

Sept. 1, 1970

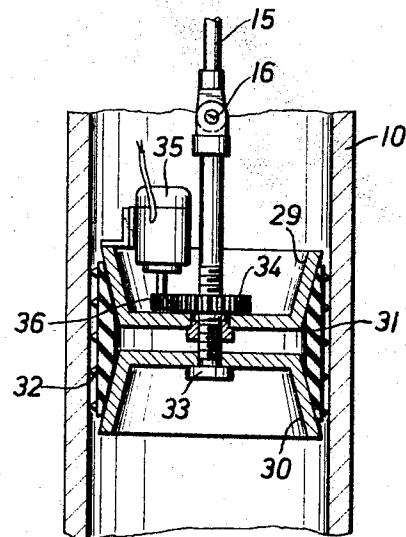
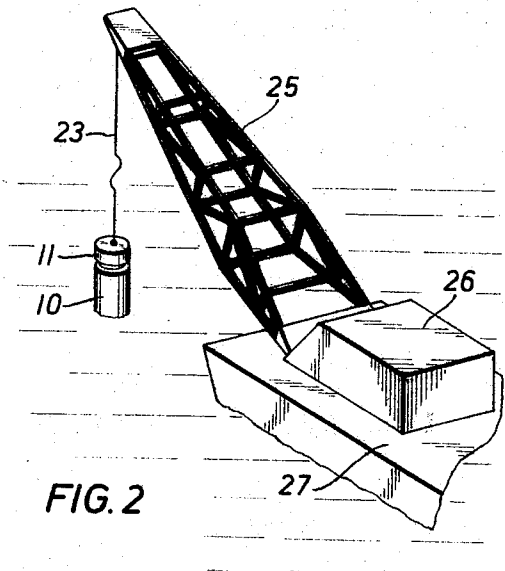
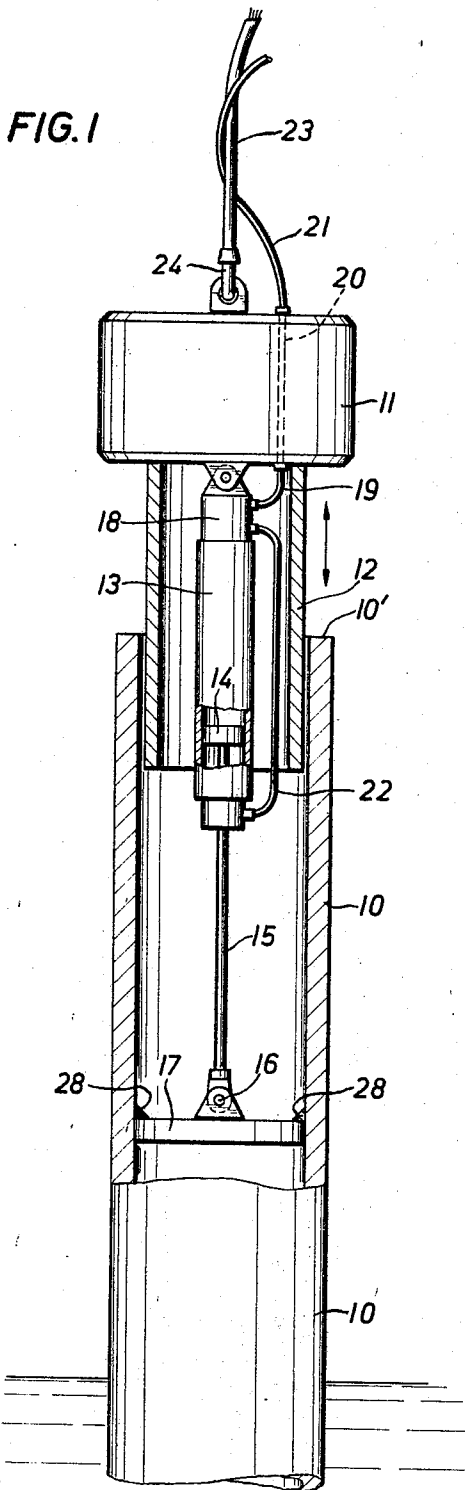
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3,526,283

