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(54) **SUCTION DREDGER VEHICLE**

(57) An unmanned suction dredger vehicle, comprising a first and a second body parts coupled together by a mechanism configured to enable an articulated steering of the vehicle, wherein the first and the second body parts with wheels configured to enable moving of the vehicle. The vehicle further comprises a power source coupled with the first body part configured to provide power to the vehicle, a boom coupled with the second body part and a pump with a piping coupled, at least partly, with the boom configured to enable a suction dredging.

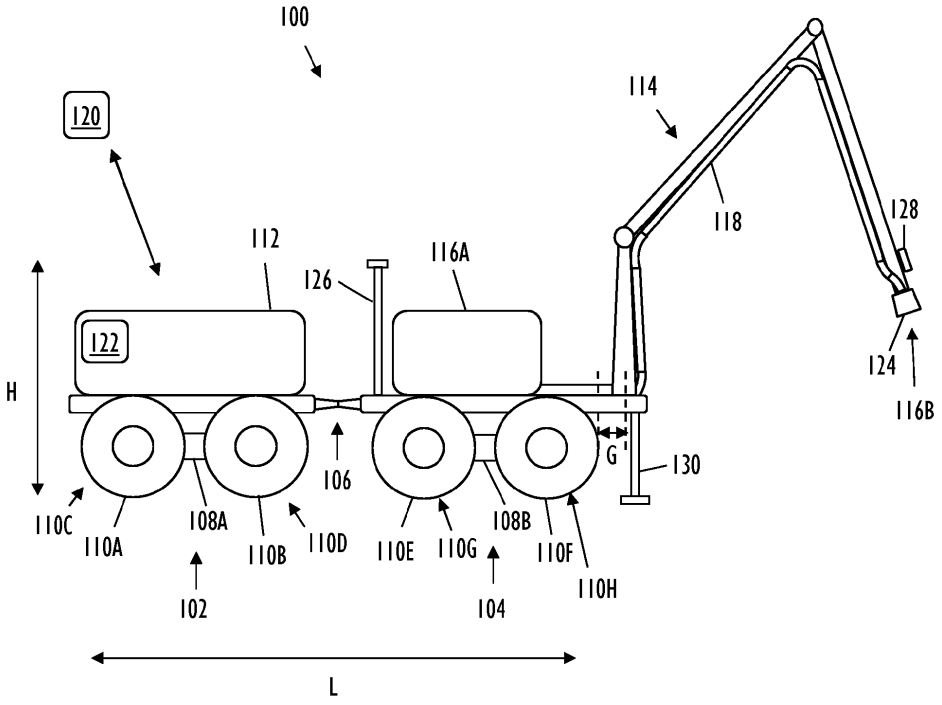

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a field of suction dredgers, especially suction dredger vehicles.

TECHNICAL BACKGROUND

[0002] The suction dredgers are widely used for dredging waters. There are a lot of suction dredger solutions available in the market, but they have many drawbacks. One drawback is a large size of the suction dredgers. Due to the large size, they are often unsuitable for small waters in a sensitive environment like in natural parks, for example. Hence, more sophisticated solution for the suction dredging is needed.

BRIEF DESCRIPTION

[0003] The present invention is defined by the subject matter of the independent claim.

[0004] Embodiments are defined in the dependent claims.

[0005] The embodiments and features, if any, described in this specification that do not fall under the scope of the independent claim are to be interpreted as examples useful for understanding various embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] In the following the invention will be described in greater detail by means of preferred embodiments with reference to the attached drawings, in which

Figure 1 illustrates an unmanned suction dredger vehicle according to an embodiment of the invention;
Figure 2 illustrates the unmanned suction dredger vehicle having a bogie drive according to an embodiment of the invention;
Figure 3 illustrates the unmanned suction dredger vehicle from a top view according to an embodiment of the invention; and
Figure 4 illustrates the unmanned suction dredger vehicle in a transport mode according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0007] The following embodiments are exemplifying. Although the specification may refer to "an", "one", or "some" embodiment(s) in several locations of the text, this does not necessarily mean that each reference is made to the same embodiment(s), or that a particular feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments.

[0008] A suction dredging is often performed by vessels in larger waters, but the vessels are not very suitable for small waters like small rivers or creeks. In addition, a remote location of the small waters may cause issues for the vessels. Many known suction dredgers that are operated from a land are manned and have a cabin from which the suction dredger is controlled by an operator. A common machine used in the suction dredging from the land is an excavator having pump and pipes in a boom, for example. A large size of the excavator may cause damages to the environment that may be an issue when operating in a sensitive environment like in natural parks, for example. There are also available remotely controlled unmanned suction dredgers having a smaller size, but these are used such that the whole apparatus is under water. These suction dredgers are not suitable for the small waters and are not meant for operating from the land such that the apparatus itself is on the land and only a suction head is placed under water. Because of the many drawbacks in the known solution, there is a clear need for the more sophisticated suction dredger.

