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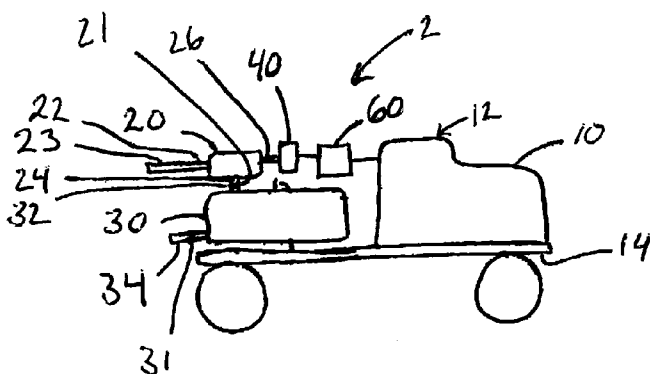


FIG. 1

(57) Abstract: The subject matter disclosed herein relates to apparatus and methods for vehicle-based mobile vacuum systems.

VEHICLE-BASED VACUUM SYSTEM APPARATUS AND METHODS

Inventor: Donald L. Emerson, Jr.

5 RELATED APPLICATION

This is a PCT application claiming priority to U.S. Provisional application No. 60/952,357, filed on July 27, 2008, which is in its entirety incorporated herein by reference.

10 FIELD OF THE INVENTION

The present invention is related to vacuum systems, and more particularly, to apparatus and methods for vehicle-based mobile vacuum systems.

BACKGROUND

15 Vehicle-based mobile vacuum systems are used in a number of applications, such as, but not limited to septic servicing, grease trap servicing, and dry waste vacuuming. Examples of septic servicing systems include, but are not limited to, portable toilet vacuum service units and septic service units. The operation of a portable toilet vacuum service unit will be described by way of
20 example.

A known portable toilet vacuum service unit is a truck-based vacuum system that includes a vacuum pump, a waste storage tank, and a vacuum hose. A common capacity of waste storage tanks is 300-3600 gallons. The vacuum pump creates a vacuum commonly in a range of 15 to 20 inches of mercury in
25 the storage tank. The vacuum hose is coupled to the storage tank and is used to draw the waste product into the storage tank.

In one known system the vacuum pump is powered via a power take-off (PTO) driven by a drive gear of a transmission of a truck. An output shaft of the PTO engages the vacuum pump via a clutch pack. In standard operation, the
30 vacuum pump is engaged with the PTO, and the engine is driven at a high idle speed sufficient to drive the vacuum pump. The vacuum pump is required to be continuously engaged with the PTO and thus the engine is operated at high idle

for the duration of a service call so as to maintain the vacuum in the storage tank. The vacuum is operable to draw material into a hose and into the storage tank.

In another known system a vacuum pump is driven by an engine driveshaft of a truck or by a driveshaft of an auxiliary internal combustion engine.

5 In standard operation, the truck or auxiliary engine is driven at a high idle speed sufficient to drive the vacuum pump. The vacuum pump is required to be continuously engaged with the engine so as to maintain a vacuum in the storage tank and thus the engine is required to be operated at high idle for the duration of a service call.

10 Continuous operation of the truck engine at high idle is associated with loud engine noise, engine exhaust emissions, high consumption of fuel, high emissions of odors from the vacuum pump exhaust, increased wear on the truck engine/transmission, vacuum pump, and the PTO, among other things.

Continuous operation of the vacuum pump, and therefore operating the
15 engine at high idle, is in-part due to convenience of operation. It is not uncommon for the vacuum hose to be extended ten's of feet, in some cases over 50 feet, from where the vacuum pump controls are located. Further, it is not uncommon for the operator to wear protective gear, including bulky water-proof gloves and body coverings, making the operation of control switches difficult and
20 inconvenient. Therefore, it is common practice for the operator to leave the vacuum pump engaged with the PTO with the engine running at high idle throughout the service call which can be for ten's of minutes.

What is needed in the art is a vacuum system for a vehicle-based mobile vacuum handling system that provides the vacuum without the associated high
25 idle operation of the truck engine and without the associated maintenance issues of the power take-off or auxiliary internal combustion engines. Also needed in the art is a vacuum control system for a vehicle-based mobile vacuum handling system that provides the vacuum as needed with little or no intervention on the part of the operator.

30

BRIEF DESCRIPTION OF THE DRAWINGS

Like reference numbers generally indicate corresponding elements in the figures.

FIG. 1 is a side view of a vehicle-based vacuum system, in accordance
5 with an embodiment;

FIG. 2 is a schematic of a vacuum system in accordance with an
embodiment;

FIG. 3 is a schematic of the vehicle-based mobile vacuum system in
accordance with another embodiment; and

10 FIG. 4 is a schematic of a vehicle-based mobile vacuum system in
accordance with another embodiment.

DETAILED DESCRIPTION

Reference will now be made to embodiments illustrated in the drawings
15 and specific language which will be used to describe the same. It will
nevertheless be understood that no limitation of the scope of the invention is
thereby intended, such alterations and further modifications in the illustrated
devices, as such further applications of the principles of the invention as
illustrated therein as being contemplated as would normally occur to one skilled
20 in the art to which the invention relates.

