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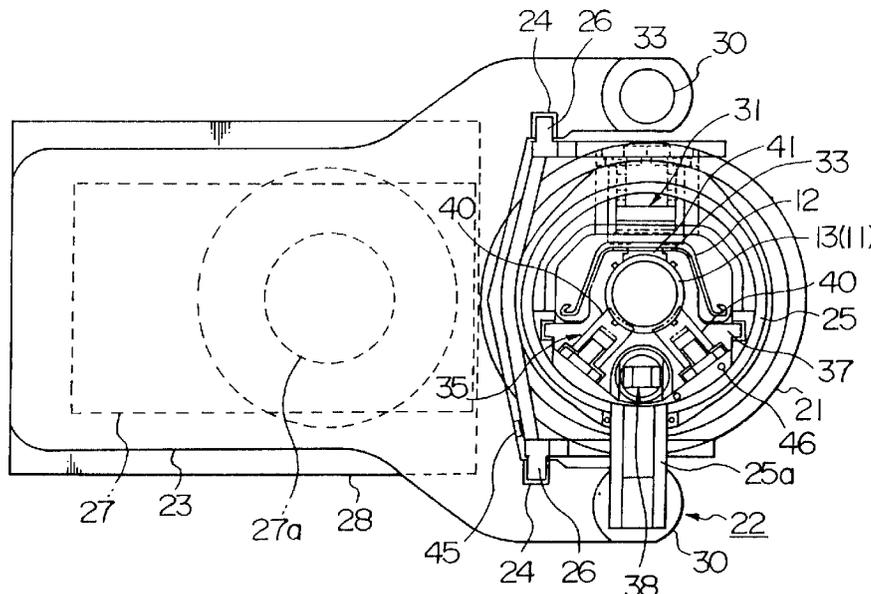
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(54) **Pile press-in apparatus and pile press-in method**

(57) An apparatus and a method for pressing-in a pile (12) and an earth auger (11) which are disposed side by side, into the ground. The apparatus comprises: a chuck (25) for gripping the pile (12), comprising an auger casing gripping mechanism (35) which can move up

and down, for gripping an auger casing, (13) of the earth auger (11), and an auger driving member (38) for moving the auger casing gripping mechanism (35) up and down; and a chuck driving member (22) for moving the chuck (25) up and down.

FIG.1



EP 0 843 048 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a pile press-in apparatus and a pile press-in method (Hydraulic pile jacking method), of a type performing both the earth auger excavation and the pile press-in.

Description of Related Art

Conventionally, a pile press-in apparatus of a type performing both the earth auger excavation and the pile press-in, which is described in Japanese Patent Application Publication (Examined) No. Tokuko-sho 63-30451, is known. Such a type of apparatus 1 is shown in FIG. 10.

However, such a pile press-in apparatus 1 having the above-described construction has the problems, as follows.

Because only an auger screw is moved up and down and an auger casing is not moved up and down, the effective range which can be excavated by the earth auger prior to the press-in of a pile, is small.

It is hard to accurately grasp the positional relation between the top end (lower end) of the auger casing and the top end (lower end) of the pile.

Further, because a cylinder for moving the auger screw up and down is attached to the upper end of the auger casing, the press-in apparatus is top-heavy, and therefore it is difficult to stable the earth auger.

SUMMARY OF THE INVENTION

The present invention was developed in view of the above-described circumstances.

An object of the present invention is to provide a pile press-in apparatus and a pile press-in method, which enables pressing-in a pile into the ground effectively by carrying out a suitable press-in according to the condition of the ground.

In accordance with an aspect of the invention, in order to accomplish the above-described object, the pile press-in apparatus comprises: a chuck for gripping the pile, comprising an auger casing gripping mechanism (termed auger chuck) which can move up and down, for gripping a casing of the earth auger, and an auger driving member for moving the auger casing gripping mechanism up and down; and a chuck driving member for moving the chuck up and down.

As the pile, for example, a steel sheet pile is generally used. However, it is not limited to this, a concrete sheet pile, a steel pipe sheet pile, an H profile steel sheet pile and the like may be also used.

In such a pile press-in apparatus, the pile and the earth auger are pressed-in into the ground by moving

down the chuck by the chuck driving member, while gripping the pile by a pile gripping mechanism and gripping the casing of the earth auger by the auger casing gripping mechanism, with maintaining the distance between lower ends of the pile and the auger casing constant.

During pressing-in the pile and the earth auger, when the pile meets with a hard layer into which it is difficult to press-in the pile, the pressing-in of the pile is stopped by stopping descent of the chuck temporarily. Thereafter, the auger casing gripping mechanism is moved downward by a predetermined depth while the auger casing gripping mechanism is moved up and down by the auger driving member, to press-in the earth auger ahead of the pile.

Next, the chuck is moved downward by the chuck driving member while the earth auger is moved upward by the auger driving member. As a result, the pile is pressed-in into the ground with the earth auger keeping the position or moving upward.

After the pile and the earth auger are pressed-in into the ground to a predetermined depth by moving the chuck down just a stroke thereof, the pile and the casing of the earth auger are released from the chuck and the auger chuck. Thereafter, the chuck is moved up to the stroke by the chuck driving member and grips the pile and the earth auger at the position. The chuck gripping the pile and the earth auger is moved down to press-in the pile and the earth auger by repeating the above-described steps for pressing-in the pile and the earth auger a predetermined times.

After the pile is pressed-in to a predetermined depth, the grip for the pile by the chuck is released, maintaining the grip for the auger casing by the auger chuck, and the chuck is moved up to the stroke thereof by the chuck driving member to draw the earth auger up a predetermined length. Thereafter, the earth auger is drew up a predetermined length by repeating the moving up and down of the chuck wherein the auger chuck grips the auger casing during moving up and releases it during moving down.

Preferably, the pile press-in apparatus comprises the auger casing gripping mechanism which comprises a structure to enable fixing the auger casing at a desired circumferential position.

In the pile press-in apparatus having such a structure, because the direction of the earth auger can be changed circumferentially in desired one even if the direction of the pile press-in apparatus is changed, that is, even if the direction of the chuck is changed, it is possible to set the direction of an discharge opening or of a hydraulic supply at a desired position.

The pile press-in apparatus preferably further comprises a first detecting device for detecting a moving up and down stroke of the chuck, and a second detecting device for detecting a moving up and down stroke of the auger chuck, so that positions of the pile and the earth auger can be determined on the basis of the chuck moving stroke detected by the first detecting device and the

auger chuck moving stroke detected by the second detecting device.

In the pile press-in apparatus having such a structure, because the positions of the pile and the earth auger can be determined on the basis of the chuck moving stroke detected by the first detecting device and the auger chuck moving stroke detected by the second detecting device, it is possible to accurately grasp the position relationship between the lower end of the auger casing and the lower end of the pile. Accordingly, the preceding excavation by the earth auger and the press-in of the pile can be easily carried out by turns according to the condition of the layer of the ground, so that an effective press-in of pile can be achieved.

The pile press-in apparatus may further comprise a reaction force detecting device for detecting a reaction force from the ground while pressing-in the pile into the ground, and a control device for controlling the auger chuck driving member and the chuck driving member on the basis of a detected value from the reaction force detecting device.

In the pile press-in apparatus having such a structure, because the positions of the pile and the earth auger can be determined on the basis of the chuck moving stroke detected by the first detecting device and the auger chuck moving stroke detected by the second detecting device, and because the reaction force from the ground is detected by the reaction force detecting device while pressing-in the pile into the ground, and the auger driving member and the chuck driving member are controlled on the basis of the detected value from the reaction force detecting device. Accordingly, the preceding excavation by the earth auger and the press-in of the pile can be easily carried out by turns according to the condition of the layer of the ground, so that an effective automatic press-in of the pile can be achieved.

In accordance with another aspect of the invention, the pile press-in method is for press-in a pile and an earth auger which are disposed side by side, into the ground, and comprises the steps of: pressing-in the pile and the earth auger into the ground, while maintaining the distance between lower ends of the pile and the auger casing constantly; stopping the pressing-in of the pile and boring by moving the earth auger up and down so that the auger casing is ahead of the pile when a reaction force from the ground exceeds a reference value; and thereafter pressing-in the pile again.

