ROVER UNIT FOR CLEANING SYSTEM INSTALLED ON SUCTION AND JETTING TRUCK AND TRUCK THEREOF

TECHNICAL FIELD

The present disclosure relates to a rover unit for a cleaning system installed on a suction and jetting truck. Additionally, the present disclosure relates to a suction and jetting truck having the rover unit.

BACKGROUND

A suction and jetting truck is a specialized vehicle which has a system for cleaning liquids, sludges, or slurries found in sewage ways and gutters. Known systems for cleaning include a pump that is designed to pneumatically, electrically, or hydraulically draw up liquids, sludges, or slurries. The liquids, sludges, or slurries thus drawn is stored in a storage tank of the truck and transported from one location to another location. Some of the key components of the known systems for cleaning which is installed on the suction and jetting trucks include, a suction unit, a hydraulic jetting unit, the storage tank, a suction hose, and a disposal mechanism.

Conventional suction units include a vacuum pump or an up-hole suction pump, which is responsible for suction and deposition of sewage waste in the storage tank for its eventual transport and disposal. Generally, the suction unit consumes power take off from an engine of the truck for powering the vacuum pump. Also, the up-hole suction pump is mounted on one side of the truck and the suction hose is laid down to reach deep inside the sewage pathway or the gutter for sucking the waste and sewage. The water jet hose, on the other hand, ejects a high-pressure water jet which is used to unclog the sewage pathway or the gutter.

Conventional cleaning systems installed in the suction and jetting trucks exhibit certain problems, namely the suction units of such cleaning systems are inefficient in cleaning a horizontal sewer line that is connecting manholes. These also exhibit difficulty in manoeuvring the suction hoses with larger diameters. Further, manoeuvring of the high-pressure water jet hoses pose safety issues as well as reduced efficiency. Another drawback of implementing the vacuum pumps of the suction systems in the known cleaning systems is that there is a limitation of a maximum practical suction head of 8 meters to 9 meters. Due to the said limitation, the depth of operation gets limited, i.e., the depth at which cleaning is sought becomes difficult. The suction system from a conventional cleaning system fails to operate as the depth to reach sludge or sewage increases by more than 8 meters. Another

problem in known cleaning systems is that as the depth of operation increases, the high-pressure water jet is unable to unclog the sewage pathway or the gutter, thereby leading to unclean sewage pathways and gutters.

The drawbacks / difficulties / disadvantages / limitations of conventional techniques explained in the background section are just for exemplary purposes and this disclosure would never limit its scope only such limitations. A person skilled in the art would understand that this disclosure and below mentioned description may also solve other problems or overcome the other drawbacks / disadvantages of conventional arts which are not explicitly captured above.

SUMMARY

This summary is provided to introduce a selection of concepts, in a simplified format, that are further described in the detailed description of the invention. This summary is neither intended to identify key or essential inventive concepts of the invention nor is it intended for determining the scope of the invention.

The present disclosure relates to a rover unit for a cleaning system installed on a suction and jetting truck. The rover unit includes a chassis. A rover mobility unit is adapted on the chassis. The rover mobility unit includes at least two pair of wheelset rotatably disposed on the chassis. A continuous track belt is adapted on each of the pair of wheelset. A plurality of rotary actuators adapted to drive each of the pair of wheelset. A manoeuvring unit is adapted on the chassis. The manoeuvring unit includes a plurality of legs. Each of the leg includes a driving link pivotably connected to the chassis, a driven link pivotably connected to the driving link, a support link pivotably connected to the driving link and the driven link, and a wheel is adapted at a distal end of the driven link.

The rover unit disclosed herein enables effortless cleaning of sewage pathways and gutters at enhanced depths of operation, particularly depth of operation more than 8 meters. The rover unit also helps in identifying characteristics of waste material, i.e., the slurry or sludge which is to be cleared with the help of sensors fitted thereon. Additionally, the driving link, the driven link, and the support link of the manoeuvring unit, together help in manoeuvring the rover unit effectively. For example, in narrow sewage ways where height of the sewage way is short, the various links help in adjust height of the rover unit, so that the rover unit can manoeuvre through the narrow space.