Embodiments in accordance with the present invention provide a vehicle-
based mobile vacuum system.

FIG. 1 is a side view of a vehicle-based mobile vacuum system 2
comprising a vacuum tank 20, a storage tank 30, an electric motor 42, and a
25 vacuum pump 40 in operable engagement with the electric motor operable to
create a vacuum in the vacuum tank 20, in accordance with an embodiment of
the present invention. The vehicle-based mobile vacuum system 2 is shown in
FIG. 1 as being carried by a truck 10. The truck 10 includes a cab 12 and a
chassis 14 suitable for mounting the vehicle-based mobile vacuum system 2.
30 This embodiment is shown by way of an example of an implementation of a
vehicle-based mobile vacuum system 2 and is not limited there to.

FIG. 2 is a schematic of an embodiment of a vehicle-based mobile vacuum

system 2 of the embodiment of FIG. 1. The vacuum tank 20 is a containment vessel having a primary inlet 22 controlled by an inlet valve 25 operable for filling the vacuum tank 20 with a material drawn in by a vacuum, and a primary outlet 24 operable for dispensing the material therefrom. The vacuum tank 20 further comprises a vacuum inlet 26 controlled by a vacuum valve 27 operable to couple with a low pressure side of the vacuum pump 40. The vacuum inlet 26 comprises a primary shutoff valve 28 that is operable to prevent material within the vacuum tank 20 from entering the vacuum inlet 26 and potentially into the vacuum pump 40. The primary inlet 22 is provided with a hose 23 as an extension of the primary inlet 22 suitable for providing vacuum pickup service operable to draw material through the hose and into the vacuum tank.

The vacuum tank 20 may be constructed of steel, aluminum, polymer or fiberglass, but may also be any material suitable for containment of the desired fluid while being structurally sound to withstand the vacuum created by the vacuum pump 40.

In operation, the vacuum inlet valve 27 is opened to the vacuum inlet 26 and the vacuum pump 40 is driven by the electric motor 42 to create a vacuum within the vacuum tank 20. The inlet valve 25 is opened such that vacuum is provided at the end of the hose 23. Material may be drawn up the hose 23 and into the vacuum tank 20.

The vacuum tank 20 has a predetermined material capacity, such as but not limited to, that associated with one or more typical service calls. In accordance with an embodiment of the present invention, the vacuum tank 20 has a capacity of 50 gallons so as to provide material volume for one or more typical service calls. It is appreciated that the capacity of the vacuum tank 20 may be of any capacity suitable for a particular purpose. The relatively small size of the vacuum tank 20 as compared with the storage tank 30 allows for rapid establishment of a working vacuum pressure in the vacuum tank 20. As compared with a vacuum system required for establishment of a working vacuum pressure in a large storage tank 30, the vacuum system 2 provided in the embodiment of FIG. 2 is smaller, more efficient, and is operable to provide suitable vacuum more quickly.

The storage tank 30 is a containment vessel having a secondary inlet 32 operable for coupling to the primary outlet 24 of the vacuum tank 20, and a secondary outlet 34 operable for dispensing the material therefrom. Control of material from the vacuum tank 20 to the storage tank 30 is provided by a first
5 valve 21. Control of material from the storage tank 30 to the secondary outlet 34 is provided by a second valve 31.

In accordance with an embodiment of a method of the present invention, the first valve 21 is closed, and the vacuum inlet valve 27 is opened. The vacuum pump 40 is caused to operate to evacuate the vacuum tank 20 to a
10 predetermined pressure below atmospheric. The inlet vacuum valve 25 is opened providing vacuum service at the end of the hose 23 that is coupled to the vacuum inlet 22. Material may be drawn through the hose and into the vacuum tank 20. The vacuum tank 20 is filled with a predetermined quantity of material.

Transfer of the material contents of the vacuum tank 20 to the storage tank
15 30 may be affected by a number of means. In the embodiment of FIG. 2, the vacuum tank 20 is located above the storage tank 30 such that gravity may be used to transfer the contents of the vacuum tank 20 to the storage tank 30. In operation, any vacuum within the vacuum tank 20 is relieved to atmospheric pressure and the first valve 21 is opened so as to allow the contents to transfer
20 from the vacuum tank 20 to the storage tank 30.

In another embodiment, the vacuum pump 40 is reversible so as to provide gas pressure to the vacuum inlet 26 to assist in the transfer of the contents of the vacuum tank 20 to the storage tank 30. Gas pressure assistance would be particularly beneficial for transferring fluid-based materials. In operation
25 of emptying the vacuum tank 20, any vacuum within the vacuum tank 20 is relieved to atmospheric pressure. The vacuum pump 40 is reversed to pressurize the vacuum tank 20 to a pressure above that within the storage tank 30. The primary outlet 24 of the vacuum tank 20 is opened to allow the contents to drain to the storage tank 30 assisted by the pressure supplied by the vacuum
30 pump 40. The vacuum tank 20 is provided with a pressure release valve suitable for overpressure protection and pressure relief.