[0009] According to an aspect, there is provided an unmanned suction dredger vehicle (also called as a vehicle later in this application), comprising a first and a second body parts coupled together by a mechanism configured to enable an articulated steering of the vehicle, wherein the first and the second body parts with wheels configured to enable moving of the vehicle, a power source coupled with the first body part configured to provide power to the vehicle, a boom coupled with the second body part and a pump with a piping coupled, at least partly, with the boom configured to enable a suction dredging.

[0010] The term "unmanned" refers to a vehicle without a person on board, in other words, vehicle in which an operator is not on the vehicle. The unmanned vehicle is also known as an uncrewed vehicle. This means that the vehicle does not comprise a cabin to the operator for controlling the operations like suction dredging and/or moving the vehicle. The vehicle may comprise a controlling unit which allow remote controlling of the vehicle and/or the controlling unit may be integrated in the vehicle, but the operator uses it such that he/she is out of the vehicle.

[0011] Referring to Figure 1, in an embodiment, the unmanned suction dredger vehicle 100 has a two-part body comprising the first and the second body parts 102, 104. The body parts are coupled together by the mechanism 106 that enables the articulated steering of the vehicle (frame steering). Hence, the mechanism 106 comprises at least one joint (swivel) enabling movement of the first and the second body part in relation to each other. Figure 3 illustrates the vehicle with the mechanism allowing the articulated steering according to an embodiment. The mechanism may further comprise one or more actuator members configured to change an angle between the body part as presented in Figure 3. The actuator member may be a hydraulic and/or electro-hydraulic

cylinder or a linear motor, for example. An arrow L1 illustrates a longitudinal axis of the first body part 102 and an arrow L2 illustrates a longitudinal axis of the second body part. The mechanism is configured to change the angle between the longitudinal axis of the first and second body parts enabling the articulated steering of the vehicle. The articulated steering enables a small radius of turn of the vehicle which is very important in a challenging terrain. The articulated steering as such is very widely known and it can be seen as obvious to the skilled person, therefore it is not described in detail in this application.

[0012] In an embodiment, the mechanism 106 is configured to enable rotation of the first and second body parts in relation to each other about the longitudinal axis L. In another embodiment, the mechanism 106 is configured to enable movement of the first and second body parts in relation to each other such that there is an angle between the longitudinal axis of the first body part L1 and second body part L2 in a height direction H (an arrow H) of the vehicle. Then the longitudinal axis of the first body part L1 and second body part L2 are not parallel in the height direction H of the vehicle.

[0013] In an embodiment, the mechanism 106 is lockable. In other words, the mechanism can be locked such that the mechanism is prevented to enable movement of the first and the second body parts in relation to each other. Then the first and the second body parts are rigidly coupled together. In an embodiment, the mechanism is lockable such that locking prevents movement and/or rotation of the first and second body part in relation to each other in one or more of the mentioned directions. Locking of the mechanism may be used in the transport mode of the vehicle, for example.

[0014] In an embodiment, the first and the second body part of the vehicle comprises at least two wheels. Then the vehicle may comprise totally four wheels. This embodiment is not illustrated in Figures.

[0015] In an embodiment, illustrated for example in Figure 1, the first and the second body part of the vehicle comprises at least four wheels. Then the vehicle may comprise totally eight wheels 110A - 110H.

[0016] Referring to another embodiment illustrated in Figure 1, the first and second body part 102, 104 comprises the bogie drive (bogie lift) 108A, 108B. The bogie drive may comprise two axes (double bogie axis), in other words, two pairs of the wheels. For example, the first body part 102 having a first bogie drive 108A may comprise two pairs of the wheels 110A - 110C and 110B - 110D. Respectively, the second body part having a second bogie drive may also comprise two pairs of the wheels 110E - 110G and 110F - 110H. Hence, there are two axes in the one bogie drive configured to receive two pairs of the wheels. Referring to Figure 2, in an embodiment the bogie drive enables movements of the individual wheel coupled with the bogie in the height direction H. Then the vehicle travels more steadily in the uneven terrain. Further, the bogie drive may be configured to dampen an oscillation of the vehicle automatically. The bogie drive is very widely known, and it can be seen as obvious to the skilled person, therefore it is not described in detail in this application.

[0017] In an embodiment, the vehicle comprises crawlers (tracks). The crawler may be an over tyre track (OTT) type, for example. The OTT refers to the crawler that is assembled over the wheels (tyres) of the vehicle. The vehicle may have rubber wheels (tyres) and the crawler may be assembled over the wheels. The rubber wheels refer to the wheels of the vehicle that can be used also without the crawlers. The crawlers may be removably assembled over the wheels and used only when needed.

[0018] In another embodiment, wheels of the vehicle refer to the wheels that are configured to be used only with crawler (tracks). This kind of wheels are not configured to be used without the crawlers. The wheel(s) is configured to transmit power (force) from the power source to the crawler, in other words, to rotate the crawler. There may be one or more wheels inside the crawler (inside a loop formed by the crawler). At least one of the wheels is configured to transmit the force from the power source to the crawler. The wheel may be a geared wheel, for example. This kind of crawler assemblies are widely used in all-terrain vehicles (ATV), for example

[0019] It is good to highlight that the term "wheel" in this application may refer to or a (rubber) tyre of the vehicle that can be used also without crawlers (tracks). In addition, the wheel may also refer to the wheel used with crawlers (part of the crawler assembly) and the wheel cannot be used without crawler.

