April 25, 1933. J. A. DAHRÉN 1,906,136

METHOD OF DRIVING PILE SHELLS

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FIG. 1.

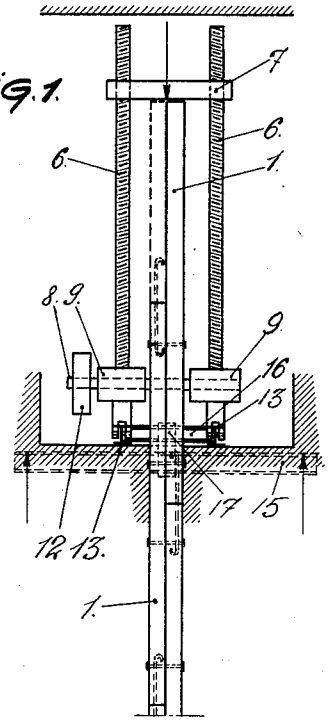


FIG. 2.

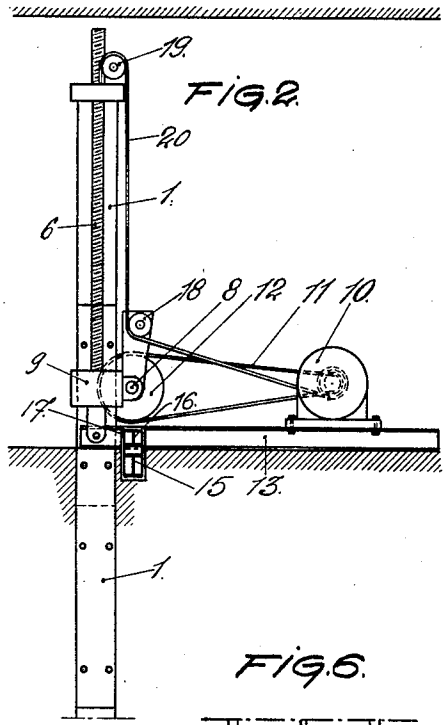


FIG. 8.

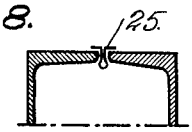


FIG. 7.

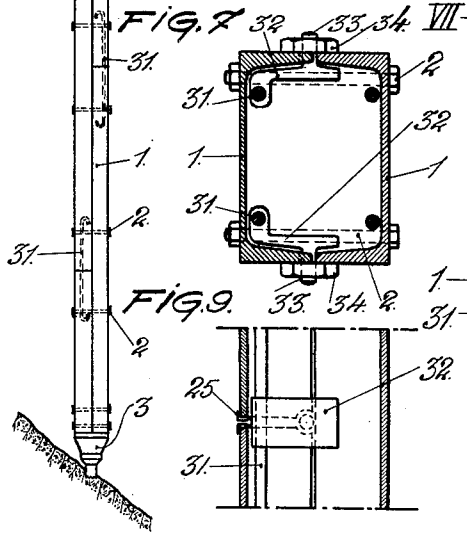
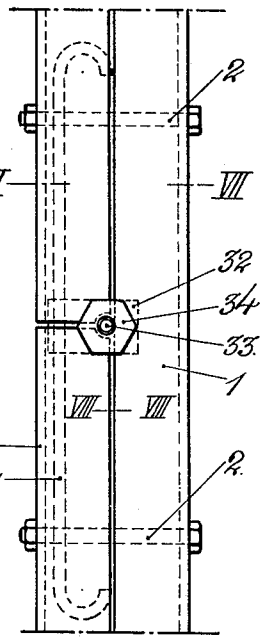


FIG. 9.

FIG. 6.



Inventor
Johan A. Dahren.

By William C. Linton.
Attorney.

April 25, 1933. J. A. DAHRÉN 1,906,136

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FIG. 3.

