ABSTRACT
A pile-driving apparatus includes a diesel hammer pile driver having a cylinder, and a piston and a striker displaceably guided therein. A combustion chamber opens into a fuel feed device for introducing a predetermined amount of fuel into the combustion chamber during each working cycle. A disengagement apparatus axially displaceable on the cylinder outside is disposed within the cylinder, to raise the piston, has a driver introduceable into a piston undercut, through a piston recess, and has an operating lever for pivoting the driver into the cylinder space if a collision with the engagement cam occurs. A disengagement cam on the cylinder above the engagement cam pivots the driver out of the cylinder space if the operating lever collides with the disengagement cam. The engagement cam and/or the operating lever is configured for movement out of the collision region of the operating lever or of the engagement cam.
DEISEL HAMMER PILE DRIVER
CROSS REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The invention relates to a pile-driving apparatus comprising a diesel hammer pile driver having a cylinder, a piston displaceably guided in the cylinder and a disengagement apparatus.
[0004] 2. Description of the Related Art
[0005] Pile-driving apparatuses having diesel hammer pile drivers are also called diesel hammers or diesel pile drivers. These apparatuses are particularly used in foundation work in the construction industry, for driving posts of all kinds, such as concrete pillars, iron beams, sheet pile wall elements or the like into a construction ground.
[0006] To start such a diesel hammer pile driver, the piston is pulled upward within the cylinder, using a disengagement apparatus, and disengaged at a specific height, thereby dropping onto the striker, under the effect of gravity. As it drops, the piston activates a fuel pump, by which fuel of fuel, particularly diesel oil, takes place. The air situated in the combustion chamber of the cylinder is compressed by means of the dropping piston, and thereby heated in such a manner that the fuel/air mixture present in the combustion chamber of the cylinder is ignited, whereupon it combusts in the manner of an explosion. By the explosion energy released during this process, for one thing the piston is accelerated back upward for a new work cycle; at the same time, the material being pile-driven is driven into the ground by way of the striker.
[0007] The disengagement apparatus for raising the piston within the cylinder has a driver that engages into an undercut in the piston. After the lifting height required for the start, the driver is moved out of the cylinder space by way of a disengagement cam, thereby releasing the piston. In this connection, the disengagement apparatus is regularly guided on a leader, as is the cylinder. In the case of short, adjustable leaders, in particular, it can happen here that because of an imprecise adjustment of the leader and/or of the disengagement apparatus, the disengagement apparatus situated on the leader is moved in the direction of the engagement cam, thereby causing the driver to be unintentionally pivoted into the cylinder. In this connection, damage to the piston and to the disengagement apparatus can occur. A corresponding set of problems arises, for example, also in the case of embodiments in which the driver is directly disposed on the diesel hammer pile driver, by way of an auxiliary construction. Furthermore, unintentional pivoting-in can also be brought about by incorrect operation.

SUMMARY OF THE INVENTION

[0008] The invention wishes to provide a remedy for these disadvantages. The invention is based on the task of creating a diesel hammer pile driver of the aforementioned type, in which unintentional pivoting-in of the driver of the disengagement apparatus into the cylinder space is avoided. According to the invention, this task is accomplished by a pile-driving apparatus, comprising a diesel hammer pile driver having a cylinder, a piston displaceably guided in the cylinder and a striker displaceably guided in the cylinder. The striker is disposed underneath the piston in the operating position of the diesel hammer. A combustion chamber is provided, which is delimited axially by a face surface of the striker that lies in the interior of the cylinder, and a face surface of the piston, and opens into a fuel feed device, by means of which a predetermined amount of fuel can be introduced into the combustion chamber during each working cycle. A disengagement apparatus is axially displaceable on the outside of the cylinder, along the cylinder, and is disposed within the cylinder, to raise the piston.

[0009] The disengagement apparatus has a driver that can be introduced into an undercut disposed in the piston, through a recess made in the piston. A lower engagement cam is disposed on the cylinder, and the disengagement apparatus has an operating lever by way of which the driver can be pivoted into the cylinder space in the event of a collision with the engagement cam. A disengagement cam is disposed on the cylinder, above the engagement cam, and by way of the former cam, the driver can be pivoted out of the cylinder space in the event of a collision of the operating lever with the disengagement cam. The engagement cam and/or the operating lever is configured in such a manner that it can be moved out of the collision region of the operating lever of the disengagement apparatus or of the engagement cam.