FILE DRIVER

Filed July 23, 1968

2 Sheets-Sheet 1



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PILE DRIVER

Filed July 23, 1968

2 Sheets-Sheet 2

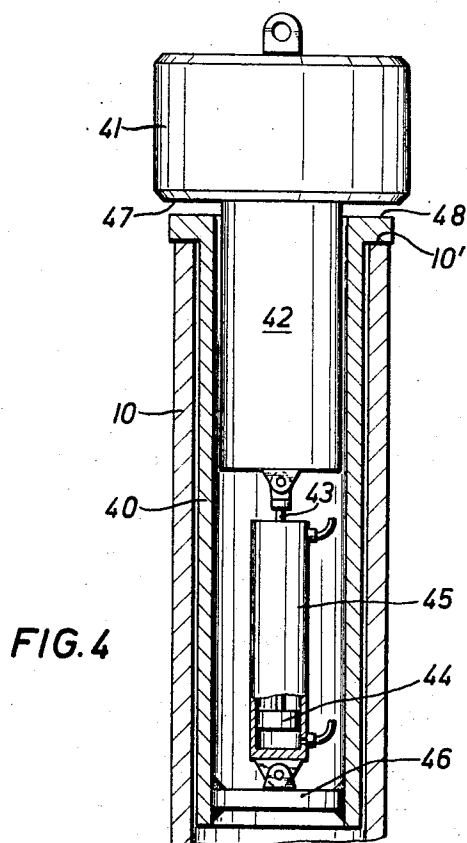


FIG. 4

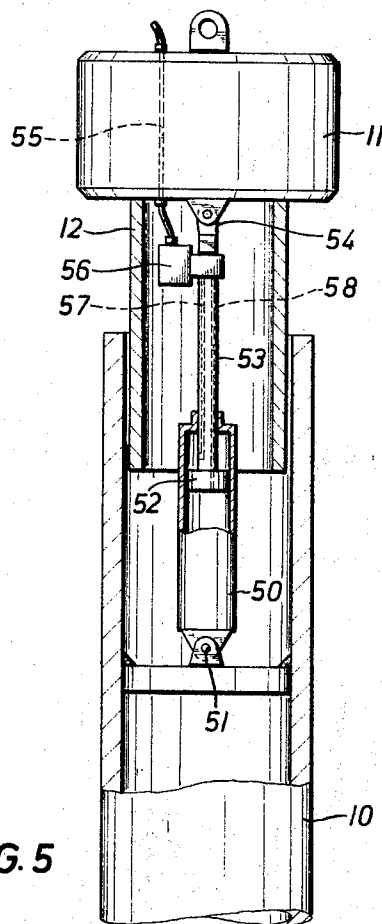


FIG. 5

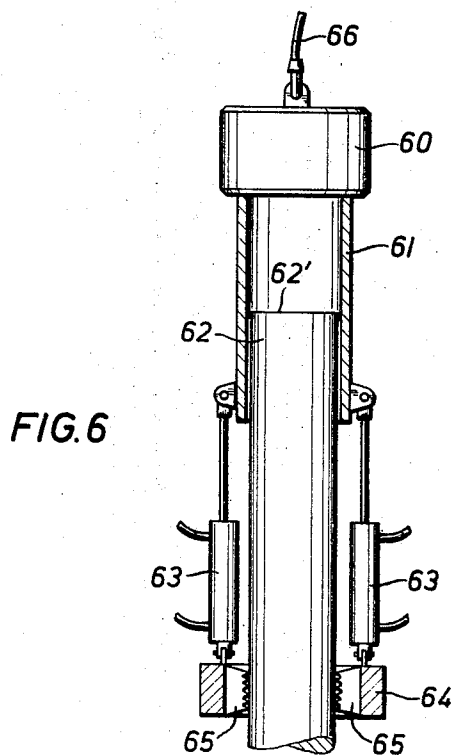


FIG. 6

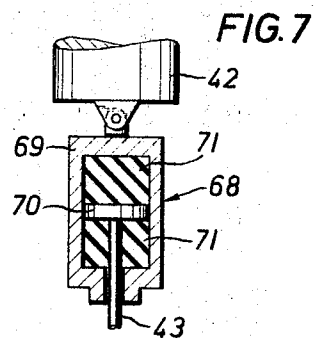


FIG. 7

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1

3,526,283

PILE DRIVER

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19 Claims

ABSTRACT OF THE DISCLOSURE

A pile driver used for pipelike piles, including a hammer with a cylindrical guide member or sleeve attached to its lower side. The hammer strikes the upper rim of the pipe as it reciprocates in a path determined by the guide sleeve which slides into or over the upper end of the pipe. The hammer is driven from below by an air or hydraulic cylinder or the like, with one side of the power mechanism being permanently or releasably coupled to the inside of the pile.

Round pilings which resemble pipes or hollow cylinders, perhaps three to five feet in diameter, are used in such applications as the construction of offshore oil drilling platforms. These pilings may be from perhaps 100 up to as much as 1,000 feet in length, and of course, must be driven a considerable length into the ocean bottom for proper support. Presently-available pile drivers are not readily adapted to driving piles of this type. Usually a pile driver includes a large weight or hammer which provides the impact force, this hammer striking a so-called "follow block" which rests upon the top of the pile, so the impact is transmitted through the follow block. After extended use, the follow block must be replaced due to fatigue failure, this being especially prevalent for large piles of great length as pertinent here. The conventional pile driver usually requires a guide shaft structure above the follow block for defining the path of the hammer in its reciprocating motion; this structure becomes more massive as the size of the pile to be driven and the length of the hammer stroke are increased as necessary for large piles which must be driven great lengths.

A primary feature of the present invention is the provision of a pile driver which is especially adapted for driving cylindrical or pipe-like pilings, and particularly such a pile driver wherein the necessity for a follow block and a complex guiding structure for the hammer is eliminated. Another feature of the pile driver of this invention is its adaptability for use in offshore construction operations. Further, the simplicity and light weight resulting from elimination of structural elements provides a pile driver which offers certain advantages for more conventional pile driving operations, as well as the offshore uses discussed above.

