

DIAPHRAGM WALL EXCAVATOR

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of Korean Patent Application No. 10-2015-0130868 filed on September 16th, 2015, the disclosures of which are incorporated herein by reference.

TECHNICAL FIELD

[0001] The present disclosure relates to a diaphragm wall excavator.

BACKGROUND

[0002] FIG. 1 is a diagram illustrating a conventional diaphragm wall excavator.

[0003] The diaphragm wall excavator illustrated in FIG. 1 was developed by BAUER from Germany. In the diaphragm wall excavator, a mud hose drum 910 is mounted on an engine room 940. The mud hose drum 910 is formed into a reel shape on which a mud hose 911 configured to convey excavated soil is wound. Further, a boom 930 is configured to support a pulley over which a wire, a hydraulic hose, and the mud hose 911 for lifting and lowering an excavation unit 920 run.

[0004] The diaphragm wall excavator generally uses a one-way (wound direction) hydraulic pump to lift and lower the excavation unit 920 by winding or unwinding a wire using a winch device. Therefore, when the excavation unit 920 excavates the ground, the wire is unwound by the weight of the excavation unit 920, and when the excavation unit 920 is moved upwards, the hydraulic pump is operated to wind the wire.

[0005] As described above, the conventional diaphragm wall excavator is configured to unwind the wire by the weight of the excavation unit 920. Thus, a lowering speed of the excavation unit 920 cannot be controlled. Therefore, it is difficult to perform excavation in a precise manner.

[0006] Further, in the conventional diaphragm wall excavator, when the excavation unit 920 is lowered, the hydraulic hose and the mud hose 911 are lowered together while being unwound. In this case, the unwinding of the hydraulic hose or the mud hose 911 cannot be easily interlocked with the lowering of the excavation unit 920. Accordingly, the hydraulic hose or the mud hose 911 is applied with excessive tension and thus damaged or excessively unwound.

[0007] Furthermore, in the conventional diaphragm wall excavator, a hydraulic pump for running the excavator, a hydraulic pump for operating a boom unit, and a hydraulic pump for operating the excavation unit 920 are separately provided, resulting in inefficiency. Further, since the multiple hydraulic pumps are provided, a high capacity cannot be allotted to each hydraulic pump. Therefore, even in case of slight overload during an operation, a capacity of each hydraulic pump is exceeded.

SUMMARY

[0008] In view of the foregoing, the present disclosure provides a diaphragm wall excavator capable of performing excavation in a more precise manner by finely adjusting a lowering speed of an excavation unit depending on geological conditions of an excavation surface.

[0009] Further, the present disclosure provides a diaphragm wall excavator in which lifting and lowering of an excavation unit can be smoothly interlocked with winding and unwinding of a hydraulic hose or a mud hose.

[0010] Furthermore, the present disclosure provides a diaphragm wall excavator capable of more comfortably driving each part of the excavator using a high-capacity hydraulic pump without a worry about overload.

[0011] According to a first aspect of the present disclosure, there is provided a diaphragm wall excavator including: a traveling unit; a base unit mounted on the traveling unit; a mud hose drum unit mounted on the base unit and configured to be able to unwind a mud hose forwards; a

hydraulic hose drum unit mounted on the base unit and configured to be able to unwind a hydraulic hose forwards; a boom unit including a mud hose guide wheel serving as a pulley for the mud hose and a hydraulic hose guide wheel serving as a pulley for the hydraulic hose and provided on the front side of the base unit; a diaphragm wall excavation unit disposed in front of the base unit via the boom unit; a winch device configured to lift and lower the diaphragm wall excavation unit; and a controller configured to control a hydraulic pressure supply to each of the mud hose drum unit and the hydraulic hose drum unit through a bidirectional hydraulic pump.

[0012] According to an exemplary embodiment, if the diaphragm wall excavation unit is lowered by unwinding of a wire of the winch device, the controller detects the magnitude of tension applied to the mud hose from a load cell provided on the mud hose while supplying a hydraulic pressure to the mud hose drum unit in a wound direction of the mud hose to increase the tension of the mud hose, and if the detected tension is greater than a predetermined mud hose tension upper limit, the controller switches the hydraulic pressure supply to a direction unwinding the mud hose from the mud hose drum unit so as to reduce the tension of the mud hose.

[0013] According to an exemplary embodiment, if the diaphragm wall excavation unit is lowered by unwinding of a wire of the winch device the controller, the controller detects the magnitude of tension applied to the hydraulic hose from a load cell provided on the hydraulic hose while supplying a hydraulic pressure to the hydraulic hose drum unit in a wound direction of the hydraulic hose to increase the tension of the hydraulic hose, and if the detected tension is greater than a predetermined hydraulic hose tension upper limit, the controller switches the hydraulic pressure supply to a direction unwinding the hydraulic hose from the hydraulic hose drum unit so as to reduce the tension of the hydraulic hose.

[0014] According to an exemplary embodiment, the winch device may include a first winch motor, a second winch motor provided on the same rotation shaft as the first winch motor, a drum unit provided to be rotatable with respect to the rotation shaft and configured to wind or unwind a

wire connected to the diaphragm wall excavation unit, and a driving force transfer unit configured to transfer a first driving force of the first winch motor or a second driving force of the second winch motor to the drum unit to rotate the drum unit.

[0015] According to an exemplary embodiment, in the winch device, the first winch motor may have a higher capacity than the second winch motor.

[0016] According to an exemplary embodiment, in the second winch motor, a force in a wound direction of the wire may be set to be smaller than the weight of the diaphragm wall excavation unit, and in the first winch motor, a force in a wound direction of the wire may be set to be greater than the weight of the diaphragm wall excavation unit.

[0017] According to an exemplary embodiment, the driving force transfer unit may provide a structure that suppresses a transfer of the first driving force to the second winch motor when the drum unit is rotated by the first driving force and suppresses a transfer of the second driving force to the first winch motor when the drum unit is rotated by the second driving force.

[0018] According to an exemplary embodiment, the driving force transfer unit may include: a housing unit connected to the drum unit; a first planetary gear unit configured to receive the first driving force from the first winch motor through a first shaft and transfer the first driving force to the housing unit through a first ring gear; and a second planetary gear unit configured to receive the second driving force from the second winch motor through a second shaft and transfer the second driving force to the housing unit through a second ring gear.

[0019] According to an exemplary embodiment, when the second driving force is supplied from the second winch motor, in the first planetary gear unit, the first ring gear rotated as being interlocked with rotation of the housing unit and multiple first planetary gears rotated as being engaged with the first ring gear may revolve around the first shaft without supplying a rotatory power to the first shaft.

[0020] According to an exemplary embodiment, when the first driving force is supplied from the first winch motor, in the second planetary gear unit, the second ring gear rotated as being interlocked with rotation of the housing unit and multiple second planetary gears rotated as being engaged with the second ring gear may revolve around the second shaft without supplying a rotatory power to the second shaft.