[0010] With the invention, a diesel hammer pile driver of the aforementioned type is created, in which unintentional pivoting-in of the driver of the disengagement apparatus into the cylinder space is avoided. Unintentional activation of the operating lever is avoided via the movement of the engagement cam and/or of the operating lever, which is made possible here, out of the collision region of the operating lever.

[0011] Here, the term “collision region” is understood to be the region that the operating lever covers throughout the possible displacement path of the disengagement apparatus. If the engagement cam or the operating lever has been moved out of the collision region, it is no longer possible for the operating lever to hit the engagement cam.

[0012] In the following, the term “diesel hammer pile driver” is understood to mean any kind of fuel-operated driving cam.

[0013] In a further development of the invention, the engagement cam and/or the operating lever is configured as a cylinder, preferably as a hydraulic cylinder. In this way, remote-controlled movement of the engagement cam or of the operating lever out of the collision region is made possible.

[0014] Alternatively, the engagement cam and/or the operating lever can also be configured so as to pivot out of or rotate out of the collision region.

[0015] In a further development of the invention, the driver in the disengagement apparatus is configured so that after it has been pivoted in and after it has been pivoted out, it is locked in the pivot position, in each instance, via the operating lever. In this way, unintentional pivoting of the driver is further counteracted.

[0016] In an embodiment of the invention, the fuel feed device comprises a pump lever that projects into the cylinder in such a manner that it is activated when the piston passes, thereby introducing fuel onto the face surface of the striker. A disengagement cam is provided that can be positioned in such a manner that in the event of a collision of the operating lever with this disengagement cam, the piston has not yet moved
past the pump lever, so that no introduction of fuel into the combustion chamber takes place. In this way, “gentle,” controlled forward ramming of a post is made possible, thereby avoiding unintentional drifting away of the post in soft subsoils. After the post has been stabilized, the piston can be raised to the height required for the start, and subsequently can be disengaged, thereby causing the pump lever to be activated by the piston and, as a result, fuel to be injected into the combustion chamber.

In a further embodiment of the invention, the disengagement cam is disposed on the cylinder in axially displaceable manner, and can be fixed in place in at least two positions, whereby fixing of the disengagement cam in a first position brings about disengagement of the piston in a position after passing the pump lever, and fixing the disengagement cam in a second position brings about disengagement of the piston in a position before passing the pump lever. In this way, the two disengagement positions “gentle forward ramming” and “starting” are made possible by means of a single, displaceable disengagement cam.

In an alternative embodiment of the invention, two disengagement cams are disposed on the cylinder axially at a distance from one another. The upper, first disengagement cam is disposed so that in the event of a collision with the operating lever of the disengagement apparatus, disengagement of the piston in a position after passing the pump lever is brought about. The second, lower disengagement cam is disposed so that in the event of a collision with the operating lever of the disengagement apparatus, disengagement of the piston in a position before passing the pump lever is brought about. In this way, the two operating modes “gentle forward ramming” and “starting” are made possible without a displacement of a disengagement cam. To implement the operating mode “starting,” the lower disengagement cam merely has to be moved out of the collision region of the operating lever. Preferably, the second disengagement cam is configured as a cylinder, preferably as a hydraulic cylinder.

In a further embodiment of the invention, the cylinder and the disengagement apparatus are disposed to be displaceable on a leader, whereby at least one detent that can be moved out orthogonally to the pivot direction of the leader is disposed on the disengagement apparatus. This detent can be positioned underneath a driver crosspiece disposed on the outside of the cylinder. By way of this detent the cylinder can be moved along the leader. In this way, displacement of the cylinder along a leader, by way of the disengagement apparatus, is made possible.

In a further development of the invention, two detents are provided, which are eccentrically connected with a circular disk, in such a manner that by means of rotation of the circular disk, retraction and extension of the detents, in opposite directions from one another, is made possible. In this way, simple and simultaneously reliable positioning of the detents on the drivers of the cylinder is made possible. The opposite arrangement of the detents counteracts tilting of the cylinder while it is being pulled along the leader.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the invention will become apparent from the following detailed description considered in connection with the accompanying drawings. It is to be understood, however, that the drawings are designed as an illustration only and not as a definition of the limits of the invention.