Further, skilled artisans will appreciate that elements in the drawings are illustrated for simplicity and may not have necessarily been drawn to scale. For example, the flow charts illustrate the method in terms of the most prominent steps involved to help to improve

understanding of aspects of the disclosure. Furthermore, in terms of the construction of the device, one or more components of the device may have been represented in the drawings by conventional symbols, and the drawings may show only those specific details that are pertinent to understanding the embodiments of the disclosure so as not to obscure the drawings with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the accompanying drawings, wherein:

Figure 1 illustrates a suction and jetting truck depicting a cleaning system installed thereon, as per an embodiment.

Figure 2 illustrates a front view of a rover unit, as per an embodiment; and

Figure 3 illustrates a top view of a rover unit, as per an embodiment.

Further, skilled artisans will appreciate that elements in the drawings are illustrated for simplicity and may not have necessarily been drawn to scale. For example, the flow charts illustrate the method in terms of the most prominent steps involved to help improve understanding of aspects of the present invention. Furthermore, in terms of the construction of the device, one or more components of the device may have been represented in the drawings by conventional symbols, and the drawings may show only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the drawings with details that will be readily apparent to those of ordinary skill in the art having benefit of the description herein.

DETAILED DESCRIPTION

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language 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 system, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates. Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary

skilled in the art to which this invention belongs. The system, methods, and examples provided herein are illustrative only and not intended to be limiting.

For example, the term "some" as used herein may be understood as "none" or "one" or "more than one" or "all." Therefore, the terms "none," "one," "more than one," "more than one, but not all" or "all" would fall under the definition of "some." It should be appreciated by a person skilled in the art that the terminology and structure employed herein is for describing, teaching, and illuminating some embodiments and their specific features and elements and therefore, should not be construed to limit, restrict or reduce the spirit and scope of the present disclosure in any way.

For example, any terms used herein such as, "includes," "comprises," "has," "consists," and similar grammatical variants do not specify an exact limitation or restriction and certainly do not exclude the possible addition of one or more features or elements, unless otherwise stated. Further, such terms must not be taken to exclude the possible removal of one or more of the listed features and elements, unless otherwise stated, for example, by using the limiting language including, but not limited to, "must comprise" or "needs to include."

Whether or not a certain feature or element was limited to being used only once, it may still be referred to as "one or more features" or "one or more elements" or "at least one feature" or "at least one element." Furthermore, the use of the terms "one or more" or "at least one" feature or element do not preclude there being none of that feature or element, unless otherwise specified by limiting language including, but not limited to, "there needs to be one or more..." or "one or more element is required."

Unless otherwise defined, all terms and especially any technical and/or scientific terms, used herein may be taken to have the same meaning as commonly understood by a person ordinarily skilled in the art.

Reference is made herein to some "embodiments." It should be understood that an embodiment is an example of a possible implementation of any features and/or elements of the present disclosure. Some embodiments have been described for the purpose of explaining one or more of the potential ways in which the specific features and/or elements of the proposed disclosure fulfil the requirements of uniqueness, utility, and non-obviousness.

Use of the phrases and/or terms including, but not limited to, "a first embodiment," "a further embodiment," "an alternate embodiment," "one embodiment," "an embodiment," "multiple embodiments," "some embodiments," "other embodiments," "further

embodiment", "furthermore embodiment", "additional embodiment" or other variants thereof do not necessarily refer to the same embodiments. Unless otherwise specified, one or more particular features and/or elements described in connection with one or more embodiments may be found in one embodiment, or may be found in more than one embodiment, or may be found in all embodiments, or may be found in no embodiments. Although one or more features and/or elements may be described herein in the context of only a single embodiment, or in the context of more than one embodiment, or in the context of all embodiments, the features and/or elements may instead be provided separately or in any appropriate combination or not at all. Conversely, any features and/or elements described in the context of separate embodiments may alternatively be realized as existing together in the context of a single embodiment.

Any particular and all details set forth herein are used in the context of some embodiments and therefore should not necessarily be taken as limiting factors to the proposed disclosure.