[0021] According to an exemplary embodiment, when the second driving force is supplied from the second winch motor, a braking power for suppressing rotation may be supplied to the first shaft, and when the first driving force is supplied from the first winch motor, a braking power for suppressing rotation may be supplied to the second shaft.

[0022] According to an exemplary embodiment, the first planetary gear unit may include a first planetary gear carrier on which multiple first planetary gears rotated as being engaged with the first ring gear are provided, and the second planetary gear unit may include a second planetary gear carrier on which multiple second planetary gears rotated as being engaged with the second ring gear are provided. The first planetary gear carrier and the second planetary gear carrier may be fixed on a rotation shaft fixing frame physically separated from the housing unit.

[0023] According to an exemplary embodiment, the first planetary gear unit may further include: a first intermediate planetary gear carrier on which multiple first intermediate planetary gears directly engaged with the first shaft are provided; a first intermediate ring gear externally engaged with the multiple first intermediate planetary gears; and a first intermediate sunwheel internally engaged with the multiple first intermediate planetary gears.

[0024] According to an exemplary embodiment, the first intermediate ring gear may be fixed on the housing unit such that the multiple first intermediate planetary gears and the first intermediate planetary gear carrier can be rotated when the first shaft is rotated, and the multiple first intermediate planetary gears may receive a rotatory power directly or indirectly from the first intermediate sunwheel and transfer the rotatory power to the first ring gear.

[0025] According to an exemplary embodiment, the second planetary gear unit may further include: a second intermediate planetary gear carrier on which multiple second intermediate planetary gears directly engaged with the second shaft are provided; a second intermediate ring gear externally engaged with the multiple second intermediate planetary gears; and a second intermediate sunwheel internally engaged with the multiple second intermediate planetary gears.

[0026] According to an exemplary embodiment, the second intermediate ring gear may be fixed on the housing unit such that the multiple second intermediate planetary gears and the second intermediate planetary gear carrier can be rotated when the second shaft is rotated, and the multiple second intermediate planetary gears may receive a rotatory power directly or indirectly from the second intermediate sunwheel and transfer the rotatory power to the second ring gear.

[0027] According to an exemplary embodiment, the diaphragm wall excavator according to the first aspect of the present disclosure may further include: a power-pack unit disposed to be detachable on the base unit.

[0028] According to an exemplary embodiment, the power-pack unit may be provided to selectively perform any one of multiple hydraulic pressure supplies including a hydraulic pressure supply for driving the traveling unit, a hydraulic pressure supply for driving the boom unit, and a hydraulic pressure supply for driving the diaphragm wall excavation unit using one main hydraulic pump.

[0029] According to an exemplary embodiment, the power-pack unit may be disposed in back of the base unit in order to secure overturning stability caused by weight balance with respect to the diaphragm wall excavation unit disposed in front of the base unit.

[0030] According to an exemplary embodiment, the diaphragm wall excavator according to the first aspect of the present disclosure may further include: a hose guide wheel unit including the

mud hose guide wheel, the hydraulic hose guide wheel, and a wire guide wheel; and an auxiliary winch device configured to lift or lower the hose guide wheel unit in front of the boom unit by winding or unwinding an auxiliary wire connected to the hose guide wheel unit.

[0031] According to at least one of the exemplary embodiments of the present disclosure, the load cell is provided on the hydraulic hose or the mud hose to check tension applied to the hose and thus control winding or unwinding of the hose. Therefore, lifting and lowering of the excavation unit can be smoothly interlocked with winding and unwinding of the hydraulic hose or the mud hose. Accordingly, it is possible to suppress a problem caused by unexpected damage or excessive unwinding of the hose.

[0032] According to at least one of the exemplary embodiments of the present disclosure, two winch motors are used to supply two kinds of driving forces to one drum unit. Therefore, a lowering speed of the excavation unit can be controlled according to the degree of progress of excavation. Accordingly, it is possible to perform excavation in a more precise manner.

[0033] Further, according to at least one of the exemplary embodiments of the present disclosure, during running, driving of a boom unit, or driving of the diaphragm wall excavation unit, it is not necessary to concurrently drive any component other than the components being driven. Thus, any one of multiple hydraulic pressure supplies including a hydraulic pressure supply for driving the traveling unit, a hydraulic pressure supply for driving the boom unit, and a hydraulic pressure supply for driving the diaphragm wall excavation unit is selectively performed using one main hydraulic pump. Therefore, the only one main hydraulic pump may be provided as a high-capacity hydraulic pump. Accordingly, it is possible to more comfortably drive each part of the excavator using the high-capacity hydraulic pump without a worry about overload.

[0034] Furthermore, according to at least one of the exemplary embodiments of the present disclosure, the auxiliary winch device may be used to lift and lower the hose guide wheel unit including the mud hose guide wheel, the hydraulic hose guide wheel, and the wire guide wheel.

Therefore, when the hose guide wheel unit is lowered, an additional depth can be obtained without replacing the diaphragm wall excavation unit. Further, if the mud hose or the hydraulic hose is damaged, it is easy to replace the mud hose or the hydraulic hose.

BRIEF DESCRIPTION OF THE DRAWINGS

In the detailed description that follows, embodiments are described as illustrations only since various changes and modifications will become apparent to those skilled in the art from the following detailed description. The use of the same reference numbers in different figures indicates similar or identical items.

[0035] FIG. 1 is a diagram illustrating a conventional diaphragm wall excavator;

FIG. 2 is a schematic side view of a diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 3 is a schematic plane view illustrating main components of the diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 4 is a schematic side view of a diaphragm wall excavator according to another exemplary embodiment of the present disclosure;

FIG. 5 is a schematic plane view illustrating main components of the diaphragm wall excavator according to another exemplary embodiment of the present disclosure;

FIG. 6 is a schematic front view provided to explain a winch device applied to a diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 7 is a schematic diagram illustrating the inside of a drum unit of the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 8 is a schematic cross-sectional view provided to explain main components of a driving force transfer unit of a winch device applied to a diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 9 is a conceptual diagram provided to explain a connection relationship among the main components of the driving force transfer unit of the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 10 is a flowchart provided to explain a principle of rotation of a housing unit and a drum unit by driving of a first planetary gear unit in the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 11 is a flowchart provided to explain a principle of rotation of the housing unit and the drum unit by driving of a second planetary gear unit in the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure;

FIG. 12 is a schematic side view provided to explain lifting and lowering of a hose guide wheel unit by an auxiliary winch device in a diaphragm wall excavator according to an exemplary embodiment of the present disclosure; and

FIG. 13 is a flowchart provided to explain a control method of appropriately maintaining tension of a hose such as a mud hose or a hydraulic hose when a diaphragm wall excavation unit is lowered in a diaphragm wall excavator according to an exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION

[0036] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings so that the present disclosure may be readily implemented by those skilled in the art. However, it is to be noted that the present disclosure is not limited to the embodiments but can be embodied in various other ways. In drawings, parts

irrelevant to the description are omitted for the simplicity of explanation, and like reference numerals denote like parts through the whole document.

