

LOW OVERHEAD CLEARANCE BORING MACHINE AND METHOD FOR ASSEMBLING THE SAME

FIELD OF THE INVENTION

[0001] The present invention relates to a low overhead clearance boring machine that includes a machine body and a traveling body mountable on the machine body. The present invention also relates to a method for assembling the low overhead clearance boring machine.

DISCUSSION OF THE BACKGROUND

[0002] To install foundation piles on construction sites, excavation work is performed using an excavator that is a combination of a frame and a turning boring machine.

Specifically, the boring machine is turned to rotate a casing tube and press the rotating casing tube into the ground. Then, a hammer grab hanging from the frame removes soil out of the casing tube. Thus, excavation work referred to as all-casing method is performed.

[0003] In the all-casing method, for example, as disclosed in JP10-205261A and JP10-205263A, first, a hydraulic system is used to activate a clamping device, a rotating motor, a pulling cylinder, and other elements of the boring machine. This causes the casing tube to be clamped by the clamping device and pressed into the ground by the pulling cylinder while being rotated by the rotating motor. Next, the hammer grab hanging from the frame is used to excavate the inside of the casing tube, and the soil obtained from the excavated casing tube is discharged to a place at a distance from the casing tube.

[0004] This excavation work is performed by, after the hammer grab hanging from the frame has been moved down into the casing tube, releasing a winch with the hammer grab at a predetermined height to drop the hammer grab. By dropping the hammer grab, an opening shell at the leading end of the hammer grab enters the ground. With the opening shell in the ground, the winch is wound up to make the shell closed and scoop soil, sand, and/or similar substances out of the ground.

[0005] The above-described excavator performs excavation work and conveyance work

with an excavation unit made up of the hammer grab and the casing tube hanging from the frame. This has necessitated a large area of work space over the excavator. That is, such excavator cannot be used at a place with a roof and a place with height restrictions, such as in a tunnel, which has been seen as a problem with the excavator. As a measure against this problem, a hanging conveyor is disclosed in which the frame is slidable horizontally so that the casing tube, H steel, and other objects are conveyable (JP8-48492A). With the hanging conveyor placed on a self-movable carriage, the hanging conveyor is moved to or near a small workspace with height restrictions. Then, a rail with a drill pipe and related elements hanging from the leading end of the rail slides in rightward and/or leftward directions to repeatedly embed the drill pipe in a predetermined excavation spot.

[0006] JP5621026B discloses a low overhead clearance boring machine that includes a base with a traveling body and a turning horizontal frame disposed on the base. The low overhead clearance boring machine includes an openable and closable arm on a column supporting the horizontal frame. The height of the horizontal frame is adjustable by opening-closing movement of the arm.

[0007] JP6088093B discloses a low overhead clearance boring machine that includes a lift mechanism. The lift mechanism horizontally movably supports the excavation unit in a height range from a minimum possible height for movement to or larger than a minimum possible height indispensable for excavation. Thus, by using the lift mechanism, the height of the horizontal frame is adjusted to move the excavation unit horizontally.

[0008] As described above, with the conventional excavators disclosed in JP10-205261A and JP10-205263A, a rotation press-fitting device is placed at an excavation spot using a heavy machine such as a crane. Then, an excavation unit made up of a casing tube, a hammer grab, and other elements for performing excavation through the rotation press-fitting device is conveyed to the excavation spot using the heavy machine. Thus, the conventional excavators have had difficulty in performing work in small work spaces. Also, large size cranes cannot be used in spaces with height restrictions, leaving such a problem that the

ground cannot be excavated to a sufficient depth.

[0009] Also, even the above-described conventional low overhead clearance boring machine have had difficulty in moving. Specifically, when the boring machines perform excavation work such as foundation renewal and foundation reinforcement in an underground space below an existing building, the excavators had to move through a place with height restrictions tighter than at the excavation spot, or the boring machines had to move in the building while avoiding beams and/or obstacles hanging from the ceiling. Under the circumstances, work that has been necessary to perform in order to move a boring machine to a target excavation spot is to: partially disassemble the excavation unit and a horizontal frame that moves the excavation unit horizontally; and re-assemble the excavation unit and the horizontal frame at an excavation work place.