Embodiments of the present invention will be described below in detail with reference to the accompanying drawings. The details regarding construction and working of the invention disclosed herein, shall now be explained with the help of the accompanying Figures 1 through 3, as follows:

Referring to **Figure 1**, a suction and jetting truck (300) depicting a cleaning system installed thereon has been illustrated. Referring to the Figure 1 along with the Figures 2 and 3, a cleaning system (200) installed on a suction and jetting truck (300) is disclosed herein. The cleaning system (200) may include a rover unit (100), which might further include, a chassis (110).

The cleaning system (200) for a suction and jetting truck (300) may include a suction unit (310-A), a hydraulic jetting unit (310-B), a rotatable robotic arm which is part of a robotic arm unit (310-C), a software system for GPS and operation monitoring, an electronic controller unit, a sludge mapping or cleanliness checking system, a manhole cover opening system, the rover unit (100) and a storage tank (310-D). In another embodiment, the cleaning system (200) may include these elements, either in entirety or in a combination thereof. Further, the cleaning system (200) as per an embodiment might further include a rodding unit or a grabbing unit or a combination thereof.

The cleaning system (200) as per an embodiment is equipped with a rotatable robotic arm which is part of the robotic arm unit (310-C) to handle heavy suction hoses as well as high pressure jetting nozzle. The robotic arm adapts to a holder to hold the suction hose or

the jetting hose. The robotic arm rotates with multiple degrees of freedom and is configured to position the suction hose or the jetting hose, which is part of a hydraulic jetting unit (310-B), over a manhole or horizontal sewer lines.

The cleaning system (200) may further include a plurality of cameras or sensors or combinations thereof adapted at various locations within the said cleaning system (200), in addition the plurality of sensors (160) adapted on the rover unit (100). Therefore, the rotating robotic arm is positioned over the manhole or the sewer line by using image processing techniques or artificial intelligence – machine learning (AI/ML) algorithms or any other techniques or software or a combination of technologies thereof, to identify the manholes or manhole covers or sewer line openings, etc. In an embodiment of the present invention, the rotating robotic arm positions the suction hose or the jetting hose or a rover unit over the manhole automatically.

The cleaning system (200) as per an embodiment of the present invention may also include the electronic controller unit. The electronic controller unit enables the rotating robotic arm to position the suction hose or jetting hose or rover unit over the manhole automatically. The electronic controller unit controls the operation of the rotating arm which is part of a robotic arm unit (310-C), such that control of the rotatable robotic arm unit (310-C) is based on an input that is inputted by a human operator, or the input is inputted through an input signal based on images acquired from the sensors and the cameras installed in the cleaning system (200).

Details of the rover unit (100) will now be provided, which is as follows:

Referring to **Figure 2**, a front view of the rover unit (100) as per an embodiment is illustrated. Additionally, referring to **Figure 3,** a top view of the rover unit (100) as per an embodiment is illustrated. Referring to the accompanying Figures 2 and 3 together, a rover unit (100) for a cleaning system installed on a suction and jetting truck (300), is herein disclosed. The rover unit (100) may include a chassis (110). A rover mobility unit (120) is adapted on the chassis (110). Here, the rover mobility unit (120) includes, at least two pair of wheelset (120-A) rotatably disposed on the chassis (110). A continuous track belt (120-B) is adapted on each of the pair of wheelset (120-A). A plurality of rotary actuators (130) is adapted to drive each of the pair of wheelset (120-A). Additionally, a manoeuvring unit (140) is adapted on the chassis (110). Here, the manoeuvring unit (140) may include a plurality of legs (140-A). Each of the plurality of legs (140-A) might further include a driving link (140-A1) pivotably which is connected to the chassis (110), a driven link (140-A2) which is pivotably connected to the driving link (140-A1), a support link (140-A3)

which is pivotably connected to the driving link (140-A1) and the driven link (140-A2), and a wheel (140-A4) adapted at a distal end (D) of the driven link (140-A2). It is noteworthy that the driving link (140-A1) and the driven link (140-A2) enable flexibility while manoeuvring the rover unit (100). Also, the support link (140-A3) provides support and stability to the leg (140) during manoeuvring of the rover unit (100). In an alternate embodiment, the wheel (140-A4) can be driven or operated using rotary actuators (not shown). The entire rover mobility unit (120) can be manoeuvred using the wheels (140-A4). The wheels (140-A4) in combination with legs (140) also can be used for manoeuvring the rover unit (100).