[0020] In an embodiment, the vehicle 100 further comprises one or more turning wheels. The vehicle may then comprise the articulated steering and further one or more of the turning wheels (pair of wheels) to enhance the steering further (compared to the articulated steering) and enable better steering of the vehicle in the challenging terrain. Still referring to Figure 3, any of the wheel pairs 110A - 110C, 110B - 110D, 110E - 110G and/or 110F - 110H of the vehicle may be turnable, for example. In an embodiment all of the above mentioned wheel pairs may be turnable.

[0021] In an embodiment, one or more wheel pairs 110A - 110C, 110B - 110D, 110E - 110G and/or 110F - 110H of the vehicle are a drive wheels. In one embodiment all the above mentioned wheels are the drive wheels, then all the 8 wheels of the vehicle are the drive wheels (traction wheels).

[0022] Referring to Figure 1, in an embodiment the vehicle 100 comprises the power source 112 coupled with the first body part 102 configured to provide power to the vehicle 100. The power source may be configured to provide all needed power for operating the vehicle. It may provide a power (force) for moving (driving and steering) the vehicle, for using the boom and for the suction dredging, for example. In an embodiment, the vehicle may comprise a plurality of the power sources. In one embodiment, both of the first and the second body part may comprise the power source. In an embodiment, the power source

is placed on the opposite part body of the vehicle than the boom. For example, the power source may be in the first body part and the boom in the second body part as illustrated in Figure 1. Then the power source is a counterweight for the boom, this is very essential to keep the vehicle in balance when using the boom. This also eliminates or reduces needs for stabilizing legs (outriggers).

[0023] In an embodiment, the power source is a combustion engine. It may be a diesel engine, for example. In another embodiment, the power source is an electric motor coupled with one or more batteries. The power source may also be a combination of the combustion engine and the electric motor.

[0024] In an embodiment, the vehicle 100 further comprises the boom 114 coupled with the second body part 104. The piping of the suction dredging 118 is coupled with the boom 114 such that the boom 114 is used to place a suction head 124 under water in the suction dredging process. The vehicle itself is on the land during the process, for example on a riverbank. The boom is configured to be movable such that it can cover certain area under the water. The operating range depends on dimensions of the boom. For example, a length of the boom may be 4 meters that gives about 8 meter operating range in a sidewise (direction W in Figure 3) and about 4 meter in the longitudinal direction (direction L in Figure 3). A depth of the water may affect the operating range. For example, 4 meter long boom may be able to operate properly in 2 meter deep water. The boom may be rotatable about the height axis H of the vehicle such that the boom can be turned above (over) the vehicle as illustrated in Figure 4.

[0025] In an embodiment, the vehicle 100 further comprises the pump 116A - B coupled with the piping 118. The pump is configured to provide a pressure needed in the suction dredging. The pump may be coupled with the power source of the vehicle. In other words, the pump gets its power from the power source of the vehicle and provides the needed suction force for the suction head via the piping. A power of the pump (capacity) may vary according to the needs. For example, a size of the piping (radius) may affect the capacity of the pump. The radius of a discharge pipe may be 2 - 6 inches, for example. A suction effect of the pump may be 2 - 7 m3, for example. Soil (mud, sludge, gravel, rocks) to be removed from the water by the suction dredging affects the selection of the pump and the piping.

[0026] In an embodiment, the pump 116B is in vicinity of one end of the boom 114. The suction head 124 may comprise the pump 116B or the pump 116B may be placed in vicinity of the suction head 124. Then the one end of the boom may refer to the end which is under water in the suction dredging. The pump may be a submersible pump type (immersion pump), for example.

[0027] In an embodiment, the pump is in the first or the second body parts. The pump may be coupled with the suction head with the piping. For example, the pump 116A may in the second body part 104 and coupled with the suction head 124 by the piping(s) 118 as illustrated in Figure 1.

[0028] The discharge pipe may be placed such that the soil removed from the water is piled far from the water and then soil does not flow back to the water. In addition, geotubes may be used with the vehicle to which the soil is stored.

[0029] The vehicle may further comprise a hydraulic pump configures to provide power for operating (driving and steering) the vehicle and the boom. The hydraulic pump may be in the second body part, for example.

[0030] In an embodiment, the power source 112 is configured to provide power for the hydraulic pump which provide power for driving motor(s) of the vehicle. The driving motors may be placed in the first and/or the second body part.

[0031] In an embodiment, the vehicle 100 comprises a remote-control unit 120 configured to control operations of the vehicle 100 remotely. The remote control of the vehicle may be based on a radio control technology wherein control signals are transmitted from the remote-control unit to the vehicle. The control signals may be transmitted wirelessly or along a cable. The control unit may comprise a transmitter and the vehicle receiver for transmitting the control signals between the control unit and the vehicle. The vehicle may comprise a processing unit configured to process the transmitted signals. The radio control technology, wireless or with a cable, is very widely known, and it can be seen as obvious to the skilled person, therefore it is not described in detail in this application. The remote control of the suction dredging vehicle also improves safety at work since the operator does not need to be in immediate vicinity of the vehicle during the operation.

