to initiation of fuel dispensing at the fuel dispenser 103 and terminate the additive injection in response to termination of the fuel dispensing at the fuel dispenser 103, and to control a volume of the additive injected to the fuel and dispensed therewith at the fuel dispenser 103.

[0022] In one embodiment, the selection button 211 is pressed to assert a selection signal 217 indicative of a choice of injecting the additives to the fuel for fuel dispensing at the fuel dispenser 103. If the controller 205 receives the selection signal 217 indicative of the additive injection choice, the additive injecting apparatus 101 is activated to standby. With the fuel dispensing process at the fuel dispenser 103, the controller 205 in the standby state automatically initiates the additive injection in response to initiation of the fuel dispensing, automatically terminates the additive injection in response to termination of the fuel dispensing, and further controls a volume of the additives dispensed for the fuel dispensing. As the additive injection proceeds, a display 213 receives real-time additive dispensing information such as dispensed additive volume, payment amount or the like from the controller 205 and displays such information accordingly.

[0023] In one embodiment, the controller 205 controls the additive injection according to a signal 219 received from the fuel dispenser 103. At the moment when the fuel dispensing is initiated, the signal 219 is asserted to indicate the initiation of the fuel dispensing. In response to the signal 219, the controller 205 asserts a control signal 221 to initiate the additive injection. In one embodiment, prior to providing the control signal 221 to the pump 203, a motor controller 223 is adopted to transform the signal 221 to an electrical signal 225 suitable for the pump 203. Upon reception of the electrical signal 225 indicative of initiation of the fuel dispensing, the pump 203 is initiated to pump the additives from the tank 201 to the fuel dispenser 103 through the additive flow tube 207. Similarly, at the moment when the fuel dispensing is terminated, the signal 219 is asserted to indicate termination of the fuel dispensing. In response to the signal 219, the controller 205 asserts the control signal 221 to terminate the additive injection. As such, the initiation and termination of the additive injection at the additive injecting apparatus 101 is conducted automatically based on the initiation and termination of the fuel dispensing at the fuel dispenser 103. The controller 205 further controls the opening and closing of the valve 209 to ensure that the additives flowing in the additive flow tube 207 is directed to the appropriate fuel flow hose 107 which is in use for the fuel dispensing at the fuel dispenser 103.

[0024] As aforementioned, the controller 205 further controls the volume of the additives injected to fuel. In one embodiment, the volume of the additives dispensed for the fuel dispensing is a predetermined volume. In this instance, the controller 205 further receives the signal 219 indicative of the predetermined volume and asserts the control signal 221 which instructs the pump 203 to inject the predetermined volume of additives to the fuel continuously in a single injection. To ensure accuracy of the volume of additives injected to the fuel, the pump 203 can comprises a motor 227, e.g., a stepper motor, and a pump head 229 to serve as a metering pump with additive measurement function. In operations, each full rotation of the stepper motor 227 produces a complete stroke of the pump head 229 which pumps a known volume of additives out of the tank 201. By determining the number of rotations of the step motor 227, the predetermined volume of additives injected to the fuel can be achieved. In an alternative embodiment, a ratio of additive to fuel dispensed for the fuel dispensing is a predetermined ratio. In this instance, the pump 203 operates in an intermittent fashion with multiple incremental additive injections. With a predetermined increment of fuel dispensing at the fuel dispenser 103, the controller 205 receives the signal 219 indicative of the predetermined fuel increment and asserts the control signal 221 which instructs the pump 203 to complete one incremental additive injection. A ratio of additive increment to fuel increment is equal to the predetermined ratio so as to ensure that additive injection according to the predetermined ratio is achieved. As mentioned above, said volume of the additive dispensed for said fuel dispensing is selected from one of: 1) a predetermined volume; 2) a predetermined ratio of the volume of additive to the fuel dispensed for said fuel dispensing.