In an embodiment, an outlet port is fluidically coupled to or is in fluid communication with an up-hole suction pump. The up-hole suction pump is installed on the in the suction and jetting truck (300). A rover pump (150) is installed on the chassis (110) which is coupled to the outlet port. The rover pump (150) is adapted to assist in maintaining a pressure differential at the outlet port during an operation mode. Generally, at greater depth of the sewage pipe, for example beyond 8 meters or 10 meters, the negative pressure differential at the output port diminishes. Hence, a suction pressure exerted by the up-hole suction pump on the waste material decreases, thereby leading to a lesser volume of the waste material to be collected for disposal. In such scenario, the electronic controller unit transmits a pumping instruction to activate the rover pump (150), upon receipt of the depth of operation detected by the electronic controller unit. Therefore, pumping by the rover pump (150) is initiated and the pressure differential at the output port, which is diminished, is now replenished. Hence, any loss of pressure experienced by the up-hole suction pump is replenished by the rover pump (150). Additionally, if the plurality of sensors (160) detects that the volume of the waste material to be collected for disposal is low, then the electronic controller unit may transmit a switch-OFF instruction to shut the up-hole suction pump. Simultaneously, the electronic controller unit may transmit the pumping instruction to activate the rover pump (150) for pumping the waste material. In this scenario, it may lead to saving of power as only the rover pump (150) is operational and the up-hole suction pump is switched-OFF.

In another embodiment, a plurality of sensors (160) is adapted on the rover unit (100). Here, each of the sensor (160) is in signal communication with an electronic controller unit which is installed in the suction and jetting truck (300). The plurality of sensors (160) is configured to detect a predetermined set of parameters, selected from a group of: a depth of operation of the rover unit (100), a characteristic of a waste material to

be pumped or a combination thereof. Additionally, the plurality of sensors (160) is configured to detect, the predetermined set of parameters, and transmit, the predetermined set of parameters to the electronic controller unit. Here, it is noteworthy that the sensors are constantly monitoring and relaying the depth of operation to the electronic controller unit. Additionally, the sensors are configured to identify various characteristics of the waste material such as, viscosity, solids content, particle size, flowrate, density, etc. Furthermore, the electronic controller unit is configured to transmit a manoeuvring instruction to the manoeuvring unit for manoeuvring the rover unit.

The said manoeuvring instruction is based on the predetermined set of parameters detected by the sensors (160). Additionally, the plurality of sensors (160) is configured to detect, the depth of operation and transmit the depth of operation detected to the electronic controller unit, such that the electronic controller unit transmits a pumping instruction to activate the rover pump (150). The said pumping instruction is transmitted by the electronic controller unit upon receipt of the depth of operation detected to initiate pumping of the waste material by the rover pump (150). Here, the rover pump (150) assists the up-hole suction pump installed on the suction and jetting truck (300) for pumping the waste material accumulated beyond the predetermined depth of operation.

The rover unit (100) disclosed herein overcomes the problems associated with of cleaning the horizontal sewer lines that is connecting manholes. The difficulty in manoeuvring the suction hoses with larger diameters exhibited in the prior art is overcome too. Further, manoeuvring of the high-pressure water jet hoses does not pose safety issues as well as reduced efficiency, as the high-pressure jet is activated only at a time when the waste material having characteristics such as solidity and toughness, is detected by the plurality of sensors (160) fitted on the rover unit (100). Also, limitation of the maximum practical suction head of 8 meters to 9 meters is overcome, and the depth of operation beyond such limits is possible by the rover unit (100) disclosed herein. As operation for cleaning is possible at higher depths, hence the high-pressure water jet can unclog the sewage pathway or the gutter effectively.