In accordance with embodiments of the present invention, electrical

service to the electric motor 42 may be provided by the truck electrical system, an auxiliary electrical system, or an independent electrical system dedicated to the vacuum delivery system 2. In accordance with an embodiment of the present invention, the vacuum supply 40 is an electric vacuum pump driven by the
5 electrical system of the truck 10, such as, but not limited to, a 12, 24, 36 and 48 volt electrical system.

In accordance with another embodiment of the present invention shown in FIG. 2, a storage battery system 60 comprises one or more storage batteries 62 in electrical communication with the truck electrical system 50 and the electric
10 motor 42. The storage batteries 62 may be charged by an electrical system, such as, but not limited to, the electrical system 50 of the truck 10 so as to provide power to the electric motor 42 that drives the vacuum pump 40. In another embodiment, the truck electrical system 50 is augmented by the addition of an alternator, besides the one commonly found on vehicles, operable to
15 charge the storage batteries 62 between service calls. The additional alternator may be of any desired predetermined voltage suitable for the particular purpose, such as, but not limited to, 24, 36, and 48 volt alternators.

The storage batteries 62 may be recharged as needed, such as, but not limited to, during transport from one job site to another. The capacity of the
20 storage batteries 62 is predetermined to provide a predetermined electrical energy capacity to power the electric motor 42 for a predetermined period of time, such as, but not limited to, that time associated with one or more typical service calls. Such capacity may allow the truck engine to be run at low idle instead of the high idle required of previous systems. Further, the capacity of the storage
25 batteries 62 may be such to allow the truck engine to be turned off during one or more service calls with all power requirements of the electric motor 42 provided by the storage batteries 62.

In an embodiment in accordance with the present invention, the vacuum supply 40 may be controlled by a control system 70 to respond to a vacuum
30 switch 44 operable to sense the vacuum in the vacuum tank 20. If the vacuum switch 44 detects that the pressure within the vacuum tank 20 is above a predetermined value, the vacuum pump 40 is caused to operate to decrease the

pressure in the vacuum tank 20. If the vacuum switch 44 detects that the pressure is below a predetermined value, the vacuum supply 40 is caused to terminate operation.

In an embodiment of the present invention a vacuum control system 70 for a mobile, vehicle-based vacuum service unit is provided. The vacuum control system 70 is provided for controlling the vacuum and associated power components on an as-needed automated basis. The vacuum control system 70 comprises a vacuum switch 44 operable to detect vacuum in the vacuum tank 20. In the embodiment of FIG. 2, the vacuum switch 44 is provided between the vacuum valve 27 and the vacuum tank 20 operable to sense vacuum in the vacuum tank 20. The vacuum switch 44 is operable to control the operation of the vacuum system 2; that is, for the engagement of the electric motor 42 driving the vacuum pump 40. The electric motor 42 is driven by a signal from the vacuum switch 44.

In operation the vacuum switch 44 is operable to control the operation of the electric motor 42 that drives the vacuum pump 40. The vacuum switch 44 is operable to close a circuit so as to provide power to the electric motor 42 if the vacuum switch 44 senses a predetermined pressure. If the vacuum switch 44 senses a predetermined pressure less than a predetermined value below atmospheric, the vacuum switch 44 closes the circuit which causes the electric motor 42 to start, driving the vacuum pump 40. If the vacuum switch 44 senses a predetermined pressure more than a predetermined value below atmospheric, the vacuum switch 44 opens the circuit which causes the electric motor 42 to stop therefore stopping the vacuum pump 40. The operation of the vacuum pump 40 may thus be controlled by the vacuum control system 70 so as to provide a vacuum within the vacuum tank 20 within a predetermined range without intervention by the operator. The vacuum pump 40 is operated on an as-needed basis rather than on a continual basis.

In an embodiment of the present invention, the vacuum switch 44 is operable to engage the electric motor 42 if the vacuum switch 44 senses a pressure value at or about between 10 to 15 inches of mercury below atmospheric and to disengage the electric motor 42 if the vacuum switch 44

senses a pressure value at or about between 20 to 25 inches of mercury below atmospheric.

The frequency of cycling of the vacuum pump 40 may be determined by a specific application. For example, once the vacuum tank 20 is brought to a predetermined vacuum, if the product being vacuumed is a liquid and the vacuum hose remains in the product if the vacuum valve 25 is opened, relatively little cycling is expected. Relatively more frequent cycling is expected if the product is dry and the vacuum hose is sucking air. The size of the vacuum tank 20 and the desired range of vacuum are factors, including others, that determine the frequency of cycling of the system 1.