[0037] Through the whole document, the term “connected to” or “coupled to” that is used to designate a connection or coupling of one element to another element includes both a case that an element is “directly connected or coupled to” another element and a case that an element is “electronically connected or coupled to” another element via still another element.

[0038] Through the whole document, the term “on” that is used to designate a position of one element with respect to another element includes both a case that the one element is adjacent to the another element and a case that any other element exists between these two elements.

[0039] Further, through the whole document, the term “comprises or includes” and/or “comprising or including” used in the document means that one or more other components, steps, operation and/or existence or addition of elements are not excluded in addition to the described components, steps, operation and/or elements unless context dictates otherwise.

[0040] Furthermore, explanation of a configuration or technical matter obvious to those skilled in the art will be briefly provided or omitted.

[0041] A diaphragm wall excavator according to an exemplary embodiment of the present disclosure (hereinafter, referred to as “the present diaphragm wall excavator”) is a device which can be used for diaphragm wall excavation performed to secure an underground space.

[0042] **FIG. 2** is a schematic side view of a diaphragm wall excavator according to an exemplary embodiment of the present disclosure, and **FIG. 3** is a schematic plane view illustrating main components of the diaphragm wall excavator according to an exemplary embodiment of the present disclosure. Further, **FIG. 4** is a schematic side view of a diaphragm wall excavator according to another exemplary embodiment of the present disclosure, and **FIG. 5** is a schematic plane view illustrating main components of the diaphragm wall excavator according to another exemplary embodiment of the present disclosure.

[0043] For reference, as compared with the diaphragm wall excavator illustrated in **FIG. 2** and **FIG. 3**, the diaphragm wall excavator illustrated in **FIG. 4** and **FIG. 5** may be referred to as “special diaphragm wall excavator”. In other words, the diaphragm wall excavator illustrated in **FIG. 4** and **FIG. 5** is a device which can be used for special diaphragm wall excavation performed to secure an underground space in an area, such as a downtown area, with a limited overall height in order to expand an underground parking lot, remodel a building, or reinforce the foundation of an overpass. However, the present diaphragm wall excavator is not limited in use to a special environmental condition but can be extensively used under various construction conditions.

[0044] Referring to **FIG. 2** to **FIG. 5**, the present diaphragm wall excavator includes a traveling unit 1, a base unit 2, a boom unit 4, a diaphragm wall excavation unit 5, and a winch device 7.

[0045] The traveling unit 1 may be a crawler-type running device including a caterpillar track. However, the traveling unit 1 is not limited thereto, but may employ various running devices.

[0046] Further, the base unit 2 is provided on the traveling unit 1. The base unit 2 may be provided so as to be rotatable (swingable) with respect to the traveling unit 1 around a vertical shaft. Such a rotating structure is obvious to those skilled in the art. Thus, a detailed explanation thereof will be omitted.

[0047] Further, the boom unit 4 is provided on the front side of the base unit 2. The boom unit 4 is configured to support a wire guide wheel 443 over which a wire 74 for lifting and lowering the diaphragm wall excavation unit 5 runs, a hydraulic hose guide wheel 442 over which a hydraulic hose runs, and a mud hose guide wheel 441 over which a mud hose 31 runs.

[0048] Furthermore, the boom unit 4 may include a lower boom 41 and a head boom 42.

[0049] Referring to **FIG. 2** and **FIG. 4**, the lower boom 41 is connected to the front side of the base unit 2. Further, referring to **FIG. 4**, the head boom 42 may include the mud hose guide wheel 441 serving as a pulley for the mud hose 31, the hydraulic hose guide wheel 442 serving as a

pulley for the hydraulic hose, and the wire guide wheel 443 serving as a pulley for the wire 74 for lifting and lowering the diaphragm wall excavation unit 5. However, referring to **FIG. 2** and **FIG. 3**, the mud hose guide wheel 441, the hydraulic hose guide wheel 442, and the wire guide wheel 443 may be provided on a hose guide wheel unit 44 provided to be movable up and down by an auxiliary winch device 9 rather than on the head boom 42 as will be described later.

[0050] Referring to **FIG. 2**, the boom unit 4 of the present disclosure is of a leader type. Therefore, an extend boom 43 may be further disposed between the lower boom 41 and the head boom 42. Thus, the boom unit 4 can be extended in a longitudinal direction. For example, a leader-type boom used in a drilling machine may be applied as the boom unit 4. Further, the leader-type boom unit 4 can be disassembled into the lower boom 41, the head boom 42, and the extend boom 43 as described above. Therefore, it is possible to greatly reduce the transporting cost which is increased in case of transporting a conventional boom having a frame structure.

[0051] Further, referring to **FIG. 2** and **FIG. 4**, the lower boom 41 may be hinge-connected to the front side of the base unit 2 so as to be rotatable back and forth around a horizontal direction. Further, referring to **FIG. 2**, a cylinder unit 21 configured to control rotation of the hinge-connected boom unit 4 may be provided on the base unit 2. For example, referring to **FIG. 2**, one side of the cylinder 21 may be hinge-connected to a frame structure provided on the base unit 2 and the other side thereof may be hinge-connected to the boom unit 4. That is, the boom unit 4 of the present disclosure can be rotated back and forth at a predetermined angle by the hinge-connection and the cylinder unit 21. Therefore, an excavation status can be set to various conditions.

[0052] Further, the diaphragm wall excavation unit 5 is disposed in front of the base unit 2 via the boom unit 4.

[0053] For example, the diaphragm wall excavation unit 5 may be a BC-cutter. A general configuration of the diaphragm wall excavation unit 5 such as a BC-cutter is obvious to those skilled in the art. Thus, a detailed explanation thereof will be omitted.

[0054] Meanwhile, **FIG. 6** is a schematic front view provided to explain a winch device applied to a diaphragm wall excavator according to an exemplary embodiment of the present disclosure, and **FIG. 7** is a schematic diagram illustrating the inside of a drum unit of the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure.

[0055] The winch device 7 is configured to lift and lower the diaphragm wall excavation unit 5 by wining or unwinding the wire 74. For reference, the winch device 7 of the present disclosure is not necessarily limited in use to lifting and lowering of the diaphragm wall excavation unit 5 but can also be applied to various heavy equipment in need of up and down movements.

[0056] To be specific, referring to **FIG. 6** and **FIG. 7**, the winch device 7 may include a first winch motor 71 and a second winch motor 72 provided on the same rotation shaft as the first winch motor 71. For example, the first winch motor 71 and the second winch motor 72 may be hydraulic motors configured to be driven by receiving a hydraulic pressure from a hydraulic pump. Further, the first winch motor 71 and the second winch motor 72 may be interlocked with a one-way hydraulic pump configured to supply a rotatory power only in one direction (wire-wound direction). During a diaphragm wall excavation, lowering of the diaphragm wall excavation unit 5 by unwinding of the wire is implemented by the weight of the diaphragm wall excavation unit 5 while the diaphragm wall excavation unit 5 excavates an excavation surface. Thus, it can be implemented using a one-way hydraulic pump.