[0010] In the low overhead clearance boring machine disclosed in JP5621026B, the horizontal frame that horizontally movably supports the excavation unit is set at a minimum possible height indispensable for excavation. However, even though the horizontal frame is slightly movable upward and downward by the opening-closing movement of the arm mounted on the column, if an existing building had an even smaller height, the boring machine has had difficulty in moving in the existing building while avoiding beams and obstacles hanging from the ceiling.

[0011] With the low overhead clearance boring machine disclosed in JP6088093B, the machine body is conveyed to a predetermined excavation spot, and the horizontal frame is conveyed to the predetermined excavation spot using a crane or a similar heavy machine. Then, the machine body and the horizontal frame are assembled together at the predetermined excavation spot. This has made it difficult to assemble the machine body and the horizontal frame at a place with height restrictions. Also, this boring machine necessitates use of a crane, leaving such a problem that the work performed by the boring machine becomes complicated.

[0012] An object of the present invention is to provide a low overhead clearance boring

machine. The low overhead clearance boring machine includes a machine body and a traveling body that causes the machine body to make a self-movement. The machine body and the traveling body are respectively conveyed to a predetermined excavation spot and easily assembled and disassembled at the predetermined excavation spot. Another object of the present invention is to provide a method for assembling the low overhead clearance boring machine.

SUMMARY OF THE INVENTION

[0013] According to one aspect of the present disclosure, a low overhead clearance boring machine includes a machine body, the machine body includes a tubing member, and a horizontal frame. The tubing member is configured to put an excavation unit into a ground. The horizontal frame horizontally movably supports the excavation unit over the tubing member. The machine body further includes lift mechanisms and a crane mechanism. The lift mechanisms are respectively disposed at a left side and a right side of the machine body. The crane mechanism is attachable and detachable to and from the machine body. Each lift mechanism of the lift mechanisms has a reference position and an extension position. At the reference position, the each lift mechanism is located in parallel with the horizontal frame at the right side or the left side of the machine body. At the extension position, the each lift mechanism is extended outward from the right side or the left side of the machine body. At the extension position, at which the each lift mechanism is extended outward from the right side or the left side of the machine body, the each lift mechanism is configured to lift up the machine body to a predetermined height. The crane mechanism includes a crane support member and a slide beam. The crane support member is rotatably mounted on the machine body. The slide beam is mounted on the crane support member, and a chain block is slidably hangable from the slide beam. The slide beam is turnable together with rotation of the crane support member mounted on the tubing member.

[0014] According to another aspect of the present disclosure, a method for assembling a

low overhead clearance boring machine is the method to assemble a low overhead clearance boring machine which is capable of mounting a traveling body on a machine body which puts an excavation unit into a ground using a tubing member and horizontally movably supports the excavation unit over the tubing member using a horizontal frame. The method for assembling the low overhead clearance boring machine includes locating each lift mechanism of lift mechanisms mounted on the machine body and located at a reference position to an extension position, and placing the each lift mechanism on the ground. The reference position is a position at which the each lift mechanism is located in parallel with the horizontal frame at a right side and a left side of the machine body. The extension position is a position at which the each lift mechanism is extended outward from the right side or the left side of the machine body. The machine body disposed on a conveyance vehicle is lifted up to make the machine body afloat from the conveyance vehicle. The conveyance vehicle is removed from the machine body supported on the ground. The traveling body hanging on and conveyed by a crane mechanism mounted on the machine body is mounted on the machine body.