[0032] In an embodiment, the vehicle 100 comprises an integrated control unit 122 configured to control the operations of the vehicle from the vehicle. For example, the control unit may be placed in the first and/or the second body parts. As described, the vehicle is unmanned but the integrated control unit may be placed such that the operator can operate the vehicle, for example, by standing next to the vehicle. In an embodiment, the integrated control unit may be in vicinity of a first end of the first body part. The first end may refer to the end that is on the opposite side of the mechanism coupling the first and second bodies together.

[0033] In an embodiment, the vehicle 100 comprises both the remote-control unit 120 and the integrated control unit 122. For example, driving of the vehicle may be controlled by the remote control unit and the suction dredging may be controlled by the integrated control unit. Further, the vehicle may comprise some control buttons, like an emergency shutdown button, in the vehicle in addition to the remote-control unit.

[0034] Referring to Figure 1, in an embodiment the boom is placed in a first end of the second body part. The first end in this case may refer to the end of the second body part which is on the opposite side of the

mechanism coupling the first and the second body parts together as illustrated in Figure 1. When the boom is placed at the end of the body part as described above, it enables the wide operating range for the suction dredging.

[0035] In an embodiment, the boom is placed in the first end of the second body part such that there is a gap G in a longitudinal direction of the vehicle between the boom and wheels that are closest to the boom. Referring to Figure 1, the wheels pair 110F - 110H is the closest to the boom 114, and the boom 114 is placed such that there is the gap between the mentioned wheels and the boom in the longitudinal direction L of the vehicle. The first end in this case may refer to the end of the second body part which is on the opposite side of the mechanism coupling the first and the second body parts together. The gap enables placing of the boom such that it is far from the nearest wheels. The technical effect of the gap is that when the boom is in a waterline, the wheels are still in the solid land properly. For example, when the vehicle is on the riverbank, there is no needs to drive the wheels in the waterline to get the boom properly over the water and /or in the waterline. For example, there may be the dense vegetation on the riverbank (bushes etc.) that makes difficult to place the wheels in the waterline.

[0036] In an embodiment, the vehicle may comprise a mechanism configured to adjust the gap G in a longitudinal direction of the vehicle L between the boom and the wheels that are closest to the boom. In other words, the base of the boom may be moved by the mechanism in the longitudinal direction. Then the whole boom may be moved. This makes possible to decrease or increase the above mentioned gap according to the needs. Further, the mechanism may be used to move the boom in the height direction H of the vehicle.

[0037] In an embodiment, the boom is removably coupled with the second body part. This enables changing of the boom. For example, the boom may be changed to another one which may give the different operating range.

[0038] In an embodiment, the boom is foldable. The foldable means that the boom can be folded up for transportation as illustrated in Figure 4, for example.

[0039] Referring to Figure 4, in an embodiment the vehicle 100 further comprises a support element 126 for the boom 114 configured to receive and support the boom 114 when the boom 114 is not in use. The support element may in the second body part on the opposite end (a second end) than the boom. In other words, in the same end in which the mechanism for coupling the body parts together is, as illustrated in Figure 4. When the boom is not in use refers to a situation wherein the suction dredging is not in progress and vehicle is moving, for example. In this kind of situation, the boom may be folded and turned such that it is above the vehicle as illustrated in Figure 4. Above the vehicle refers to a position wherein the (folded) boom is substantially parallel with the longitudinal axis of the vehicle and further it is turned such that it is pointing towards the first end of the first body part.

[0040] In an embodiment, the vehicle further comprises one or more stabilizing legs. For example, the vehicle 100 may comprise a pair of the retractable stabilizing legs 130 substantially under the base of the boom as illustrated in Figure 1. In an embodiment, a location of the stabilizing legs is adjustable in the longitudinal direction L of the vehicle. This enables to adjust the stabilizing legs to a position which is the most suitable for the suction process and/or location of the vehicle.

[0041] In an embodiment, the vehicle comprises a camera configured to monitor the suction dredging under water. Referring to Figure 1, the camera 128 may be placed in the boom 114 in vicinity of the suction head 124 such that the camera 128 is capable of monitoring the suction process and an area under water in which the suction is performed. In an embodiment, the vehicle comprises a user interface configured to present materials (images and/or video image) captured by the camera. The user interface may comprise a screen. The user interface may be in the control unit. The camera coupled with the user interface enables monitoring of the suction dredging in real time. In addition, the camera helps to identify object under water that may damage the suction head or any other part of the vehicle. The camera may also help to identify protected objects like endangered species under water and damaging of the species may be avoided.