[0057] However, it is recognized that according to such a method of lowering the diaphragm wall excavation unit 5 by the weight of the diaphragm wall excavation unit 5, it difficult to perform excavation in a precise manner. Accordingly, the present diaphragm wall excavator is

conceived as a device which is improved so as to control a lowering speed of the diaphragm wall excavation unit 5 while using a one-way hydraulic pump.

[0058] In the winch device 7, the first winch motor 71 may have a higher capacity than the second winch motor 72. That is, if a driving force is transferred from the first winch motor 71 having a high capacity, the diaphragm wall excavation unit 5 may be lifted in a general manner. Further, if a driving force is transferred from the second winch motor 72 having a lower capacity than the first winch motor 71, the diaphragm wall excavation unit 5 may be driven in a precise manner such as being lowered at a speed lower than a speed of lowering by the weight of the diaphragm wall excavation unit 5 or being lifted at a speed lower than a speed of lifting in a general manner.

[0059] For example, in the second winch motor 72, a force in a wound direction of the wire 74 may be set to be smaller than the weight of the diaphragm wall excavation unit 5, and in the first winch motor 71, the force in the wound direction of the wire 74 may be set to be greater than the weight of the diaphragm wall excavation unit 5. In this case, if the first winch motor 71 is driven in the wound direction, the diaphragm wall excavation unit 5 is lifted by the force in the wound direction. Meanwhile, even if the second winch motor 72 is driven in the wound direction, since the force is set to be smaller than the weight of the diaphragm wall excavation unit 5, the diaphragm wall excavation unit 5 cannot be lifted but is lowered. In this case, a lowering speed (acceleration) is reduced by the force in the wound direction.

[0060] That is, according to the winch device 7 of the present disclosure, the diaphragm wall excavation unit 5 can be lowered by its own weight and can also be lowered or lifted at a low speed. Therefore, excavation suitable for each excavation condition can be performed in a more precise manner as compared with a conventional one.

[0061] Further, referring to **FIG. 6**, the winch device 7 may include a drum unit 73 provided to be rotatable with respect to the rotation shaft and configured to wind or unwind the wire 74

connected to the diaphragm wall excavation unit 5. The drum unit 73 is a typical component of a winch. Thus, a detailed explanation thereof will be omitted.

[0062] Furthermore, the winch device 7 may include a driving force transfer unit 75 configured to selectively transfer two kinds of driving forces to one drum unit 73 through two winch motors 71. That is, the driving force transfer unit 75 is configured to transfer a first driving force of the first winch motor 71 or a second driving force of the second winch motor 72 to the drum unit 73 to rotate the drum unit 73.

[0063] The driving force transfer unit 75 may provide a structure that suppresses a transfer of the first driving force to the second winch motor 72 when the drum unit 73 is rotated by the first driving force and suppresses a transfer of the second driving force to the first winch motor 71 when the drum unit 73 is rotated by the second driving force. Hereinafter, a structure and a driving of the driving force transfer unit 75 will be described in detail with reference to the accompanying drawings.

[0064] **FIG. 8** is a schematic cross-sectional view provided to explain main components of a driving force transfer unit of a winch device applied to a diaphragm wall excavator according to an exemplary embodiment of the present disclosure, and **FIG. 9** is a conceptual diagram provided to explain a connection relationship among the main components of the driving force transfer unit of the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure.

[0065] Further, **FIG. 10** is a flowchart provided to explain a principle of rotation of a housing unit and a drum unit by driving of a first planetary gear unit in the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure, and **FIG. 11** is a flowchart provided to explain a principle of rotation of the housing unit and the drum unit by driving of a second planetary gear unit in the winch device applied to the diaphragm wall excavator according to an exemplary embodiment of the present disclosure.

[0066] Referring to **FIG. 7** and **FIG. 8**, the driving force transfer unit 75 includes a housing unit 753 connected to the drum unit 73; a first planetary gear unit 751 configured to receive the first driving force from the first winch motor 71 through a first shaft 7511 and transfer the first driving force to the housing unit 753 through a first ring gear 7514; and a second planetary gear unit 752 configured to receive the second driving force from the second winch motor 72 through a second shaft 7521 and transfer the second driving force to the housing unit 753 through a second ring gear 7524.

[0067] Firstly, referring to **FIG. 9**, the first planetary gear unit 751 or the second planetary gear unit 752 are provided such that components A, B, C, and D illustrated in **FIG. 9** are organically interlocked with each other. For example, when a component A corresponding to a shaft or a sunwheel is fixed, if a component D corresponding to a ring gear is rotated, a component B corresponding to a planetary gear is engaged a gear of the fixed component A and revolves around the component A and thus a component C corresponding to a planetary gear carrier is also rotated. As another example, when the component C corresponding to a planetary gear carrier is fixed, if the component A corresponding to a shaft or a sunwheel is rotated, the component B (planetary gear) and the component D (ring gear) are rotated unconditionally. As yet another example, all the components A, B, C, and D may be rotated at the same time.

[0068] Hereinafter, referring to **FIG. 8** and **FIG. 10**, a rotational driving of the drum unit 73 caused by a driving of the first winch motor 71 will be described on the basis of a basic understanding of the planetary gear illustrated in **FIG. 9**.

[0069] If the first winch motor 71 is driven to supply the first driving force to the first shaft 7511, the first shaft 7511 is rotated. In this case, a braking power is supplied to the second shaft 7521, so that the second shaft 7521 may be kept fixed. That is, when the first driving force is supplied from the first winch motor 71, a braking power that suppresses rotation may be supplied to the second shaft 7521. For example, referring to **FIG. 7**, the second shaft 7521 may be fixed by a

second brake unit 721. The second brake unit 721 may have a structure that limits rotation by applying a physical pressure to the second shaft 7521, but is not limited thereto.

[0070] In this case, referring to **FIG. 8**, a first intermediate ring gear A 7514a is connected to the housing unit 753. Thus, according to rotation of the first shaft 7511, a first intermediate planetary gear A 7512a and a first intermediate planetary gear carrier A 7513a are rotated. Further, according to the rotation of the first intermediate planetary gear A 7512a, a first intermediate sunwheel A 7511a is rotated.

[0071] In this case, referring to **FIG. 8**, a first intermediate ring gear B 7514b is connected to the housing unit 753. Thus, according to the rotation of the first intermediate sunwheel A 7511a, a first intermediate planetary gear B 7512b and a first intermediate planetary gear carrier B 7513b are rotated. Further, according to the rotation of the first intermediate planetary gear B 7512b, a first intermediate sunwheel B 7511b is rotated.