In the pile press-in method, when the reaction force from the ground exceeds a reference value while pressing-in the pile and an auger casing into the ground, the pressing-in of the pile is stopped and a boring is carried out by moving the earth auger up and down, so that the auger casing is ahead of the pile. Thereafter, the pile is pressed-in again. As a result, it is possible to press-in a pile by only a small press-in force, and to effectively press-in a pile when meeting a hard layer of the ground during pressing-in.

The pile press-in method can be automatically per-

formed by using the pile press-in apparatus as described in claim 4.

That is, while pressing-in the pile and an earth auger into the ground, the reaction force from the ground is detected by the reaction force detecting device, and the auger driving member and the chuck driving member are controlled on the basis of the detected value. Thereby, the pressing-in of the pile is stopped and a boring is carried out by moving the earth auger up and down, so that the auger casing is ahead of the pile. Thereafter, the pile can be automatically pressed-in again.

Preferably, the pile press-in method for pressing a pile into the ground is carried out by using a pile press-in apparatus as claimed in any one of the claims 1 to 4, and comprises the steps of: pressing-in an earth auger into the ground, so that the auger casing is ahead of the pile; and thereafter moving up the auger chuck gripping the earth auger by the auger driving member; and moving down the chuck gripping the pile by the chuck driving member at the same time as or after a predetermined time the moving-up of the earth auger, to press-in the pile.

In such a pile press-in method, when drawing the earth auger up by moving the auger chuck up by the auger driving member, a downward reaction force is generated against the earth auger by the skin friction (resistance on the peripheral surface). Thereof the reaction force is transferred to the chuck through the auger auger chuck to push the chuck down. When moving down the chuck gripping the pile by the chuck driving member at the same time as or after a predetermined time the moving-up of the earth auger, a force which equals a press-in force given by the chuck driving member added to the reaction force acts on the chuck.

Therefore, it is possible to reduce the chuck driving force necessary to press-in the pile by an amount of the reaction force.

Further, because the reaction force acts to the chuck, that is, the reaction force can be given to the center of gravity of the pile while pressing-in the pile, and the chuck driving force necessary to press-in the pile can be reduced, as described above, the pile press-in apparatus is hard to be out of balance and therefore it is possible to press-in the pile vertically and therefore to extremely improve the execution accuracy for pressing-in the pile.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, and wherein;

FIG. 1 is a plan view of a pile press-in apparatus according to an embodiment of the invention;
FIG. 2 is a side view of the pile press-in apparatus;

FIG. 3 is a cross-sectional view taken on line III-III of FIG. 2;

FIG. 4 is an enlarged plan view of a principal portion in FIG. 1;

FIG. 5 is a partially vertical sectional view of an earth auger;

FIG. 6 is a block diagram of the control system for controlling the chuck and auger chuck;

FIGS. 7A to 7D are partially sectional views for showing steps for pressing-in a pile, in an embodiment of the press-in method of the invention;

FIGS. 8A to 8E are partially sectional views for showing steps for pressing-in a pile, in another embodiment of the press-in method of the invention;

FIG. 9 is a plan view for showing another embodiment of the auger casing gripping mechanism (auger chuck); and

FIG. 10 is a side view of an example of a conventional pile press-in apparatus.

PREFERRED EMBODIMENT OF THE INVENTION

An embodiment of the present invention will be explained with reference to the drawings.

FIG. 1 is a plan view showing an embodiment of the press-in apparatus according to the present invention, FIG. 2 is a side view thereof, FIG. 3 is a front sectional view thereof, and FIG. 4 is an enlarged plan view of the principal part in FIG. 1.

As shown in these figures, the pile press-in apparatus comprises; a chuck 25 for gripping a pile 12 and an auger casing 13 of an earth auger 11, a chuck body 21 to which the chuck 25 is rotatably attached, and a chuck driving member 22 for moving the chuck body 21 up and down.

The earth auger 11 comprises an auger casing 13 having a cylindrical shape, and an auger screw 15 provided in the auger casing 13 as a housing, the top end (lower end) of which projects from the top end (lower end) of the auger casing 13 by a predetermined length, as shown in FIG. 5. On the upper end of the auger casing 13, an auger motor (hydraulic motor) 16 for rotating the auger screw 15 is mounted. On a peripheral surface of the upper end of the auger casing 13, an discharge opening 13a for discharging the earth which is excavated by the auger screw 15, out of the auger casing 13 is attached.

The chuck body 21 is attached to a swing arm 23, to be movable up and down, as shown in FIG. 1. That is, a pair of guide rails 24 and 24 extending in a direction parallel with the central axis of the auger casing 13 are provided on the swing arm 23.

On outer sides of the chuck body 21, a pair of projections 26 and 26 for engaging with the guide rails 24 and 24 are disposed to be able to slide up and down thereon. Therefore, the chuck body 21 is attached to the swing arm 23 so as to be movable up and down.

The swing arm 23 is attached on an axis 27a which

is erected on a slide base 27, as shown in FIGS. 1 and 2. The swing arm 23 is swung around the axis 27a in a horizontal plane by rotating the axis 27a by using a hydraulic motor or the like which is not shown.

The slide base 27 is provided on a saddle 28 to be able to slide from right to left, as shown in FIGS. 1 and 2. On the lower side of the saddle 28, a plurality of clamps 29, ... for sandwiching a plurality of piles 12a, ... which were driven into the ground side by side, to hold them are disposed.

The chuck driving member 22 for moving up and down the chuck body 21 comprises a pair of hydraulic cylinders 30 and 30, as shown in FIGS. 1 and 3. The chuck body 21 is moved up and down by pushing or pulling the piston rods of the cylinders 30.

In the chuck body 21, a chuck 25 is provided to be rotatable around the axis thereof. In the chuck 25, a pile gripping mechanism 31 is provided for gripping a pile 12 independently.

That is, the pile gripping mechanism 31 comprises a hydraulic cylinder 32 provided on a lower portion of the chuck 25, a pile fixing piece 33 provided at a position facing the hydraulic cylinder 32, as shown in FIG. 3. The pile 12 is sandwiched and fixed by a cylinder tube 32a of the hydraulic cylinder 32 and the pile fixing piece 33.

In the chuck 25, an auger casing gripping mechanism 35 for gripping the auger casing 13 is provided to be able to move up and down.

That is, a pair of long guide rails 36 and 36 extending to the direction parallel to the central axis of the auger casing 13 are provided in the chuck 25, as shown in FIG. 4. In the chuck 25, an auger chuck 37 is provided. The auger chuck 37 can slide upward and downward while a pair of longitudinal projections 37a and 37a which are arranged on the periphery of the auger chuck 37 are engaged with the guide rails 36 and 36 to be able to slide thereon.

In the chuck 25, an auger driving member 38 is provided for moving the auger chuck 37 upward and downward, as shown in FIG. 3. The auger driving member 38 comprises a hydraulic cylinder to move the auger chuck 37 upward and downward by pushing and pulling a piston rod 38b.

The auger casing gripping mechanism 35 is provided on the auger chuck 37.

The auger casing gripping mechanism 35 comprises a pair of hydraulic cylinders 40 and 40, and a casing fixing piece 41 which is provided to face the hydraulic cylinders 40 and 40 through an opening for inserting the auger casing 13, as shown in FIG. 4. The auger casing 13 is fixed by sandwiching it between cylinder tubes 40a and 40a of the hydraulic cylinders 40 and 40 and the casing fixing piece 41.

On the outer periphery of the auger casing 13, a pair of longitudinal projections 13b and 13b extending to the axis direction are formed 90° apart from each other circumferentially, as shown in FIG. 4.

In the inner surface in the opening mouth of the au-

ger chuck 37, four longitudinal grooves 37b, ... which are engageable with the longitudinal projections 13b and 13b are formed 90° apart from the next circumferentially.

By engaging the longitudinal projections 13b and 13b with two longitudinal grooves 37b and 37b, it is possible to prevent the auger casing 13 from axial rotation and to determine and hold a desired circumferential direction of the auger casing 13 by selecting two adjacent grooves with a desired 90°. Only one longitudinal projection 13b may be also provided on the outer periphery of the auger casing 13.