In the drawings, wherein similar reference characters denote similar elements throughout the several views:

FIG. 1 is a schematic representation of a pile-driving apparatus in longitudinal section;
FIG. 2 is a schematic representation of the disengagement apparatus of the pile-driving apparatus from FIG. 1 in a side view as well as a top view;
FIG. 3 is a representation of the disengagement apparatus from FIG. 2 with extended driver and extended detents;
FIG. 4 is a detail view of the engagement region of the diesel hammer pile driver from FIG. 1, and
FIG. 5 is a schematic representation of the cylinder of the diesel hammer pile driver in a side view, with detents extended for lifting operation.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The pile-driving apparatus selected as an exemplary embodiment comprises a diesel hammer pile driver having a cylinder 2 that is open on both sides, and regularly can have a length of 5 to 10 meters and a diameter of 0.2 to 1 meter. A piston 3 is displaceably disposed in the cylinder 2. A striker 4 coaxial to this piston engages into the open lower end of the cylinder 2, in displaceable manner. A ring-shaped bearing unit 9 is attached at the lower end of the cylinder 2, in which unit a central shaft section 41 of the striker 4 is guided in tight and displaceable manner, which section has an outside diameter that is reduced as compared with the inside diameter of the cylinder 2.

A strike plate 42 is formed onto the lower end of the shaft section 41, lying underneath the cylinder 2, the lower convex delimitation surface 43 of which plate, directed outward, interacts with the upper end of a material to be pile-driven, during operation.

A piston section 44 having multiple circumferential sealing rings 91, axially at a distance from one another, which run on the inner mantle surface 21 of the cylinder 2, is formed on at the upper end of the shaft section 41 of the striker 4. A combustion chamber 22 is delimited by the top of the piston section 44, together with the underside of the piston 3, as well as the inner mantle surface 21 of the cylinder 2. The face surface 45 of the striker 4 that faces the combustion chamber 22 of the cylinder 2 is ground to be level with a flat fuel bowl 46.

A clamping ring 92 is disposed between the strike plate 42 of the striker 4 and the bearing unit 9 of the cylinder 2. A further clamping ring 93 is disposed adjacent to the bearing unit 9, between the top of the bearing unit 9 and the underside of the piston section 44 of the striker 4.

A lower working end 34 of the piston 3, provided with circumferential sealing rings 94 that are axially spaced apart from one another, runs in the interior of the piston 2, above the striker 4. The lower, free face surface 31 of the piston 3, ground to be level, is set off by a circumferential step that lies radially on the outside.

A mass section 32 is formed onto the lower working end 34 of the piston 3, which section extends into the upper section of the cylinder 2.

An injection apparatus 5 is disposed on the circumference wall of the cylinder 2, which apparatus comprises a fuel pump 51 (see FIG. 4) that is connected with the injection nozzle 52 by way of a line 53. The inlet of the fuel pump 51 is supplied with diesel oil by way of a fuel tank 54.
The fuel pump 51 has a biased pump level 55 that projects into the interior of the cylinder 2, by way of which the pump is driven when the dropping piston 3 goes past. The injection nozzle 52 is configured and oriented in such a manner that the fuel emitted is sprayed approximately in the center of the face surface 45 of the striker 4, in an essentially cohesive jet.

Furthermore, lubricant is emitted between the piston 3 and the inner mantle surface 21 of the cylinder 2 by means of a lubricant pump 6, furthermore disposed on the cylinder 2, which pump is connected with lubricant nozzles distributed in the circumference direction of the cylinder 2.

The circumference wall of the cylinder 2 has working connectors 23 passing through it approximately at the height of the injection apparatus 5, by way of which connectors combustion air is drawn in and combustion gases are discharged. In order to raise the piston 3 for the first time to start the diesel hammer pile driver, the mass section 32 of the piston 3 has an undercut 33 that forms a drive shoulder, for engagement of a driver 73 of a disengagement apparatus 7. On the outside of the cylinder 2, two driver crosspieces 28 (see FIG. 5) for engagement of the detents 76 of the disengagement apparatus 7 are disposed.

The disengagement apparatus 7 comprises a housing 70 on which a guide 72 (see FIG. 2) for replaceable mounting on a leader 8 is disposed. A driver 73 is mounted in the housing 70 so as to pivot. The driver 73 is connected with an operating lever 74, by way of which it can be pivoted. A cable pulley 75 for accommodating a cable 81 is disposed on the housing 70 at its upper end, opposite the operating lever 74. The disengagement apparatus 7 can be moved along the leader 8 by way of the cable 81.