[0025] In addition to control the additive injection, the controller 205 further generates a signal 233 indicative of additive dispensing information such as dispensed ad-

ditive volume, payment amount or the like. In one embodiment, the controller 205 is programmed with a software code which monitors dynamic volume data of dispensed additive and calculates the dynamic payment according to additive unit price when executed. Upon reception of the signal 233 indicative of these volume data and payment information, the display 213 is updated on a real-time basis. In alternative embodiments, the controller 205 can be further programmed to display various types of information, e.g., advertising, graphics, promotional content.

[0026] In one embodiment, the controller 205 further receives a detection signal 231 indicative of an volume of the additives in the tank 201 detected by the tank gauge 215. If the volume of the additives in the tank 201 is determined to be outside a predetermined range according to the detection signal 231, the controller 205 will generate an alarm. More specifically, if the additive volume in the tank 201 is greater than an upper limit value of the predetermined range, the alarm indicates the tank 201 is close to be full. If the additive volume in the tank 201 is less than a lower limit value of the predetermined range, the alarm indicates the tank 201 is close to be empty. If the volume of the additives in the tank 201 is determined to be less than a predetermined threshold below the lower limit value, the controller 205 stops the additives from being injected to the fuel.

[0027] Advantageously, the additive injecting apparatus 101 not only conducts the additive injection automatically, but also has a flexible control over the volume of the dispensed additives, e.g., according to the predetermined volume value or the predetermined ratio of additive to fuel for fuel dispensing. As such, user experience for dispensing additive blended fuel at a gas station is further improved. In addition to user experience, anti-explosion performance is also crucial for installation of a gas station. Accordingly, the anti-explosion performance of the additive injecting apparatus 103 is also a focus of embodiments of the present invention.

[0028] FIG. 3 is a perspective view 300 of the additive injecting apparatus 101 in FIG. 1 in accordance with one embodiment. The perspective view 300 further includes a perspective view 301 looking from the front of the additive injecting apparatus 101 and a perspective view 303 looking from the back of the additive injecting apparatus 101. In one embodiment, the additive injecting apparatus 101 includes a housing 305 configured to enclose the components discussed with reference to FIG. 2 and cables connected to various electrical components like the controller 205, the tank gauge 215, the motor controller 223 and so on. The space within the housing 305 is divided into a non-hazardous zone 307 and a hazardous zone 309 by a first substrate 311. The non-hazardous zone 307 is positioned above the hazardous zone 309 within the housing 305. In one embodiment, the non-hazardous zone 307 occupies the upper area of the space within the housing 305, and electrical components including the controller 205, the display 213, the selection button 211, the motor controller 223 and cables connected to these electrical components are placed in the non-hazardous zone 307. In one embodiment, the additive injecting apparatus 101 further includes a power supply (not shown) placed in the non-hazardous zone 307 for supplying power to the controller 205.

[0029] In one embodiment, the hazardous zone 309 is further divided into an air-gap zone 313 and a hydraulic zone 315 by a second substrate 317. The air-gap zone 313 is positioned between the non-hazardous zone 307 and the hydraulic zone 315. Non-electrical components like the tank 201, the additive flow tube 207 and the valve 209 are placed in the hydraulic zone 315. As aforementioned, the pump 203 in one embodiment includes the stepper motor 227 and the pump head 229. With reference to FIG.2, the stepper motor 227 which is electrically coupled to the controller 205 through the motor controller 223 is herein placed in the non-hazardous zone 307 and the non-electrical pump head 229 is placed in the air-gap zone 313. The hazardous zone 309 mainly accommodates non-electrical components of the additive injecting apparatus 101. In other words, the non-hazardous zone 307 accommodates electrical components of the additive injecting apparatus 101, while the hazardous zone 309 accommodates non-electrical components. In some instances, the hazardous zone 309 may also contain one or more electrical components, like the tank gauge 215 placed in the hydraulic zone 315. If one or more electrical components are placed in the hazardous zone 309, these electrical components must be anti-explosive. In one embodiment, to further enhance safety of the additive injecting apparatus 101, the housing approximate the air-gap zone 313 and the housing approximate the hydraulic zone 315 each has one or more ventilation holes 319 and 320. As an example, the ventilation holes 319 are positioned on back and front sides of the housing around the air-gap zone 313 and the ventilation holes 320 are positioned on the four sides of the housing around the hydraulic zone 315.