Therefore, even if the circumferential direction of the pile press-in apparatus is changed, that is, even if the circumferential direction of the chuck body 21, the circumferential direction of the auger casing 13 can be always directed to a predetermined direction by engaging the longitudinal projections 13b and 13b of the auger casing 13 with desired two longitudinal grooves 37b and 37b among the four grooves. Accordingly, it is possible to keep the direction of an discharge opening or of a hydraulic supply at a desired position.

The above-described pile press-in apparatus comprises; a first detecting device 45 for detecting a lifting stroke of the chuck body 21, and a second detecting device 46 for detecting a moving stroke of the auger chuck 37 having the auger casing gripping mechanism 35.

The first detecting device 45 is a stroke sensor which is disposed on an inner wall of the swing arm 23, as shown in FIG. 1. The first detecting device 45 measures the distance of vertical movement of the chuck body 21 from a reference position, and converts the measured value into an electrical signal. The electrical signal is input to an operation unit of the control device 47, as shown in FIG. 6. As the reference position, a vertical position of the swing arm at which the chuck body 21 is attached may be adopted.

In FIG. 6, although the first detecting device 45 is shown as if it detected a vertical movement of the cylinder 30 of the chuck driving member 22 for moving the chuck body 21, to suit the convenience of this figure, actually, it detects the vertical movement of the chuck body 21, as described above.

The second detecting device 46 is a stroke sensor like the first detecting device 45, and is disposed on an inner wall of the chuck 25, as shown in FIGS. 1 and 4. The second detecting device 46 measures the distance of vertical movement of the auger chuck 37 from a reference position in the chuck 25, and converts the measured value into an electrical signal. The electrical signal is input to an operation unit of the control device 47.

In FIG. 6, although the second detecting device 46 is shown as if it detected a vertical movement of the auger driving member (hydraulic cylinder) 38 for moving the auger chuck 37, to suit the convenience of this figure, actually, it detects the vertical movement of the auger chuck 37, as described above.

In the operation unit of the control device 47, the

movement distance of the pile 12 from the reference position is found on the basis of the movement of the chuck body 21 while the chuck body 21 is moved up and down with the pile 12 gripped by the pile gripping mechanism 31, and the movement distance of the auger casing 13 with respect to the chuck body 21 is found on the basis of the movement of the auger chuck 37 while the auger casing 13 gripped by the auger casing gripping mechanism 35. As a result, the positions of the pile 12 and the auger casing 13 can be determined.

The above-described pile press-in apparatus is provided with reaction force detecting devices 48 and 48 for detecting a reaction force from the ground while pressing-in the pile 12 into the ground.

Each of the reaction force detecting devices 48 and 48 are pressure sensors and are connected to the hydraulic cylinder 30 for moving up and down the chuck body 21, as shown in FIG. 6. Each reaction force detecting device 48 detects the oil pressure which is given to the hydraulic operating fluid in the cylinder tube of the hydraulic cylinder 30 from the ground through the pile 12 and the chuck 21, and converts the detected value into an electrical signal. The electrical signal is input to the control device 47 through a pressure detecting device 49.

The pressure detecting device 49 compares the oil pressure value which was converted to the electrical signal, with a reference value and outputs the result to the control device 47. When the oil pressure value is larger than the reference value, the pressure detecting device 49 concludes that a hard layer which is difficult to press-in a pile therethrough exists in the course of pressing-in the pile 12 and the auger casing 13. When the oil pressure value is smaller than the reference value, the pressure detecting device 49 concludes that a flimsy ground exists.

The reference value is the oil pressure value based on the reaction force from the boundary between the hard layer and the flimsy ground.

When the pressure detecting device 49 concludes that a hard layer which is difficult to press-in a pile therethrough exists in the course of pressing-in the pile 12 and the auger casing 13, the control device 47 controls the automatic operation of a directional control valve 50 which is connected to the hydraulic cylinder 30 and the control device 47, to stop the moving-down movement of the chuck body 21 due to the hydraulic cylinder 30 and controls the automatic operation of a directional control valve 51 which is connected to the hydraulic cylinder 38 and the control device 47, to move the auger chuck 37 downward by a predetermined depth by the hydraulic cylinder 38 while moving the auger chuck up and down, in order to press-in the auger casing ahead of the pile.

When the pressure detecting device 49 concludes that a flimsy ground exists, the control device 47 controls the hydraulic cylinder 30 to move the chuck body 21

downward, in order to press-in the pile 12 and the auger casing 13, keeping a constant distance to each other.

A pressure sensor 52 is connected to the hydraulic cylinder 32 of the pile gripping mechanism 31 and to the control device 47. The pressure sensor 52 detects the oil pressure in the hydraulic cylinder 32, and converts the value of the oil pressure into an electrical signal to input it into the control device 47. The control device 47 judges whether or not the pile gripping mechanism 31 grips the pile 12, according to the value of the oil pressure which was converted into an electrical signal.

A pressure sensor 54 is connected to the hydraulic cylinders 40 and 40 of the auger casing gripping mechanism 35 and to the control device 47. The pressure sensor 54 detects the oil pressure in the hydraulic cylinders 40 and 40, and converts the value of the oil pressure into an electrical signal to input it into the control device 47. The control device 47 judges whether or not the auger casing gripping mechanism 35 grips the auger casing 13, according to the value of the oil pressure which was converted into an electrical signal.

Next, a method for pressing-in the pile 12 together with the auger casing 13 into the ground by the pile pressing-in apparatus which has the above-described structure will be explained.

First, as shown in FIG. 7A, the pile 12 and the auger casing 13 are pressed-in by moving down the chuck body 21 by the chuck driving member 22 while the pile 12 and the auger casing 13 are gripped by the pile gripping mechanism 31 and the auger casing gripping mechanism 35, respectively, while keeping a distance between the lower ends of the pile 12 and the auger casing 13 constant.

During pressing-in the auger casing 13, the auger screw 15 is rotated to excavate the ground by the top end thereof, and the earth and sand are discharged from the discharge opening 13a (refer to FIG. 5) through the inside of the auger casing 13.

When the pile 12 and the auger casing 13 are pressed-in into the ground, the positions of the pile 12 and the auger casing 13 are detected as occasion arises by the first detecting device 45 and the second detecting device 46, and the reaction force given to the pile 12 from the ground during the pile is pressed-in into the ground, is detected by the reaction force detecting devices 48 and 48.

When a hard layer of ground which is difficult to press-in a pile therethrough exists in the course of pressing-in the pile 12 and the auger casing 13, the reaction force detecting devices 48 and 48 detect it, as described above, and the descent of the chuck body 21 is stopped temporarily by stopping the operation of the hydraulic cylinder 30 by the control device. Thereby, the press-in of the pile 12 is stopped temporarily.

Then, the hydraulic cylinder (auger driving member) 38 works by the control device 47, and the auger chuck 37 having the auger casing gripping mechanism 35 descends by a predetermined amount while moving up

and down by the hydraulic cylinder 38. By these movement, the auger casing 13 descends while moving up and down, as shown in FIG. 7B, and it is pressed-in prior to pressing-in the pile 12.

When the auger casing 13 descends by a predetermined amount, the second detecting device 46 detects the descent and the descending movement of the auger casing 13 caused by the hydraulic cylinder 38 is stopped by the control device 47. Thereafter, the auger casing 13 is moved up by making the auger chuck 37 ascendant by the hydraulic cylinder 38, so that the heights of the lower ends of the auger casing 13 and the pile 12 are made approximately uniform, as shown in FIG. 7C. At this time, a void space S is formed in the ground under the auger casing 13.

When the heights of the lower ends of the auger casing 13 and the pile 12 are made approximately uniform, the hydraulic cylinder 30 works again by the control device 47, as shown in FIG. 7D, to press-in the pile 12 and the auger casing 13 together by making the chuck body 21 descent. In this case, the pile 12 can be pressed-in by a small press-in force as much as pushing aside earth in the circumference of the void space S.

Thus, the pile press-in apparatus of this embodiment can press-in a pile 12 efficiently when a hard layer exists in the course of pressing-in because the effective range which can be excavated by the earth auger 11 prior to pressing-in of the pile 12 is larger.