[0042] In an embodiment, the vehicle further comprises a processing unit configured, together with the camera, to identify objects under water. For example, the processing unit may identify object under water that may damage some part of the vehicle or to identify protected objects like endangered species under water. The processing unit may provide alarm signal for the operator of the vehicle. For example, some endangered species, like a river pearl mussel, may live in a bottom of a creek in which the suction dredging will be performed. The processing unit, coupled with the camera in the boom, may identify the river pearl mussels in the creek and provide an alarm for the operator of the vehicle. In an embodiment, the processing unit is configured to stop the suction dredging process based on the results of the identification.

[0043] In addition or instead of the camera, any other sensor type may be used to provide information about the suction dredging and/or are around the suction head.

[0044] In an embodiment, the vehicle comprises the suction head configured to perform the suction dredging under water wherein an inlet of an inlet pipe of the suction head is a cone. The inlet pipe may be a part of the piping 118. The inlet pipe is coupled with the suction head and the soil from the bottom of the water is sucked via inlet pipe. The inlet pipe comprises the inlet which may be a separate part from the inlet pipe or integrated in the inlet pipe. The inlet is configured to have a shape of the cone such that diameter of the inlet reduces towards the inlet pipe (piping). This means that the diameter of the inlet is

larger at the beginning of the inlet and reduces towards the inlet pipe, in other words, the diameter gets smaller. The conical shape improves the suction force.

[0045] In an embodiment, the vehicle can be coupled with another vehicle for transportation. For example, the unmanned suction dredging vehicle can be towed by another vehicle in a long-distance transportation. A power transmission of the unmanned suction dredging vehicle may be put into neutral (turned off) enabling the towing.

[0046] In an embodiment, the unmanned suction dredging vehicle 100 further comprises a towing element 132 configured to enable towing of the vehicle. The towing element enables coupling of the towing vehicle to the unmanned suction dredging vehicle. The towing element may be a feature to which a towing hook (drawhook) of the towing vehicle may be coupled.

[0047] In an embodiment, the suction head further comprises a sieve configured to determine which size of the soil can pass the piping. A size of holes in the sieve may be selected according to the material (soil) desired to remove from the bottom of the water. The sieve may be removably coupled with the inlet.

[0048] In an embodiment, the suction head may comprise a cutter and/or a drag for removing material from the bottom of the water.

[0049] In an embodiment, the suction head may comprise a water jet for removing material from the bottom of the water.

[0050] In an embodiment, the first and/or the second body part comprises a fuel tank for the power source and/or a tank for a hydraulic fluid (hydraulic oil). In an embodiment, at least one of the tanks may be integrated in the first and/or second body part. Also, both tanks may be integrated into the first and/or the second body parts. Preferably into the second body part if the power source is in the first body part. In another embodiment, the tank(s) (one or both) is/are the separate tanks removably coupled with the vehicle.

[0051] The unmanned suction dredger vehicle having above mentioned structure is very suitable for operating in the smaller waters of the sensitive environment. Its structure is light, and steering is very efficient in the dense vegetation and/or the uneven terrain. Because of the light structure, the vehicle does not leave remarkable marks in the environment. Still the suction dredging capacity is high. The unmanned suction dredging vehicle is also configured to be operated and controlled by one person.

[0052] In addition, since the vehicle is self-propelled, there are no needs for a separate vehicle for moving the suction dredging device to the environment in which the suction dredging take place. Roads or any kind of roadways are not needed which is usually mandatory with the bigger suction dredgers. Often some kind of the roadway must be done beforehand for the bigger suction dredger to get it to the desired destination in the remote locations. The unmanned suction dredging vehicle according to the invention removes this issue since it is configured to be driven in the challenging uneven terrain and/or dense forests without damaging the sensitive environment. Hence, it can be used, for example, in the conservation areas such that it would not cause harm to the environment. In addition, the unmanned suction dredging vehicle can be coupled to the towing vehicle if transported on road. In addition to the suction dredging, the vehicle can also be used for pumping water, for example, in case of a forest fire or a flood protection.

[0053] It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

Claims

1. An unmanned suction dredger vehicle, comprising:

   a first and a second body parts coupled together by a mechanism configured to enable an articulated steering of the vehicle, wherein the first and the second body parts comprises wheels configured to enable moving of the vehicle;
   a power source coupled with the first body part configured to provide power to the vehicle;
   a boom coupled with the second body part; and
   a pump with a piping coupled, at least partly, with the boom configured to enable a suction dredging.

2. The unmanned suction dredger vehicle of claim 1, wherein the first and the second body part comprises a bogie drive coupled with the wheels.

3. The unmanned suction dredger vehicle of any preceding claim, wherein the vehicle further comprises crawlers configured to be assembled on the wheels.

4. The unmanned suction dredger vehicle of any preceding claim, wherein the vehicle comprises a remote-control unit configured to control operations of the vehicle remotely.

5. The unmanned suction dredger vehicle of claims 1 - 3, wherein the vehicle comprises an integrated control unit configured to control the operations of the vehicle from the vehicle.

6. The unmanned suction dredger vehicle of claims 4 - 5, wherein the vehicle comprises both the remote-control unit and the integrated control unit.