FIG. 3 is a schematic of a vehicle-based mobile vacuum system 3 which is substantially the same as that of FIG. 2 with the addition of a secondary vacuum tank 120. The secondary vacuum tank 120 is in fluid communication between the vacuum pump 40 and the vacuum tank 20. The secondary vacuum tank 120 is provided as a containment vessel in case material is drawn into the vacuum inlet 26 of the vacuum tank 20. The secondary vacuum tank 120 is provided with a secondary shutoff valve 29 that is operable to prevent material contained in the secondary vacuum tank 120 from entering the vacuum pump 40. Containment of any material within the secondary vacuum tank 120 prevents any material from being drawn directly into the vacuum pump 40 potentially damaging the vacuum pump 40. The primary shutoff valve 28 and the secondary shutoff valve 29 provide an effective system for preventing foreign material from entering the vacuum pump 40.

FIG. 4 is a schematic of a vehicle-based mobile vacuum system 4 comprising a vacuum waste storage tank 130, a vacuum pump 40 operable to produce vacuum in the vacuum waste storage tank 130, a secondary vacuum tank 120 in fluid communication between the vacuum pump 40 and the vacuum waste storage tank 130, an electric motor 42, and a storage battery system 60 including one or more storage batteries 62 provided between a truck electrical system 50 and the electric motor 42, in accordance with an embodiment of the present invention. The vacuum waste storage tank 130 is a containment vessel having a primary inlet 132 operable for filling the tank 130 with a material drawn

in by a vacuum, and a primary outlet 134 for dispensing the material therefrom. The vacuum waste storage tank 130 further comprises a vacuum inlet 26 operable to couple with the secondary vacuum tank 120 which itself is coupled to the vacuum pump 40. The vacuum inlet 26 comprises a primary shutoff valve 28
5 that is operable to prevent material contained in the vacuum tank 130 from entering the vacuum inlet 26 and potentially into the vacuum pump 40.

The secondary vacuum tank 120 is provided as a containment vessel in case material is drawn into the vacuum inlet 26 of the secondary vacuum tank 120. The secondary vacuum tank 120 is provided with a secondary shutoff valve
10 29 that is operable to prevent material contained in the secondary vacuum tank 120 from entering the vacuum pump 40. Containment of any material within the secondary vacuum tank 120 substantially prevents any material from being drawn directly into the vacuum pump 40 potentially damaging the vacuum pump 40. The primary shutoff valve 28 and the secondary shutoff valve 29 operable to
15 provide an effective system for preventing foreign material from entering the vacuum pump 40.

The primary inlet 132 is provided with a hose 131 as an extension of the primary inlet 132 used for providing vacuum service as previously described.

The vacuum waste storage tank 130 may be constructed of steel,
20 aluminum, polymer or fiberglass, but may also be any material suitable for containment of the desired fluid while being structurally sound to withstand the vacuum created by the vacuum pump 40. The vacuum waste storage tank 130 has a predetermined material capacity. By way of example, the vacuum waste storage tank 130 has a capacity of 300-3600 gallons so as to provide volume for
25 a large single service call or provide for multiple service calls without the need to release the vacuum from the vacuum waste storage tank 130 in order to empty the vacuum waste storage tank 130 as would be the case with a smaller storage tank.

In accordance with an embodiment of the present invention shown in FIG.
30 4, storage batteries 62 are operable to be charged by the electrical system 50 of the truck 10 and provide power to the electric motor 42 that drives the vacuum pump 40. The storage batteries 62 are recharged as needed, such as, but not

limited to, during transport from one job site to another. The capacity of the storage batteries 62 is predetermined to provide a predetermined electrical energy to power the electric motor 42 for a predetermined period of time, such as, but not limited to, that time associated with one or more typical service calls.

5 Such capacity allows the truck engine to be run at low idle instead of the high idle required of previous systems. Further, the capacity of the storage batteries 62 may be such to allow the truck engine to be turned off during one or more typical service calls with all power requirements of the electric motor 42 provided by the storage batteries 62.

10 It is appreciated that multiple elements as described above may be used in combination to provide apparatus suitable for a particular purpose. It is appreciated that the use of multiple vacuum pumps 40 may be operable to increase efficiencies of the system. It is understood that these combinations are appreciated and within the scope of the present invention.

15 Embodiments in accordance with the present invention provide vehicle-based mobile vacuum systems that address the limitations of current systems. The power take-off (PTO) subsystem has been eliminated such that the operation of the vacuum system is not dependent on the operation of the truck engine. An electrical motor that drives the vacuum pump is provided with electrical energy
20 from a storage battery system. Therefore the engine of the truck need not be running for the operation of the vacuum system, thus saving in fuel costs, reducing noise and air pollution, and reducing engine wear and tear. With the elimination of the PTO elements, the components and complexity of the system is greatly reduced resulting in reduced equipment costs.

25 While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known
30 or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as fall within the scope of the invention and the limits of the appended claims.