[0072] In this case, referring to **FIG. 7** and **FIG. 8**, a first planetary gear carrier 7513 is fixed on a rotation shaft fixing frame 73a or the like so as not to be rotated. To be specific, the first planetary gear unit 751 may include the first planetary gear carrier 7513 on which multiple first planetary gears 7512 rotated as being engaged with the first ring gear 7514 are provided, and the first planetary gear carrier 7513 may be fixed on the rotation shaft fixing frame 73a physically separated from the housing unit 753. Herein, referring to **FIG. 7**, the rotation shaft fixing frame 73a has a frame structure on which the first winch motor 71 or the second winch motor 72 is fixedly provided and is configured to fix a rotation shaft for the first winch motor 71, the second winch motor 72, the first shaft 7511, and the second shaft 7521 in a state in which the housing unit 753 can be rotated.

[0073] Since the first planetary gear carrier 7513 is fixed as such, the first planetary gear 7512 and the first ring gear 7514 are rotated according to the rotation of the first intermediate sunwheel B 7511b. According to the rotation of the first ring gear 7514, the housing unit 753

connected thereto is finally rotated. If the housing unit 753 is rotated as such, the drum unit 73 interlocking with the housing unit 753 may also be rotated and the wire 74 may be wound by the first driving force supplied from the first winch motor 71.

[0074] The first intermediate planetary gear carrier A may be referred to as a first intermediate planetary gear carrier and the first intermediate planetary gear A may be referred to as a first intermediate planetary gear, and the first intermediate ring gear A may be referred to as a first intermediate ring gear and the first intermediate sunwheel A may be referred to as a first intermediate sunwheel. In this case, the first planetary gear unit 751 may include the first intermediate planetary gear carrier 7513a in which multiple first intermediate planetary gears 7512a directly engaged with the first shaft 7511 are provided, the first intermediate ring gear 7514a externally engaged with the multiple first intermediate planetary gears 7512a, and the first intermediate sunwheel 7511a internally engaged with the multiple first intermediate planetary gears 7512a. In this case, the first intermediate ring gear 7514a is fixed on the housing unit 753 such that the multiple first intermediate planetary gears 7512a and the first intermediate planetary gear carrier 7513a can be rotated when the first shaft 7511 is rotated. Further, the multiple first planetary gears 7512 may receive a rotatory power directly or indirectly from the first intermediate sunwheel 7511a and transfer the rotatory power to the first ring gear 7514.

[0075] Further, according to the rotation of the housing unit 753, the second ring gear 7524 and a second intermediate ring gear 7524a connected thereto are rotated. In this case, a second planetary gear carrier 7523 is fixed on the rotation shaft fixing frame 73a or the like so as not to be rotated. Thus, according to the rotation of the second ring gear 7524, a second planetary gear 7522 and a second intermediate sunwheel 7521a are rotated, and according to the rotation of the second intermediate sunwheel 7521a, a second intermediate planetary gear 7522a and a second intermediate planetary gear carrier 7523a are rotated.

[0076] Since the second intermediate planetary gear 7522a and the second intermediate ring gear 7524a are rotated as such, a driving force (first driving force from the first winch motor) is not transferred to the second shaft 7521. Even if the first driving force from the first winch motor 71 is transferred in a very small amount to the second shaft 7521 due to unexpected variables such as an error occurring during an actual manufacturing process or introduction of foreign materials, since the second shaft 7521 is braked as described above, only the second intermediate planetary gear 7522a and the second intermediate ring gear 7524a are finally rotated.

[0077] Accordingly, it is deemed that when the first driving force is supplied from the first winch motor 71, the second ring gear 7524 rotated as being interlocked with rotation of the housing unit 753 and the multiple second planetary gears 7522 rotated as being engaged with the second ring gear 7524 revolve around the second shaft 7521 without supplying a rotatory power to the second shaft 7521.

[0078] As described above, the driving force transfer unit 75 of the present disclosure may provide a structure that transfers the first driving force of the first winch motor 71 to the drum unit 73 through the first shaft 7511 but does not transfer the first driving force to the second shaft 7521 connected to the second winch motor 72.

[0079] Meanwhile, referring to **FIG. 8** and **FIG. 11**, a rotational driving of the drum unit 73 caused by a driving of the second winch motor 72 will be described below.

[0080] If the second winch motor 72 is driven to supply the second driving force to the second shaft 7521, the second shaft 7521 is rotated. In this case, a braking power is supplied to the first shaft 7511, so that the first shaft 7511 may be kept fixed. That is, when the second driving force is supplied from the second winch motor 72, a braking power that suppresses rotation may be supplied to the first shaft 7511. For example, referring to **FIG. 7**, the first shaft 7511 may be fixed by a first brake unit 711. The first brake unit 711 may have a structure that limits rotation by applying a physical pressure to the first shaft 7511, but is not limited thereto.

[0081] In this case, referring to **FIG. 8**, a second intermediate ring gear 7524a is connected to the housing unit 753. Thus, according to rotation of the second shaft 7521, a second intermediate planetary gear 7522a and a second intermediate planetary gear carrier A 7523a are rotated. Further, according to the rotation of the second intermediate planetary gear 7522a, a second intermediate sunwheel 7521a is rotated.

[0082] In this case, referring to **FIG. 7** and **FIG. 8**, a second planetary gear carrier 7523 is fixed on the rotation shaft fixing frame 73a or the like so as not to be rotated. To be specific, the second planetary gear unit 752 may include the second planetary gear carrier 7523 on which multiple second planetary gears 7512 rotated as being engaged with the second ring gear 7524 are provided, and the second planetary gear carrier 7523 may be fixed on the rotation shaft fixing frame 73a physically separated from the housing unit 753. Herein, referring to **FIG. 7**, the rotation shaft fixing frame 73a has a frame structure on which the first winch motor 71 or the second winch motor 72 is fixedly provided and is configured to fix a rotation shaft for the first winch motor 71, the second winch motor 72, the first shaft 7511, and the second shaft 7521 in a state in which the housing unit 753 can be rotated.

[0083] Since the second planetary gear carrier 7523 is fixed as such, the second planetary gear 7522 and the second ring gear 7524 are rotated according to the rotation of the second intermediate sunwheel 7521a. According to the rotation of the second ring gear 7524, the housing unit 753 connected thereto is finally rotated. If the housing unit 753 is rotated as such, the drum unit 73 interlocking with the housing unit 753 may also be rotated and the wire 74 may be wound by the second driving force supplied from the second winch motor 72.

[0084] That is, the second planetary gear unit 752 may include the second intermediate planetary gear carrier 7523a in which multiple second intermediate planetary gears 7522a directly engaged with the second shaft 7521 are provided, the second intermediate ring gear 7524a externally engaged with the multiple second intermediate planetary gears 7522a, and the second

intermediate sunwheel 7521a internally engaged with the multiple second intermediate planetary gears 7522a. In this case, the second intermediate ring gear 7524a is fixed on the housing unit 753 such that the multiple second intermediate planetary gears 7522a and the second intermediate planetary gear carrier 7523a can be rotated when the second shaft 7521 is rotated. Further, the multiple second planetary gears 7522 may receive a rotatory power directly or indirectly from the second intermediate sunwheel 7521a and transfer the rotatory power to the second ring gear 7524.