Activation of the operating lever 74 takes place by way of two cams disposed on the outside of the cylinder 2, an engagement cam 26 and an upper disengagement cam 24. The engagement cam 26 is positioned on the cylinder 2 in such a manner that when the operating lever 74 is activated, the driver 73, when it hits against the engagement cam 26, is pivoted into the interior of the cylinder 2 underneath the undercut 33 of the piston 3, through a slot 27 introduced into the cylinder 2.

For this purpose, the operating lever 74 is provided, on its side facing the engagement cam 26, at the end, with a radius, thereby allowing it to better slide along the engagement cam 26. In order to avoid over-rotation of the operating lever 74, a recess 71 is introduced into the housing 70 of the disengagement apparatus 7, by means of which the cam stop 711 (see FIG. 2) for the engagement cam 26 is formed. Pivoting of the operating lever 74 is therefore only possible until the engagement cam 26 reaches the stop 711.

After the driver 73 has been extended, the disengagement apparatus 7 can be moved along the leader 8 by way of the cable 81, thereby causing the driver 73 to engage into the undercut 33 of the piston 3 and the piston 3 to be moved upward within the cylinder 2. Once the operating lever 74 makes contact with the upper disengagement cam 24, the driver 73 is pivoted out, thereby causing the piston 3 to be released and to drop in the direction of the striker 4, as the result of gravity. As it drops, the piston 3 passes the pump lever 55 of the injection apparatus 5, thereby causing fuel to be sprayed onto the fuel bowl 46 of the striker 4, by way of the injection nozzle 52, which fuel explodes when the piston 3 impacts the striker 4, thereby catapulting the piston 3 back upward. In the exemplary embodiment, a lower disengagement cam 25 is disposed on the cylinder 2 between the engagement cam 26 and the upper disengagement cam 24.

In the exemplary embodiment, the lower disengagement cam 25 is configured as a hydraulic cylinder. It is positioned between the upper disengagement cam 24 and the engagement cam 26 in such a manner that when the piston 3 is disengaged by the operating lever 74 of the disengagement apparatus 7 hitting against the lower disengagement cam 25, the pump lever 55 of the injection apparatus 5 was not passed completely, and therefore no fuel feed by means of the injection apparatus 5 takes place during the subsequent drop of the piston 3. The piston 3 therefore impacts the striker 4 only once, thereby causing the post to be driven to experience only one impact. By means of repeating this method of procedure, “gentle,” controlled driving of the post, particularly into soft subsoil, is possible. After the lower disengagement cam 25 has been moved in, the piston 3 can then be moved further upward by way of the disengagement apparatus 7, until the operating lever 74 makes contact with the upper disengagement cam 24. In this connection, the piston 3 has moved completely past the pump lever 55, and for this reason, the pump lever 55 projects into the cylinder space 2 because of its bias. When the piston subsequently drops, the pump lever 55 is thereby activated, and therefore fuel injection onto the fuel bowl 46 of the striker 4 takes place. The diesel hammer pile driver 1 is thereby started.

Furthermore, a rotatable mounted circular disk 77 is disposed on the disengagement apparatus 7, above the driver 73, which disk is connected with two detents 76 that project in opposite directions, in such a manner that extension or retraction of the detents 76 is brought about by rotation of the circular disk 77. See FIG. 2. The circular disk 77, which can also be structured as a cylindrical element, is connected with a setting lever 78, by way of which it can be rotated. The setting lever 78 can be operated by way of a cord attached to it. The circular disk 77 is held in a position, using a spring element—not shown, in which the detents 76 are extended. Retraction of the detents 76 takes place by means of pulling on the cord 79. See FIG. 3. When the cord 79 is released, the circular disk 77 is moved back into its original position, with the detents 76 extended, by means of the spring element. The detents 76 allow raising or positioning of the diesel hammer pile driver 1 along the leader 8, on which it is guided by way of guide jaws 29, after engagement into the driver crosspiece 26 of the cylinder 2.