7. The unmanned suction dredger vehicle of any preceding claim, wherein the pump is in vicinity of an end of the boom.

8. The unmanned suction dredger vehicle of any preceding claim, wherein the boom is placed in a first end of the second body part.

9. The unmanned suction dredger vehicle of claim 8, wherein the boom is placed in the first end of the second body part such that there is a gap in a longitudinal direction of the vehicle between the boom and wheels that are closest to the boom.

10. The unmanned suction dredger vehicle of any preceding claim, wherein the vehicle further comprises a support element for the boom configured to receive and support the boom when the boom is not in use.

11. The unmanned suction dredger vehicle of any preceding claim, wherein the vehicle comprises a camera configured to monitor the suction dredging under water.

12. The unmanned suction dredger vehicle of claim 11, wherein the vehicle further comprises a processing unit configured, together with the camera, to identify objects under water.

13. The unmanned suction dredger vehicle of any preceding claim, wherein the vehicle further comprises a suction head configured to perform the suction dredging under water wherein an inlet of an inlet pipe of the suction head is a cone.

14. The unmanned suction dredger vehicle of any preceding claim, wherein the mechanism, configured to couple the first and the second body parts together, is lockable.

15. The unmanned suction dredger vehicle of any preceding claim, wherein the vehicle further comprises a towing element configured to enable towing of the vehicle.

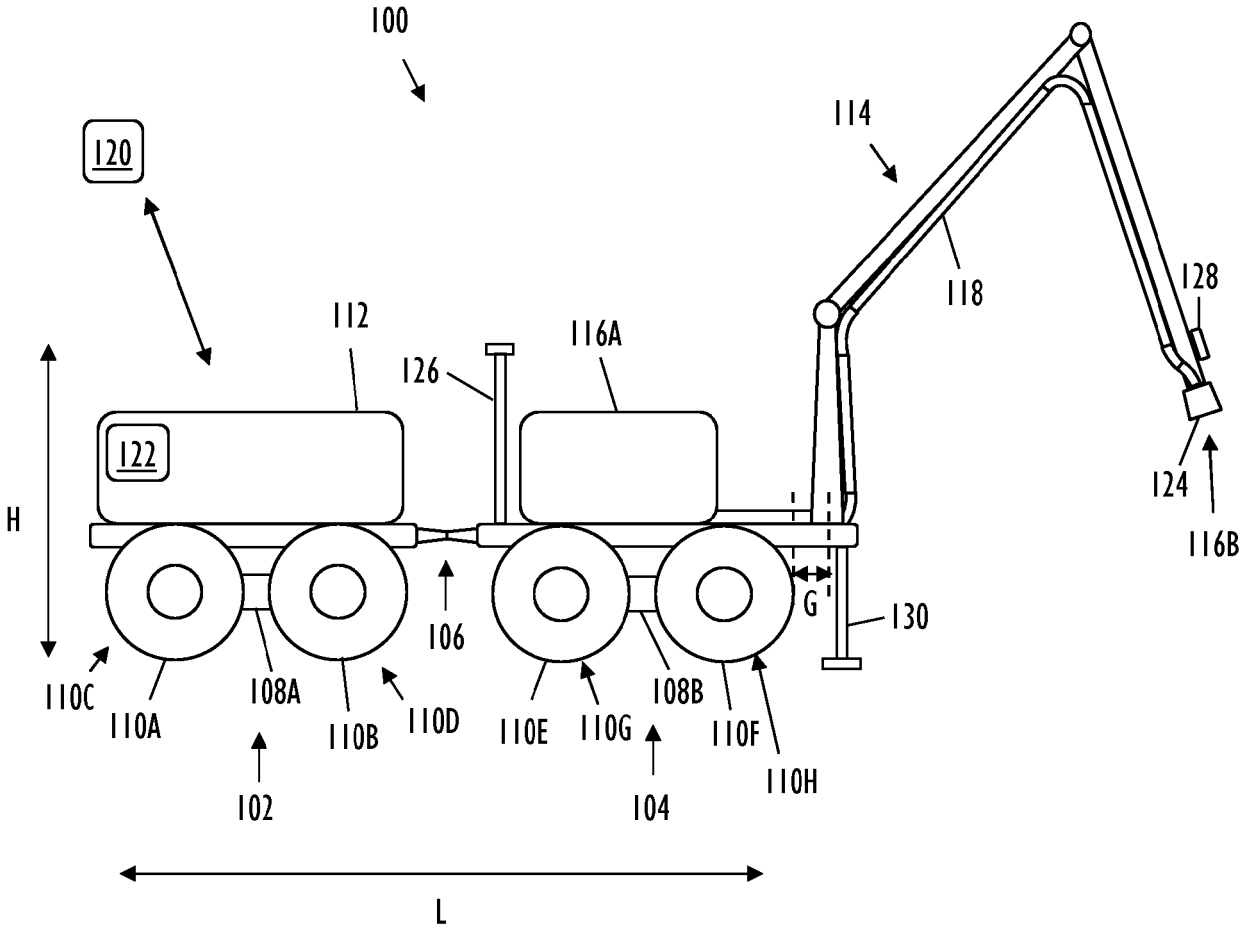
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FIG. 1