[0085] Further, according to the rotation of the housing unit 753, the first ring gear 7514 and a first intermediate ring gear B 7514b connected thereto are rotated. In this case, the first planetary gear carrier 7513 is fixed on the rotation shaft fixing frame 73a or the like so as not to be rotated. Thus, according to the rotation of the first ring gear 7514, the first planetary gear 7512 and the first intermediate sunwheel B 7511b are rotated, and according to the rotation of the first intermediate sunwheel B 7511b, the first intermediate planetary gear B 7512b and the first intermediate planetary gear carrier B 7513b are rotated.

[0086] Since the first intermediate planetary gear B 7512b and the first intermediate ring gear B 7514b are rotated as such, a driving force (second driving force from the second winch motor) is not transferred to the first intermediate sunwheel A 7511a and thus not transferred to the first shaft 7521. Even if the second driving force from the second winch motor 72 is transferred in a very small amount to the first shaft 7511 due to unexpected variables such as an error occurring during an actual manufacturing process or introduction of foreign materials, since the first shaft 7511 is braked as described above, only the first intermediate planetary gear B 7512b, the second intermediate planetary gear carrier B 7513b, and the first intermediate ring gear B 7514b are finally rotated.

[0087] Accordingly, it is deemed that when the second driving force is supplied from the second winch motor 72, the first ring gear 7514 rotated as being interlocked with rotation of the housing unit 753 and the multiple first planetary gears 7512 rotated as being engaged with the first

ring gear 7514 revolve around the first shaft 7511 without supplying a rotatory power to the first shaft 7511.

[0088] As described above, the driving force transfer unit 75 of the present disclosure may provide a structure that transfers the second driving force of the second winch motor 72 to the drum unit 73 through the second shaft 7521 but does not transfer the second driving force to the first shaft 7511 connected to the first winch motor 71.

[0089] Meanwhile, the present diaphragm wall excavator may include a mud hose drum unit 3 and a hydraulic hose drum unit 8.

[0090] Referring to **FIG. 2** to **FIG. 5**, the mud hose drum unit 3 is mounted on the base unit 2 and configured to be able to unwind a mud hose 31 forwards. The mud hose drum unit 3 may be stood and mounted on one side of the base unit 2 so as to be able to rotate around a horizontal direction and unwind the mud hose 31 forwards. That is, the mud hose drum unit 3 of the present disclosure may be mounted on a lateral side rather than on a top side. In the present diaphragm wall excavator, an engine room typically used in the prior art is substituted with a power-pack unit 6 to be described later, and, thus, the mud hose drum unit 3 is disposed on a lateral side of the base unit 2 (in a space adjacent to a cabin 100) where the engine room is conventionally disposed. Since the mud hose drum unit 3 is mounted on a lateral side as such, an overall height of the present diaphragm wall excavator can be greatly reduced as compared with a conventional one.

[0091] Particularly, the diaphragm wall excavator for special diaphragm wall excavation illustrated in **FIG. 4** and **FIG. 5** has high applicability and thus can be used in a limited space with a low overall height. That is, since the mud hose drum unit 3 is mounted on a lateral side, even if an extension of the mud hose 31 is increased, a size of the mud hose drum unit 3 is increased only in a transverse direction but an overall height of the present diaphragm wall excavator is not increased unlike a conventional one. Therefore, a length of the mud hose 31 can be increased, so that an excavation depth can be increased more freely.

[0092] Further, the hydraulic hose drum unit 8 is mounted on the base unit 2 and configured to be able to unwind a hydraulic hose forwards.

[0093] Further, referring to **FIG. 3** and **FIG. 5**, the boom unit 4 may include the mud hose guide wheel 441 serving as a pulley for the mud hose 31 and the hydraulic hose guide wheel 442 serving as a pulley for the hydraulic hose.

[0094] **FIG. 12** is a schematic side view provided to explain lifting and lowering of a hose guide wheel unit by an auxiliary winch device in a diaphragm wall excavator according to an exemplary embodiment of the present disclosure.

[0095] Referring to **FIG. 12**, the present diaphragm wall excavator may include the hose guide wheel unit 44 including the mud hose guide wheel 441, the hydraulic hose guide wheel 442, and the wire guide wheel 443 and the auxiliary winch device 9 configured to lift or lower the hose guide wheel unit 44 in front of the boom unit 4 by winding or unwinding an auxiliary wire connected to the hose guide wheel unit 44.

[0096] Referring to **FIG. 12**, the hose guide wheel unit 44 may be disposed on a front surface of the extend boom 43 so as to be movable up and down. For example, the hose guide wheel unit 44 may be combined with the boom unit 43 by a rail so as to be slidable up and down with respect to the extend boom 43. Further, referring to **FIG. 12**, the auxiliary winch device 9 may be provided on the lower boom 41, but is not limited thereto.

[0097] According to an exemplary embodiment of the present disclosure, the hose guide wheel unit 44 including the mud hose guide wheel, the hydraulic hose guide wheel, and the wire guide wheel can be lifted and lowered using the auxiliary winch device 9. Thus, if the hose guide wheel unit 44 is lowered, an additional depth can be obtained without replacing the diaphragm wall excavation unit 5. Further, if the mud hose or the hydraulic hose is damaged, the mud hose or the hydraulic hose can be easily replaced by lowering the hose guide wheel unit 44 through the auxiliary winch device 9.

[0098] For reference, in the drawings of the present disclosure, illustration of the wire 74 partially wound on the wire guide wheel 443, the mud hose 31 partially wound on the mud hose guide wheel 441, the hydraulic hose partially wound on the hydraulic hose guide wheel 442 is briefly provided or omitted for easier understanding of the major components of the present disclosure.

[0099] Meanwhile, the present diaphragm wall excavator may include a controller configured to control a hydraulic pressure supply to each of the mud hose drum unit 3 and the hydraulic hose drum unit 8 by using a bidirectional hydraulic pump. The controller may be implemented by various computing devices obvious to those skilled in the art.

[00100] FIG. 13 is a flowchart provided to explain a control method of appropriately maintaining tension of a hose such as a mud hose or a hydraulic hose when a diaphragm wall excavation unit is lowered in a diaphragm wall excavator according to an exemplary embodiment of the present disclosure.

[00101] Referring to FIG. 13, if the diaphragm wall excavation unit 5 is lowered by unwinding of the wire 74, the controller may detect the magnitude of tension applied to the mud hose 31 from a load cell provided on the mud hose 31 while supplying a hydraulic pressure to the mud hose drum unit 3 in a wound direction of the mud hose 31 to increase the tension of the mud hose 31, and if the detected tension is greater than a predetermined mud hose tension upper limit (for example, 3 TON), the controller may switch the hydraulic pressure supply to an unwound direction of the mud hose 31 to reduce the tension of the mud hose 31.