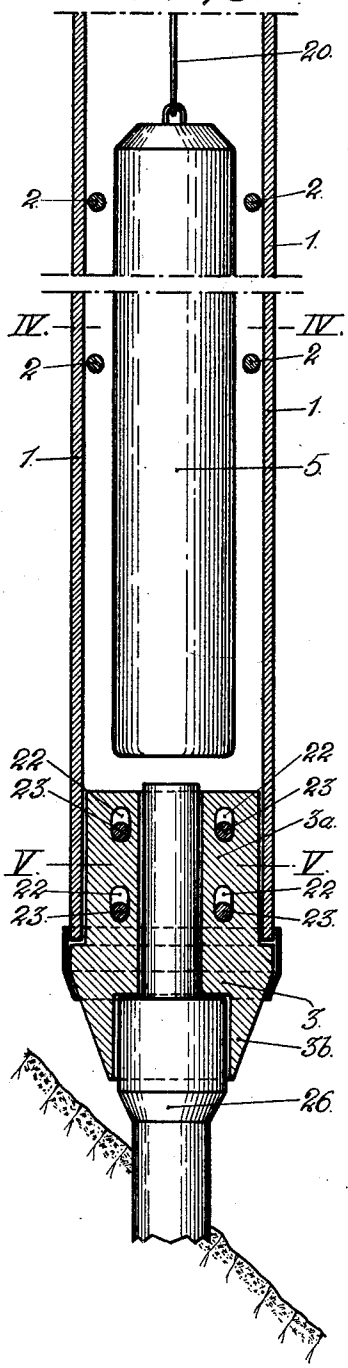


FIG. 4.

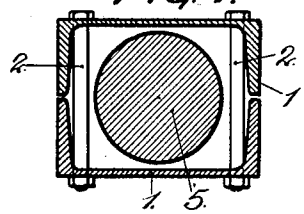


FIG. 5.

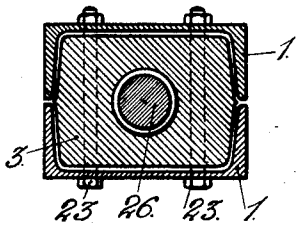
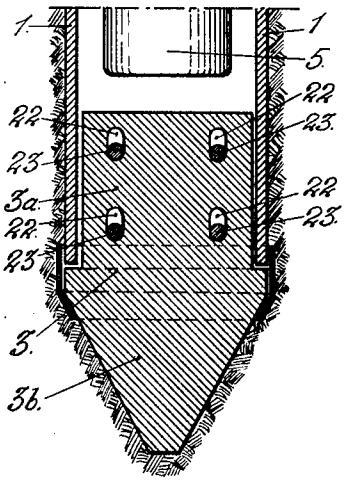


FIG. 10.



Inventor
Johan A. Dahren.

By William C. Linton.
Attorney.

Patented Apr. 25, 1933 1,906,136

UNITED STATES PATENT OFFICE

JOHAN ALBERT DAHRÉN, OF GOTTENBORG, SWEDEN

METHOD OF DRIVING PILE SHELLS

Application filed September 11, 1930, Serial No. 481,304, and in Sweden September 11, 1929.

The present invention has for its object a method for driving down supporting piles intended for buildings and the like, which method renders possible to drive down piles of considerable length from the interior of buildings where free operating space can be obtained even through layers of earth offering a very great resistance.

The method may suitably be carried out in such cases where it is question of reinforcing the foundation of already existing buildings by driving down supporting piles underneath the same because of the fact that the method requires only so much space in height that the usual height of cellars will be quite sufficient for executing a reinforcement in accordance with the present method.

The characteristic of the method according to the invention consists in the fact that at the same time as the pile to be driven down is subjected at its lower end to blows acting in the direction of driving down the pile, a considerable pressure is applied upon the upper end of the pile in the direction of driving down, which pressure is maintained with substantially unreduced force during the process of driving down the pile.

Tests have proved that the pile on account of its being simultaneously subjected to the aforesaid forces, acting in different manners, gets a surprisingly great capacity of penetrating through layers of earth or gravel.

In order to increase the penetrating capacity of the pile being driven down according to the present method the pile ought to have certain characteristic properties, and the present invention also has for its object to provide a pile suitable for carrying out the said method. Thus, the member provided at the lowermost end of the pile and intended to receive the blows contributive to the driving down of the pile, which member suitably has the shape of a downwards tapered pile-foot, is slidably mounted in relation to the pile.

For the same purpose, i. e. for increasing the penetrating capacity of the pile the joints are, if the question is of piles consisting of a plurality of joined parts, constructed in such way that they allow a certain reciprocal longitudinal displacement between the joined parts, by which means the forces effecting the driving down of the pile, viz, the blows acting upon the lower end of the pile and the pressure applied at the upper end of the same, will co-operate in a manner especially favourable for obtaining the desired result.