[0030] Furthermore, the first and second substrates 311 and 317 for dividing the space within the housing 305 must meet a certain degree of protection provided by an enclosure, which is also referred to as an IP code, e.g. the standard IP code of People's Republic of China. In one embodiment, the minimum IP code for the first and second substrates 311 and 317 is IP54, which indicates that the protection levels provided by the first and second substrates 311 and 317 against ingress of solid foreign objects and liquid with harmful effects are at least dust-protected and splash-protected.

[0031] Advantageously, the additive injecting apparatus 101 achieves a safer configuration without extra cost by dividing the internal space into different zones according to each zone's hazardous level and placing each component into an appropriate zone.

[0032] FIG. 4 is a flowchart 400 of a method for injecting additives to fuel in accordance with one embodiment. Although specific steps are disclosed in flowchart 400,

such steps are exemplary. That is, embodiments of the present invention are well suited to performing various other steps or variations of the steps recited in flowchart 400. It is appreciated that the steps in flowchart 400 can be performed in an order different than presented, and that not all of the steps in flowchart 400 may be performed. FIG. 4 is described in combination with FIG. 1 and FIG. 2.

[0033] In step 401, injection of additive to fuel by an additive injecting apparatus is initiated in response to reception of a signal received from a fuel dispenser indicative of initiation of a fuel dispensing. As an example, the additive injecting apparatus 101 initiates the additive injection in response to reception of the signal 219 received from the fuel dispenser 103 indicative of initiation of fuel dispensing. In step 403, a volume of the additive injected to fuel and dispensed for the fuel dispensing is controlled by the additive injecting apparatus. As mentioned with respect to FIG. 2, the controller 205 of the additive injecting apparatus 101 has a flexible control over volume of the additive injected to fuel and dispensed for the fuel dispensing, e.g., according to the predetermined volume value or the predetermined ratio of additive to fuel for the fuel dispensing. In step 405, the injection of the additive to the fuel by the additive injecting apparatus is terminated in response to reception of a signal received from the fuel dispenser indicative of termination of the fuel dispensing. For instance, the additive injecting apparatus 101 terminates the additive injection in response to reception of the signal 219 received from the fuel dispenser 103 indicative of termination of the fuel dispensing.

[0034] One person skilled in the art will recognize the interchangeability of various features from different embodiments. The various features described, as well as other known equivalents for each feature, can be mixed and matched by one of ordinary skill in this art to construct additional systems and techniques in accordance with principles of this disclosure.

Claims

1. An additive injecting apparatus used with a fuel dispenser, the additive injecting apparatus comprising:

a tank configured to store an additive;
a pump coupled with said tank; and
a controller coupled with said pump, said controller configured to initiate injection of the additive in response to initiation of fuel dispensing at said fuel dispenser and terminate the additive injection in response to termination of said fuel dispensing at said fuel dispenser, and operable to control a volume of the additive injected to said fuel and dispensed therewith at said fuel dispenser.

2. The additive injecting apparatus of claim 1, further comprising:

a housing enclosing said tank, said pump and said controller; and
a first substrate dividing the space within said housing into a non-hazardous zone and a hazardous zone, wherein said non-hazardous zone is configured to preferentially accommodate electrical components of said fuel injecting apparatus, and said hazardous zone is configured to preferentially accommodate non-electrical components of said fuel injecting apparatus, wherein at least one of said electrical components is positioned in said hazardous zone and said electrical component in said hazardous zone is anti-explosive.

3. The additive injecting apparatus of claim 2, wherein said pump comprises a metering pump including a motor and a pump head, and wherein said motor is placed in said non-hazardous zone and said pump head is placed in said hazardous zone.