Effects of the Invention

[0015] The low overhead clearance boring machine of this invention includes lift mechanisms each of which has an extension position, at which the each lift mechanism is extended outward from the left side or right side of the machine body. This makes the machine body removable from the traveling body, which causes the traveling body to make a self-movement, so that the machine body alone can be conveyed to and installed at a predetermined place. As a result, the machine body can be conveyed into a place having a limited height from the ground.

[0016] Also, the low overhead clearance boring machine of this invention includes a crane mechanism, which is attachable and detachable to and from the machine body. By using the crane mechanism, the traveling body can be mounted on the machine body.

[0017] In the method of this invention for assembling a low overhead clearance boring

machine, the machine body alone can be conveyed to a predetermined place by the lift mechanisms disposed on the machine body. Also, the traveling body can be easily assembled with the machine body at the predetermined place. Also, when the traveling body is assembled with the machine body, the traveling body can be conveyed by the crane mechanism mounted on the machine body while hanging on the crane mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a side view of a low overhead clearance boring machine according to an embodiment of this invention;

FIG. 2 is a side view of a machine body provided in a trailer;

FIG. 3 is a plan view of main components of a horizontal frame and lift mechanisms;

FIG. 4 is a plan view of a lift mechanism making a rotational movement;

FIG. 5 is a plan view of the low overhead clearance boring machine;

FIG. 6 is a side view of the machine body lifted up by the lift mechanisms;

FIG. 7 is a front view of the machine body lifted up by the lift mechanisms;

FIG. 8 is a side view of the machine body supported by the lift mechanisms on the ground;

FIG. 9 is a side view of the machine body lifted down on the ground by the lift mechanisms;

FIG. 10 is a side view of a crane post disposed on the machine body;

FIG. 11 illustrates a process of assembling a crane mechanism with the machine body;

FIG. 12 is a side view of the machine body on which the crane mechanism is disposed;

FIG. 13 illustrates a process of hanging a traveling body using the crane mechanism;

FIG. 14 illustrates a process of mounting the traveling body on machine body using the crane mechanism;

FIG. 15 illustrates a process of mounting the traveling body on another machine body

using the crane mechanism;

FIG. 16 illustrates how the low overhead clearance boring machine is traveling in a low overhead workspace;

FIG. 17 illustrates excavation work in the low overhead workspace; and

FIG. 18 is a side view of the low overhead clearance boring machine having its height increased by an added column.

DESCRIPTION OF THE EMBODIMENTS

[0019] An embodiment of the low overhead clearance boring machine of this invention will be described in detail below by referring to the accompanying drawings. As illustrated in FIG. 1, the low overhead clearance boring machine of this invention (hereinafter referred to as “boring machine 10”) includes a machine body 11 and a traveling body (a pair of crawlers) 15. Each crawler 15 of the pair of crawlers 15 is mounted on the machine body 11 and causes the machine body 11 to make a self-movement. FIG. 2 illustrates a state in which the machine body 11 separated from the crawlers 15 is placed on a conveyance vehicle (trailer) 20 and conveyed to a target excavation spot.

[0020] As illustrated in FIG. 1, the machine body 11 includes a tubing member 12, a horizontal frame 13, a plurality of columns 17, and lift mechanisms 41. The tubing member 12 includes a casing tube (not illustrated) having a cutter at the leading end, and puts the casing tube into the ground while rotating the casing tube. The horizontal frame 13 is disposed over the tubing member 12, and discharges soil, sand, and/or similar substances to a predetermined place, after these substances have been obtained by an excavation unit (hammer grab) 22, which has an openable and closable shell. The plurality of columns 17 support the horizontal frame 13 at a predetermined height over the tubing member 12. The lift mechanisms 41 are rotationally movably mounted on the respective columns 17, and are extendable outward from positions at the left and right sides of the machine body 11.

[0021] As illustrated in FIGs. 3 to 5, a total of four lift mechanisms 41 are provided.