According to the invention, the hammer used in the improved pile driver impacts directly upon the top of the pile, and the motive power mechanism along with the guide arrangement is positioned below the hammer. The guide arrangement may include a cylindrical sleeve which fits inside the pile and defines the reciprocating path of the hammer. The motive power device may be an air cylinder positioned within or beneath the guide sleeve. Preferably, the guide sleeve itself forms a major part of the weight of the hammer, so that the center of gravity of the hammer is below the top of the pile, reducing the tendency for the hammer to tip. One end of the motive power device is anchored to the inside of the pile below the guide sleeve by a permanent or releasable arrangement. Similar structures are provided wherein the entire

2

apparatus is mounted within a cylinder which fits into the pile, rather than the guide sleeve itself bearing upon the interior wall of the pile. Also, similar structural elements may be arranged to fit around the outside of a pile, still employing a hammer impacting upon the pile itself, along with a guide sleeve and motive power means below the hammer.

Novel features which are believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as further objects and advantages thereof, may best be understood by reference to the following detailed description of particular embodiments, when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is an elevation view, partly broken away and partly in section, of pile driver apparatus according to one embodiment of the invention;

FIG. 2 is a schematic view in perspective of an offshore operation using the pile driver of the invention;

FIG. 3 is a detail view in section of a portion of the apparatus of FIG. 1, using a removable anchor according to one embodiment of the invention;

FIG. 4 is an elevation view in section of a pile driver according to another embodiment of the invention;

FIG. 5 is a detail view of a portion of the pile driver of FIG. 1, according to a modified version of the invention;

FIG. 6 is an elevation view, partly in section, of a pile driver according to another embodiment of the invention; and

FIG. 7 is a detail view in section of a preferred coupling arrangement between the hammer and motive power means.