Claims:

I claim:

1. A vehicle-based mobile vacuum system, comprising:
 - a vacuum tank including a primary inlet controlled by an inlet valve, and a primary outlet;
 - a storage tank including a secondary inlet and a secondary outlet, the secondary inlet operable for coupling to the primary outlet of the vacuum tank;
 - an electric motor;
 - a first valve in fluid communication between the vacuum tank and the storage tank; and
 - a vacuum pump in operable engagement with the electric motor, the vacuum pump operable to draw a vacuum in the vacuum tank, the vacuum tank further including a vacuum inlet controlled by a vacuum valve operable to couple with a low pressure side of the vacuum pump.
2. The system of claim 1, wherein the vacuum inlet further includes a primary shutoff valve operable to prevent material within the vacuum tank from entering the vacuum inlet.
3. The system of claim 1, further comprising a hose, wherein the primary inlet is coupled with the hose operable for providing vacuum pickup service so as to draw material through the hose and into the vacuum tank.
4. The system of claim 1, wherein the vacuum tank has a smaller capacity than the storage tank.
5. The system of claim 1, wherein the vacuum tank is located above the storage tank such that gravity may be used to transfer contents of the vacuum tank to the storage tank.

6. The system of claim 1, wherein the vacuum pump is operable to provide gas pressure to the vacuum inlet to assist in the transfer of contents of the vacuum tank to the storage tank.
7. The system of claim 1, further comprising electrical service operable with the electric motor, electrical service selected from the group consisting of a truck electrical system, an auxiliary electrical system, and an independent electrical system dedicated to the vacuum delivery system.
8. The system of claim 1, further comprising electrical service operable with the electric motor.
9. The system of claim 8, wherein the electrical service comprises a storage battery system comprising one or more storage batteries in electrical communication with a truck electrical system and the electric motor.
10. The system of claim 8, wherein the electrical service comprises:
 - a truck electrical system including an alternator; and
 - at least one storage battery, the alternator operable to charge the at least one storage battery.
11. The system of claim 1, wherein the vacuum supply may be controlled by a control system operable to respond to a vacuum switch operable to sense the vacuum in the vacuum tank.
12. The system of claim 1, further comprising:
 - a control system including a vacuum switch operable to sense vacuum in the vacuum tank, the control system in communication with the electric motor such that if the vacuum switch detects that a pressure within the vacuum tank is above a predetermined value, the vacuum pump is caused to operate to decrease the pressure in the vacuum tank, and if the vacuum switch detects that a pressure within the vacuum tank is below a predetermined value, the vacuum pump is caused to terminate operation.

13. The system of claim 12, wherein the vacuum switch is operable to engage the electric motor if the vacuum switch senses a pressure value at or about between 10 to 15 inches of mercury below atmospheric and to disengage the electric motor if the vacuum switch senses a pressure value at or about between 20 to 25 inches of mercury below atmospheric.

14. The system of claim 1, further comprising:

a secondary vacuum tank in fluid communication between the vacuum pump and the vacuum tank, the secondary vacuum tank having a secondary shutoff valve that is operable to prevent material contained in the secondary vacuum tank from entering the vacuum pump.

15. A vehicle-based mobile vacuum system, comprising:

a vacuum waste storage tank having a primary inlet operable for filling the vacuum waste storage tank with a material drawn in by a vacuum, and a primary outlet operable for dispensing material therefrom;

a vacuum pump operable to produce vacuum in the vacuum waste storage tank;

a secondary vacuum tank in fluid communication between the vacuum pump and the vacuum waste storage tank, the vacuum waste storage tank further comprising a vacuum inlet operable to couple with the secondary vacuum tank;

an electric motor; and

a storage battery system including one or more storage batteries provided between a truck electrical system and the electric motor.

16. The system of claim 15, wherein the secondary vacuum tank includes a secondary shutoff valve that is operable to prevent material contained in the secondary vacuum tank from entering the vacuum pump.

17. The system of claim 15, further comprising a hose, the hose in fluid communication with the primary inlet.

18. A method of operating a vehicle-based mobile vacuum system, comprising:

- a vacuum tank including a primary inlet controlled by an inlet valve operable for filling the vacuum tank with a material drawn in by a vacuum, and a primary outlet operable for dispensing the material therefrom;

- a storage tank including a secondary inlet operable for coupling to the primary outlet of the vacuum tank, and a secondary outlet operable for dispensing contents therefrom;

- an electric motor;

- a first valve operable to control transport of contents from the vacuum tank to the storage tank; and

- a vacuum pump in operable engagement with the electric motor operable to draw a vacuum into the vacuum tank, the vacuum tank further including a vacuum inlet controlled by a vacuum valve operable to couple with a low pressure side of the vacuum pump,

- the method comprising:

- opening the vacuum inlet valve to the vacuum inlet;

- driving the vacuum pump by the electric motor to create a vacuum within the vacuum tank; and

- opening the inlet valve such that vacuum is provided at the primary inlet.