Specifically, a pair of lift mechanisms 41 are provided at a front part of the machine body 11 and at the left and right sides of the machine body 11, and another pair of lift mechanisms 41 are provided at a rear part of the machine body 11 and at the left and right sides of the machine body 11. Each lift mechanism 41 of the lift mechanisms 41 has a reference position P1 and an extension position P2. At the reference position P1, the lift mechanism 41 is located in parallel with the horizontal frame 13 at the left and right sides of the machine body 11. At the extension position P2, the lift mechanism 41 extends outward from the left and right sides of the machine body 11. The machine body 11 according to this embodiment has each column 17 of the plurality of each columns 17 located at each of four corners of the machine body 11. The lift mechanism 41 is mounted on the column 17 via a rotational movement mechanism 42.

[0022] As illustrated in FIGs. 2 to 4, the lift mechanism 41 includes a hydraulic cylinder device (cylinder body) 46. The cylinder body 46 includes a rod 47, which is expandable and contractible to a predetermined length. A support plate 43 is mounted on the cylinder body 46, and a bracket 44 is mounted on the column 17. The support plate 43 and the bracket 44 are rotationally movably connected to each other via a rotation shaft 44a. This makes the lift mechanism 41 rotationally movable by a predetermined angle in a horizontal direction relative to the column 17. In this embodiment, the rotational movement mechanism 42 includes the support plate 43, the bracket 44, and the rotation shaft 44a. The support plate 43 is mounted on the cylinder body 46. The bracket 44 is mounted on the column 17. The rotation shaft 44a rotationally movably connects the support plate 43 and the bracket 44 to each other.

[0023] To the cylinder body 46, hydraulic pressure for driving purposes is supplied through a hydraulic pressure unit (not illustrated) provided in the machine body 11 or through a hydraulic pressure supplier device (not illustrated) connected to the machine body 11. It is to be noted that the state of the boring machine 10 illustrated in FIGs. 1 and 2 is such that the columns 17 support the horizontal frame 13. While the boring machine 10 is in this state,

the lift mechanism 41 is kept from being driven into operation, with the rod 47 incorporated in the cylinder body 46 in expandable and contractible state.

[0024] As illustrated in FIG. 1, the crawler 15 includes a pair of driving wheels 16a, a plurality of aiding wheels 16b, and a rubber crawler belt 16c. The machine body 11 includes traveling-body reception members (not illustrated) to and from which the crawlers 15 are attachable and detachable. Also, the machine body 11 includes a controller (not illustrated) that drives the crawlers 15 into operation by wired or wireless remote control. Using the controller at a distance from the crawlers 15, the crawlers 15 can be controlled to make forward movement, backward movement, rightward rotation, and leftward rotation, and to make these movements at variable speeds.

[0025] As illustrated in FIG. 5, the tubing member 12 has a circular insertion hole 23 at a center portion of the tubing member 12. Through the insertion hole 23, the rotating casing tube (not illustrated) is press-fitted into the ground. Also the hammer grab 22 goes down through the insertion hole 23. For these purposes, the insertion hole 23 penetrates a base 14. On the inner surface of the insertion hole 23, a rotation push-in ring (not illustrated) is disposed. The rotation push-in ring clamps the outer circumferential surface of the casing tube and drives the casing tube into rotation.

[0026] As illustrated in FIG. 5, the horizontal frame 13 is supported by the columns 17, which are disposed at the respective four corners of the machine body 11. The horizontal frame 13 includes a pair of guide rails 27 and a carriage 29. The pair of guide rails 27 extend in parallel with each other. The carriage 29 is movable horizontally along the pair of guide rails 27. On the inner surface of each guide rail 27, a guide groove (not illustrated) is formed. The guide groove is for making the carriage 29 movable horizontally. Also, at a lower portion of the guide rail 27, a rack (not illustrated) made up of a plurality of teeth is disposed. The rack linearly extends in the longitudinal direction of the guide rail 27.