4. The additive injecting apparatus of claim 2, further comprising:

a second substrate dividing said hazardous zone into a hydraulic zone and an air-gap zone, wherein said non-hazardous zone is positioned above said hazardous zone, wherein said air-gap zone is positioned between said non-hazardous zone and said hydraulic zone.

5. The additive injecting apparatus of claim 4, wherein each of the first and second substrates is dust-protected against ingress of solid foreign objects and splash-protected against ingression of liquid with harmful effects.

6. The additive injecting apparatus of claim 4, wherein said housing proximate said air-gap zone and said housing proximate said hydraulic zone each has a ventilation hole.

7. The additive injecting apparatus of claim 1, further comprising:

a tank gauge coupled with said controller and operable to generate a detection signal indicative of an volume of the additive in said tank,
wherein an alarm is generated if said volume of the additive in said tank is determined to be outside a predetermined range according to said detection signal, and
wherein said additive is stopped from being injected to said fuel if said volume of the additive in said tank is determined to be less than a predetermined threshold below a lower limit value

of said predetermined range.

8. The additive injecting apparatus of claim 1, wherein said volume of the additive dispensed for said fuel dispensing is selected from one of: 1) a predetermined volume; 2) a predetermined ratio of the volume of additive to the fuel dispensed for said fuel dispensing.

9. A method for injecting an additive to a fuel, comprising:

initiating injection of said additive to said fuel by an additive injecting apparatus in response to reception of a signal received from a fuel dispenser indicative of initiation of a fuel dispensing;
controlling a volume of said additive injected to said fuel and dispensed with said fuel dispensing by said additive injecting apparatus; and
terminating said injection of said additive to said fuel by an additive injecting apparatus in response to reception of a signal received from said fuel dispenser indicative of termination of said fuel dispensing.

10. A method for injecting an additive to a fuel, further comprising:

receiving by a controller a detection signal from a tank gauge indicative of a volume of the additive in a tank;
generating by said controller an alarm if said volume of the additive in said tank is determined to be outside a predetermined range according to said detection signal; and
stopping by said controller said injection of said additive to said fuel if said volume of the additive in said tank is determined to be less than a predetermined threshold below a lower limit value of said predetermined range.

11. An additive injecting apparatus, comprising:

a tank configured to store an additive;
a metering pump coupled with said tank and configured to inject said additive from said tank to a fuel in a fuel dispenser and operable to meter a volume of the additive injected to said fuel, wherein said metering pump includes a motor and a pump head;
a controller coupled with said metering pump and configured to control the additive injection and operable to control said volume of the additive injected to said fuel;
a housing configured to enclose said tank, said metering pump and said controller; and
a first substrate configured to divide the space in said housing into a non-hazardous zone and a hazardous zone, wherein said controller and said motor are placed in said non-hazardous zone, and said pump head and said tank are placed in said hazardous zone.