Because the auger casing 13 can be moved by the hydraulic cylinder 38, it is possible to bore by moving the rotating auger screw 15 up and down. Therefore, since it is not required to install a cylinder for moving the auger screw 15 up and down on the upper end of the auger casing 13, which was required for a conventional apparatus, the mechanical stability for the earth auger 11 can be easily obtained.

When the pile 12 and the auger casing 13 are pressed-in by one pitch by descending the chuck body 21 by its one stroke, the pile 12 and the auger casing 13 are released from the grips of the pile gripping mechanism 31 and the auger casing gripping mechanism 35, respectively, and the chuck body 21 is moved up to the stroke thereof by the hydraulic cylinder 38 to grip the pile 12 and the auger casing 13 by the pile gripping mechanism 31 and the auger casing gripping mechanism 35, respectively, at the position, and thereafter the pile and the auger casing are pressed-in by moving the chuck body 21 down. The pile 12 and the auger casing 13 are pressed-in by repeating the steps shown in FIGS. 7A to 7D a predetermined times.

When there is no hard layer of ground in the course of pressing-in, the pile 12 and the auger casing 13 are pressed-in with aligning the lower ends thereof.

After the pile 12 is pressed-in to a predetermined depth, the grip for the pile 12 by the pile gripping mechanism 31 is released, maintaining the grip for the auger casing 13 by the auger casing gripping mechanism 35, and the chuck body 21 is moved up to the stroke thereof

by the hydraulic cylinder 38 to pull the auger casing 13 up by only one pitch. Thereafter, the auger casing 13 is pulled up pitch by pitch by repeating the moving up and down of the chuck body 21 wherein the auger casing 13 is gripped by the auger casing gripping mechanism 35 during moving up and is released from the auger casing gripping mechanism 35 during moving down.

Thus, the pile press-in apparatus of this embodiment detects a reaction force from the ground at the reaction force detecting device 48 while the pile 12 and the auger casing 13 are pressed-into the ground. On the basis of the detected value, the hydraulic cylinder 38 and the chuck driving member 22 are controlled by the control device 47. Therefore, the pile press-in apparatus enables two press-in methods automatically which comprises a method for pressing-in the pile 12 and the auger casing 13 simultaneously and a method wherein the auger casing 13 is pressed-in ahead of the pile 12 and then the pile 12 is pressed-in, so that an effective press-in for a pile can be realized.

According to the pile press-in apparatus of this embodiment, it is possible to reduce the press-in force necessary to press-in the pile 12 by pressing-in the pile 12 as described below.

That is, first, the pile 12 and the auger casing 13 are pressed-in to the ground by moving the chuck body 21 down by the chuck driving member 22 (cylinder 30), as shown in FIG. 8A, while gripping the pile 12 and the auger casing 13 by the pile gripping mechanism 31 and the auger casing gripping mechanism 35, which are attached to the chuck body 21, respectively, with maintaining the distance between lower ends of the pile 12 and the auger casing 13 constant.

Next, the descending movement of the chuck body 21 is stopped by stopping the cylinder 30, and thereafter the auger casing 13 is pressed-in to the ground ahead of the pile 12, as shown in FIG. 8B, by moving the auger chuck 37 downward which has the auger casing gripping mechanism 35 by the hydraulic cylinder 38.

Thereafter, the auger casing 13 is moved up by moving up the auger chuck 37 gripping the auger casing 13 by the hydraulic cylinder 38, and the chuck body 21 gripping the pile 12 is moved down by the cylinder 30 at the same time as or after a predetermined time the moving-up of the auger casing 13, to press-in the pile 12, as shown in FIGS. 8C to 8E. The pile 12 is pressed-in into the ground by repeating the steps shown in FIGS. 8A to 8D a predetermined times.

During pulling up the auger casing 13 by moving up the auger chuck 37, as described above, a downward reaction force caused by skin friction thereof works to the auger casing 13. The reaction force is transferred to the chuck body 21 through the auger chuck 37 to push the chuck body 21 downward. When moving down the chuck body 21 gripping the pile 12 by the cylinder 30 at the same time as or after a predetermined time the moving-up of the auger casing 13, a force which equals a press-in force given by the cylinder 30 added to the re-

action force works to the chuck body 21.

Therefore, it is possible to reduce the chuck driving force necessary to press-in the pile 12 by an amount of the reaction force. For example, in the case of an ordinary chuck driving force (a value of ton for pressing-in) is 60 ton, the amount of ton necessary to press-in can be reduced to about 30 ton when the reaction force acts on. That is, 30 ton of reaction force is given from the skin friction.

Further, because the reaction force acts on the chuck body 21, that is, the reaction force can be given to the center of gravity of the pile while pressing-in the pile 12, and the chuck driving force necessary to press-in the pile 12 can be reduced, as described above, the pile press-in apparatus is hard to be out of balance and therefore it is possible to press-in the pile 12 vertically and therefore to extremely improve the execution accuracy for pressing-in the pile 12.

According to the pile press-in apparatus of the embodiment, because the pile 12 can be gripped independently by the pile gripping mechanism 31, the apparatus can be used for pressing-in a pile without an earth auger 11.

In the pile press-in apparatus of the embodiment, the auger casing gripping mechanism 35 may be substituted for one shown in FIG. 9. In the auger casing gripping mechanism 35 shown in the Figure, a through hole 57 for passing the auger casing 13 through is formed in the auger chuck 37. A recess portion 58 is formed in the inner wall of the through hole 57, and a cylinder 59 is arranged in a hole formed at a side wall of the recess portion 58 in the auger chuck 37 so that it can enter and leave the recess portion 58. On a side wall opposite to the cylinder 59, a casing fixing pawl 60 is disposed.

On the outer periphery of the auger casing 13, a projection 61 is attached to project into the recess portion 58. The auger casing 13 is gripped by pinching the projection 61 between the cylinder 59 and the casing fixing pawl 60. The reference numerals 62 and 62 in FIG. 9 denote hydraulic cylinders for moving the auger chuck 37 up and down.

Such an auger casing gripping mechanism 35 has a simple structure, in comparison with one shown in FIG. 4 or the like, and an advantage to enable gripping and rotation prevention, of the auger casing 13 simultaneously.

As explained above, because the pile press-in apparatus of the invention comprises: a chuck for gripping the pile, comprising an auger casing gripping mechanism which can move up and down, for gripping an auger casing of the earth auger, and an auger driving member for moving the auger casing gripping mechanism up and down; and a chuck driving member for moving the chuck up and down, it is possible to carry out excavation by the earth auger ahead of press-in of the pile. Therefore, since it is possible to make larger the effective range which can be excavated by the earth auger ahead of press-in of the pile, it is possible to effectively press-

in a pile when meeting a hard layer of the ground during pressing-in.

Because the auger casing can be moved up and down, it is not required to install a cylinder for moving the auger screw up and down on the upper end of the auger casing, which was required for a conventional apparatus, the mechanical stability for the earth auger can be easily obtained. 5

Because the pile can be gripped independently by the pile gripping mechanism, the apparatus can be used for pressing-in a pile solely without an earth auger. 10

Claims

1. A pile press-in apparatus, for pressing-in a pile (12) and an earth auger (11) into the ground while gripping them, comprising:

a chuck (25) for gripping the pile (12), comprising an auger casing gripping mechanism (35) which can move up and down, for gripping an auger casing (13) of the earth auger (11), and an auger driving member (38) for moving the auger casing gripping mechanism (35) up and down; and 20

a chuck driving member (22) for moving the chuck (25) up and down. 25

2. A pile press-in apparatus as claimed in claim 1; wherein the auger casing gripping mechanism (35) comprises a structure to enable fixing the auger casing (13) at a desired circumferential position. 30

3. A pile press-in apparatus as claimed in claim 1 or 2; further comprising a first detecting device (45) for detecting a moving stroke of the chuck (25), and a second detecting device (46) for detecting a moving stroke of the auger casing gripping mechanism (35), so that positions of the pile (12) and the auger casing (13) can be determined on the basis of the moving stroke of the chuck (25) detected by the first detecting device (45) and the moving stroke of the auger casing gripping mechanism (35) detected by the second detecting device (46). 35 40 45

4. A pile press-in apparatus as claimed in claim 3; further comprising a reaction force detecting device (48) for detecting a reaction force from the ground while pressing-in the pile (12) into the ground, and a control device (47) for controlling the auger driving member (38) and the chuck driving member (22) on the basis of a detected value from the reaction force detecting device (48). 50 55

5. A pile press-in method for pressing-in a pile (12) and an earth auger (11) which are disposed side by side, into the ground, comprising the steps of:

pressing-in the pile (12) and an auger casing (13) of the earth auger (11) into the ground, while maintaining the distance between lower ends of the pile (12) and the auger casing (13) constant;

stopping the pressing-in of the pile (12) and boring by moving the auger casing (13) up and down so that the auger casing (13) is ahead of the pile (12) when a reaction force from the ground exceeds a reference value; and thereafter

pressing-in the pile (12) again.