[0027] At one end of the carriage 29, a pulley 32 is disposed. The pulley 32 supports the hammer grab 22 by hanging the hammer grab 22 from the pulley 32. At the other end of

the carriage 29, a winch 34 is disposed. The winch 34 is used for winding-up manipulation of a wire 33, with which the hammer grab 22 is lifted upward and downward via the pulley 32.

[0028] The hammer grab 22 is hung directly from the pulley 32, which is disposed at the carriage 29. As illustrated in FIG. 1, the hammer grab 22 is used for deep hole digging and/or excavation in making foundations at construction sites. The hammer grab 22 includes a cylindrical body 22a and a pair of openable and closable shells 22b. The pair of shells 22b are disposed at the leading end of the body 22a. The body 22a is equipped with a mechanism that opens and closes the shells 22b by winding-up manipulation of the wire 33.

[0029] Next, description will be made with regard to an assembly method for attaching and detaching the crawlers 15 to and from the machine body 11. First, as illustrated in FIG. 2, a cylindrical crane support member (crane post) 62 is mounted on the machine body 11. The crane post 62 is attached to the inside of a cylindrical post base 63, which is mounted on the tubing member 12. Examples of the method of attaching the crane post 62 to the inside of the post base 63 include: tightening using bolts and nuts; and tightening using magnetic forces of magnetic materials. In mounting the post base 63 and the crane post 62 on the machine body 11, the carriage 29, which is mounted on the horizontal frame 13, is withdrawn toward the front end of the horizontal frame 13, making the tubing member 12 open at the upper end. After the crane post 62 is mounted on the machine body 11 in this manner, the machine body 11 is put in the trailer 20 and then, without the crawlers 15, is moved to a predetermined excavation spot. The pair of crawlers 15 are conveyed together with the machine body 11.

[0030] After the machine body 11 and the crawlers 15 have reached an excavation work site, the four lift mechanisms 41 extend outward to the extension position P2 from the reference position P1, as illustrated in FIGs. 6 and 7. A pair of lift mechanisms 41 are provided at the front part of the machine body 11 and at the left and right sides of the machine body 11, and another pair of lift mechanisms 41 are provided at the rear part of the machine

body 11 and at the left and right sides of the machine body 11. At the reference position P1, the lift mechanisms 41 are located in parallel with the horizontal frame 13 at the left and right sides of the machine body 11. At the extension position P2, the lift mechanisms 41 are extended outward from the reference position P1. Via the rotational movement mechanism 42, which is disposed between the column 17 and the lift mechanism 41, the lift mechanism 41 is rotationally moved by a predetermined angle in a horizontal direction. The lift mechanisms 41 are extended outward from the left and right sides of the machine body 11 and, at the same time, are extended outward from the left and right sides of the trailer 20. Specifically, the lift mechanisms 41 extending outward from the left and right sides of the machine body 11 are made to face a ground 67. Then, the leading ends of the rods 47 extending from the cylinder bodies 46 are brought into connection with rod fixing members 48, which are disposed on the ground 67. With the lift mechanisms 41 in this state, the rods 47 are expanded by hydraulic pressure uniformly supplied to the cylinder bodies 46 from the hydraulic pressure unit (not illustrated). This causes the machine body 11 to be lifted up in a vertical direction, together with the cylinder body 46. An example of the amount of lift-up of the machine body 11 is such that the bottom of the machine body 11 is afloat from the trailer 20 by some tens of centimeters.

[0031] With the lift mechanisms 41 in this state, the trailer 20 is removed from the machine body 11, as illustrated in FIG. 8. After the trailer 20 is removed from the machine body 11, the hydraulic pressure is adjusted to make the rods 47 contract and be incorporated into the cylinder bodies 46. Thus, the machine body 11 is lifted down. Then, as illustrated in FIG. 9, support legs 68, which are disposed on the bottom of the machine body 11, are put onto the ground 67, so that the support legs 68 support the machine body 11. In this respect, the lengths of the support legs 68 are adjusted to keep the machine body 11 level relative to the ground 67. With the machine body 11 in this state, the rod fixing members 48 are removed from the leading ends of the rods 47, leaving the lower ends of the rods 47 located at uniform heights from the ground 67.