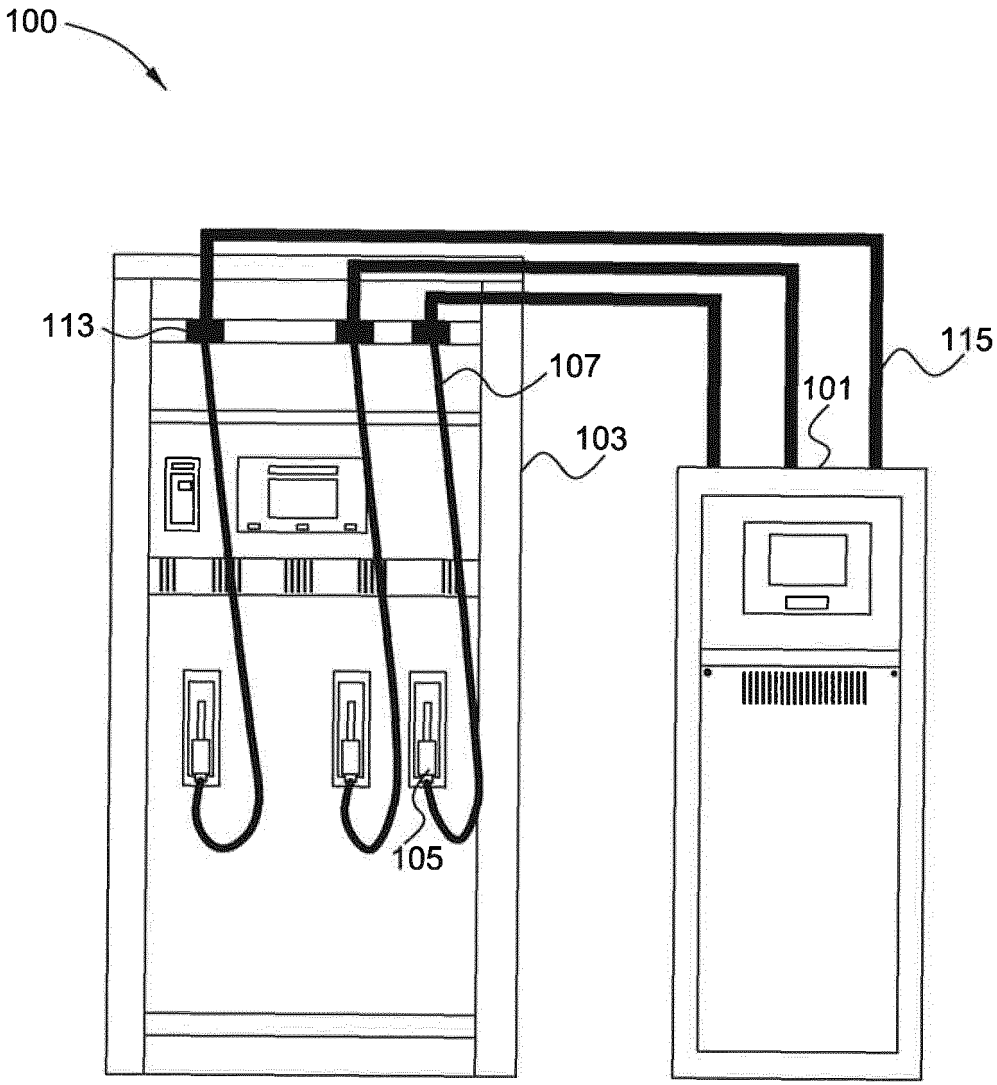