6. A pile press-in method for pressing a pile (12) into the ground by using a pile press-in apparatus as claimed in any one of the claims 1 to 4, comprising the steps of: 15

pressing-in an auger casing (13) into the ground, so that the auger casing (13) is ahead of the pile (12); and thereafter moving up the auger casing gripping mechanism (35) gripping the auger casing (13) by the auger driving member (38); and moving down the chuck (25) gripping the pile (12) by the chuck driving member (22) at the same time as or after a predetermined time the moving-up of the auger casing (13), to press-in the pile (12). 20 25 30 35 40 45

FIG.1

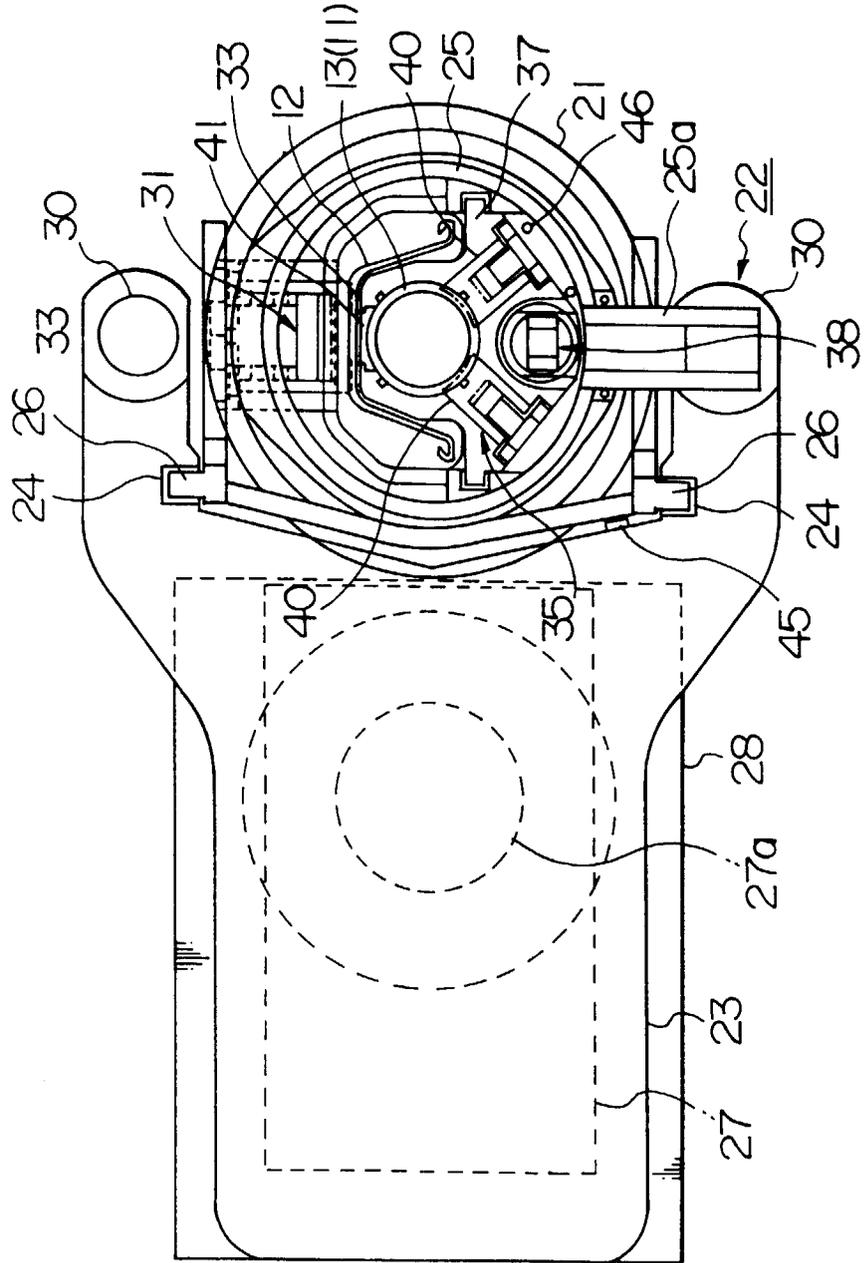


FIG. 2

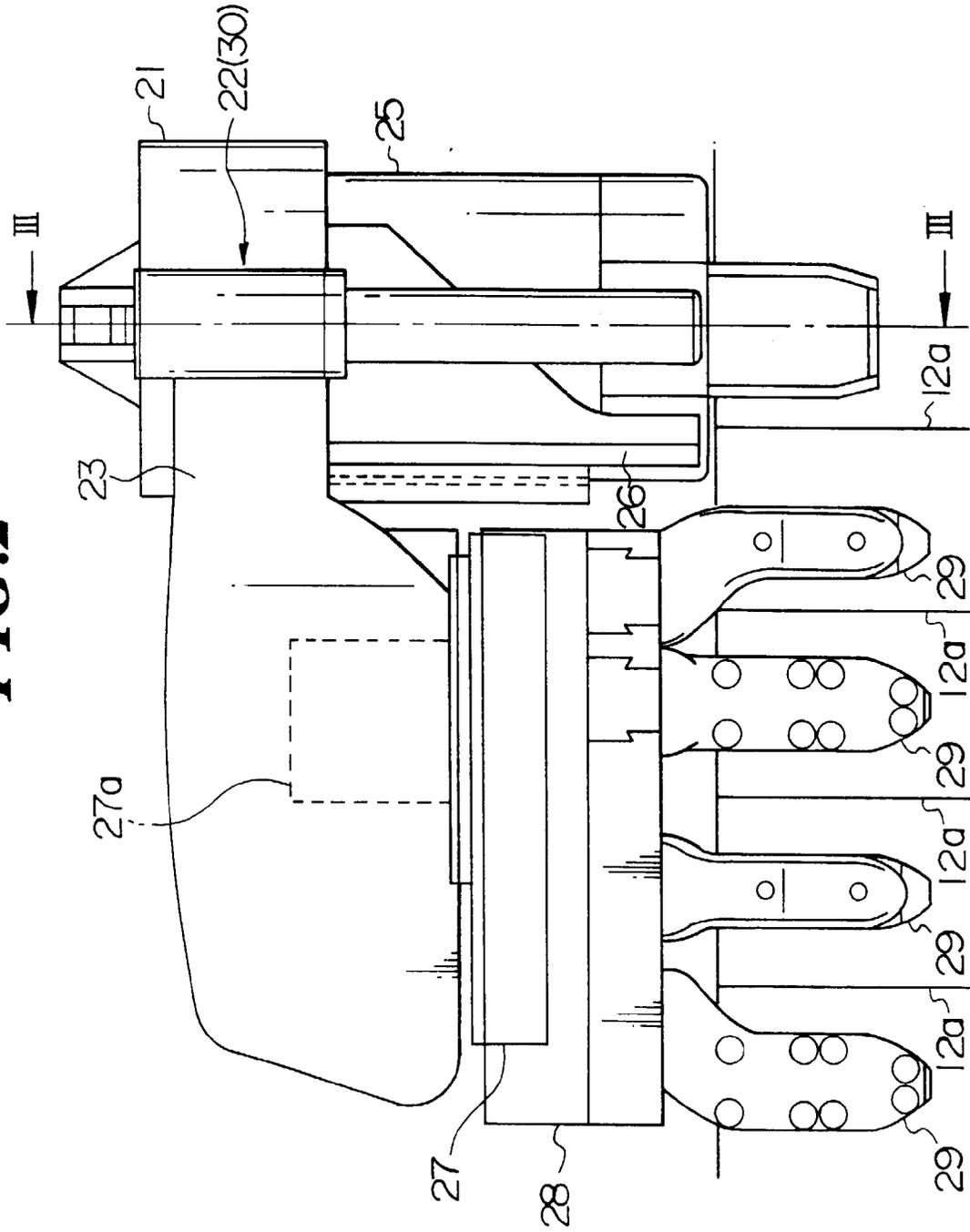


FIG.3
(SECTION III-III)