While specific language has been used to describe the present disclosure, any limitations arising on account thereto, are not intended. As would be apparent to a person in the art, various working modifications may be made to the method in order to implement the inventive concept as taught herein. The drawings and the foregoing description give examples of embodiments. Those skilled in the art will appreciate that one or more of the described elements may well be combined into a single functional element. Alternatively,

certain elements may be split into multiple functional elements. Elements from one embodiment may be added to another embodiment.

WE CLAIM:

1. A rover unit (100) for a cleaning system installed on a suction and jetting truck (300), the rover unit (100), comprising:

a chassis (110);

a rover mobility unit (120) adapted on the chassis (110), the rover mobility unit (120) comprising:

at least two pair of wheelset (120-A) rotatably disposed on the chassis (110);

a continuous track belt (120-B) adapted on each of the pair of wheelset (120-A);

a plurality of rotary actuators (130) adapted to drive each of the pair of wheelset (120-A);

a manoeuvring unit (140) adapted on the chassis (110), the manoeuvring unit (140) comprising:

a plurality of legs (140-A), each of the leg (140-A) comprising:

a driving link (140-A1) pivotably connected to the chassis (110);

a driven link (140-A2) pivotably connected to the driving link (140-A1);

a support link (140-A3) pivotably connected to the driving link (140-A1) and the driven link (140-A2); and

a wheel (140-A4) adapted at a distal end (D) of the driven link (140-A2).

2. The rover unit as claimed in claim 1, comprising:

an outlet port fluidically coupled to an up-hole suction pump; and

a rover pump (150) installed on the chassis (110) coupled to the outlet port, wherein the rover pump (150) is adapted to assist in maintaining a pressure differential at the outlet port during an operation mode.

3. The rover unit as claimed in claim 1, comprising a plurality of sensors (160) adapted on the rover unit (100), wherein each of the sensor (160) is in signal communication with an electronic controller unit installed in the suction and jetting truck (300).

4. The rover unit as claimed in claim 1, wherein the plurality of sensors (160) is configured to detect a predetermined set of parameters, selected from a group of: a depth of operation of the rover unit (100), a characteristic of a waste material to be pumped or a combination thereof.

5. The rover unit as claimed in claim 1, wherein the plurality of sensors (160) is configured to:

detect, the predetermined set of parameters;

transmit, the predetermined set of parameters to the electronic controller unit,

wherein the electronic controller unit is configured to transmit a manoeuvring instruction to the manoeuvring unit for manoeuvring the rover unit, based on the predetermined set of parameters detected.

6. The rover unit as claimed in claim 1, wherein the plurality of sensors (160) is configured to:

detect, the depth of operation and transmit the depth of operation detected to the electronic controller unit, wherein

the electronic controller unit transmits a pumping instruction to activate the rover pump (150), upon receipt of the depth of operation detected, and initiates pumping of the waste material.

7. The rover unit as claimed in claim 1, wherein the rover pump (150) assists the up-hole suction pump installed on the suction and jetting truck (300), for pumping the waste material accumulated beyond the predetermined depth of operation.

8. The rover unit as claimed in claim 1, wherein the wheel (140-A4) is operated through a rotary actuator, wherein the wheels (140-A4) manoeuvre the rover mobility unit (120), further wherein the wheels (140-A4) in combination with the plurality of legs (140) manoeuvres the rover unit (100).

9. A cleaning system (200) installed on a suction and jetting truck (300), the cleaning system (200), comprising:

a rover unit (100), comprising:

a chassis (110);

a rover mobility unit (120) adapted on the chassis (110), the rover mobility unit (120) comprising:

at least two pair of wheelset (120-A) rotatably disposed on the chassis (110);

a continuous track belt (120-B) adapted on each of the pair of wheelset (120-A);

a plurality of rotary actuators (130) adapted to drive each of the pair of wheelset (120-A);

a manoeuvring unit (140) adapted on the chassis (110), the manoeuvring unit (140) comprising:

a plurality of legs (140-A), each of the leg (140-A) comprising:

a driving link (140-A1) swivelably connected to the chassis (110);

a driven link (140-A2) swivelably connected to the driving link (140-A1);

a support link (140-A3) hingedly connected to the driving link (140-A1) and the driven link (140-A2); and

a wheel (140-A4) adapted at a distal end (D) of the driven link (140-A2).