The pile-driving apparatus 1 described above works as follows: in the starting state, the disengagement apparatus 7 is moved in such a manner that the housing 70, with its housing 70, lies against the engagement cam 26 of the cylinder 2 of the diesel hammer pile driver 1, thereby causing the operating lever 74 to be moved upward, thereby causing the driver 73 to be pivoted into the cylinder 2 through the slot 27. Subsequently, the disengagement apparatus 7 is moved upward by way of the cable 81, thereby causing the driver 73 to engage into the undercut 33 of the piston 3 and the piston 3 to be pulled up. When the operating lever 74 makes contact with the upper disengagement cam 24, the driver 73 is retracted, thereby releasing the piston 3. Under the effect of gravity, the piston 3 falls downward, closes the working connectors 23, and activates the pump lever 55 of the injection apparatus 5 with its face surface 31, thereby causing fuel to be sprayed onto the fuel bowl 46 of the striker 4 by way of the injection nozzle 52. Here, an ignitable mixture of fuel droplets and air forms by means of impact atomization.
When the piston 3 impacts the striker 4 and/or by way of the gas cushion between piston 3 and striker 4, a force directed downward is exerted on the striker and, by way of the striker, on the material to be pile-driven, which force drives the material to be pile-driven further into the ground. During the subsequent upward movement of the piston 3, triggered by the explosion-like combustion of the fuel, the piston releases the working connectors 23 again, thereby causing the combustion gases to relax and to flow away by way of the working connectors 23. The piston 3 is now accelerated further upward, drawing fresh air in through the working connectors 23, until it has reached its upper end position and the work cycle, as described, is repeated.

If the lower disengagement cam is extended, feed of fuel is prevented, and for this reason a one-time impact of the piston 3 on the striker 4 takes place. Subsequently, the piston 3 must be raised by way of the disengagement apparatus 7 once again.

Although only a few embodiments of the present invention have been shown and described, it is to be understood that many changes and modifications may be made thereto without departing from the spirit and scope of the invention.

What is claimed is:

1. A pile-driving apparatus comprising:
   (a) a diesel hammer pile driver having a cylinder comprising a cylinder interior and a cylinder outside, a piston displaceably guided in the cylinder and comprising a piston face surface, and a striker displaceably guided in the cylinder, wherein the striker is disposed underneath the piston in an operating piston of the diesel hammer pile driver and comprises a striker face surface lying in the cylinder interior;
   (b) a fuel feed device;
   (c) a combustion chamber delimited axially by the striker face surface and the piston face surface and opening into the fuel feed device for introducing via the fuel feed device a predetermined amount of fuel into the combustion chamber during each working cycle;
   (d) a lower engagement cam disposed on the cylinder;
   (e) a disengagement apparatus disposed within the cylinder and axially displaceable along the cylinder on the cylinder outside to raise the cylinder, wherein the disengagement apparatus has a driver introducible into an undercut disposed in the piston through a recess made in the piston and an operating lever for pivoting the driver into the cylinder interior if a collision with the lower engagement cam occurs; and
   (f) a disengagement cam disposed on the cylinder above the lower engagement cam for pivoting the driver out of the cylinder interior if a collision of the operating lever with the disengagement cam occurs;

2. The pile-driving apparatus according to claim 1, wherein at least one of the lower engagement cam and the operating lever is configured for movement out of a collision region of the operating lever of the disengagement apparatus or of the lower engagement cam.

3. The pile-driving apparatus according to claim 2, wherein at least one of the lower engagement cam and the operating lever is configured as a cylinder.

4. The pile-driving apparatus according to claim 1, wherein at least one of the lower engagement cam and the operating lever is configured as a hydraulic cylinder.

5. The pile-driving apparatus according to claim 1, wherein the driver in the disengagement apparatus is configured so that the driver can be locked in a pivot position, in each instance, after having been pivoted into and after having been pivoted out by the operating lever.

6. The pile-driving apparatus according to claim 5, wherein the disengagement cam is disposed on the cylinder in an axially displaceable manner, and is fixable in place in at least first and second positions, wherein fixing of the disengagement cam in the first position brings about disengagement of the piston in a position after passing the pump lever, and fixing the disengagement cam in the second position brings about disengagement of the piston in a position before passing the pump lever.

7. The pile-driving apparatus according to claim 5, wherein an upper, first disengagement cam and a lower, second disengagement cam are disposed on the cylinder axially at a distance from one another, wherein the upper, first disengagement cam is disposed in such a manner that if a collision with the operating lever of the disengagement apparatus occurs, disengagement of the piston in a position after passing the pump lever is brought about, and the lower, second disengagement cam is disposed so that if a collision with the operating lever of the disengagement apparatus occurs, disengagement of the piston in a position before passing the pump lever is brought about, wherein the lower, second disengagement cam is moveable out of the collision region of the operating lever of the disengagement apparatus.

8. The pile-driving apparatus according to claim 7, wherein the lower, second disengagement cam is configured as a cylinder.

9. The pile-driving apparatus according to claim 8, wherein the lower, second disengagement cam is configured as a hydraulic cylinder.