[00102] Further, referring to FIG. 13, the controller may detect the magnitude of tension applied to the hydraulic hose from a load cell provided on the hydraulic hose while supplying a hydraulic pressure to the hydraulic hose drum unit 8 in a wound direction of the hydraulic hose to increase the tension of the hydraulic hose, and if the detected tension is greater than a

predetermined hydraulic hose tension upper limit, the controller may switch the hydraulic pressure supply to an unwound direction of the hydraulic hose to reduce the tension of the hydraulic hose.

[00103] Accordingly, the load cell is provided on the hydraulic hose or the mud hose to check tension applied to the hose and thus control winding or unwinding of the hose. Therefore, lifting and lowering of the diaphragm wall excavation unit 5 can be smoothly interlocked with winding and unwinding of the hydraulic hose or the mud hose while keeping a predetermined tension. Therefore, it is possible to suppress a problem caused by unexpected damage or excessive unwinding of the hose.

[00104] Further, the present diaphragm wall excavator may include the power-pack unit 6 disposed to be detachable on the base unit 2.

[00105] Referring to **FIG. 2** to **FIG. 5**, the power-pack unit 6 may be disposed in back of the base unit 2. The power-pack unit 6 is a hydraulic pressure generating motor configured to obtain a driving force required to drive various devices using an engine and a hydraulic system. Since the power-pack unit 6 is provided, an engine room of a conventional diaphragm wall excavator typically having a crawler crane can be removed. Further, since the power-pack unit 6 is disposed to be detachable, when a failure occurs, the present diaphragm wall excavator can be returned to normal conditions by replacement of the power-pack unit 6 unlike the conventional engine room. The faulty power-pack unit 6 may be removed and separately inspected.

[00106] For example, referring to **FIG. 4** and **FIG. 5**, the power-pack unit 6 may be disposed on a power-pack mounting table 61 provided at a back end of the base unit 2, but is not limited thereto. For example, as illustrated in **FIG. 2** and **FIG. 3**, the power-pack unit 6 may be disposed in back of a frame structure provided on the base unit 2.

[00107] Since the power-pack unit 6 is disposed in back of the base unit 2, the base unit 2 can secure overturning stability caused by weight balance between the diaphragm wall excavation

unit 5 disposed in front of the base unit 2 and the power-pack unit 6 disposed in back of the base unit 2.

[00108] Further, the power-pack unit 6 is configured to unify a running pump, a winch pump, a swing pump, etc. into one hydraulic system and thus causes improvement of easiness in control and reduction in maintenance time. To be specific, the power-pack unit 6 may include a unified hydraulic system configured to supply a running force to the traveling unit 1, a swing force for the base unit 2 to be rotated around a vertical shaft with respect to the traveling unit 1, a driving force to the winch unit 7, and a driving force to the diaphragm wall excavation unit 5.

[00109] The unified hydraulic system of the power-pack unit 6 of the present disclosure is conceived on the basis of the finding that in a general diaphragm wall excavator, it is not necessary to simultaneously perform two or more of multiple hydraulic pressure supplies including a hydraulic pressure supply for driving the traveling unit 1, a hydraulic pressure supply for driving the boom unit 4, a hydraulic pressure supply for driving the diaphragm wall excavation unit 5, a hydraulic pressure supply for rotating the base unit 2, a hydraulic pressure supply for lifting and lowering the diaphragm wall excavation unit 5, etc. For example, due to the characteristics of the diaphragm wall excavator as the heavy construction equipment and the characteristics of a diaphragm wall excavation process, while the diaphragm wall excavator runs, the boom unit 4 is driven or the diaphragm wall excavation unit 5 is not driven for stability. As another example, while the diaphragm wall excavation unit 5 performs excavation, preferably, the boom unit 4 is driven or the traveling unit 1 is not driven.

[00110] As described above, in a diaphragm wall excavator, preferably, a driving based on a hydraulic pressure supply is performed solely by any one driving unit. In the present disclosure, one hydraulic pump is unified as a main hydraulic pump instead of providing a hydraulic pump in each driving unit as shown in a conventional one. That is, the power-pack unit 6 of the present disclosure may be provided to selectively perform any one of multiple hydraulic pressure supplies including a

hydraulic pressure supply for driving the traveling unit 1, a hydraulic pressure supply for driving the boom unit 4, and a hydraulic pressure supply for driving the diaphragm wall excavation unit 5.

[00111] Accordingly, only one main hydraulic pump may be provided as a high-capacity hydraulic pump. Therefore, it is possible to more comfortably drive each part of the excavator using the high-capacity hydraulic pump without a worry about overload. Further, by the above-described unification, easiness in control can be improved and. If there is a problem with a supply of a driving force, only the power-pack unit 6 is separated and replaced or inspected. Thus, maintenance time can be reduced.

[00112] Further, referring to FIG. 2 to FIG. 5, the power-pack unit 6 may be disposed in back of the base unit 2 in order to secure overturning stability caused by weight balance with respect to the diaphragm wall excavation unit 5 disposed in front of the base unit 2.

[00113] The above description of the present disclosure is provided for the purpose of illustration, and it would be understood by those skilled in the art that various changes and modifications may be made without changing technical conception and essential features of the present disclosure. Thus, it is clear that the above-described embodiments are illustrative in all aspects and do not limit the present disclosure. For example, each component described to be of a single type can be implemented in a distributed manner. Likewise, components described to be distributed can be implemented in a combined manner.

[00114] The scope of the present disclosure is defined by the following claims rather than by the detailed description of the embodiment. It shall be understood that all modifications and embodiments conceived from the meaning and scope of the claims and their equivalents are included in the scope of the present disclosure.

EXPLANATION OF CODES

[00115] 1: Traveling unit

2: Base unit

21: Cylinder unit

3: Mud hose drum unit

31: Mud hose

4: Boom unit

41: Lower boom

42: Head boom

43: Extend boom

44: Hose guide wheel unit

441: Mud hose guide wheel

442: Hydraulic hose guide wheel

443: Wire guide wheel

5: Diaphragm wall excavation unit

6: Power-pack unit

7: Winch device

8: Hydraulic hose drum unit

9: Auxiliary winch device

91: Auxiliary wire

100: Cabin

71: First winch motor

711: First brake unit

72: Second winch motor

721: Second brake unit

73: Drum unit

73a: Rotation shaft fixing frame

74: Wire

75: Driving force transfer unit

751: First planetary gear unit

7511: First shaft

7511a: First intermediate sunwheel A

7511b: First intermediate sunwheel B

7512: First planetary gear

7512a: First intermediate planetary gear A

7512b: First intermediate planetary gear B

7513: First planetary gear carrier

7513a: First intermediate planetary gear carrier A

7513b: First intermediate planetary gear carrier B

7514: First ring gear

7514a: First intermediate ring gear A

7514b: First intermediate ring gear B

752: Second planetary gear unit

7521: Second shaft

7521a: Second middle sunwheel

7522: Second planetary gear

7522a: Second intermediate planetary gear

7523: Second planetary gear carrier

7523a: Second intermediate planetary gear carrier

7524: Second ring gear

7524a: Second intermediate ring gear

753: Housing unit

WE CLAIM

1. A diaphragm wall excavator comprising:

a traveling unit;