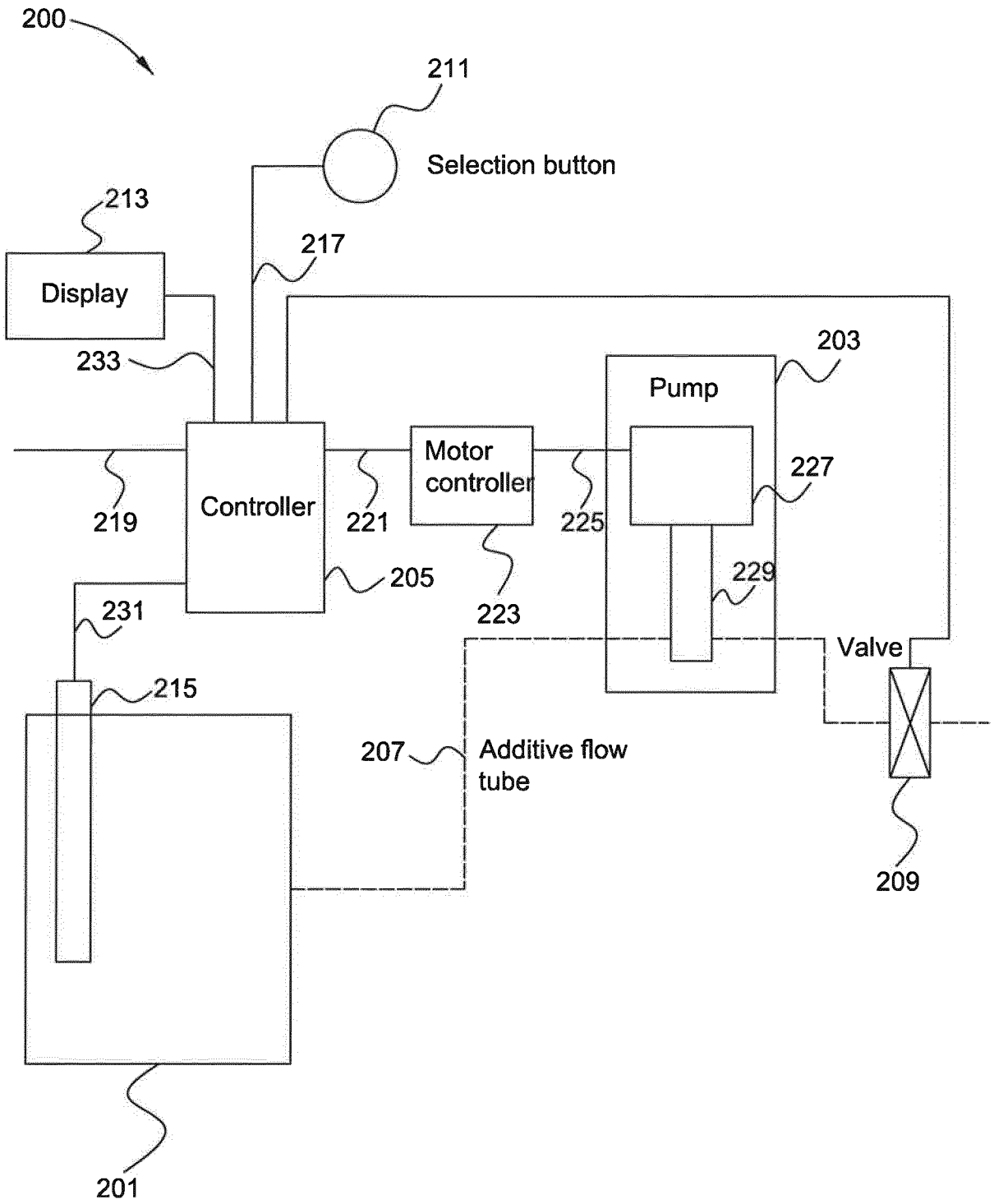