[0032] After the installment position of the machine body 11 has been determined in the above-described manner, the crane post 62 is moved upward to a predetermined height using the rotation push-in ring of the tubing member 12, as illustrated in FIG. 10. Then, as illustrated in FIG. 11, a crane mechanism 61 is detachably mounted onto an upper portion of the crane post 62 by a forklift truck 21 or a similar device. As illustrated in FIG. 12, the crane mechanism 61 includes the crane post 62, a joint post 64, and a slide beam 65. The joint post 64 is connected to the crane post 62. The slide beam 65 extends horizontally from the joint post 64. The joint post 64 has a cylindrical shape having approximately the same diameter as the diameter of the crane post 62. A chain block 66 is slidably movably mounted on the slide beam 65. The sliding movement of the chain block 66 may be implemented either manually or electrically.

[0033] As illustrated in FIG. 13, the support legs 68 of the machine body 11 are extended to slightly move the machine body 11 upward. Then, a carriage 69 on which the pair of crawlers 15 are placed is stopped at a position next to one side (the left side or the right side) of the machine body 11. Then, as illustrated in FIG. 14, the slide beam 65 is turned to a position over one crawler 15, and the one crawler 15 is hung from the chain block 66 and conveyed to the one side of the machine body 11. Then, the one crawler 15 is mounted onto one of the traveling-body reception members (not illustrated) of the machine body 11. Upon completion of the mounting of the one crawler 15, as illustrated in FIG. 15, the carriage 69 is moved to the other side (the left side or the right side) of the machine body 11, and the slide beam 65 is turned by 180 degrees to a position over the other crawler 15. Then, similarly to the one crawler 15, the other crawler 15 is hung from the chain block 66 and conveyed to the other side of the machine body 11. Then, the other crawler 15 is mounted onto the other traveling-body reception member (not illustrated) of the machine body 11.

[0034] After the pair of crawlers 15 have been mounted on the left and right sides of the machine body 11, the crane mechanism 61 is disassembled and the crane post 62 is removed from the machine body 11. Also, the support legs 68 of the machine body 11 are made to

contract, putting the crawlers 15 onto the ground 67, so that the crawlers 15 support the machine body 11. After the above-described series of assembly steps, the machine body 11 is able to make a self-movement using the crawlers 15, and the carriage 29 is able to make a sliding movement, as illustrated in FIG. 1. Thus, after the machine body 11 has moved to a predetermined excavation spot, the machine body 11 is able to perform excavation work using the hammer grab 22.

[0035] When predetermined excavation work has ended and the machine body 11 is withdrawn from the excavation spot, the machine body 11 is again assembled with the crane mechanism 61, and the crawlers 15 are removed from the machine body 11. Then, or at the same time, the machine body 11 is lifted up to a predetermined height by the lift mechanisms 41, and the machine body 11 is put onto the trailer 20. The trailer 20 with the machine body 11 on moves to a next excavation spot.

[0036] As illustrated in FIG. 16, the boring machine 10 with the crawler 15 on is self-movable to a target excavation spot while taking a low posture. In this respect, the boring machine 10 is capable of supporting the hammer grab 22 at its lowest position by hanging the hammer grab 22 from the horizontal frame 13. In the boring machine 10, the horizontal frame 13 is supported over the base 14 by the columns 17, which have approximately the same heights as the height of the hammer grab 22. This ensures that the height, h_{11} , between the ground 67, which serves as a reference, and the upper end of the pulley 32 is restricted at or below three meters. This enables the boring machine 10 to self-move through a space to the target excavation spot if the height, h_{01} , of the space between the ground 67 and a lowest ceiling surface T1 is slightly in excess of three meters.