It is noted that like parts appearing in several views of the drawings will bear like reference numerals. The drawings form a part of this specification and are incorporated herein.

With reference now to FIG. 1, a mechanism for driving pipe-like piles 10 of the type used for offshore drilling rigs or the like is illustrated. It is noted that the piles 10 may be of rather large diameter, perhaps 36" or more. The pile driving apparatus basically comprises a large cylindrical weight or hammer 11 which is of sufficient diameter to engage the top rim 10' of the pile, and is of large mass, perhaps weighing several tons, as needed for driving the pile. The hammer 11 is driven in a reciprocating motion to impact the rim 10' by means of an air or a hydraulic piston and cylinder arrangement of conventional form. The motion is defined by a guide sleeve 12 which is just slightly smaller in diameter than the interior of the pipe 10; as set forth below, this guide sleeve may be solid and form a major part of the weight of the hammer to avoid problems of tipping due to a high center of gravity. The motive power arrangement may include a cylinder 13 having a piston 14 therein, with an elongated piston rod 15 being connected by a suitable coupling 16 to an anchor 17 at the lower end. Pressurized air is admitted alternately to the upper and lower sides of the piston 14 by a valve arrangement 18 which may be triggered or operated by the position of the rod 15, or other means, according to conventional practice. Pressurized air is supplied to the valve 18 by a conduit 19 which in turn is coupled through an interior passageway 20 within the hammer 11, to a conduit 21 which goes to a compressor. An interior passage, not shown, connects the valve 18 to the inside of the cylinder on the upper side of the piston, while a line 22 connects the valve to the lower side of the piston. Vents, not shown, would release air from the nonpressurized side of the piston during each cycle. The apparatus is supported by a cable 23 which is connected by a suitable coupling 24 to the hammer 11.

Turning to FIG. 2, it is noted that the pile driver apparatus including the hammer 11 would be suspended on the cable 23 from a long boom 25 on a crane 26, probably mounted on a barge 27, the barge carrying a supply of the piles to be driven. Usually the entire operation would be performed offshore in utilizing the preferred embodiment of the invention, although it is, of course understood that similar principles would apply to driving pipe-like piles on land.

The anchor 17 seen in FIG. 1, is for the purpose of providing a fixed support for the lower end of the motive power mechanism, such as the piston and cylinder arrangement. The anchor 17 may be fixed in place by welds 28, this being done before the piles are lifted out into the driving position. The anchor 17 in the embodiment of FIG. 1 is expendable; it is left in the pile after the driving operation is completed. If the driven pile is to be filled with concrete or the like, it is preferable that the anchor 17 be open, i.e., not occupy the entire diameter of the pipe 10, so that the filler may be added after the pile is driven without the necessity of removing the anchor. A remotely-operated release mechanism is included in the coupling 16 so that after the pile is driven the release mechanism may be actuated from the crane 26 to free the driver mechanism from the pile. Also, when connecting the driver apparatus to the pile, the apparatus obscures the coupling 16, so again it must be remotely operable to permit this operation.

The coupling between the hammer 11 and the motive power mechanism including the cylinder 12, in the embodiment of FIG. 1, is preferably of the resilient type seen in FIG. 7.

Referring to FIG. 3, the permanently-mounted anchor 17 may be replaced by a remotely-operated expanding plug or packer apparatus of the type illustrated. This mechanism would be permanently fixed to the lower end of the shaft 15 by a coupling 16 as before. The mechanism includes a pair of opposed members 29 and 30 which have frusto-conical surfaces. A resilient band 31, of rubber or springlike materials, surrounds the outer surfaces of the cones 29 and 30 and includes a plurality of teeth 32 surrounding the cylindrical member 31 to engage the interior surface of the pipe-like pile 10. When the cone members 29 and 30 are pulled together, the teeth 32 are forced outwardly to engage the pipe wall; then when the members 29 and 30 are allowed to spread apart in an axial direction, the band 31 contracts to release this anchor mechanism. A threaded shaft 33 extends through the two members 29 and 30, and a gear member 34 having a threaded interior bore is operative to move the cone members 29 and 30 toward one another or force them apart. An electric motor 35 or other motive power mechanism, along with a gear 36, function to operate the gear 34 by remote control from the crane 26. In this manner, the entire mechanism of FIG. 1, using the anchor mechanism of FIG. 3, would be inserted into the top of the pile while the pile is on the supply barge, then the mechanism including the motor 35 actuated to cause the teeth 32 to grip the interior wall. The pile is lifted out and placed, then driven, after which the mechanism of FIG. 3 is released by activating the motor in the reverse direction, and the driver mechanism pulled out of the pile.