19. A method of operating a vehicle-based mobile vacuum system, comprising:

- a vacuum tank including a primary inlet controlled by an inlet valve operable for filling the vacuum tank with a material drawn in by a vacuum, and a primary outlet operable for dispensing the material therefrom;

- a storage tank including a secondary inlet operable for coupling to the primary outlet of the vacuum tank, and a secondary outlet operable for dispensing contents therefrom;

- an electric motor;

- a first valve operable to control transport of contents from the vacuum tank to the storage tank; and

- a vacuum pump in operable engagement with the electric motor

operable to draw a vacuum into the vacuum tank, the vacuum tank further including a vacuum inlet controlled by a vacuum valve operable to couple with a low pressure side of the vacuum pump,

the method comprising:

closing the first valve;

opening the vacuum inlet valve;

operating the vacuum pump so as to evacuate the vacuum tank to a predetermined pressure below atmospheric; and

opening the inlet valve such that vacuum is provided at the primary inlet.

20. A vacuum system for a vehicle-based vacuum system with the inventive features shown and described.

21. A vehicle-based vacuum system with the inventive features shown and described.

22. A method for a vehicle-based vacuum system with the inventive features shown and described.

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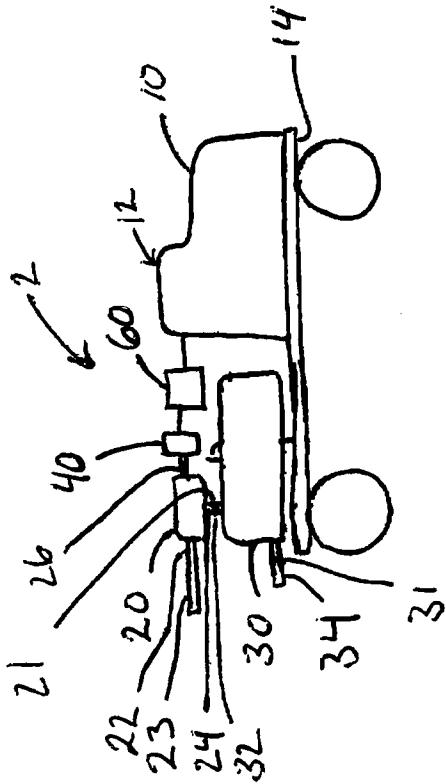


FIG. 1

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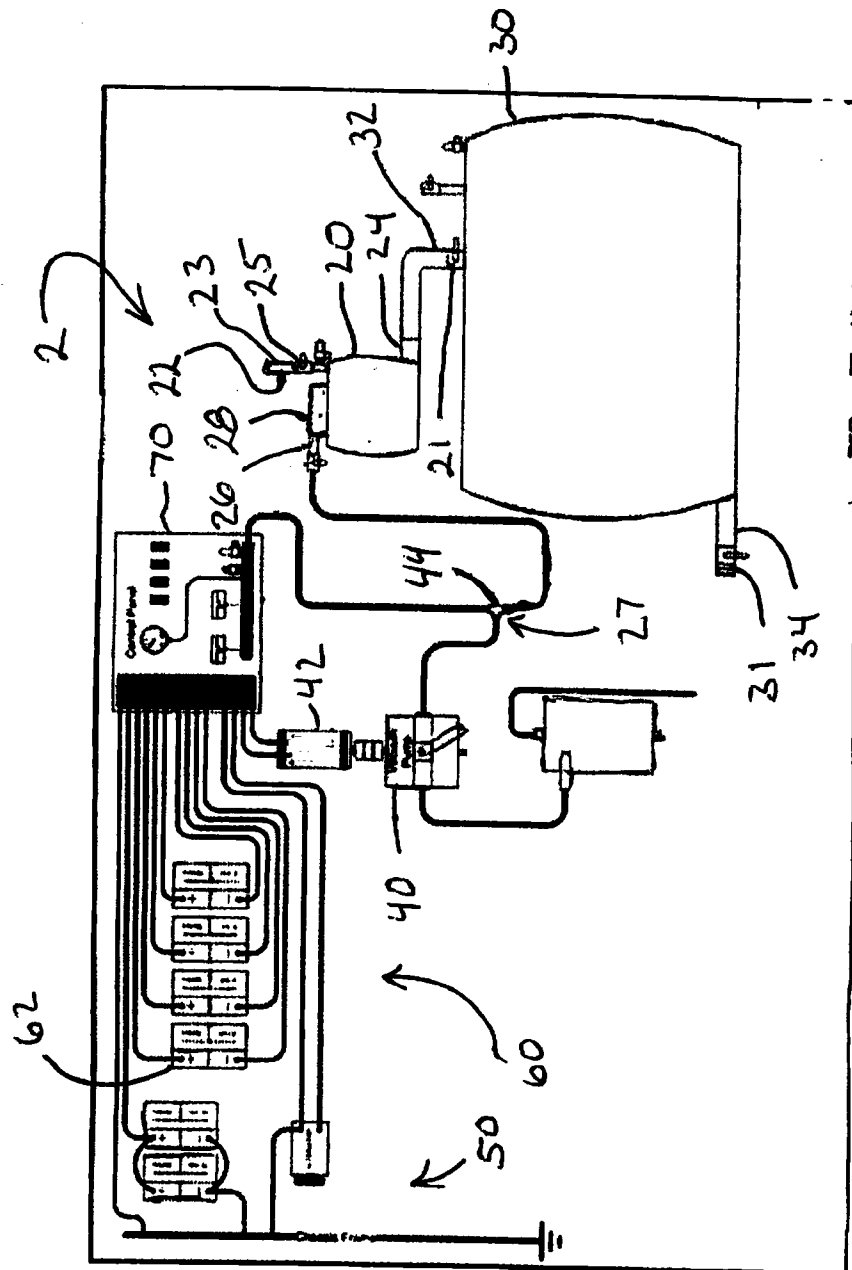