[0037] Next, by referring to FIGs. 16 and 17, description will be made with regard to a procedure for excavation work performed by the hammer grab 22. As illustrated in FIG. 16, the hammer grab 22 hangs on the wire 33 at a height over the tubing member 12, and is dropped from this height into the insertion hole 23. The shells 22b are in open state when the hammer grab 22 is dropped, so that the open shells 22b stick into the ground. With the

shells 22b in this state, the wire 33 is wound up by the winch 34, making the shells 22b closed with excavation substances such as soil and rocks contained in the shells 22b.

[0038] Then, the winch 34 is wound up to pull the hammer grab 22 from the ground with the shells 22b closed. Then, the hammer grab 22 is further pulled to a position above the tubing member 12. Next, as illustrated in FIG. 17, the carriage 29 is made to slide along the guide rails 27 to move toward a leading end 13a. Then, at a predetermined position, the shells 22b are opened to discharge the excavation substances such as soil and rocks out of the shells 22b. By repeating this operation, the hammer grab 22 is reciprocated horizontally by the carriage 29 between the position over the tubing member 12 and the discharge spot. This enables the boring machine 10 to perform excavation and discharge work in a simplified and efficient manner even in a space with height restrictions.

[0039] The boring machine 10 with the above-described configuration is set at a minimum height necessary for self-movement. When, however, there is enough space over the boring machine 10, the horizontal frame 13 may be set at a larger height by, for example, providing the columns 17 with added columns 18, as illustrated in FIG. 18. In this case as well, the lift mechanisms 41 and the crane mechanism 61 can be used.

[0040] The height of the horizontal frame 13 may be set according to the following procedure. First, in the boring machine 10 illustrated in FIG. 1, the rods 47 are extended from the respective cylinder bodies 46 and brought into connection with the respective rod fixing members 48 placed on the ground. Thus, the machine body 11 is supported on the ground. Then, a column engagement member 45 and the column 17, which are disposed on the base 14, are disengaged from each other. This makes the column 17 removable from the base 14, and the lift mechanism 41 removes the column 17 from the base 14 together with the horizontal frame 13, so that the column 17 is supported at a predetermined height. Then, each rod 47 is extended by a height equivalent to the height of the added column 18, and the columns 17 are lifted up in a vertical direction together with the horizontal frame 13.

[0041] The added column 18 is provided with positioning means at the upper end and the

lower end of the added column 18. The positioning means is for aligning the connection portion of the column 17 and the connection portion of the added column 18 with each other. The positioning means may be made up of a protrusion and a depression. The protrusion may be disposed at one end (the upper end or the lower end) of the added column 18, and the depression may be disposed at the other end (the upper end or the lower end) of the added column 18 and engageable with the protrusion. Using such positioning means prevents the centers of the column 17 and the added column 18 from being displaced from each other, ensuring that the horizontal frame 13 is supported stably.

[0042] This work may be performed in the following manner. First, the lower end of the added column 18 is placed on the column engagement member 45, which is disposed on the base 14. Then, the lower end of the added column 18 is fastened to the column engagement member 45 with a fastening member such as a lock pin. Then, each column 17, which has been lifted up by an amount equivalent to the work space, is lifted down, and the lower end of the column 17 is positioned on the upper end of the added column 18. Then, the lower end of the column 17 is fastened to the upper end of the added column 18 with a fastening member. After all the added columns 18 have been mounted, the leading end of each rod 47 is removed from the rod fixing member 48 and incorporated into the cylinder body 46. This ensures that the crawlers 15 enable the machine body 11 to make a self-movement.

[0043] Thus, by making the height of each column 17 variable, the boring machine 10 is able to keep its posture low while passing through, for example: an underground space below an existing building where beams are protruding from the ceiling; and an underpass, a tunnel, and other underground passages with height restrictions. In contrast, when the boring machine 10 moves in a place where there is enough space above the boring machine 10, added columns may be used to position the horizontal frame 13 at a height suitable for excavation.