Tests have proved that, if the point of the pile during the driving down reaches a considerable resistant layer of earth, the upper part of the pile is to be subjected to a pressure in many cases exceeding 100 tons so that the pile must be assembled in such a way that it possesses high resistance to breaking strain. For that purpose the pile according to the invention consists of U-shaped steel-beams the flanges of which face each other and which are joined together by means of bolts passing through the beams. When the pile reaches a layer of high resistance and its upper end is subjected to a heavy pressure by a jack, the material of the pile will be compressed under simultaneous strain of its elasticity. If under this condition the monkey effects a number of blows in small intervals of time and thus that for each strike of the monkey the displacement of the pile-foot amounts to a fraction of the total compression of the pile, the result will be that the pile-foot during the acting of the blow also will be affected by a pressure of the jack under the intermedium of the compressed pile.

The following example will fully explain this fact:

A pile, the friction of which against the ground can be neglected, is at its upper end subjected to a pressure of 100 tons, by which load the material of the pile is compressed 10 millimeters of the total length of the pile. If the pile-foot, thus affected by a blow of the monkey, be moved downwards one millimeter, i. e. one tenth of the total compression of the pile, there will at the termination of the blow still result a compression of the pile of 9 millimeters. As the pressure of the pile upon the pile-foot is proportionate to the compression of the pile, the pile-foot will

after that the blow having been terminated still be subjected to a pressure of 90 tons. The resistance which the pile-foot during the blow of the monkey can overcome is consequently equal to the power of the blow plus 90 tons.

As a conclusion of the aforesaid a pile suitable for the method in question ought to have the following properties:

1, it ought to possess high resistance to bending strain, 2, it ought to be easily assembled of parts of a length suitable for the available space in height, and 3, it ought to be tensible in longitudinal direction under the blows affecting the base of the pile.

The accompanying drawings illustrate partly an example for carrying out the method and partly some embodiments of a pile according to the invention. In the drawings Fig. 1 diagrammatically shows a side view of a pile driven down and the devices for carrying out the driving down, Fig. 2 the aforesaid devices seen from another side, Fig. 3 on an enlarged scale a longitudinal section through the lower part of a pile constructed according to the invention. Figures 4 and 5 are cross-sections through the pile along the lines IV—IV and V—V respectively in Fig. 3. Fig. 6 represents a lateral view of a pile at a joint and Fig. 7 a cross-section through the pile along the line VII—VII in Fig. 6. Fig. 8 shows a section through a part of the pile along the line VIII—VIII in Fig. 6, whilst Fig. 9 is a vertical section through a joint and Fig. 10 a vertical section through the lower end of a pile constructed according to a modified embodiment.

Suitably the pile is composed of U-irons of such length as is convenient for the space obtainable on the working place, which irons, the flanges of which face each other, are bolted together by means of bolts 2. According as the pile is driven down, additional U-irons are joined to the upper end of the pile the joints being suitably arranged in such way that the joints of the one side of the pile are situated approximately half-way between the joints of the opposite side of the pile. The assembled hollow pile is at its lower end provided with a pile-foot 3, which with a portion 3*a* projects a little into the pile, whilst the portion 3*b* projecting out of the pile is tapered so as to facilitate the driving down of the pile.

The driving down is executed in such way that by means of a monkey (shown in Fig. 3) introduced in the interior of the hollow pile frequent blows are given against the inner end of the pile-foot at the same time as, by means of a jack of suitable construction, the pile is pressed down with the same speed as the monkey can transmit to the pile-foot. For that purpose the jack is arranged in such way that the speed of the pressing down, when the pressure amounts to a certain maximum, is accommodated to the speed which the monkey transmits to the pile-foot. The force of pressure ought to overcome the frictional resistance of the pile to the surrounding earth and furthermore effect an important pressure upon the pile-foot, upon which the monkey strikes directly, thus obtaining a convenient co-operation between blow and pressure.