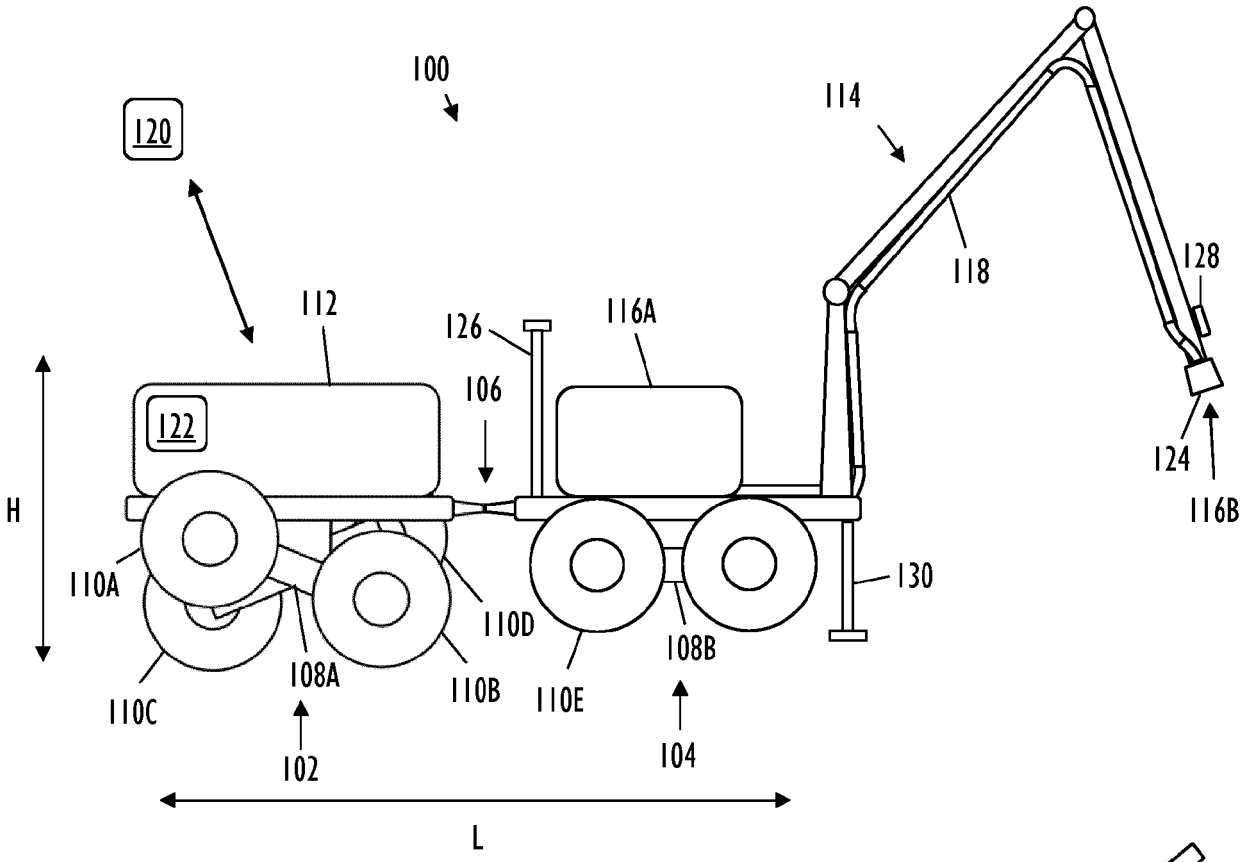
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FIG. 2