a base unit mounted on the traveling unit;

a mud hose drum unit mounted on the base unit and configured to be able to unwind a mud hose forwards;

a hydraulic hose drum unit mounted on the base unit and configured to be able to unwind a hydraulic hose forwards;

a boom unit including a mud hose guide wheel serving as a pulley for the mud hose and a hydraulic hose guide wheel serving as a pulley for the hydraulic hose, and provided on the front side of the base unit;

a diaphragm wall excavation unit disposed in front of the base unit via the boom unit;

a winch device configured to lift and lower the diaphragm wall excavation unit; and

a controller configured to control a hydraulic pressure supply to each of the mud hose drum unit and the hydraulic hose drum unit,

wherein if the diaphragm wall excavation unit is lowered by unwinding of a wire of the winch device, the controller detects the magnitude of tension applied to the mud hose from a load cell provided on the mud hose while supplying a hydraulic pressure to the mud hose drum unit in a wound direction of the mud hose to increase the tension of the mud hose, and if the detected tension is greater than a predetermined mud hose tension upper limit, the controller switches the hydraulic pressure supply to a direction unwinding the mud hose from the mud hose drum unit so as to reduce the tension of the mud hose , and

if the diaphragm wall excavation unit is lowered by unwinding of a wire of the winch device, the controller detects the magnitude of tension applied to the hydraulic hose from a load cell provided on the hydraulic hose while supplying a hydraulic pressure to the hydraulic hose drum unit in a wound direction of the hydraulic hose to increase the tension of the hydraulic hose, and if the detected tension is greater than a predetermined hydraulic hose tension upper limit, the controller switches the hydraulic pressure supply to a direction unwinding the hydraulic hose from the hydraulic hose drum unit so as to reduce the tension of the hydraulic hose.

2. The diaphragm wall excavator of Claim 1,

wherein the winch device includes a first winch motor, a second winch motor provided on the same rotation shaft as the first winch motor, a drum unit provided to be rotatable with respect to the rotation shaft and configured to wind or unwind a wire connected to the diaphragm wall excavation unit, and a driving force transfer unit configured to transfer a first driving force of the first winch motor or a second driving force of the second winch motor to the drum unit to rotate the drum unit, and

in the winch device, the first winch motor has a higher capacity than the second winch motor.

3. The diaphragm wall excavator of Claim 2,

wherein in the second winch motor, a force in a wound direction of the wire is set to be smaller than the weight of the diaphragm wall excavation unit, and

in the first winch motor, a force in a wound direction of the wire is set to be greater than the weight of the diaphragm wall excavation unit.

4. The diaphragm wall excavator of Claim 2,

wherein the driving force transfer unit provides a structure that suppresses a transfer of the first driving force to the second winch motor when the drum unit is rotated by the first driving force and suppresses a transfer of the second driving force to the first winch motor when the drum unit is rotated by the second driving force.

5. The diaphragm wall excavator of Claim 2,

wherein the driving force transfer unit includes:

a housing unit connected to the drum unit;

a first planetary gear unit configured to receive the first driving force from the first winch motor through a first shaft and transfer the first driving force to the housing unit through a first ring gear; and

a second planetary gear unit configured to receive the second driving force from the second winch motor through a second shaft and transfer the second driving force to the housing unit through a second ring gear.

6. The diaphragm wall excavator of Claim 5,

wherein when the second driving force is supplied from the second winch motor, in the first planetary gear unit, the first ring gear rotated as being interlocked with rotation of the housing unit and multiple first planetary gears rotated as being engaged with the first ring gear revolve around the first shaft without supplying a rotatory power to the first shaft, and

when the first driving force is supplied from the first winch motor, in the second planetary gear unit, the second ring gear rotated as being interlocked with rotation of the housing unit and multiple second planetary gears rotated as being engaged with the second ring gear revolve around the second shaft without supplying a rotatory power to the second shaft.

7. The diaphragm wall excavator of Claim 6,

wherein when the second driving force is supplied from the second winch motor, a braking power for suppressing rotation is supplied to the first shaft, and

when the first driving force is supplied from the first winch motor, a braking power for suppressing rotation is supplied to the second shaft.

8. The diaphragm wall excavator of Claim 5,

wherein the first planetary gear unit includes a first planetary gear carrier on which multiple first planetary gears rotated as being engaged with the first ring gear are provided,

the second planetary gear unit includes a second planetary gear carrier on which multiple second planetary gears rotated as being engaged with the second ring gear are provided, and

the first planetary gear carrier and the second planetary gear carrier are fixed on a rotation shaft fixing frame physically separated from the housing unit.

9. The diaphragm wall excavator of Claim 8,

wherein the first planetary gear unit further includes:

a first intermediate planetary gear carrier on which multiple first intermediate planetary gears directly engaged with the first shaft are provided;

a first intermediate ring gear externally engaged with the multiple first intermediate planetary gears; and

a first intermediate sunwheel internally engaged with the multiple first intermediate planetary gears,

the first intermediate ring gear is fixed on the housing unit such that the multiple first intermediate planetary gears and the first intermediate planetary gear carrier can be rotated when the first shaft is rotated, and

the multiple first intermediate planetary gears receive a rotatory power directly or indirectly from the first intermediate sunwheel and transfer the rotatory power to the first ring gear.

10. The diaphragm wall excavator of Claim 8,

wherein the second planetary gear unit further includes:

a second intermediate planetary gear carrier on which multiple second intermediate planetary gears directly engaged with the second shaft are provided;

a second intermediate ring gear externally engaged with the multiple second intermediate planetary gears; and

a second intermediate sunwheel internally engaged with the multiple second intermediate planetary gears,

the second intermediate ring gear is fixed on the housing unit such that the multiple second intermediate planetary gears and the second intermediate planetary gear carrier can be rotated when the second shaft is rotated, and

the multiple second intermediate planetary gears receive a rotatory power directly or indirectly from the second intermediate sunwheel and transfer the rotatory power to the second ring gear.

11. The diaphragm wall excavator of Claim 1, further comprising:

a power-pack unit disposed to be detachable on the base unit,

wherein the power-pack unit is provided to selectively perform any one of multiple hydraulic pressure supplies including a hydraulic pressure supply for driving the traveling unit, a hydraulic pressure supply for driving the boom unit, and a hydraulic pressure supply for driving the diaphragm wall excavation unit using one main hydraulic pump.

12. The diaphragm wall excavator of Claim 11,

wherein the power-pack unit is disposed in back of the base unit in order to secure overturning stability caused by weight balance with respect to the diaphragm wall excavation unit disposed in front of the base unit.

13. The diaphragm wall excavator of Claim 1, further comprising:

a hose guide wheel unit including the mud hose guide wheel, the hydraulic hose guide wheel, and a wire guide wheel; and

an auxiliary winch device configured to lift or lower the hose guide wheel unit in front of the boom unit by winding or unwinding an auxiliary wire connected to the hose guide wheel unit.