FIG. 2

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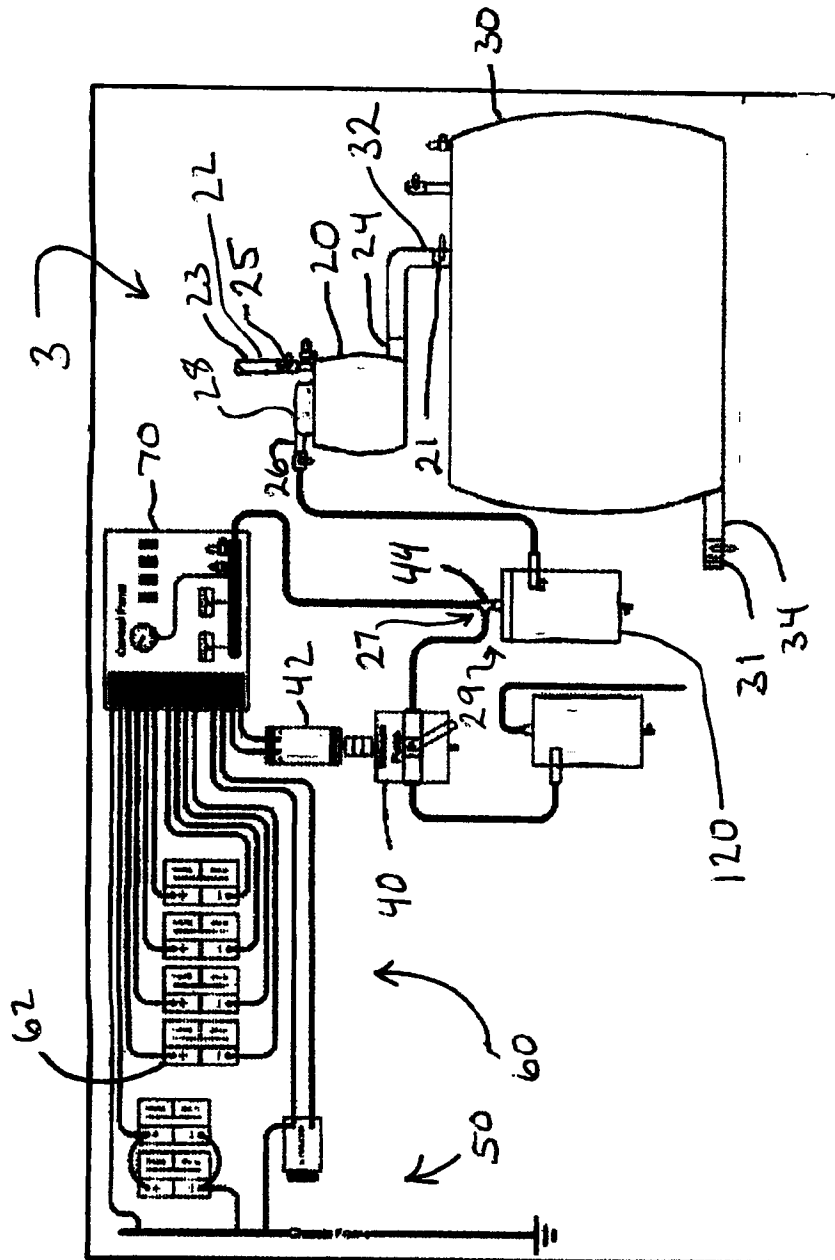