FIG. 1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Motor controller
Controller
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Valve
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Additive flow tube
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201

FIG. 2

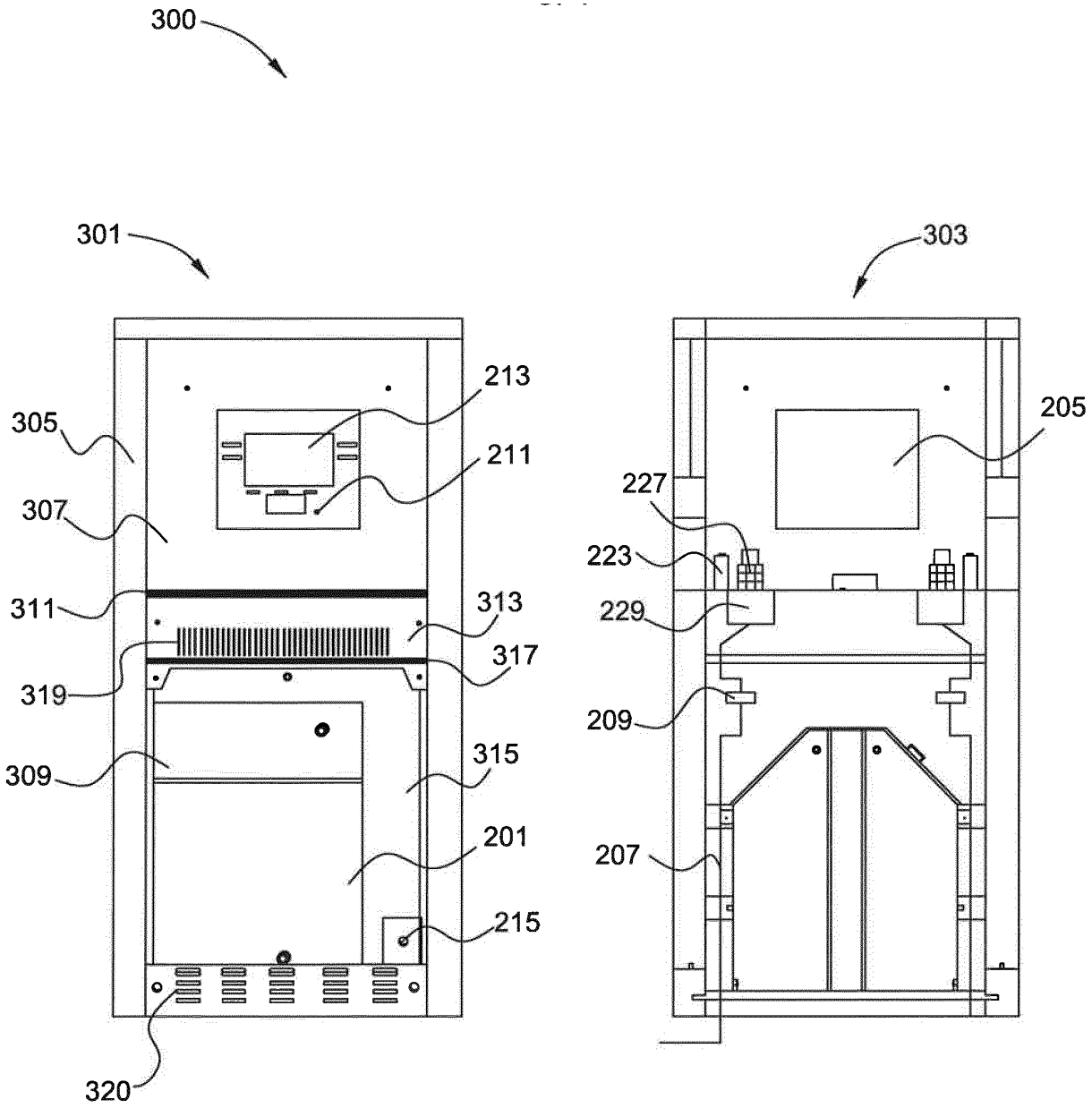
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FIG. 3