Figures 1 and 2 show diagrammatically such a jack, which is especially suitable for piling in cellars where the question is of reinforcing the foundation of an already existing building. This jack consists mainly of two, vertical, rotatorily mounted screw spindles 6, which pass through the threaded holes of a yoke 7 connecting the spindles, which yoke when the spindles rotate is moving down or up. The spindles are moved by means of a shaft 8 and worms carried by the same, which latter engage into worm-wheels 9 fixed on the spindles. The shaft 8 can be driven by means of an electric motor 10 the power of which can be transmitted by means of a belt 11 to a pulley 12 carried by the shaft 8. The said pulley is connected to the shaft 8 by a coupling (not shown in the drawings) constructed in such way that, if the resistance reaches a certain amount, the movement of the shaft is stopped until the resistance has diminished below the allowed maximum. Thus the pressure-speed of the jack is accommodated to the speed by which the monkey can drive down the pile-foot. The spindles 6, the motor 10 and the described devices for power transmission are supported by means of a common frame consisting of two, principally parallel bars or beams 13, and the jack is placed above the pile to be driven down in such way that the yoke 7 when the jack is working will effect a considerable pressure upon the upper end of the pile. As it is essential to fasten safely the jack on account of the arising of considerable reaction power, special arrangements are to be made for that purpose. A convenient manner for fastening the jack is shown in Figs. 1 and 2, where 15 indicates a beam horizontally placed below the frame, the ends of which beam are extended under the walls of the building the foundation of which is to be reinforced. Above this tie-beam and above the beams 13 forming the frame of the jack is another beam 16 which by means of a connecting iron 17 placed half-way between the frame-beams 13 is connected to the tiebeam 15.

It is suitable that the motor 10, as shown in the drawings, also drives a hoist, by means of which a wire 20 passing over grooved pulleys 18 and 19 can lift the monkey 5, which after the hoist having been disconnected, can fall upon the pile-foot 3.

According to the invention the pile-foot is on account of the above mentioned reason not immovably fixed to the lower end of the pile but slidably connected to the same, so that

the pile-foot, when it is struck by the monkey, can move a short length before it during its continued movement downwards draws the pile with it. According to the embodiments shown in the drawings a suitable connection between pile-foot and pile is performed in such way that the holes 22 in the pile-foot through which a number of bolts 23 connecting the U-irons pass, are oblong in the longitudinal direction of the pile.

It is furthermore to be observed that, on account of the above described reciprocally alternating joints of the U-beams, there is obtained an elastic resistance in longitudinal sense convenient for the driving down of the pile, as the relatively long connection-bolts 2 are allowed occasionally to incline somewhat.

After having been driven down to the necessary depth the pile is filled with concrete and, in order to avoid that, during the driving down, mud, water or the like enters into the pile, it is suitable to apply packing both in the vertical as well as in the horizontal joints of the pile. Such packing may consist of folded strips of asphalt-board 25 or the like (see Figs. 8 and 9).

The embodiment shown in Fig. 3 is at its lower end provided with a plunger-like member 26, which can be forced into rock situated below a more easily penetrated layer of earth, thus ensuring a reliable support for the lower end of the pile.

In order to reinforce the pile at the joints, before filling the pile with concrete, some iron-bars 31, placed longitudinally in the corners of the U-irons, are inserted (see especially Figures 6 and 7), which bars are fixed in the desired position by means of the heads 32 of two bolts 33, which heads are situated inside of the pile. Externally the bolts are secured by means of nuts 34. The heads 32, bolts 33 and the nuts 34 are furthermore intended to guide the flanges of the U-irons in order to ensure that they cannot be displaced.

What I claim is:—

1. A method of driving supporting hollow piles comprising, applying a downward tensile force to the lower end of the pile by subjecting the same to repeated blows, and applying a continuous downward compressive force directly upon the upper end of the pile.

2. A method of driving supporting hollow piles comprising, applying a downward tensile force to the lower end of the pile by subjecting the same to repeated blows, applying a continuous downward compressive force to the upper end of the pile and maintaining said force applied to the upper end of the pile, during and between the repeated blows.

3. A method of driving supporting hollow piles comprising introducing a driver with the hollow pile, applying a downward tensile force to the lower end of the pile by subjecting the same to repeated blows by means of said drive, and applying a continuous downward compressive force directly upon the upper end of the pile.

In witness whereof I have hereunto set my hand.

JOHAN ALBERT DAHRÉN.