[0044] As has been described hereinbefore, the boring machine of this invention can be easily conveyed to excavation spots with height restrictions, and can be assembled on site into

a state in which the boring machine is ready to start excavation work. This ensures that excavation work in a space with low overhead clearance is performed efficiently and at low cost.

WHAT IS CLAIMED IS:

1. A low overhead clearance boring machine comprising a machine body and an excavation unit,
the machine body comprising:
 - a tubing member configured to put the excavation unit into a ground,
 - a horizontal frame horizontally movably supporting the excavation unit over the tubing member,
 - lift mechanisms respectively disposed at a left side and a right side of the machine body,
 - wherein each lift mechanism of the lift mechanisms has a reference position and an extension position,
 - the reference position being a position at which the each lift mechanisms located in parallel with the horizontal frame at the right side or the left side of the machine body, and
 - the extension position being a position at which the each lift mechanism is extended outward from the right side or the left side of the machine body,
 - wherein at the extension position, at which the each lift mechanism is extended outward from the right side or the left side of the machine body, the each lift mechanism is configured to lift up the machine body to a predetermined height, and
 - a crane mechanism attachable and detachable to and from the machine body, wherein the crane mechanism comprises
 - a crane support member rotatably mounted on the machine body, and
 - a slide beam which is mounted on the crane support member and from which a chain block is slidably hangable, the slide beam being turnable

together with rotation of the crane support member mounted on the tubing member.

2. The low overhead clearance boring machine according to claim 1, wherein at the right side and the left side of the machine body, the machine body comprises a plurality of columns supporting the horizontal frame at a predetermined height, and

wherein the each lift mechanism is mounted on each column of the plurality of columns via a rotational movement mechanism.

3. The low overhead clearance boring machine according to claim 2, wherein the each lift mechanism comprises a hydraulic cylinder device comprising a rod expandable and contractible to a predetermined length, the hydraulic cylinder device being mounted on the each column via the rotational movement mechanism.

4. The low overhead clearance boring machine according to claim 2 or 3, wherein the rotational movement mechanism comprises a rotation shaft between the each column and the each lift mechanism, and

wherein the rotational movement mechanism is configured to cause the each lift mechanism to rotationally move about the rotation shaft by a predetermined angle in a horizontal direction between the reference position, at which the each lift mechanism is located in parallel with the horizontal frame at the right side or the left side of the machine body, and the extension position, at which the each lift mechanism is extended outward from the right side or the left side of the machine body.

5. The low overhead clearance boring machine according to claim 1, wherein a traveling body that is configured to cause the machine body to make a self-movement and that

is attachable and detachable to and from the machine body is mounted on the machine body.

6. A method for assembling a low overhead clearance boring machine, the method comprising:

locating each lift mechanism of lift mechanisms mounted on the machine body and located at a reference position to an extension position, and placing the each lift mechanism on the ground, the reference position being a position at which the each lift mechanism is located in parallel with the horizontal frame at a right side and a left side of the machine body, the extension position being a position at which the each lift mechanism is extended outward from the right side or the left side of the machine body;

lifting up the machine body disposed on a conveyance vehicle to make the machine body afloat from the conveyance vehicle;

removing the conveyance vehicle from the machine body supported on the ground;

mounting a crane support member rotatably on a tubing member of the machine body;
and

mounting a travelling body on the machine body by a crane mechanism comprising the crane support member and a slide beam, wherein the slide beam is turned with rotation of the crane support member to a position over the travelling body, and the traveling body is hung from a chain block which is slidably hangable from the slide beam and conveyed to the machine body by sliding the chain block, and the travelling body is mounted on the machine body.

7. The method according to claim 6, further comprising:

removing the conveyance vehicle from the machine body, lifting down the machine body to a predetermined height; and

with the machine body at the predetermined height, mounting the traveling body on the machine body.