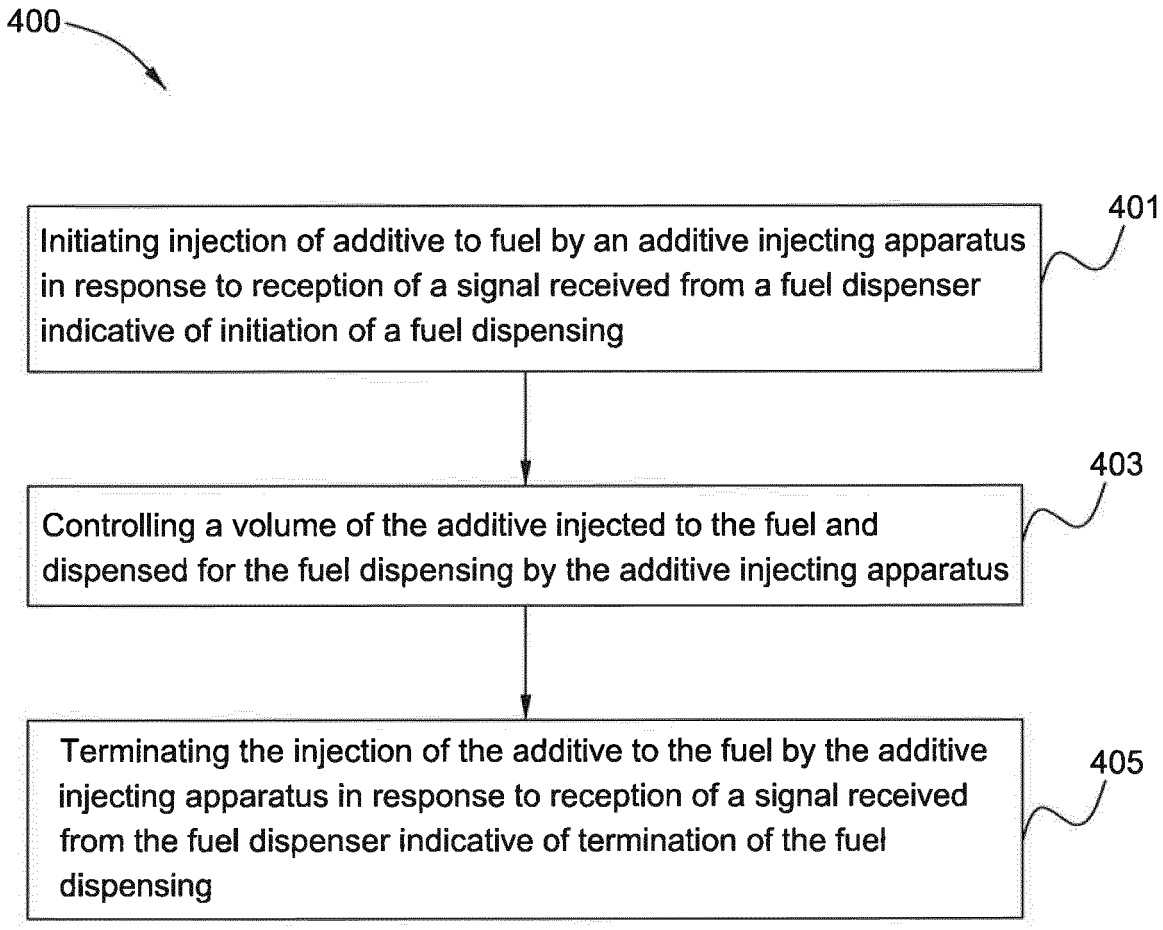
400
Initiating injection of additive to fuel by an additive injecting apparatus in response to reception of a signal received from a fuel dispenser indicative of initiation of a fuel dispensing
401
Controlling a volume of the additive injected to the fuel and dispensed for the fuel dispensing by the additive injecting apparatus
403
Terminating the injection of the additive to the fuel by the additive injecting apparatus in response to reception of a signal received from the fuel dispenser indicative of termination of the fuel dispensing
405

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/087837

A. CLASSIFICATION OF SUBJECT MATTER

B67D 7/04 (2010.01) i; B67D 7/84 (2010.01) i; B67D 7/22 (2010.01) i
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)

B67D 7/+

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)

CNTXT; CNABS; VEN; CNKI: fuel, gas, gasoline, additive?, ratio

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 201325867 Y (SHANXI NEW ENERGY CHEM IND CO LTD) 14 October 2009 (14.10.2009) description, page 3, line 19 to page 4, line 19 and figure 2	1, 7-10
Y	CN 201325867 Y (SHANXI NEW ENERGY CHEM IND CO LTD) 14 October 2009 (14.10.2009) description, page 3, line 19 to page 4, line 19 and figure 2	2-6, 11
X	CN 101486436 A (SHANXI NEW ENERGY CHEM IND CO LTD) 22 July 2009 (22.07.2009) description, page 3, line 19 to page 4, line 19 and figure 2	1, 7-10
Y	CN 101486436 A (SHANXI NEW ENERGY CHEM IND CO LTD) 22 July 2009 (22.07.2009) description, page 3, line 19 to page 4, line 19 and figure 2	2-6, 11
Y	CN 202529835 U (BEIJING QUANSHENG HUAN EXPLOSION PROOF TECHNOLOGY CO LTD) 14 November 2012 (14.11.2012) description, paragraphs [0031] and [0032] and figure 3	2-6, 11

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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

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Date of the actual completion of the international search	Date of mailing of the international search report
18 December 2014	24 December 2014
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/087837

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2010200609 A1 (CADIGAN) 12 August 2010 (12.08.2010) the whole document	1-11

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Information on patent family members

International application No.
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