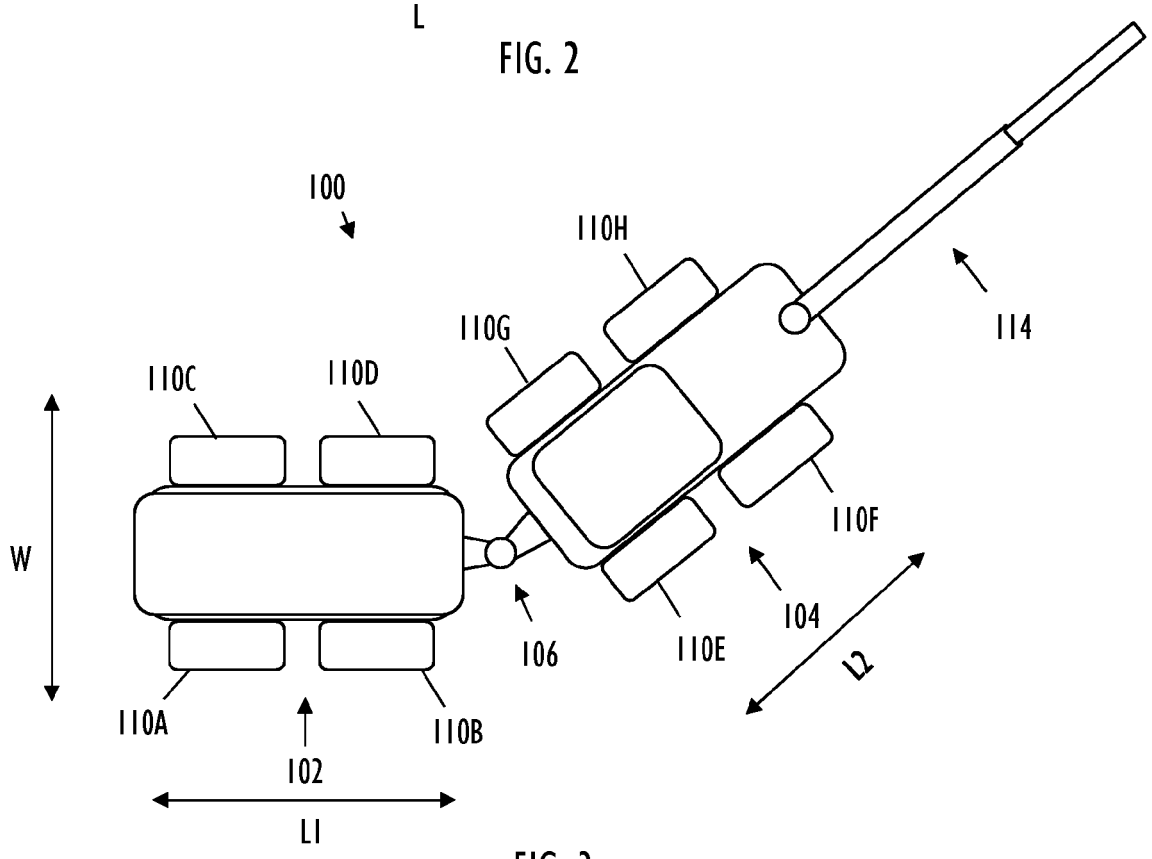
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FIG. 3

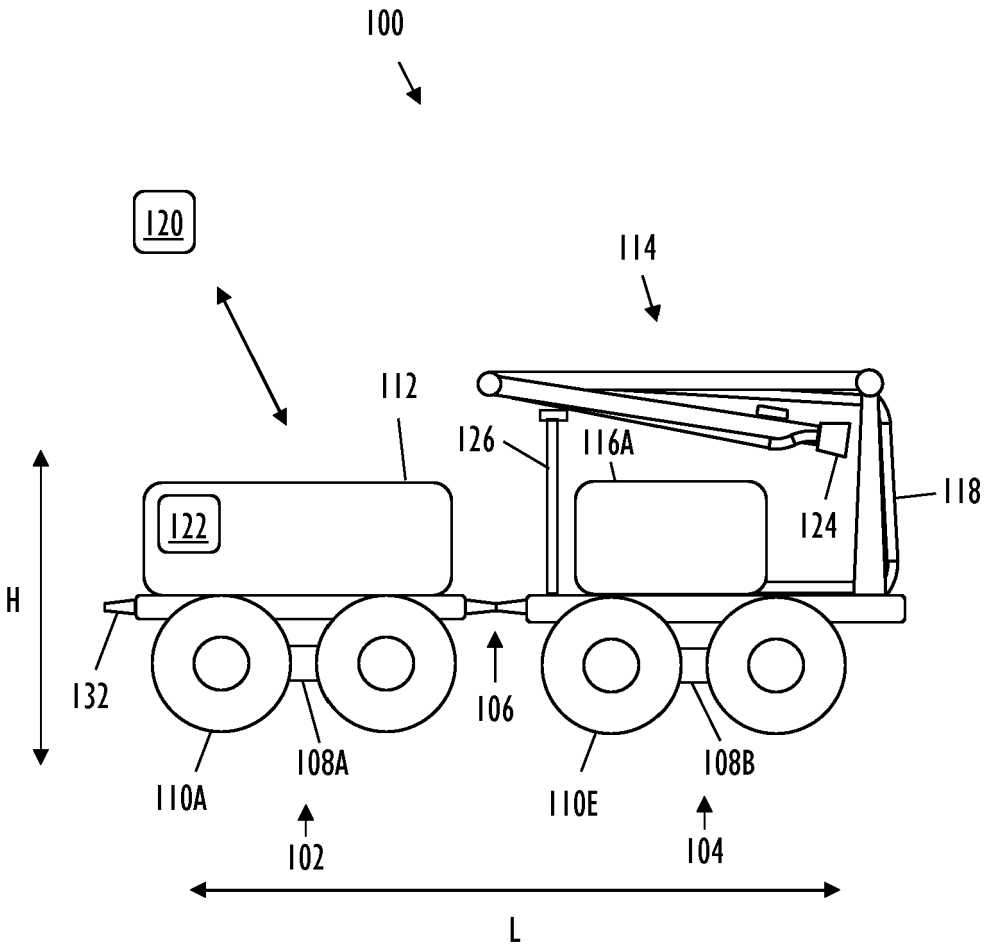
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FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 9654

DOCUMENTS CONSIDERED TO BE RELEVANT

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