Fig. 3

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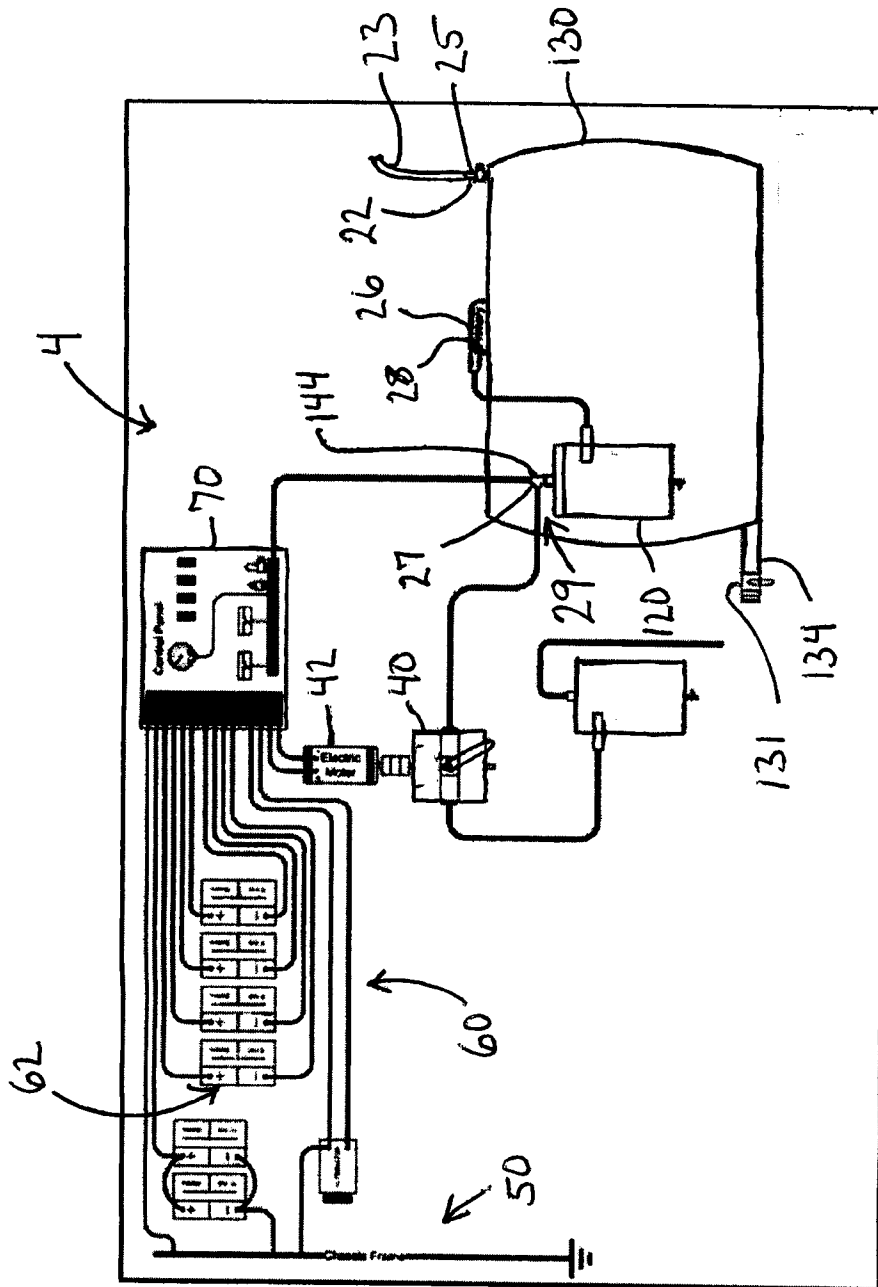


FIG. 4

A. CLASSIFICATION OF SUBJECT MATTER***F04B 37/16(2006.01)i, F04C 25/00(2006.01)i, E03D 11/00(2006.01)i, E03D 5/00(2006.01)i, E01F 1/00(2006.01)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)

IPC 8 : F04B, F04D, B01D, B60P, B65F, A01G

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

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKIPASS(KIPO internal) & keywords: "vehicle", "truck", "vacuum", "pump", "valve", "tank", "motor", "strotage", "inlet", and "outlet"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,098,580 A (ANDERSEN, A.) 24 March 1992 See claims 1-5; figure 1.	1-19
A	US 5,755,264 A (RICHARDS, J. et al.) 26 May 1998 See claims 1-10; figures 1-4.	1-19
A	JP 05-170025 A (ASK KK. et al.) 09 July 1993 See claims 1-2; figures 1-3.	1-19
A	KR 10-2003-0090428 A (KIM, M. S. et al.) 28 November 2003 See abstract; claims 1-4; figures 1-3.	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

20 NOVEMBER 2008 (20.11.2008)

Date of mailing of the international search report

20 NOVEMBER 2008 (20.11.2008)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2008/071398**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 20-22
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 20-22 are too broad to make meaningful search and include unclear terms.
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2008/071398

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5098580 A	24.03.1992	AT 74108 T AU 8175587 A DK 172654 B1 DK 503586 D0 DK 503586 A EP 0287642 B1 EP 0287642 A1 NO 180080 B NO 180080 C NO 882675 A WO 88-03126 A1	15.04.1992 25.05.1988 12.04.1999 21.10.1986 22.04.1988 25.03.1992 26.10.1988 04.11.1996 12.02.1997 16.06.1988 05.05.1988
US 5755264 A	26.05.1998	None	
JP 05-170025 A	09.07.1993	None	
KR 10-2003-0090428 A	28.11.2003	None	