Turning now to FIG. 4, another embodiment of the invention is shown wherein the driver apparatus is mounted permanently within a tube 40 which slides down into the top of the pipe-like pile 10 for the driving operation, and the entire assembly is then removed. As before, the driving apparatus includes a weight or hammer 41, and the reciprocating, up-and-down movement is controlled by a guide sleeve 42. Here the guide sleeve 42 is shown to be a solid body rather than a hollow cylinder; this provides a center of gravity which is below the top rim of the pipe, thereby reducing the tendency of the hammer to tip or skew. The lower end of the hammer 41, or of the guide sleeve 42, is connected by a piston rod

43 to a piston 44 within a cylinder 45, the lower end of the cylinder being fixed to an anchor plate 46 which would be welded to the interior of the tube 40. A conventional valve arrangement would control the movement of the piston 44 within the cylinder using compressed air or the like, with conduits for coupling the air supply through the hammer and guide sleeve as above. It is noted that the lower surface 47 of the hammer 41 will impact upon a flange 48 which functions to hold the entire assembly in place at the top of the pile. While this arrangement avoids the necessity for providing an anchor of the permanent type as in FIG. 1, or the removable type as in FIG. 3, it is understood that the flange 48 will be subjected to fatigue failure due to the repeated impact of the hammer thereon. Nevertheless, for some applications, the embodiment of FIG. 4 may prove to be the most expedient.

Referring to FIG. 5, an embodiment of the invention is shown wherein the piston rod is used as a conduit for the pressurized air which is used to drive the piston. This embodiment includes a hammer 11 and a cylindrical guide sleeve 12 of the type seen, or of the type shown in FIG. 4 with a solid rather than hollow guide; a different motive power arrangement is used wherein a cylinder 50 is provided which is coupled by a connection 51 to a permanent or removable anchor as in FIGS. 1 or 3. A piston 52 within this cylinder is connected by a shaft 53 to the lower side of the hammer 11 by a suitable coupling 54, this coupling being of course preferably of the type seen in FIG. 7. The piston 52, along with the shaft 53, the hammer 11, and the guide sleeve 12, will reciprocate, while the cylinder 50 will remain fixed along with the anchor. The air supply conduit is connected from above to a passageway 55 through the hammer 11, thence to a valve 56 which may be operated by limit switches, by mechanical detents, by inertia, or other conventional means. A pair of interior passageways 57 and 58 connect the valve 56 to the upper and lower sides of the piston 52 within the cylinder. In operation, when the piston is at the lower end of the cylinder, pressurized air will be admitted through the passage 58 to the lower side of the cylinder, while the passage 57 will be vented to atmosphere, so the piston will be driven upward along with the hammer. When the piston reaches the upper end, the valve 56 will reverse and pressurized air will be applied through the passage 57 to the upper end of the cylinder while the passage 58 will be vented to atmosphere, thus driving the piston and the hammer downward for the impact stroke. This action will be repetitive. It is to be understood that any of a wide variety of valving and piston-cylinder arrangements such as this may be used with the invention.

The motive power system may include a hydraulic cylinder, rather than the pressurized air arrangement shown. However, the pressurized air system is faster in operation and may be preferable in most circumstances. Of course, steam may be used, since a steam source may be readily available in connection with other pile driving equipment of conventional design.