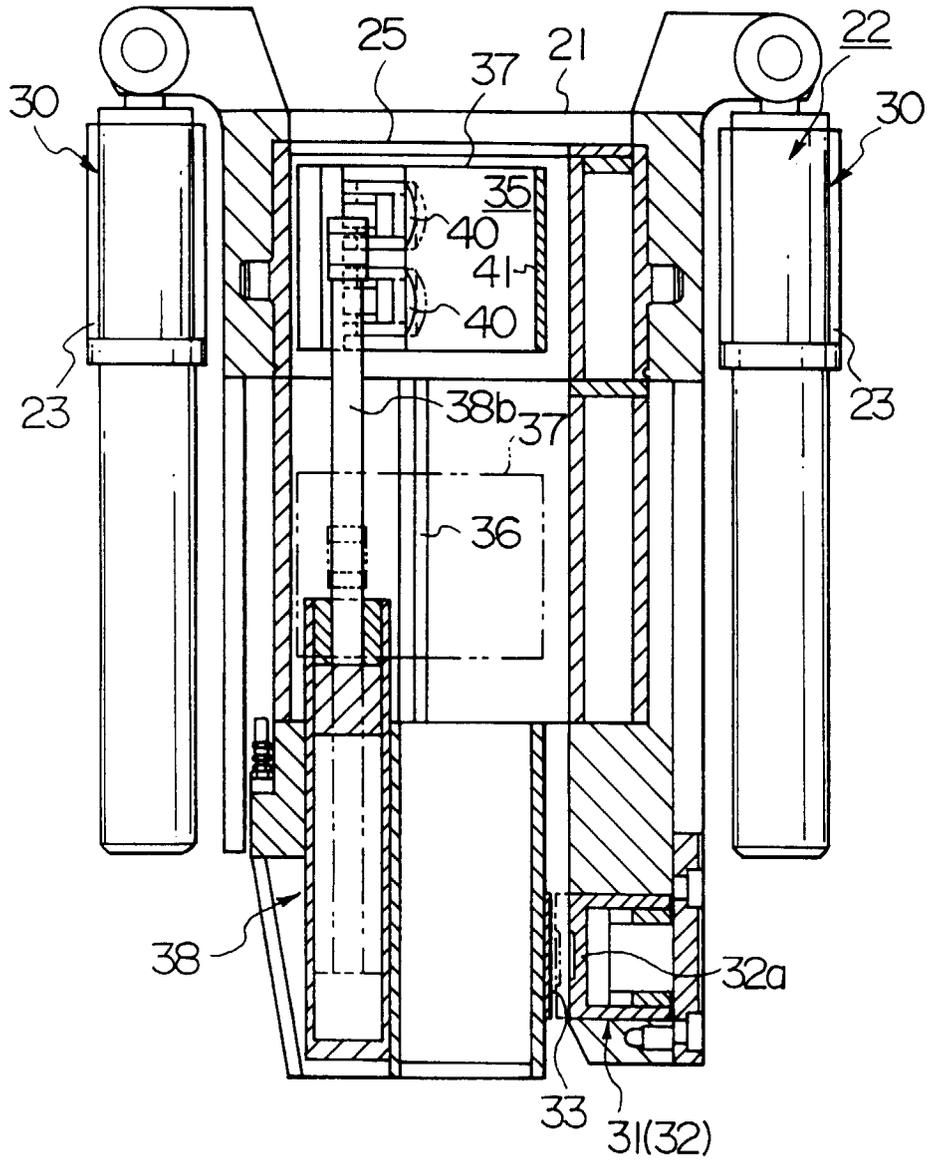


FIG. 4

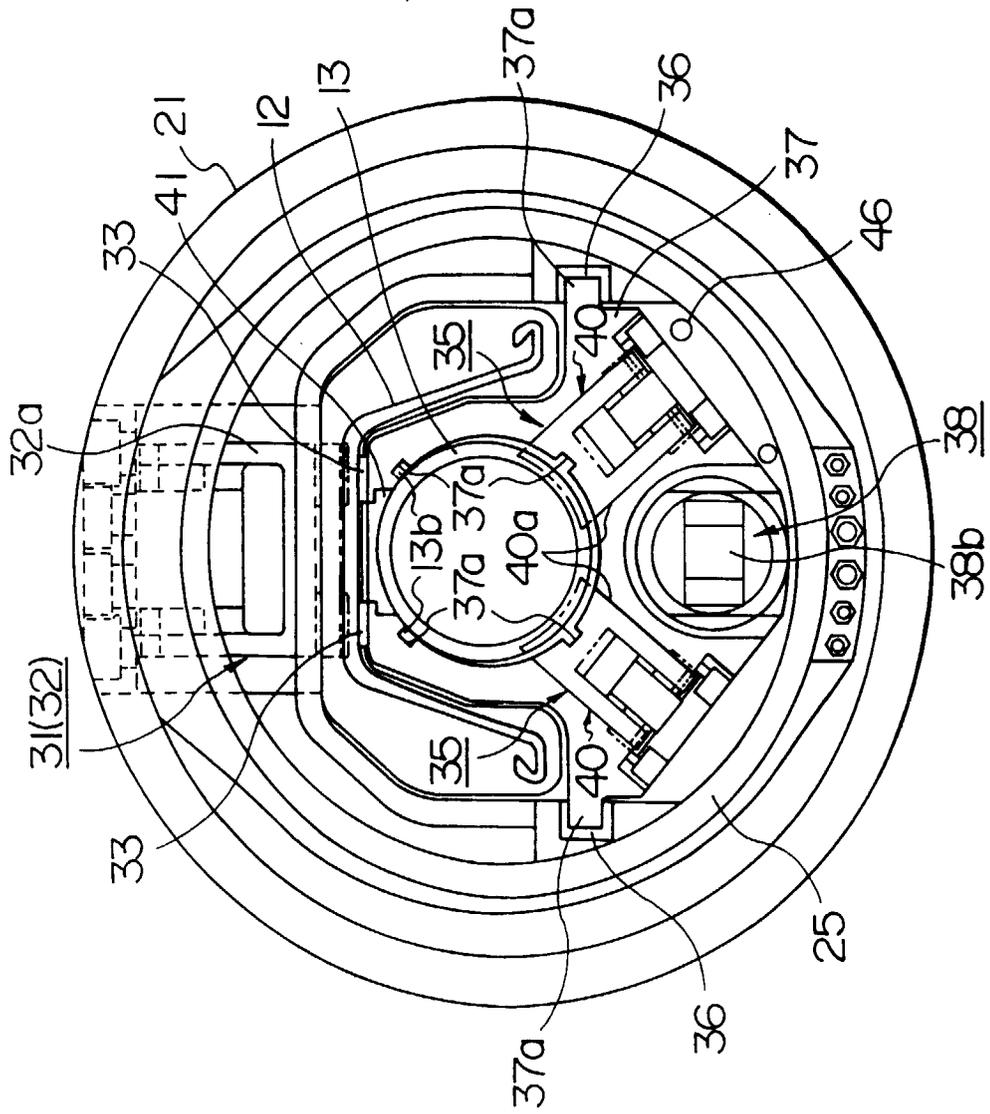


FIG.5

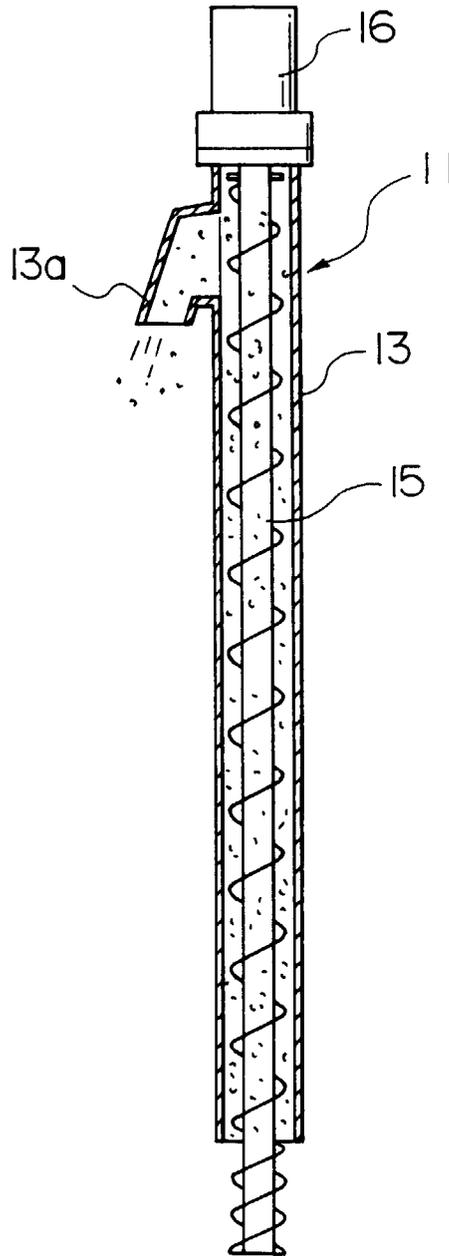


FIG. 6

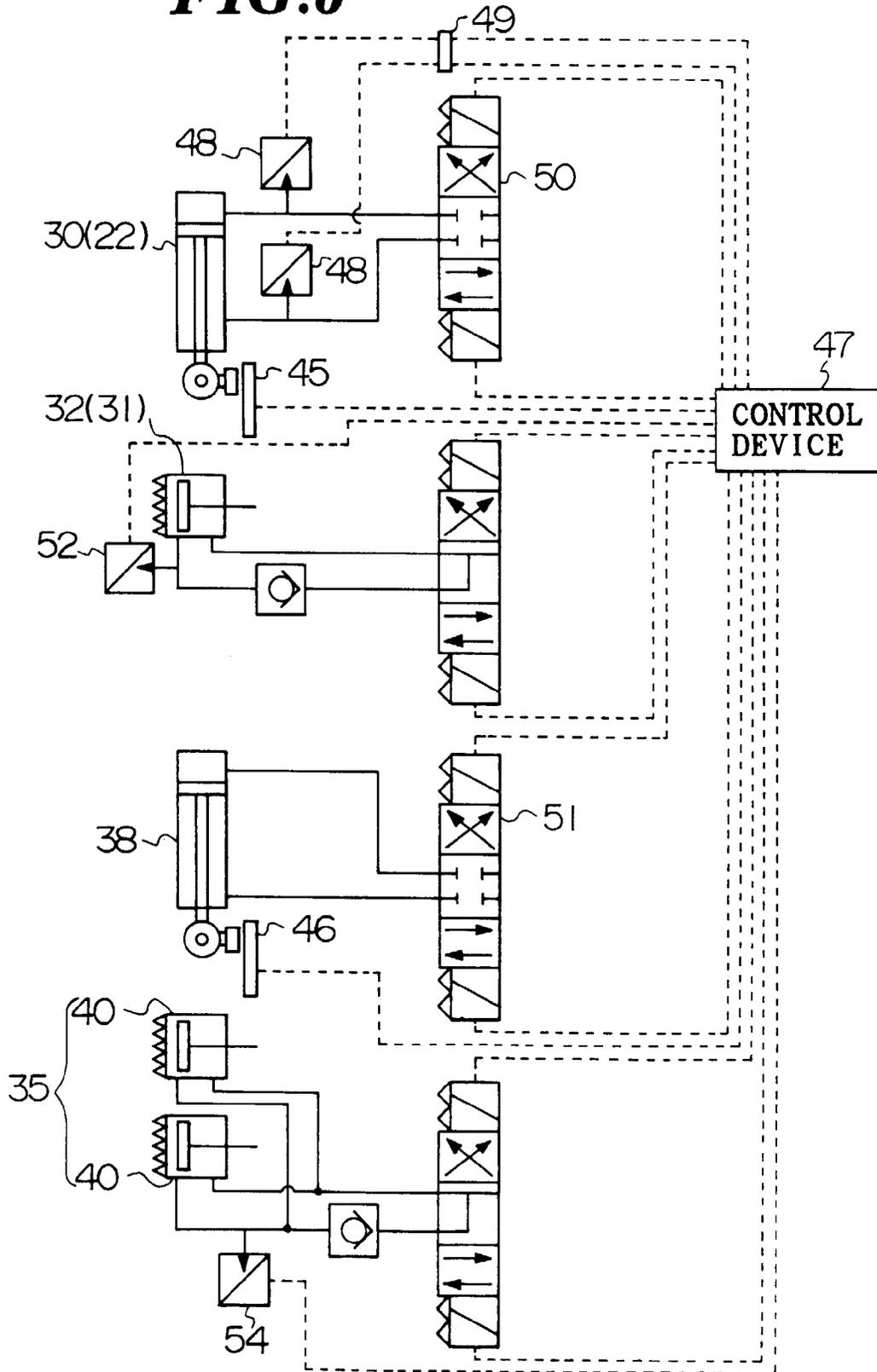


FIG.7A **FIG.7B** **FIG.7C** **FIG.7D**

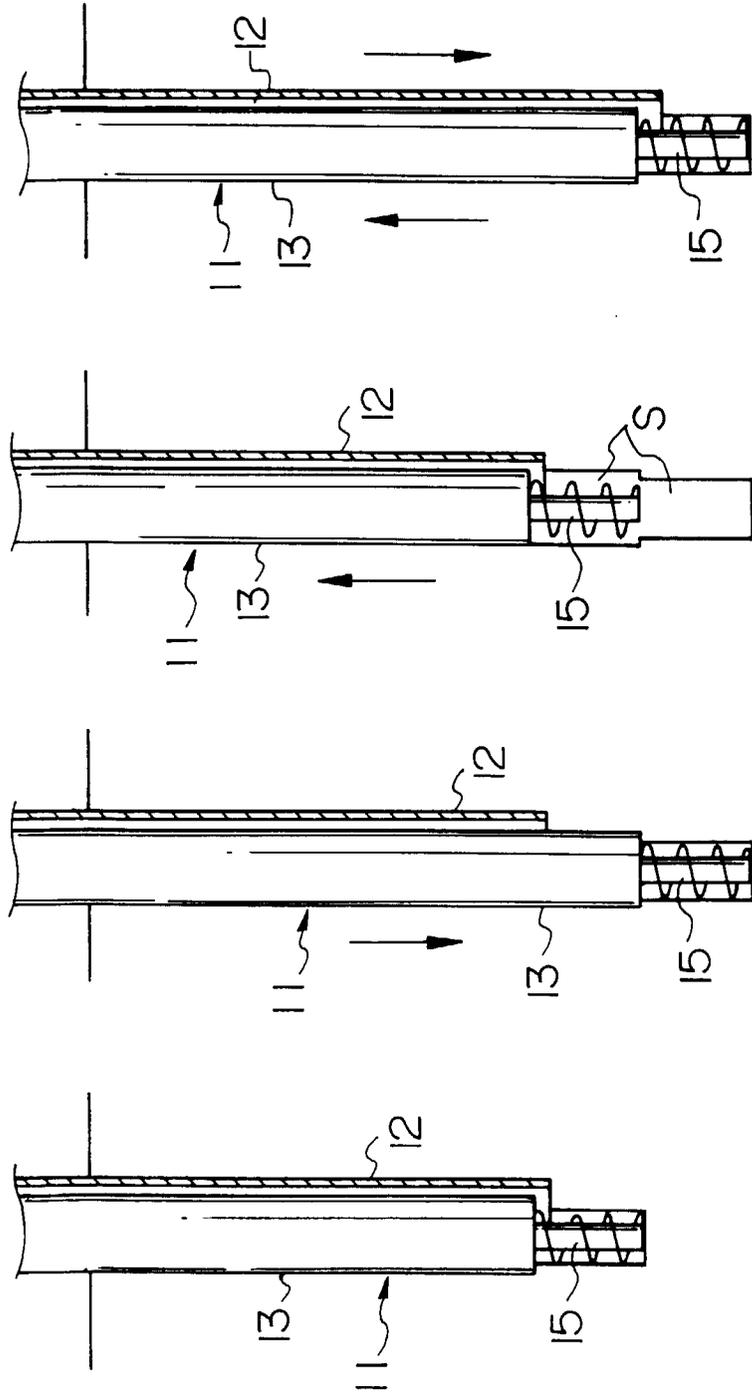


FIG.8A FIG.8B FIG.8C FIG.8D FIG.8E

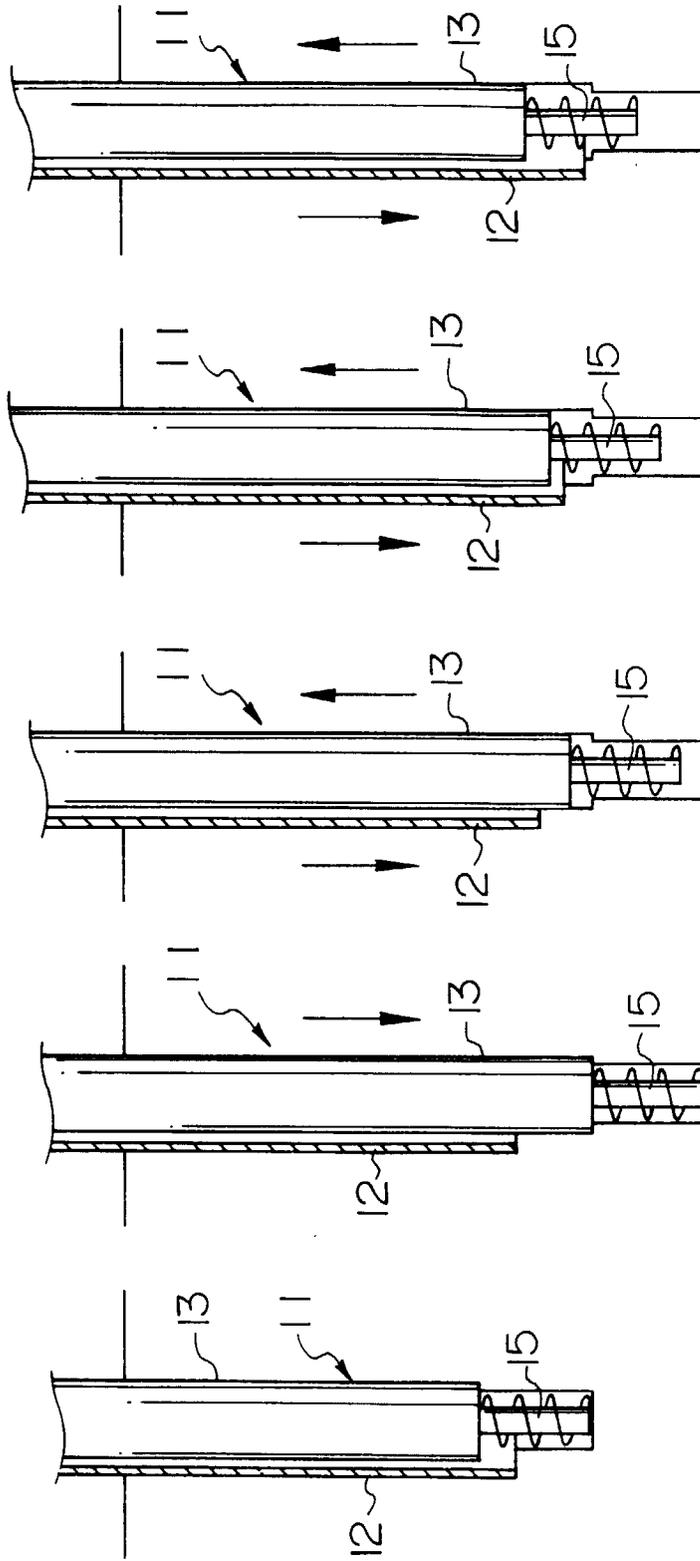


FIG. 9

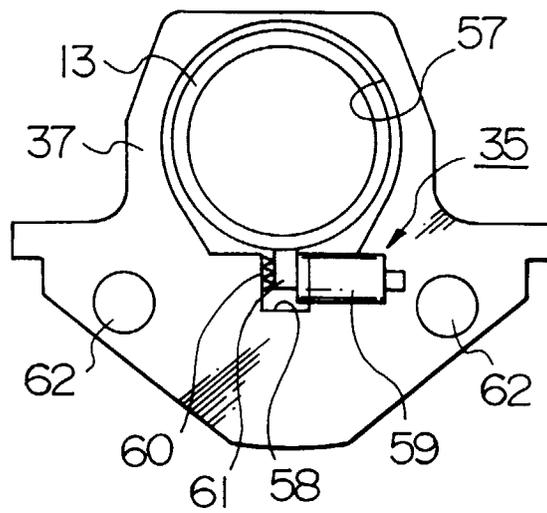
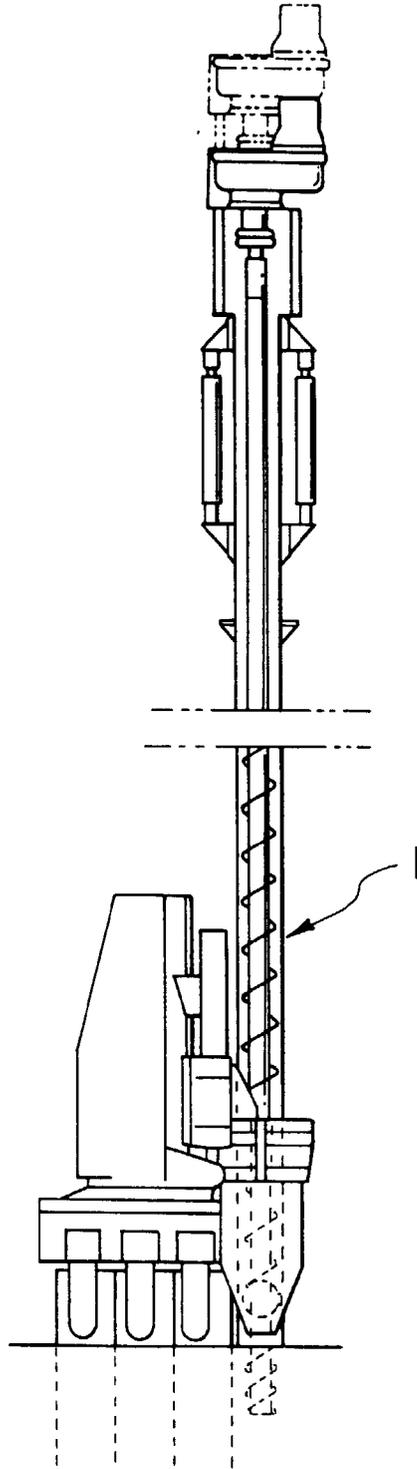


FIG.10
PRIOR ART





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 97 30 9112

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 004, no. 167 (M-042), 19 November 1980 & JP 55 116926 A (NAKAKAWANISHI TADASHI), 8 September 1980, * abstract *	1,2	E02D7/26 E02D13/06
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A	PATENT ABSTRACTS OF JAPAN vol. 009, no. 268 (M-424), 25 October 1985 & JP 60 112925 A (GIKEN SEISAKUSHO:KK), 19 June 1985, * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) E02D
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 102 (M-576), 31 March 1987 & JP 61 250229 A (MITSUO SUGAYA), 7 November 1986, * abstract *	1	
A	GB 2 060 742 A (SANWA KIZAI KABUSHIKI) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26 March 1998	Examiner Kergueno, J
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