In FIG. 6, a pile driver for conventional post-shaped piles is illustrated which is in a sense conceptually similar to the embodiments previously described. A hammer 60 forms the uppermost element, and this hammer is driven in a reciprocating manner in a path determined by a guide sleeve 61 which surrounds the upper end of a pile 62. Two or more air-operated piston and cylinder arrangements 63 are coupled to the lower end of the cylindrical guide sleeve 61 and to an anchor collar 64. This collar includes jaws 65 to engage the pile 62 and provide a fixed support at the lower end of the apparatus. Pressurized air is supplied to the cylinder 63 by conduits and a valving mechanism of conventional form. The hammer is caused to repeatedly impact upon the top surface 62' of the pile. After the pile is driven, the collar 64 is operable to release the grip with the jaws 65 so the driving mechanism may be moved to another pile by a crane engaging a cable 66

connected to a lifting hook on the top of the hammer 60. As in the previous embodiments where the guide sleeve fits inside a pipe-like pile, here the hammer impacts directly upon the pile rather than upon a follow block. Also, the support mechanism is simplified in that the guide sleeve, a major structural element, performs the function of guiding the path of the hammer as well as transmitting the motive power.

In FIG. 7, a coupling arrangement 68 is shown which provides a resilient coupling between the guide sleeve 42 and the motive power mechanism including the piston rod 43, as seen in FIG. 4. This same coupling arrangement 68 is also preferably used with the embodiments of FIGS. 1, 5 and 6. A cylinder 69 bears a piston 70, and rubber shock absorbers 71 above and below the piston prevent part of the impact shock of the hammer hitting the top of the pile, from being transmitted to the motive power device. This prolongs the operating life of the mechanism.

While the invention has been described with reference to particular embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiments as well as other embodiments of the invention, may be apparent to persons skilled in the art upon reference to this description. It is, therefore, contemplated that the appended claims will cover any such modifications or embodiments as fall within the true scope of the invention.

What is claimed is:

1. Pile driver apparatus comprising:

a weighted reciprocating hammer adapted to impact upon the upper end of a pile with sufficient force for driving the pile,

an elongated guide member engaging the upper end of the pile and rigidly connected to the lower side of the hammer to move with the hammer, the guide member being fitted with respect to the upper end of the pile to guide the path of the hammer in impacting upon the pile, the guide member reciprocating with respect to the upper end of the pile,

motive power means coupled to the lower side of the hammer and operative to drive the hammer in a reciprocating motion, and

anchor means engaging the pile to provide a fixed support for the motive power means.

2. Apparatus according to claim 1 wherein pipe-like piles are to be driven, and the guide member is a sleeve shaped to fit into the upper end of the pile.

3. Apparatus according to claim 2 wherein the hammer impacts directly upon the upper rim of the pile without an intermediate follow block.

4. Apparatus according to claim 1 wherein the guide member is a solid cylinder of substantial weight, providing a major part of the weight of the hammer to thereby lower the center of gravity of the hammer.

5. Pile driver apparatus for driving pipe-like piles comprising:

a weighted hammer adapted to impact directly upon the upper rim of the pile with sufficient force for driving the pile, without an intermediate follow block,

an elongated guide member engaging the upper end of the pile and connected to the lower side of the hammer, the guide member being a sleeve shaped to fit into the upper end of the pile to guide the path of the hammer in impacting upon the pile,

motive power means coupled to the lower side of the hammer and operative to drive the hammer in a reciprocating motion, and

anchor means engaging the pile to provide a fixed support for the motive power means, the anchor means including a member permanently fixed to the interior of the pile at a position spaced from the upper end thereof.

6. Apparatus according to claim 5 wherein lower side of the motive power means is removably coupled to the anchor means.

7. Apparatus according to claim 3 wherein the anchor means includes a releasable gripping mechanism which is remotely operable.

8. Apparatus according to claim 7 wherein the gripping mechanism includes radially expandable means having sharp protruding members.

9. Apparatus according to claim 2 wherein the motive power means includes a piston and cylinder arrangement of the fluid-operated type.

10. Apparatus according to claim 9 wherein the supply of pressurized fluid for operating the motive power means is coupled through the hammer.

11. Pile driver apparatus for driving pipe-like piles comprising:

a weighted hammer adapted to impact upon the upper end of a pile with sufficient force for driving the pile,

an elongated guide member engaging the upper end of the pile and connected to the lower side of the hammer, the guide member being a sleeve shaped to fit into the upper end of the pile to guide the path of the hammer in impacting upon the pile,

motive power means coupled to the lower side of the hammer and operative to drive the hammer in a reciprocating motion, the motive power means including a piston and cylinder of the fluid-operated type, and

anchor means engaging the pile to provide a fixed support for the motive power means,

the cylinder being fixed to the lower side of the hammer and a piston rod extending from the piston being fixed to the anchor.

12. Pile driver apparatus for driving pipe-like piles comprising:

a weighted hammer adapted to impact upon the upper end of a pile with sufficient force for driving the pile,

an elongated guide member engaging the upper end of the pile and connected to the lower side of the hammer, the guide member being a sleeve shaped to fit into the upper end of the pile to guide the path of the hammer in impacting upon the pile,

motive power means coupled to the lower side of the hammer and operative to drive the hammer in a reciprocating motion, and

anchor means engaging the pile to provide a fixed support for the motive power means,

the guide member being positioned within a flanged cylinder, and the anchor means being permanently fixed to the cylinder, the hammer impacting upon the flange of the cylinder whereby the driving force is transmitted to the rim of the pile through the flange.

13. Apparatus according to claim 1 wherein the guide member is a sleeve fitting around the outside of the upper end of the pile, and the pile to be driven is of the post type or the like.

14. Pile driver apparatus for driving piles of the post type or the like, comprising:

a weighted hammer adapted to impact upon the upper end of a pile with sufficient force for driving the pile, the hammer impacting directly upon the upper end of the pile,

an elongated guide member engaging the upper end of the pile and connected to the lower side of the hammer, the guide member being a sleeve fitting around the outside of the pile to guide the path of the hammer in impacting upon the pile,

motive power means coupled to the lower side of the hammer and operative to drive the hammer in a reciprocating motion, and

anchor means engaging the pile to provide a fixed support for the motive power means.

15. Pile driver apparatus for driving pipe-like piles comprising:

a weighted hammer adapted to impact directly upon

7

the upper rim of the pile with sufficient force for driving the pile, without an intermediate follow block,

an elongated guide member engaging the upper end of the pile and connected to the lower side of the hammer, the guide member being a sleeve shaped to fit into the upper end of the pile to guide the path of the hammer in impacting upon the pile, motive power means coupled to the lower side of the hammer and operative to drive the hammer in a reciprocating motion, and anchor means engaging the pile to provide a fixed support for the motive power means, the guide member being a solid cylinder, and the motive power means engaging the lower side of the guide member through shock-absorbing coupling means.

16. Apparatus for driving pipe-like piles or the like comprising:

a reciprocating hammer weighted sufficiently to drive the pile upon impacting on the upper rim thereof, a cylindrical guide member rigidly connected to the lower side of the hammer to fit within the upper end of the pile for guiding the path of the hammer, the guide member moving with the hammer, and motive power means coupled to the hammer and adapted to be anchored to the pile, for driving the hammer in a reciprocating motion.

17. Apparatus according to claim 16 wherein the motive power means is anchored to the pile by anchor means engaging the interior of the pile below the guide member.

18. Apparatus according to claim 17 wherein the anchor means is releasably connected to the pile during the driving operation.

8

19. Apparatus for driving pipe-like piles or the like comprising:

a hammer weighted sufficiently to drive the pile upon impacting on the upper rim thereof, a cylindrical guide member connected to the lower side of the pile for guiding the path of the hammer, and motive power means coupled to the hammer and adapted to be anchored to the pile, for driving the hammer in a reciprocating motion, the motive power means being anchored to the pile by anchor means engaging the interior of the pile below the guide member, the anchor means being releasably connected to the pile during the driving operation, the motive power means including a fluid-operated piston and cylinder arrangement, with a fluid being coupled thereto by an interior passageway in said hammer and guide member, and the guide member being a solid cylindrical member.

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